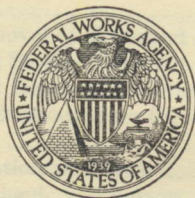


Specifications
FOR
CONSTRUCTION OF ROADS
AND BRIDGES
IN NATIONAL FORESTS *and*
NATIONAL PARKS

AS REVISED JULY 15, 1941

FEDERAL WORKS AGENCY
PUBLIC ROADS ADMINISTRATION

(This publication may be designated as FP-41)



United States
Government Printing Office
Washington : 1941

For sale by the Superintendent of Documents, Washington, D. C.
Price \$1.00 (Fabrikoid)

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FOREWORD

This book, *Specifications for Construction of Roads and Bridges in National Forests and National Parks*, contains a collection of specification items. Some items are preferred and others are designed to meet local conditions and needs. This book does not contain items covering bituminous pavements, classes H, I, or J, nor items covering portland cement concrete base or pavement.

This book, cited in the contract (Form 23) under article 1 thereof, is a contract document and shall be binding in its entirety upon the parties signatory to the contract, except that such specification items as are not cited or involved in the plans, bid schedule, special provisions, or other contract documents shall not be a part of the particular contract, and except that anything contained herein which is modified by, or is in conflict with, any supplemental specifications or any special provisions identified as part of the contract under said article 1 of Form 23, shall not be binding for the particular contract.

This book includes an article on patents, an article on liquidated damages, articles construing matters applicable under articles 3 and 4 of Form 23, an article providing certain administrative procedures for partial payments and certain clauses mutually agreed upon covering administrative procedures necessary in applying articles 2, 3, 4, 5, and 15 of Form 23 to the various contingencies encountered.

VIII

DIVISION I.—GENERAL REQUIREMENTS AND COVENANTS

TERMS OF SPECIAL SIGNIFICANCE AND ABBREVIATIONS

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

Article 1.1 A. A. N.—American Association of Nurserymen, Inc.

Art. 1.2 A. A. S. H. O.—American Association of State Highway Officials.

Art. 1.3 A. S. T. M.—American Society for Testing Materials.

Art. 1.4 BID.—The offer of the bidder submitted on Form 21 to perform the work and to furnish the labor and materials, for the consideration of payment at the unit prices stated and submitted by the bidder on the prepared bid schedule.

Art. 1.5 BIDDER.—Any individual, firm, or corporation submitting a bid for the work contemplated, acting directly or through a duly authorized representative.

Art. 1.6 BID GUARANTY.—The required security submitted with the bid to insure execution of contract and bond for the performance of the work if the bid is accepted.

Art. 1.7 BRIDGE.—A structure which provides a waterway or other opening and which has a clear span of over 20 feet measured along its center line between the inside faces of abutments or a multiple span structure of which the sum of the individual clear spans plus the aggregate width of the intermediate supports is in excess of 20 feet.

Art. 1.8 COMMISSIONER.—The Commissioner of the Public Roads Administration of the Federal Works Agency. The Commissioner is hereby designated an authorized representative of the Head of the Department, defined in article 21 (a) of Form 23, and is hereby designated an authorized representative of the contracting officer.

Art. 1.9 CONTRACT.—The agreement executed between the United States of America, by the contracting officer, and the successful bidder, covering the performance of the work and the furnishing of labor and materials, by which the contractor

is bound to perform the work and furnish the labor and materials, and by which the United States of America is obligated to compensate him therefor at the mutually established and accepted rate or price.

The contract shall include the plans, specifications, bid, bid schedule, supplemental specifications, special provisions, performance bond, payment bond, and any written mutual understandings and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof.

Art. 1.10 CONTRACTOR.—Party of the second part to the contract, acting directly or through an authorized lawful agent or employee.

Art. 1.11 CONTRACT FORMS.—*Form 20.*—U. S. Standard Form No. 20, entitled Standard Government Form of Invitation for Bids (Construction Contract), approved by the President November 19, 1926, or the latest revision thereof in effect on the date of invitation for bids.

Form 21.—U. S. Standard Form No. 21 (Revised), entitled, Bid (Construction Contract), approved by the Secretary of the Treasury April 5, 1937, or the latest revision thereof in effect on the date of invitation for bids.

Form 22.—U. S. Standard Form No. 22, entitled, Standard Government Instructions to Bidders (Construction and Supplies), approved by the President November 19, 1926, or the latest revision thereof in effect on the date of invitation for bids.

Form 23.—U. S. Standard Form No. 23, entitled, Contract (Construction), approved by the Secretary of the Treasury (Revised) September 9, 1935, further revised by the Secretary of the Treasury January 28, 1937, so as to change article 9 by inserting after "concerned" in the third from the last line thereof, the words "or his duly authorized representative," or the latest revision thereof approved to date of opening of bids.

Form 24.—U. S. Standard Form No. 24, entitled, Standard Government Form of Bid Bond (Construction or Supply), approved by the President November 19, 1926, or the latest revision thereof in effect on the date of invitation for bids.

Form 25.—U. S. Standard Form No. 25 (Revised), entitled, Performance Bond (Construction or Supply), approved by the Secretary of the Treasury September 16, 1935, or the latest revision thereof approved to date of opening of bids.

Form 25A.—U. S. Standard Form No. 25A, entitled, Payment Bond (Construction), approved by the Secretary of the Treasury September 16, 1935, or the latest revision thereof approved to date of opening of bids.

Art. 1.12 CONTRACT ITEM.—The obligation of the contractor, including the performance of all work and the furnishing of all labor and materials, described in the text of a specifica-

tion item included in the contract or described in any subdivision of the text of the supplemental specifications or special provisions of the contract identified as an "item" with title and number.

A specification item is a subdivision of the text of division II of this book, identified as an "item" with title and number.

The word "item" in the contract shall be construed to mean "contract item," (notwithstanding that for convenience in the bid schedule, when a contract item involves more than one pay name, each pay name is given a place and number in the column headed "Items.") Provided, however, that solely for carrying out the purposes of articles 8.1 and 9.3, the word "item" (with or without modifiers) shall be construed to refer to an individual pay name of a contract item whether or not the given individual pay name constitutes an entire contract item, and provided further that distinction between major and minor items in all cases shall be calculated from original contract prices and quantities.

Major items are listed as such in the bid schedule. All other original contract items shall be considered as minor items.

When, in the text of a contract item it is necessary to refer to another contract item, the contract item referred to will be indicated by capitalized title without giving its number or the use of the word "Item." For example, reference to SELECTED BORROW BASE COURSE shall be to all intents and purposes the same as reference to ITEM 50.—SELECTED BORROW BASE COURSE.

Art. 1.13 CONTRACTING OFFICER.—The officer signing the contract on behalf of the United States of America.

Art. 1.14 CROWN.—The vertical rise expressed in inches between the edge and the center line of the base or surface, or the rate of rise. The term does not refer to the elevation of the surface.

Art. 1.15 CULVERT.—Any structure, not classified as a bridge, which provides an opening under any roadway.

Art. 1.16 ENGINEER.—The District Engineer of the Public Roads Administration in whose district the proposed project is located, or his duly authorized representative. The District Engineer is hereby designated an authorized representative of the contracting officer.

Art. 1.17 EQUIPMENT, TOOLS.—The terms "equipment" and "tools" shall be considered to include the supplies necessary for their operation, upkeep and/or maintenance. The word "equipment" shall be considered to include any livestock used.

Art. 1.18 EXTRA WORK.—Work to be performed or labor and materials to be furnished by the contractor in order to complete the project in an acceptable manner, but for which there is no applicable basis of payment either direct or indirect, or contingent fund, provided in the bid schedule.

Art. 1.19 HIGHWAY.—The entire improvement comprising the roadway and roadside development within the limits of the right-of-way.

Art. 1.20 HORTICULTURAL STANDARDS.—Horticultural Standards of the American Association of Nurserymen, Inc.

Art. 1.21 PAYMENT BOND (FORM 25A).—The security furnished by the contractor to guarantee the payment to all persons supplying labor and materials in the prosecution of the work provided for in the contract.

Art. 1.22 PERFORMANCE BOND (FORM 25).—The security furnished by the contractor to guarantee the completion of the work in accordance with the terms of the contract.

Art. 1.23 PLANS, DRAWINGS.—Contract documents, or exact reproductions thereof, showing the alinement of the roadway, lay-out and design of structures, profiles, typical cross sections, earthwork cross sections, accessory features, and the particular location, character, dimensions, and/or details of the work to be done.

Art. 1.24 PROFILE GRADE.—The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal center line of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

Art. 1.25 RIGHT-OF-WAY.—The land secured and reserved to the public for highway purposes.

Art. 1.26 ROADBED.—That portion of the roadway which by reason of its comparatively flat cross-sectional slope is intended for traffic and/or for the direct and lateral support of base or surface courses. On embankments the roadbed extends to the intersection of top and side slopes. In cuts, where the form of the cross section shows a decided increase in slope to a ditch or gutter, the roadbed extends to the point of such slope change. Where the form of the cross section shows no decided change in slope to a ditch, gutter or curb, the roadbed extends to the ditch, gutter or curb line. The roadbed shall include any intervening area between separated traveled ways except where the separation is so wide as to introduce areas of undisturbed land.

Art. 1.27 ROADSIDE.—The portion of the right-of-way not occupied by surface courses, curbs, paved gutters, or paved median areas. Where no surface courses are provided, the roadside shall include only such width or area of the roadbed as may be indicated on the plans.

Art. 1.28 ROADSIDE DEVELOPMENT.—The landscape development of the highway including landscape development of adjacent lands publicly owned or controlled.

Art. 1.29 ROADWAY.—The portion of the right-of-way included within the construction limits of the grading, drainage, base course, and surface course improvements and the appurtenant structures.

Art. 1.30 SHOULDER.—Any portion of a roadbed remaining on either side of an undivided surfaced traveled way. On divided traveled ways, where the separation is so wide as to introduce areas of undisturbed land, shoulders shall be considered as any portion of the separated roadbeds remaining on either side of the traveled ways.

Art. 1.31 SKEW or SKEW ANGLE.—The acute angle formed by the intersection of the line normal to the center line of the roadway with a line parallel to the face of the abutments, or in the case of culverts with the center line of the culverts.

Art. 1.32 SPECIFICATIONS.—The directions, provisions, and requirements contained in this book and any which may be added as supplemental specifications or as special provisions, and identified by title and made a part of the contract in article 1 of Form 23 as prepared for the project, all setting forth or relating to the method and manner of performing or paying for the work or to the quantities, kinds and qualities of materials and labor to be furnished under the contract.

Art. 1.33 SPECIAL PROVISIONS.—Certain specific directions, provisions and requirements identified as special provisions in article 1 of Form 23 as prepared for the project, included within the general term "specifications," and made a part of the contract with the express purpose that they shall prevail over all other specifications and over all plans, in that and because they set forth the final contractual intent as to the matter involved. On each sheet of special provisions, for positive identification, there shall appear the caption "Special Provisions, Project _____"

Art. 1.34 STANDARDIZED PLANT NAMES.—Official Code of Standardized Plant Names of the American Joint Committee on Horticultural Nomenclature.

Art. 1.35 SUBGRADE.—The portion of the roadbed which is below the base course or surface course.

Art. 1.36 SUBSTRUCTURE.—All of that part of a bridge below the bridge seats, or below the spring line of arches, or below the bottoms of caps of timber trestles.

Art. 1.37 SUPERSTRUCTURE.—All of that part of a bridge above the bridge seats, or above the spring line of arches, or above the bottoms of caps of timber trestles.

Art. 1.38 SUPPLEMENTAL SPECIFICATIONS.—Certain directions, provisions and requirements adopted as supplemental specifications and so identified in article 1 of Form 23 as prepared for the project, included within the general term "specifications," and made a part of the contract with the express purpose that they shall prevail over the specifications contained in this book but not over special provisions.

Art. 1.39 SURETY.—The individuals or company signing, as guarantors, the bid guaranty, payment bond, or performance bond furnished by the contractor.

Art. 1.40 ABBREVIATIONS.—The abbreviations used in the contract are in lieu of and are to be construed the same as the respective expressions represented; they include but are not limited to "CS₂"—carbon disulphide; "duct."—ductility; "F."—Fahrenheit; "hr."—hour; "insol."—insoluble; "pene."—penetration; "pt."—point; "soft."—softening; "sol."—soluble; "sp. gr."—specific gravity; "sp. vis."—specific viscosity; "temp."—temperature; "vol."—volume.

BIDDING REQUIREMENTS AND CONDITIONS

Article 2.1 CONTENTS OF BID FORMS.—Bids must be submitted upon Form 21 and on the prepared bid schedule form. The prepared form mentioned schedules the quantity estimated for each and every item upon which a bid is required, and is furnished expressly for the actual bid. The bid schedule appearing in this book is not to be filled in as the actual bid for submission. All necessary standard government forms may be obtained upon application. Any special provisions and any supplemental specifications that are to govern the execution of the project will be found attached to the prepared bid schedule form.

Art. 2.2 INTERPRETATION OF QUANTITIES IN BID SCHEDULE.—The quantities appearing in the prepared bid schedule are approximate only and are prepared for the comparison of bids. Payment to the contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the contract, and it is understood that the scheduled quantities of work to be done and materials to be furnished may each be increased or diminished as hereinafter provided.

Art. 2.3 EXAMINATION OF PLANS, SPECIFICATIONS, AND SITE OF WORK.—Pursuant to the requirement of article 1 of Form 22, the bidder is required to examine carefully the site of the project contemplated, and the bid form, bid schedule, plans, specifications, and contract form prepared for the project contemplated. It is mutually agreed that submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work as scheduled, or as at any time altered without resulting in increases or decreases of more than the percentage limits hereinafter stipulated, and as to the character, quality, and quantities of work to be performed and material to be furnished, including said contingent increases and decreases, and as to the requirements of the specifications, supplemental specifications, special provisions, and contract.

Art. 2.4 BID GUARANTY.—Guaranty will be required with each bid in the sum of not less than 5 percent of the total amount bid for the work. Any checks must be made payable to the Treasurer of the United States and must be certified.

Art. 2.5 PATENTS, ALTERNATES.—It is hereby mutually understood that the article on patents provided conditionally on page 9 of Form 23 shall be a part of the contract.

Where alternate materials or methods are provided in the bidding, unless definitely stated to the contrary, contractors are not required to bid on any particular alternate unless they so elect. A particular proprietary alternate is required by the Government only in the event the contract is awarded on the basis of use of such particular alternate, and any contractor choosing to base his bid on a proprietary or patented alternate shall be assumed to have the necessary right to the use and control of any proprietary feature or article which is involved in his bid on such alternate. Contractors bidding on a particular alternate of their own choice shall include in their estimate and unit bid price such additional cost as they believe necessary to cover any claims or suits for which liability may be established for infringements of any patent or copyright, and brought in connection with the construction of said alternate according to the specifications, and shall hold and save the Government, its officers, agents, servants and employees harmless from liability of any nature or kind for or on account of the use of this alternate.

Art. 2.6 COMPETENCY OF BIDDERS.—Each bidder shall submit with his bid, or previously, an attested statement on the prescribed forms, of his business and technical organization available for the contemplated work, including his financial resources and his highway or bridge construction experience, comparable with the requirements of the project bid upon.

The Government expressly reserves the right to reject any bid in which the facts as to business and technical organization, financial resources, or construction experience, compared with the requirements of the project bid upon, justify such rejection.

Each bidder shall submit with his bid complete answers to the prescribed plan and equipment questionnaire showing in detail the proposed manner of handling the contract, the organization of forces, the equipment and equipment lay-out, camp set-ups and other pertinent information.

AWARD AND EXECUTION OF CONTRACT

Article 3.1 CONSIDERATION OF BIDS.—The right is reserved, as the interest of the Government may require, to reject any and all bids, and to waive any informality in bids received.

Art. 3.2 ORIGINAL QUANTITIES AND PRICES, ORIGINAL CONTRACT COST.—The summation of the indicated costs of each and every original contract item, obtained by multiplying the contract unit price as awarded by the appurtenant bid schedule quantity as awarded, shall be considered the original total contract cost, and such contract unit prices and bid schedule quantities as awarded shall be considered the original contract prices and original quantities. Also the indicated length in miles of the project, as shown in the bid or as awarded, shall be considered the original mileage of the project.

Art. 3.3 PERFORMANCE AND PAYMENT BONDS.—The bidder to whom award is made shall enter into written contract on Form 23, and shall furnish a performance bond on Form 25 in the sum of 50 percent of the original total contract cost, and a payment bond on Form 25A in the sum of 50 percent of the original total contract cost.

SCOPE OF CONTRACT

Article 4.1 INTENT OF PLANS AND SPECIFICATIONS.—

The intent is to prescribe a complete work or improvement which the contractor undertakes to do, in full compliance with the plans, specifications, bid, and contract. The contractor shall perform the work in accordance with the lines, grades, typical cross sections, dimensions, and other data shown on the plans or as modified by written orders. Except as specified in article 6.1, he shall furnish all materials, equipment, tools, all labor, and all other things necessary to the satisfactory prosecution of the project.

Art. 4.2 SUBSURFACE AND/OR LATENT CONDITIONS AT THE SITE.—

(a) It is mutually agreed that the words "subsurface and/or latent conditions at the site," as used in article 4 of Form 23 shall be construed to mean and to refer solely to conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inhering in work of the character provided for in the plans and specifications.

(b) It is further agreed that any modifications of the contract under articles 3 or 4 shall be made only as herein provided under articles 4.3 (c), 9.3 (b), and 9.4 (c), and any claims must be asserted in writing.

Art. 4.3 CHANGES AND INCREASED OR DECREASED QUANTITIES OF WORK.—

(a) It is mutually agreed that due to latent and/or unforeseen conditions, adjustments of plans to field conditions which cannot be foreseen at the time of advertising, will be necessary during construction, and it is therefore of the essence of the contract, to recognize such changes in plans as constituting a normal and expected margin of adjustment, not unusual and not differing materially in the meaning of article 4.2 (a) and not involving nor permitting change or modification of contract prices, provided only that resulting overruns or underruns from the quantities in the bid schedule do not exceed reasonable percentages.

(b) It is further necessary and expedient that the contract fix within itself reasonable percentage limits (normal and expected) mentioned in 4.3 (a), and the percentage limits so fixed are as follows:

1. If any or all items are changed resulting in a sum total change of 25 percent, or less, of the total cost of the contract calculated from the original bid quantities and the original contract unit prices, such change shall not be considered to involve or constitute an increase or decrease in the amount due the contractor, or any adjustment thereof, save

the payment for the actual quantities at the original contract prices and save in the case described in article 4.3 (c) 2 below.

2. Within the above sum total change, any changes involving overruns or underruns in the case of one or more minor items, regardless of percent, shall not be considered to involve or constitute an increase or decrease in the amount due the contractor, or any adjustment thereof save the payment for the actual quantities at the original contract unit prices.

3. In no case shall a waiver of contract unit price apply to any item the quantity of which is changed less than 25 percent from the quantity appearing in the bid schedule.

(c) 1. It is mutually agreed that, if demand is made by either party, overruns or underruns in any or all items resulting in a sum total change of more than 25 percent of the total cost of the contract calculated from the original bid quantities and the original contract unit prices, shall require a negotiated change order or supplemental agreement signed by both parties setting forth the necessity for the change and an adjustment of unit prices agreed upon as satisfactory to both parties.

2. It is mutually agreed that, if demand is made by either party, overruns or underruns of more than 25 percent of one or more major items shall require a negotiated change order or supplemental agreement signed by both parties setting forth the necessity for the change and an adjustment of unit price or prices agreed upon as satisfactory to both parties.

3. The contract does not obligate the contractor to perform at original contract unit prices, overruns or underruns generating a total in dollars or in miles of more than 25 percent of the original contract.

Art. 4.4 CONSTRUCTION AND MAINTENANCE OF DETOURS.—

Any existing road while undergoing improvement shall be kept open to traffic by the contractor; provided, however, that, except where otherwise indicated on the original plans on which contract was awarded, the contractor may bypass traffic over a detour approved by the engineer. The contractor shall keep the road undergoing improvement or the detour, as the case may be, continuously in such condition satisfactory to the engineer that traffic will be accommodated during the entire contract period; he shall provide and maintain in safe condition temporary approaches and crossings; he shall keep open and safely passable intersections with trails, roads and highways; provided, however, that snow removal will not be required of the contractor for accommodation of traffic. The contractor shall bear all expense of constructing and maintaining such road, detours, approaches, intersections, and any accessory features without direct compensation, save as provided in (a) and (b) below.

(a) *Special Detours.*—Where the bid schedule contains a contingent sum for "Maintenance of Special Detours" and the plans show "special detours," the contractor shall construct

and maintain them as located by the engineer, including any and all temporary bridges and accessory features. The cost of construction and maintenance of such detours, appurtenant temporary bridges and necessary features as ordered shall be paid for in the manner provided hereinafter in articles 9.4 and 9.5. Only such detours as are shown on the plans and identified thereon as "special detours" shall be paid for.

(b) *Maintenance of Road During Winter Suspension of Construction.*—If, during suspension of the project for the winter season, as ordered by the engineer, the contractor is required by the engineer to keep open to traffic and maintain portions of the original roadbed on which he has performed no construction operations, payment for such maintenance shall be made to the contractor in accordance with the provisions of article 9.5.

Art. 4.5 REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS.—All fences, buildings, structures, or encumbrances of any character upon or within the limits of the highway, shall be removed by the contractor and placed carefully on the abutting property or otherwise disposed of as indicated on the plans. Materials so removed, including any existing drain or culvert pipes, which the engineer may order salvaged shall be carefully removed and shall remain the property of the Government.

Payment for this work shall not be made directly except for specific cases expressly identified for payment in the bid schedule.

Art. 4.6 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK.—The contractor may use in the proposed construction suitable stone, gravel, or sand found in excavation and will be paid for the excavation of such materials at the corresponding contract unit price therefor, but he shall provide at his own expense sufficient suitable material to complete the portion of the work which was originally contemplated to be completed with such used material. No charge for materials so used shall be made against the contractor except the replacement herein provided for. The contractor shall not excavate or remove any such material from within the highway except that which is within the excavation, as indicated by the plans, without written authorization from the engineer.

Art. 4.7 FINAL CLEANING UP.—Before final acceptance, the highway, borrow pits and all ground occupied by the contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures and equipment and all parts of the work shall be left in a neat and presentable condition. After completion of any base or surface course involved in the contract, the gutters shall be cleaned of any accumulations, reconditioned, and maintained until the final inspection. This work shall be considered necessary work auxiliary to the accomplishment of the contract and no direct payment shall be made therefor.

CONTROL OF WORK

Article 5.1 PROTESTS TO BE IN WRITING—TIME LIMITS.—Claims for adjustment (articles 3 or 4 of Form 23) and disputes (article 15 of Form 23) must be made and submitted in writing by the contractor within the prescribed time limit after the date of issue of the order dealing therewith, and any disagreement with the interpretation of plans and/or specifications, made by the engineer, must likewise be asserted and submitted by the contractor in writing within 10 days from the date of such interpretation, subject to appeal under article 15 of Form 23.

Art. 5.2 WORKING AND DETAIL DRAWINGS.—The contractor shall furnish necessary working and detail drawings.

Working and detail drawings for material to be fabricated shall include, but not be limited to, shop detail plans, stress sheets, camber diagrams, erection diagrams, bending diagrams for reinforcing steel, shipping statements giving lists of parts and, in the case of structural steel, lists of field rivets and bolts and weights of parts. They should also include, as necessary, lay-outs for cribs, cofferdams, falsework, centering, form work, bracing, and masonry lay-out diagrams.

Approval of all such plans by the engineer must be obtained before any work involving these plans is started, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement. Any material ordered prior to the approval of such plans shall be at the contractor's risk. No deviation from the said approved plans will be allowed without the engineer's written consent.

Such plans furnished must conform to the general plans and drawings and to the general stress sheets and to the specifications. It is mutually agreed that such approved general plans and specifications shall prevail over any plans, drawings, or details prepared by the contractor or his agents. The mutual correctness of plans and details, fits, and field connections shall not be the responsibility of the Government, and formal approval of drawings and other documents prepared by the contractor shall not alter this relation.

Shop drawings shall be 22 inches by 36 inches in size. Three sets of blueprints or other copies shall be submitted to the engineer for his purposes, one set of which will be returned to the contractor with desired revisions noted thereon. After correction and approval, five additional sets of prints or copies

shall be given the Government. Upon completion of fabrication, the original tracings, or one set of vandyke negatives, shall be given the Government. No payment for these plans and drawings shall be made.

Art. 5.3 CONFORMITY WITH PLANS AND ALLOWABLE DEVIATIONS.—Finished surfaces in all cases shall conform with lines, grades, dimensions and adjustments shown on the approved plans, except as modified by written orders by the engineer. The crown of the finished roadbed shall be as shown on the plans, except at intersecting highways or wherever, to insure correct drainage or for other reasons, changes may be directed. On curves or at other places, where deemed necessary, the contractor will be required to superelevate the roadbed. Any deviations from the plans and approved working drawings that may be required by the exigencies of construction or otherwise will in all cases be determined by the engineer and authorized by him in writing.

Art. 5.4 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, AND SPECIAL PROVISIONS.—These specifications, the approved plans, any supplemental specifications, any special provisions and all documents affecting the work duly issued by the engineer to the contractor are essential parts of the contract. They are intended to be mutually complementary. In case of discrepancy, figured dimensions shall prevail over scaled dimensions, supplemental specifications shall prevail over the specifications in this book, and special provisions shall prevail over all plans and all supplemental specifications.

Art. 5.5 CONSTRUCTION STAKES.—The engineer will set construction stakes establishing lines, slopes and continuous profile-grade in road work, and center line and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as he may deem necessary, and will furnish the contractor with all necessary information relating to lines, slopes, and grades. These stakes and marks shall constitute the field control by and in accordance with which the contractor shall govern and execute the work.

The contractor shall furnish, free of charge, all additional stakes, all templates, batter boards, and other materials and supplies necessary for marking and maintaining points and lines established, and shall furnish the engineer such labor as he may reasonably require in establishing points and lines necessary to the prosecution of the work to satisfactory completion. The contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing them shall be charged against him, and shall be deducted from the payment for the work.

In the case of "changes" or "changed conditions" which involve any changes in stakeout, the contractor shall cooperate with the engineer and facilitate the prompt reestablishment of the field control for the altered or adjusted work.

Art. 5.6 INSPECTION. TESTING FINISHED SURFACE OF BASE COURSES, SURFACE COURSES, AND PAVEMENTS.—Before final acceptance, the finished surface of base courses and surface courses shall be tested by a crown template and a 10-foot straightedge applied at right angles and parallel, respectively, to the center line of the roadbed. The crown template shall conform to the typical cross section shown on the plans. The variation of the surface from the testing edge of the crown template between any two contacts with the surface shall at no point exceed one-half inch. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed the following:

Items 50 to 57 inclusive, base courses.....	½ inch
Items 59 and 60, base courses.....	¾ inch
Items 100, 101, and 102, surface courses.....	½ inch
Items 120, 121, 122, 140, and 141, surface courses.....	¼ inch
Items 123, 130, 131, and 133, surface courses.....	¾ inch
Item 132 { Macadam surface.....	¾ inch
{ Plant-mix seal	¼ inch

Art. 5.7 REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK.—Any area of finished surface that exceeds the applicable variation limit specified in article 5.6, or any area of any base or surface course where soft or imperfect places or spots develop, or that does not comply with plans and specifications in any other respect shall be corrected before final acceptance. Areas ordered removed and replaced shall be reconstructed in accordance with the specifications and finished so that the connections between the old and new surfaces are not noticeable. The finished surface shall be maintained by the contractor in that condition until final inspection, except as provided under article 7.11. All correction work and removal and replacement of unsatisfactory material shall be done at the expense of the contractor.

Art. 5.8 FINAL INSPECTION.—Whenever all the materials have been furnished, all the work has been performed, and the construction provided and contemplated by the contract has been completed, all in accordance with the specifications, the engineer shall make the final inspection under the following procedure:

(a) Upon due notice from the contractor of presumptive completion of the entire project, the engineer shall make a semifinal inspection and if at such semifinal inspection, all construction provided for and contemplated by the contract is

found completed to his satisfaction, such inspection shall constitute the final inspection and the engineer shall make the final acceptance and the contractor shall be notified of such acceptance in writing within 10 days or as soon thereafter as practicable.

(b) If, however, at any semifinal inspection any work in whole or in part is found unsatisfactory, the engineer shall give the contractor the necessary instructions as to replacement of material and performance or reperformance of work necessary and prerequisite to final completion and acceptance, and the contractor forthwith shall comply with and execute such instructions. Upon satisfactory replacement of such material and performance or reperformance of such work, another inspection shall be made which shall constitute the final inspection if the said material is found to have been replaced and the work completed satisfactorily. In such event the engineer shall make the final acceptance and the contractor shall be notified of such acceptance in writing within 10 days or as soon thereafter as practicable.

(c) If any living, planted and/or seeded material is installed during a spring planting or seeding period, as elsewhere defined, such material shall not be considered as established and in a completed condition satisfactory for acceptance until it is found to be in an acceptable growing condition after the lapse of a 45-day spring growing period as defined in the paragraph which follows. The above provision is not applicable to material planted before or after the said spring planting or seeding period and/or to sodding operations.

Forty-five calendar days, beginning on the date (within the applicable spring planting or seeding period), fixed as prescribed below, shall constitute the 45-day spring growing period above prescribed. The 45-day period shall commence on the date the living material is planted in place and all planting operations are completed. The engineer shall notify the contractor in writing of the commencement of the 45-day period and the date so fixed by the engineer shall govern. By "acceptable growing condition" is meant that the planted or seeded materials are making a satisfactory healthy growth under the existing conditions.

CONTROL OF MATERIAL

Article 6.1 SOURCES OF MATERIAL. FURNISHING MATERIAL. ROYALTIES.—

(a) The Government does not assume any responsibility as to the quantity of acceptable material available at sources designated in the special provisions or otherwise designated. The contractor shall satisfy himself as to the quantity of acceptable material available at designated sources and as to the amount and nature of work required in producing material, complying with specifications for the individual contract item, from the natural material available at such sources. It is to be understood that the engineer may order procurement of material from any portion of any area designated as a pit or quarry site, and may reject portions of the deposit as unacceptable.

The contractor shall notify the engineer sufficiently in advance of the actual opening of any designated pit or quarry to permit staking of boundaries of the site and taking of elevations and measurements of the ground surface before any material is disturbed. The engineer may stake the minimum area which he estimates as necessary to supply the required material, and thereafter he may stake additional areas as the work proceeds if he finds it necessary. When crushed aggregate is required by the specifications, all suitable oversize material found in gravel pits and having a maximum dimension of less than 10 inches shall be crushed.

(b) Except as to material sources under STRIPPING AND STORING TOPSOIL, ROADWAY AND DRAINAGE EXCAVATION, UNCLASSIFIED EXCAVATION FOR STRUCTURES, BORROW, SELECTED BORROW BASE COURSE, and SELECTED BORROW SURFACE COURSE, the contractor may elect to obtain materials from sources of his own choice (satisfactory to the engineer). He may make such election even though sources are designated in the special provisions (or designated by the engineer upon failure of the sources designated in the special provisions.) However, with respect to all sources of his own choice, the contractor shall obtain the right from the owners to procure materials from the sources, pay all royalty and all other charges involved, bear all the expense of developing the sources, and of producing, delivering, and placing the material.

(c) *Furnishing Material.*—Except as set forth in 1, 2, and 3 below, the phrase "furnishing material" when used in any contract item shall be construed to mean that the contractor shall bear all the expense of purchasing, producing, preparing, hauling

and delivering the material to the site of the work, including any required construction, repair and obliteration of access roads, any clearing and stripping of pits and quarries and all expense incidental to the acquisition of rights to the material so far as may be or may become necessary in supplying all such material for use in the construction of the contract item and payment as specified in the said item shall constitute full compensation therefor. Under the conditions set forth in 1, 2, and 3 below, additional payment shall be made as therein stated.

1. When the pit or quarry sources for the material for any contract item are designated in the special provisions and identified by signs conspicuously set near the sites of such pits or quarries, and quantities and unit prices for the individual item for one or more of the several operations involved—namely: pit-clearing, pit-stripping, pit-moves, and additional haul—are called for in the bid schedule, then the contractor shall be relieved of the responsibility of obtaining the right to take material from the sources so designated in the special provisions and so identified by signs conspicuously set near the sites, but the contractor shall bear all other expense of whatever nature of developing sources, and of producing, delivering and placing the material, except as provided under 3 below.

2. When the engineer determines that the contractor has obtained all the acceptable material from all of the sources designated in the special provisions and the amount of acceptable material obtained from such sources is found insufficient to complete the individual contract item, the engineer shall designate a new source of material by written order. In such case the contractor shall be relieved of the responsibility of obtaining the right to take material from the new source, but the contractor shall bear all other expense of whatever nature, of developing the new source and of producing, delivering and placing material, except as provided under 3 below.

3. When for any contract item, quantities and unit prices for such of the subsidiary operations—pit-clearing, pit-stripping, pit-moves and additional haul—as are involved in the said item are called for in the bid schedule, direct payment at those prices for such operations shall be made, and measurement for such payment shall be made as explained below. If unit prices for “pit-moves, Item ()” and/or “additional haul, Item (),” are set in the bid schedule, the prices so set shall govern and any prices bid for same will not be recognized. In any event, borrow shall be measured and paid for only as required under BORROW.

Measurement of pit-clearing.—The area of clearing of designated pit or quarry sites to be paid for shall be the number of acres and fractions thereof of land cleared as ordered within the limits of pit or quarry sites as staked by the engineer. Areas cleared outside the boundaries staked by the engineer shall not be included in the number of acres to be paid for. In no case

shall areas cleared for any pit or quarry site selected or substituted by the contractor be included in the number of acres to be paid for.

Measurement of pit-stripping.—The yardage of stripping of designated pit or quarry sites to be paid for shall be the number of cubic yards of overburden excavated as ordered to the depth, and within the limits of the pit or quarry sites as staked by the engineer, measured in original position and computed by average end area method. Unsuitable material found below the elevation to which the engineer has ordered overburden removed and stripping excavated outside of boundaries staked by the engineer shall not be included in the yardage to be paid for. Stripping shall be measured before excavation of material for any contract item is started. In no case shall yardage of stripping of pit or quarry sites selected or substituted by the contractor be included in the yardage to be paid for.

Measurement of pit-moves.—The pit-moves to be paid for shall be the number of pit-moves, ordered in writing by the engineer and performed by the contractor, to sources designated by the engineer (other than those sources designated in the special provisions) provided, however, that pit-moves to such sources shall not be included in the number of pit-moves to be paid for unless the shortest horizontal distance between such sources and any pit or quarry previously utilized under this contract item is greater than 1,000 feet. Pit-moves to, between, or from sources of “filler” material for blending shall in no case be included in the number of pit-moves to be paid for. Pit-moves to, between, or from sources selected or substituted by the contractor shall not be included in the number of pit-moves to be paid for.

Measurement of additional haul.—The number of cubic-yard-miles or ton-miles of additional haul to be paid for shall be the product of the number of cubic yards or tons of accepted contract material (obtained from any source designated in writing for this item by the engineer but not designated in the special provisions) and the additional haul distance. The additional haul distance shall be the number of miles or fractions thereof by which the actual distance such material is hauled exceeds the distance the same amount of material would have been hauled had it been obtained from the nearest of those pit sources designated in the special provisions, and hauled to the same point of placement on the road. Distances shall be measured between centers of volume, pit source to point of placement over the shortest feasible and satisfactory route as determined by the engineer. In no case shall additional haul from sources selected or substituted by the contractor be included in the number of cubic-yard-miles or ton-miles of additional haul to be paid for.

Art. 6.2 SAMPLES, TESTS, CITED SPECIFICATIONS.—When requested, the contractor shall furnish a complete

written statement of the origin, composition and/or manufacture of any or all materials (manufactured, produced or grown) that are to be used in the work.

Unless otherwise provided, tests of materials shall be made by the engineer in accordance with the methods given in the 1935 "Standard Specifications for Highway Materials and Methods of Sampling and Testing" of A.A.S.H.O., and revisions thereof in effect on the date of invitation for bids. Insofar as applicable, samples of material shall be obtained using A.A.S.H.O. Method T-2.

When sampling and testing of seeds is required, sampling and testing methods shall be as prescribed in United States Department of Agriculture Circular 480, "Rules and Recommendations for Testing Seeds" (July 1938), and revisions thereof in effect on the date of invitation for bids.

Inspection and grading of living plant material for type, size and quality shall be in accordance with the latest edition of Horticultural Standards of the A.A.N. in effect on the date of invitation for bids.

Inspection and identification of living plant material for trueness to name shall be in accordance with the latest edition of Standardized Plant Names, the official code of the American Joint Committee on Horticultural Nomenclature, in effect on the date of invitation for bids.

Where the abbreviated citation "A.A.S.H.O. Method" followed by the appropriate method number is used, it shall be construed to mean the test and revisions thereof of the A.A.S.H.O. adopted, and in effect on the date of invitation for bids.

Where the abbreviated citation "A.A.S.H.O. Specification" followed by the appropriate specification number is used, it shall be construed to mean the specification and revisions thereof of the A.A.S.H.O. adopted, and in effect on the date of invitation for bids.

Where the abbreviated citation "A.S.T.M. Designation" followed by the appropriate serial designation is used, it shall be construed to mean the test or specification, as the case may be, of the A.S.T.M., either as standard, tentative standard, or supplement, and revisions thereof, adopted, and in effect on the date of invitation for bids.

Where the abbreviated citation "Federal Specification" followed by the appropriate symbol is used, it shall be construed to mean the specification and revisions and amendments thereof, approved and promulgated by the Director of Procurement, United States Treasury Department, and in effect on the date of invitation for bids.

Art. 6.3 STORAGE AND STOCKPILING OF MATERIALS.—Materials shall not be stored on the highway except where and as permitted by the engineer. Stockpiling of con-

struction materials within the highway shall be confined to such cleared areas as may be approved by the engineer.

Where stockpiling is done outside of the roadway, the site shall be abandoned immediately when the portion of the project for which it is required is completed, and the natural surfaces shall then be restored as nearly as possible to the original condition by the contractor at his expense. This shall not apply to the stripping and storing of topsoil, or to the storing of other materials salvaged from the work as specifically prescribed under these specifications.

Storage of plant material.—In the case of living plant materials, a temporary or "heeling-in" nursery shall be required, the location of which shall be approved by the engineer. The contractor shall properly care for such living materials before and during planting. Immediately following delivery and inspection at the site of the work, all plants with exposed roots shall be "puddled" and such plants as cannot be planted promptly shall be "heeled-in" in moist soil, in a manner satisfactory to the engineer. All plants heeled-in shall be properly cared for by the contractor until planted. In the event heeled-in plant material must be held over until the next planting season, such heeled-in material shall be lifted and replanted in a satisfactory manner in nursery rows. Such emergency storage of materials, including care of same, shall be at the sole risk of the contractor.

The balls or roots of balled and burlapped (B & B) plants, which are not immediately planted after delivery and inspection, shall be protected adequately by topsoil covering until removed for planting, in a manner appropriate to the conditions and satisfactory to the engineer.

Art. 6.4 DEFECTIVE MATERIALS.—All materials not conforming to the requirements of these specifications shall be considered as defective. No defective material, the defects of which have been subsequently corrected, shall be used until approval has been given. Upon failure on the part of the contractor to comply forthwith with any order of the engineer made pursuant to the provisions of this article, the engineer shall have authority to remove and replace defective material and to deduct the cost of removal and replacement from any moneys due or to become due the contractor.

Art. 6.5 BITUMINOUS MATERIAL VENDOR'S RESPONSIBILITY.—(a) *Samples.*—Samples of the bituminous materials that the contractor proposes to use, together with a statement as to their source and character must be submitted and approval obtained before use of such materials begins. The contractor shall require the vendor of the bituminous materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials that have been demonstrated by service tests as satisfactory for the intended use will be acceptable.

When requested by the engineer, the contractor shall cause the vendor to furnish and ship a 1-quart sample from each car delivered to such point or destination as may be required. The right is reserved to sample and test the bituminous material at the point of delivery on the project. No bituminous material shall be applied until approved by the engineer, and if separation of the ingredients of the material in the car at the time of proposed use is found to have occurred, the material shall be rejected. The contractor shall not be allowed any compensation for any delays or damages sustained pending the completion of testing and approval.

Samples of bituminous material shall be taken in accordance with A.A.S.H.O. Method T-40. In the case of emulsified asphalt, samples shall consist of not less than 1 gallon and shall be stored in clean, airtight, black-iron containers at a temperature of not less than 40° F. until tested.

(b) *Test Report.*—A test report shall be furnished in duplicate by the vendor at the time of shipment of each car or tank truck, showing the results of all the required tests on the shipment, together with the date of shipment, car initial and number, destination, project number for which shipped, type and grade of material, gravity of the material, both specific and A.P.I., the loading temperature with the number of gallons loaded at that temperature and the number of gallons converted to 60° F., and the weight in tons, when that unit of measurement is called for in the bid schedule.

Copies of the report shall be mailed as required by the engineer.

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

Article 7.1 LAWS TO BE OBSERVED.—The contractor is assumed to be familiar with, and at all times shall observe and comply with all Federal, State, and local laws, bylaws, safety laws, building and construction codes, and ordinances and regulations in any manner affecting the conduct of the work. Before any camp, quarry, borrow pit, storage, detour or bypass site is opened or operated on Government property, a permit shall be obtained from the Forest Service, National Park Service, or other Federal agency having jurisdiction.

Workmen's compensation insurance.—The contractor shall obtain workmen's compensation insurance in accordance with the requirements of the laws of the State in which the work is to be performed in case the constituted authority of such State shall apply such laws to this project. In the event such laws do not apply to the project, the contractor shall provide workmen's compensation insurance equal at least to that required by the laws of the State for other work. In those States where there are no workmen's compensation laws the contractor shall provide workmen's compensation insurance at least equal to that ordinarily carried for work of this kind performed for the United States Government in that section of the country, which insurance shall be subject to the approval of the engineer, and shall provide for payments to workmen in case of temporary or permanent disability resulting from the work provided for herein and for payments to their dependents in case of death.

Art. 7.2 PERMITS AND LICENSES.—The contractor shall pay all charges, taxes, and fees and shall give all notices necessary and incident to the due and lawful prosecution of the work.

Art. 7.3 PATENTED DEVICES, MATERIALS, AND PROCESSES.—The contractor shall hold and save the Government, its officers, agents, servants, and employees harmless from liability of any nature or kind, including costs and expenses, for or on account of any patented or unpatented invention, article, or appliance manufactured or used in the performance of this contract, including their use by the Government.

Art. 7.4 SURFACES OPENED BY PERMIT.—Openings in the highway for purposes other than those required for the prosecution of the contract shall not be allowed without written permission from the engineer.

Art. 7.5 SANITARY PROVISIONS.—The contractor shall provide such accommodations for the use of his employees as may be necessary, and shall maintain same in a neat and sanitary condition. The locations of such accommodations at camps or elsewhere shall be subject to prior approval by the engineer.

Such accommodations shall comply with the requirements and regulations of the State health department, the Forest Service or the National Park Service, or other authorities having jurisdiction. All such requirements and regulations, in effect prior to the opening of bids for the contract, shall be considered as binding upon the contractor as if actually included in these specifications.

The contractor shall observe the following specific regulations pertaining to camp sanitation:

(a) Sleeping quarters shall be provided for all such employees as desire to reside at the camp and such quarters shall have ample window and air space and floors that can be kept clean.

(b) Cooking and dining quarters shall be well lighted and ventilated, fly proof and kept in a clean, sanitary condition at all times. Places used for dining rooms, kitchens, or for storing or preparing food shall not be used for sleeping or living rooms and persons affected with communicable diseases shall not be allowed in the cooking or dining quarters. All perishable food shall be protected from putrefaction and from insects, and all food shall be handled in a clean and sanitary manner.

(c) A water supply for drinking and domestic purposes shall be obtained from a source free from contamination.

(d) Sewage shall be disposed of in earth pit toilets covered with fly-proof and well-ventilated buildings, or by chemical toilets, or by other approved methods. If pit toilets are used, they shall be located not less than 100 feet from streams, 75 feet from sleeping quarters, and 150 feet from kitchens or mess houses, and the pits shall be sprayed with disinfectant not less than 3 times each week. Flush toilets shall not be used before plans for method of disposing of sewage have been approved by the engineer.

(e) Garbage and refuse shall be stored in closed containers and shall be disposed of either by burning or by burial and covering every day.

(f) Liquid kitchen wastes shall be discharged through vitrified or iron pipe to a covered cesspool located not less than 50 feet from the kitchen.

(g) Stables and corrals shall be located not less than 600 feet from kitchens and 500 feet from sleeping quarters.

(h) When a camp is abandoned, all tin cans, rubbish, toilet buildings, and other foreign material shall be removed and disposed of to the satisfaction of the engineer. All pits used for

toilets, garbage, or cesspools shall be covered with chloride of lime or other disinfectant and filled with earth. The entire camp area shall be left by the contractor in a neat and clean condition appropriate to the surrounding landscape.

Art. 7.6 PUBLIC CONVENIENCE AND SAFETY.—Where the contractor constructs temporary bridges or provides temporary stream crossings, he shall be responsible for accidents occurring on the roadway approaches as well as on the structures at such crossings when due to his failure to provide adequately for the reasonable safety of traffic. Material stored upon the highway shall be placed so as to cause only such obstruction to the traveling public as is unavoidable. No road shall be closed by the contractor to the public except by express permission of the engineer. Care shall be taken at all times to regulate the operations so as to protect visitors and campers in the National Forest or Park or other Government reservation involved. The contractor shall take necessary care at all times, in all the operations and use of his equipment, to protect the traveling public and to facilitate traffic. The contractor shall at all times exercise reasonable precautions for the safety of employees on the work.

Art. 7.7 BARRICADES, DANGER, DETOUR, AND WARNING SIGNS.—The contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals, detour, and other signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades, and obstructions shall be illuminated at night. Suitable warning signs, illuminated at night by lanterns or flares, shall be provided to mark the places where surfacing ends or is not compacted. All lights for this purpose shall be kept burning from sunset to sunrise.

Warning signs.—The contractor will be required to erect warning signs outside of, and 500 feet from each end of the project, and 500 feet in advance of any place on the project where operations interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road. Such warning signs shall be constructed and erected in accordance with the plans furnished. Payment for these signs shall not be made directly, but payment for the pay items performed and accepted under the contract shall be considered to cover the furnishing and erecting of these signs.

Facilitating public traffic by part-width construction.—Where for purposes of facilitating traffic, the plans require any base course, surface course, or pavement to be constructed part-width at a time, the width not under construction shall be made available to public traffic under alternate one-way control. In

such case the contractor shall furnish flagmen, pilot car, and drivers to direct traffic through sections of road under one-way control. Such sections shall not exceed 2 miles in length. Suitable warning signs, illuminated at night by lanterns or flares, shall be provided to mark the places where surfacing ends or is not compacted. If required after the first part-width has been completed, the contractor shall place substantial barricades along the inside edge of the completed surface so that the traffic will be confined to the compacted portion while the other part-width is placed. One-way control shall be continued until the completed surface is opened to traffic.

Art. 7.8 USE OF EXPLOSIVES.—In the use of explosives, the contractor shall exercise the utmost care not to endanger life or property.

Before any drilling operations in preparation for blasting are started, the contractor shall furnish the engineer a detailed plan of operations showing the method proposed for the prevention of damage. In order to assure adequate protection such plan may be modified to meet the conditions that may develop.

Blasting operations shall be conducted under the most careful supervision. Ordinarily only light shooting shall be permitted. In using explosives the contractor shall adopt precautions that will prevent damage to surrounding objects. Where so indicated on the plans, the contractor shall use suitable mats or other approved means to smother the blasts. Nothing herein shall release the contractor from full responsibility for damage or injury resulting from the use of explosives.

Where specifically indicated on the plans, blasting operations shall be carried out by using not over one-half pound of explosives (equivalent in strength to 40 percent dynamite) per cubic yard of material to be blasted and by shooting of only a few holes simultaneously.

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

Art. 7.9 PROTECTION AND RESTORATION OF PROPERTY.—The contractor shall be responsible for the preservation of all public and private property, monuments, telephone lines, other utilities, etc., along and adjacent to the roadway insofar as they may be endangered by his operations, shall use every precaution necessary to prevent damage to pipes, conduits, and other underground structures; and shall protect carefully from disturbance or damage all land monuments and property marks until the engineer has witnessed or otherwise referenced their location and shall not remove them

until directed. Any utility lines injured by the contractor shall be repaired at once at his expense. All trails and roads adjacent to or intersecting the project shall be protected from damage.

The contractor shall be responsible for the preservation of all artifacts found in the roadway or disclosed by his operations and shall deliver them promptly into the custody of the engineer.

He shall prevent his employees from trespassing on or otherwise damaging natural, geological or historical features, structures or monuments.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the nonexecution thereof on the part of the contractor, such property shall be restored by or for the contractor, and at the contractor's expense, to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring same or he shall make good such damage or injury in some other acceptable manner.

Art. 7.10 RESPONSIBILITY FOR DAMAGE CLAIMS, ETC.—The contractor shall save harmless the Government and all of its representatives from all suits, actions, or claims of any character brought on account of any injuries or damages sustained by any person or property in consequence of any neglect in safeguarding the work, or through the use of unacceptable materials in the construction of the improvement, or on account of any act or omission by the said contractor or his employees, or from any claims or amounts arising or recovered under the Workmen's Compensation Laws or any other law, by-law, ordinance, regulation, order, or decree. During the prosecution of the work the contractor shall be responsible for all damage or injury to property of any character resulting from any act, omission, neglect, or misconduct in the manner or method of executing said work satisfactorily, or due to the nonexecution of said work at any time, or due to defective work or materials, and said responsibility shall continue until the date of final completion.

Art. 7.11 OPENING OF SECTIONS OF HIGHWAY TO TRAFFIC.—When any substantial portion or feature of the project is completed, it may be designated as "Accepted for Traffic" previous to the completion of the whole project, if and as deemed expedient by the engineer. Such acceptance shall not constitute final acceptance of the work or any part of it or a waiver of any provisions of the contract; provided, however, that on such portions of the project as are "Accepted for Traffic," the contractor shall not be required to assume any expense entailed in maintaining the roadway for traffic as a result of ordinary wear and tear after such acceptance, but

shall be compensated therefor in the manner provided herein after in article 9.5. Any damage to the highway that may occur on such section not attributable to traffic shall be repaired by the contractor at his expense, provided, however, that any unavoidable "slides" shall be removed as ordered and paid for at the respective contract unit prices for the quantities and items of work involved.

Art. 7.12 CONTRACTOR'S RESPONSIBILITY FOR WORK.—Until the final acceptance of the work by the engineer, as evidenced in writing, the contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, or from any other cause, whether arising from the execution or from the nonexecution of the work. The contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof, except damages to the work due to unforeseeable causes beyond the control of and without fault or negligence of the contractor, including but not restricted to acts of God or of the public enemy, acts of the Government, slides found by the engineer to have been unavoidable and ordinary wear and tear on any section of the road opened to traffic by order of the engineer.

In case of suspension of work from any cause whatever, the contractor shall be responsible for all materials, and shall properly store them, if necessary, and shall provide suitable drainage of the roadway and erect necessary temporary structures at his expense. He shall properly and continuously maintain, during such period of suspension of work, in an acceptable growing condition all living material in newly established plantings, seedlings and soddings furnished under his contract, and shall take adequate precautions to protect and establish new tree growth and other important vegetative growth against injury.

Art. 7.13 PUBLIC OFFICIALS NOT PERSONALLY LIABLE.—There shall be no personal liability upon the contracting officer or the engineer, their agents or employees, for any act performed in the discharge of any duty imposed or the exercise of any power or authority conferred upon them by, or within the scope of, the contract, it being understood that in all such matters they act solely as agents and representatives of the Government.

Art. 7.14 NO WAIVER OF LEGAL RIGHTS.—The Government shall not be precluded or estopped by any measurement, estimate or certificate made either before or after the completion and acceptance of the work and payment therefor from showing the true amount and character of the work performed and materials furnished by the contractor, nor from showing that any such measurement, estimate or certificate is untrue

or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Government shall not be precluded or estopped, notwithstanding any such measurement, estimate or certificate and payment in accordance therewith from recovering from the contractor or his sureties, or both, such damages as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the engineer or by his representative, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the engineer shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

PROSECUTION AND PROGRESS

Article 8.1 SUBLETTING AND SUBCONTRACTING.—

(a) *General Restrictions.*—Except as provided in (b) below, the contractor shall perform with his own organization and with the assistance of workmen under his immediate superintendence, work of a contract value not less than 80 percent of the contract value of all work embraced in the contract exclusive of work not commonly found in contracts for similar work, or which require highly specialized knowledge, craftsmanship or equipment not ordinarily available in the organizations of contractors performing work of the character embraced in the contract.

(b) *Named Subcontractors, When Permissible.*—If any bidder shall state in his bid the particular item or items which he proposes to sublet, and shall name therein the subcontractor to whom he proposes to sublet such work in the event of an award to him, such item or items may be performed by such subcontractor notwithstanding the 80 percent limitation above mentioned, provided that the engineer's consent is given and that the subcontractor named in the proposal is a contractor of recognized standing, has a record of satisfactory performance, and the work proposed to be sublet does not constitute the major item or items embraced in the contract. Any bidder who shall name a subcontractor in his bid shall attach thereto a certificate that the use of the name of such subcontractor was with his knowledge and consent. Any subcontractor so named in any bid may be required to submit complete answers to questionnaires to establish his experience and financial ability. The naming of a subcontractor in any such bid will not insure approval of the proposed subletting to him, and in the event of disapproval of such subletting, the contractor shall perform such item or items of work with his own organization in full compliance with all applicable terms of the contract.

(c) *Routine Procedure With Subcontracts.*—No portion of the contract shall be sublet except with the written consent of the engineer. Requests for permission to sublet any portion of the contract shall be in writing and accompanied by a showing that the organization that will perform the work is particularly experienced and equipped for such work. The contractor shall give assurance that all pertinent contract requirements shall apply on all work sublet. Written consent to sublet any portion of the contract shall not be construed

to relieve the contractor of any responsibility for the fulfillment of the contract.

(d) *Subcontracting of Board and Subsistence.*—The contractor will not be permitted to subcontract the construction or the operation and maintenance of messes and camps for the boarding and lodging of his employees without prior written permission from the engineer.

Art. 8.2 PROSECUTION OF WORK.—Following receipt of notification of award, the contractor will receive a notice to proceed with the performance of the construction required by the contract.

The contractor, within 20 days after he receives the notice to proceed, shall file with the engineer a time chart or schedule of proposed progress, a plan of construction and the proposed detailed method of carrying on the work, including a full statement of the equipment and equipment lay-out for the job. He shall start construction operations on that part of the project designated by the engineer, and the work shall be conducted in such manner and with sufficient materials, equipment and labor as are considered necessary to insure its completion in accordance with the plans and specifications as interpreted by the engineer, within the time set forth in the proposal. Should the prosecution of the work for any reason be discontinued, the contractor shall notify the engineer at least 24 hours in advance of resuming operations.

Art. 8.3 LIMITATIONS OF OPERATIONS. LANDSCAPE PRESERVATION. FIRE SUPERVISION. PLANTING PERIODS.—The contractor shall not open up work to the prejudice of work already started, and the engineer may require the contractor to finish a section on which work is in progress before work is started on any additional section. The contractor shall be held responsible for any damage done by him or his agents to work performed by any other contractor. The contractor shall give special attention to the effect of his operations upon the landscape, shall take special care to maintain natural surroundings undamaged, and shall conduct the work at all times in compliance with the following requirements.

(a) *Prevention of Landscape Defacement.*—The contractor shall not deface, injure or destroy trees or shrubs nor remove or cut them without special authority. No ropes, cables or guys shall be fastened to or attached to any existing nearby trees for anchorages in lieu of placing of deadmen, unless specifically authorized by the engineer. Where such special emergency use is permitted, the contractor shall first adequately wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable or wire is placed. The contractor shall in any event be responsible for any damage resulting from such use and shall repair any damage which may occur.

Where, in the opinion of the engineer, trees may be defaced, bruised, injured or otherwise damaged by the contractor's equipment or by his blasting, dumping or other operations, he may direct the contractor to protect adequately such trees by placing boards, planks or poles around them. Monuments and works of art shall be protected similarly before beginning operations near them. All these precautions shall be at the expense of the contractor.

(b) *Restoration of Landscape Damage.*—Any tree or other landscape feature scarred or damaged by the contractor's equipment or operations shall be restored as nearly as possible to original condition at the contractor's expense. The engineer shall decide what method of restoration shall be used, and whether damaged trees shall be trimmed or removed.

All scars made on trees by equipment, construction operations or by the removal of limbs larger than 1 inch in diameter shall be painted as soon as possible with an approved paint. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes shall not be permitted. Where tree climbing is necessary, the use of climbing spurs shall not be permitted. The use of climbing ropes shall be required by the engineer where deemed necessary for safety.

(c) *Location of Camp Sites, Storage and Housing Facilities.*—The location of the contractor's camps, storage and other construction buildings, required temporarily in the performance of the work shall require written approval of the engineer. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Where buildings or tent platforms are constructed on sidehills, cribbing shall be used to obtain level foundations. Benching or leveling of earth will not be allowed.

(d) *Lay-out and Abandonment of Camps and Buildings.*—All temporary camps, storage and other construction buildings shall be placed upon cleared portions of the right-of-way, other cleared areas, or areas to be cleared unless otherwise authorized in writing by the engineer. When the work is completed all camps, storage and other construction buildings shall be removed, and the sites shall be restored by the contractor at his expense, to a neat and presentable condition appropriate to the surrounding landscape.

(e) *Lay-out and Abandonment of Roads and Trails.*—Where the contractor may require temporary roads and trails, so far as possible, such roads and trails, including access roads to pits and quarries, shall be confined to cleared areas or areas to be cleared, unless otherwise authorized in writing by the engineer. All such roads and trails shall be abandoned immediately when the construction of the portion of the project for which they are required is completed, and the natural surfaces, disturbed by their construction and use, shall be

restored as nearly as possible to their original condition by the contractor at his expense and to the satisfaction of the engineer.

(f) *Opening and Abandonment of Pits and Quarries.*—All pit and quarry sites shall be subject to the approval of the engineer prior to opening. Pit and quarry sites shall not be opened within clear view from the roadway, except where widening of roadway cuts or quarrying from the roadway prism is called for on the plans, or where they may be authorized and designated in writing by the engineer.

Where practicable, pits and quarries shall be so excavated that water will not collect and stand therein. Upon completion of the work all equipment, timber, and rubbish shall be removed or burned. Where shown on the plans, the sides of pits shall be neatly sloped and trimmed and overburden or stripping spread uniformly on the bottoms and slopes of the pits and quarries. The sites shall be left in a condition acceptable to the engineer.

(g) *Blasting Precautions and Methods.*—When using explosives, the contractor shall adopt precautions which will prevent damage to landscape features and other surrounding objects, and which will prevent the scattering of rocks, stumps, or other debris outside the finished roadway slopes. When directed by the engineer, trees within an area designated to be cleared shall be left as a protective screen for surrounding vegetation during blasting operations. Trees so left shall be removed and disposed of after blasting has been completed.

The contractor shall use electric detonators exclusively in connection with all blasting operations, except that when the Forest Service, National Park Service, or other Federal agency having jurisdiction, determines that weather conditions are such that other approved methods of setting off explosives will not cause a fire hazard in the area in which the contractor is operating, the contractor shall be so notified through the engineer and will be permitted to use such other approved methods.

For breaking up surface boulders or rock fragments, the method of "plastering" or "mudcapping" shall be used in preference to "blockholing."

Rock blasting and sidehill excavation shall not be done by means of "coyote" or "gopher" holes except with the prior written consent of the engineer. The engineer's consent, if given, will be only on the condition that any damage to surrounding objects, landscape features, to the roadway or slopes, or to any part of the work resulting from such blasting, shall be repaired by the contractor at his own expense.

The contractor shall gather rock which falls outside of the roadway due to his blasting operations and place it in the fills at his expense.

(h) *Fire Prevention Regulations and Control.*—The contractor shall abide by such rules and instructions as to fire prevention and control and as to the time and place for burning as the Forest Service, National Park Service, or other Federal agency having jurisdiction may prescribe. The contractor shall take all necessary steps to prevent his employees from setting fires not required in the construction of the project, shall be responsible for preventing the escape of fires set in connection with the construction of the project and shall extinguish any and all fires that may escape.

At all times during the period of contract operations, the contractor shall maintain spark arresters, satisfactory to the Federal agency having jurisdiction, on all steam engines, internal combustion engines, and on all flues used in his operations and in construction camps.

The contractor shall maintain a fire patrol in the vicinity of blasting and other operations creating a fire hazard. When in the opinion of the Federal agency having jurisdiction such a patrol is unnecessary because of weather conditions, the contractor shall be so notified through the engineer.

(i) *Fire Guard.*—When required by the special provisions, the contractor shall employ a trained fire guard who shall be acceptable to the engineer. Such fire guard shall carry out all instructions received from the engineer and shall be charged with the responsibility of enforcing regulations and stipulations of the Forest Service, National Park Service, or other Federal agency concerned. The first guard shall obtain such regulations and stipulations directly from the engineer. He shall be charged with the responsibility of protecting from fires, the area affected by the operations of the contractor and shall see that the contractor and his employees comply with all regulations and stipulations dealing with fire protection.

(j) *Fire-fighting Equipment Required.*—At all times during the period of contract operations a supply of fire-fighting tools consisting of at least 25 shovels, 10 axes, 35 canteens, and 6 back pack pumps shall be maintained by the contractor at his expense at his camp or at some other central location for the sole purpose of fire fighting. All steam or internal combustion engine operated machinery, such as tractors, trucks, power rollers, and power shovels shall be equipped with a shovel, an ax, and a 2-quart or larger fire extinguisher of approved type that will extinguish oil or gasoline fires.

When indicated on the plans, the contractor shall be required to furnish a portable gasoline-driven pump and not less than 1,500 feet of 1½-inch hose, a ¾-inch nozzle, and other necessary accessories. The pump shall be powered with a 4-cycle engine and be capable of delivering at least 25 gallons of water per minute through 1,500 feet of 1½-inch hose with a ¾-inch nozzle, at an elevation of 300 feet above the pump.

The equipment shall be maintained at all times in readiness for immediate use, and shall be tested as frequently as the Federal agency having jurisdiction over burning may require.

(k) *Regulations for Burning.*—Before setting any fires whatsoever, the contractor shall notify the responsible Federal agency having jurisdiction for the area concerned. All burning shall be done at night unless otherwise authorized in writing by the engineer. During burning operations, special care shall be taken to prevent scorching or causing any damage to adjacent trees and shrubbery. Piles of material to be burned shall be of such size and so placed that during burning no damage shall result to adjacent objects. The decision as to the maximum safe size of such piles shall rest with the appropriate officer of the Forest Service, National Park Service, or other Federal agency having jurisdiction, and instructions regarding same will be given to the contractor through the engineer.

When in the judgment of the Federal agency having jurisdiction, burning should be suspended or should be performed only when a pump and sufficient water are available, the engineer shall require the contractor to suspend burning operations or to furnish such pump and water for any protective purpose ordered and for extinguishing all burning embers (before they are left unattended). Any pumping equipment furnished shall be in accordance with (j) above and shall be set up and hose laid out at all times while burning operations are in progress.

(l) *Contractor's Responsibility in Fighting Own Fires.*—The contractor, under the direction of the appropriate Federal agency, or, in the absence of an officer from any such agency, acting independently, shall extinguish all fires set or caused by his employees and all other fires which may escape from the project, whether or not set directly or indirectly as a result of construction operations, without expense to the Government.

Where the contractor is obligated to suppress any fire without expense to the Government under the provisions of this article, if the amount and character of labor, subsistence supplies and transportation which the contractor is in a position to furnish promptly for fire suppression prove inadequate for that purpose, in the judgment of the Federal agency in charge, then the appropriate officer of such agency is authorized to procure and to charge to the contractor, such additional labor, subsistence supplies and use of transportation facilities as he may deem necessary for the suppression of the fire. These expenses shall be billed to the contractor for payment directly by him, and if not promptly met by him shall be paid by the Government and deducted from the moneys due or which may become due the contractor under his contract, or collected from his sureties until the entire amount due the Government for said fire suppression is recovered.

(m) *Use of Contractor's Employees to Fight Other Fires.*—For the purpose of fighting forest fires in the vicinity of the right-of-way which are not caused by the contractor or his employees, the contractor, when requested by the Forest Service, National Park Service or other Federal agency having jurisdiction, shall place his employees temporarily at the disposal of the appropriate Federal agency, with the understanding, however, that payment to such employees for such services will be made by the Government at not less than the current rate for such services established by the said Federal agency in the area concerned, and any employees furnished will be relieved from fire fighting as soon as the officer of the Federal agency in charge finds that it is practicable to employ other labor adequate for the protection of the area. If such Federal officer is on the ground, the fighting of the fire will be under his direction.

(n) *Periods for Planting, Seeding, and Sodding.*—Except as otherwise authorized in writing by the engineer, the contractor shall perform all planting, seeding, and sodding work only within the respective normal planting, seeding, or sodding periods stated by symbols and dates in the special provisions for the respective classified materials and work, and in any case, only when local climatic and soil conditions favor the proper performance of each item of work. Movement of living materials to or from nursery rows, storage warehouses, heeling-in grounds and similar operations shall be considered a part of planting operations.

In general, the dating of the "normal planting or seeding period" will be fixed between the end of a "normal growing season" and the beginning of the next "normal growing season" of the locality. The end of a "normal growing season" shall be defined as the average date of the falling or drying up of the leaves of deciduous trees in the locality. The beginning of a "normal growing season" shall be defined as the average date when the leaves of the most common native deciduous trees are about one-third full (mature) size in that locality.

The beginning and the ending dates for sodding operations (e-1) will be found listed in the special provisions. The beginning and the ending dates of the spring planting and seeding periods, for such of the operations enumerated in (o) as are involved in the contract, will be found listed by day and month in the special provisions. Similarly where fall planting is to be permitted, the beginning and the ending dates of the fall planting and seeding periods, for such of the operations enumerated in (o) as are involved in the contract, are listed by day and month in the special provisions. The dates listed in the special provisions for spring or fall planting and seeding periods are not necessarily identical with calendar spring

or fall months. In cases where, for any of the classes of work, no dates for fall planting appear in the special provisions, fall planting shall not be allowed.

(o) *Symbols for Planting and Allied Operations.*—In the special provisions the intended beginning and ending dates of the planting or seeding periods will be found listed in the following manner: Where the caption (a-1) appears followed by two dates, it shall be understood that the said two dates constitute the beginning and ending dates for the spring planting period for deciduous (dry or bare-rooted) plant stock and similarly, where the caption (a-2) appears followed by two dates, it shall be understood that the said two dates constitute the beginning and ending dates for the fall planting period permitted for deciduous (dry or bare-rooted) plant stock. A similar understanding is intended for the successive captions given below:

- (a-1) For spring planting deciduous (dry or bare-rooted) plant stock.
- (a-2) For fall planting deciduous (dry or bare-rooted) plant stock.
- (b-1) For spring planting deciduous (balled and burlapped—B & B) stock.
- (b-2) For fall planting deciduous (balled and burlapped—B & B) stock.
- (c-1) For spring planting evergreen (balled and burlapped—B & B) stock.
- (c-2) For fall (late or early fall) planting evergreen (balled and burlapped—B & B) stock.
- (d-1) For spring (grass) seeding operations.
- (d-2) For fall (grass) seeding operations.
- (e-1) For sodding operations.
- (f-1) For spring wild flower seeding operations.
- (f-2) For fall wild flower seeding operations.
- (g-1) For large-size tree-moving operations (spring).
- (g-2) For large-size tree-moving operations (fall).

Art. 8.4 CHARACTER OF WORKMEN AND EQUIPMENT.—The contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

(a) *Proficiency of Workmen.*—All workmen must have sufficient skill and experience to perform properly the work assigned them. All workmen engaged on special work or skilled work, such as that required in the construction of bituminous pavements, concrete bases, pavements, or structures, or required in planting, seeding, or landscaping work, or in any trade, shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

(b) *Equipment Requirements.*—All equipment which is proposed to be used on the work, shall be of sufficient size and in such mechanical condition as to meet with the requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highways will result from its use. The engineer may order the removal and require replacement of any unsatisfactory equipment.

Should the contractor fail to furnish suitable and sufficient equipment for the proper prosecution of the work, the engineer may withhold all estimates, which are or may become due, or may suspend the work until his orders are complied with. Failure of the contractor to provide adequate and satisfactory equipment may result in annulment of the contract.

No change in the machinery and equipment employed on the work, which shall have the effect of decreasing its capacity, shall be made except upon written permission from the engineer. The measure of the capacity of machinery and equipment shall be its actual performance on the project.

(c) *Special Requirements for Equipment for Heating and Road Application of Bituminous Materials.*—Equipment for heating bituminous material shall consist of a retort or steam coils so designed that steam will not be introduced into the material. The distributor shall have pneumatic tires of such width and number that the load produced on the road surface shall not exceed 650 pounds per inch of tire width, and shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates of from 0.05 to 2.0 gallons per square yard, with a pressure range of from 25 to 75 pounds per square inch, and with an allowable variation from any specified rate not to exceed 5 percent. Distributor equipment shall include a tachometer, pressure gages, volume measuring devices, and a thermometer for reading temperatures of tank contents.

(d) *Discharge of Workmen for Cause.*—Any foreman or workman employed by the contractor or by any subcontractor who, in the opinion of the engineer or his authorized representative, does not perform his work in a proper and skillful manner or is disrespectful, intemperate, disorderly or otherwise objectionable, shall, at the written request of the engineer, be removed forthwith by the contractor or subcontractor employing such foreman or workman, and shall not be employed again in any portion of the work without the written consent of the engineer.

Should the contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the engineer may withhold all estimates, which are or may become due, or may suspend the work until such orders are complied with.

Art. 8.5 TEMPORARY SUSPENSION OF WORK.—The engineer shall have the authority to suspend the work wholly or in part by written order, for such period as he may deem necessary due to unsuitable weather, to conditions considered unfavorable for the suitable prosecution of the work, or to failure on the part of the contractor to correct conditions unsafe for workmen or the general public or to carry out orders given or to perform any provisions of the contract. The contractor shall immediately comply with such order to suspend the work wholly or in part.

Art. 8.6 CONTRACT TIME, DETERMINATION AND EXTENSION OF.—The "contract time" for performance of the work, furnishing of the materials and completion of the construction contemplated by the contract shall be the number of calendar days allowed in the contract as awarded subject to adjustment under the following terms:

The number of calendar days for performance allowed in the contract as awarded is based on the original quantities as defined in article 3.2. If satisfactory fulfillment of the contract, with extensions and increases authorized under article 4.3 (b) shall require the performance of work in greater quantities than those set forth in the bid schedule, the time allowed for performance shall be increased in the same ratio that the total cost of the work actually performed shall bear to the total cost in the bid schedule. The time allowance for any extensions and increases authorized under article 4.3 (c) shall be as agreed upon and set forth in the covering order or agreement, as the case may be. In case of total suspension, not due to any fault of the contractor, the elapsed time between effective order to suspend operations and order to resume work shall be allowed the contractor in adjusting the time allowed for performance. No time allowance will be granted as a result of partial suspension.

The contract time shall begin 10 days after the date of receipt by the contractor of the notice to proceed. When the final inspection has been duly made by the engineer as prescribed in article 5.8, the daily time charge shall cease.

Suspension involving cessation of work on all items except minor construction not affected by or connected with the cause of suspension shall be considered as "total suspension." Work of an emergency nature ordered by the engineer for the convenience of public traffic and the production of materials for storage if performed during a period of "total suspension" shall not be charged to contract time.

Where all work is completed but deferment of final inspection and acceptance is necessary pending lapse of any 45-day spring growing period, as hereinbefore defined, and due solely to that cause, no daily time charge shall accrue against the contractor for such elapsed period.

Art. 8.7 FAILURE TO COMPLETE WORK WITHIN CONTRACT TIME.—Pursuant to article 9 of Form 23, providing for "liquidated damages for each calendar day of delay until the work is completed or accepted," the amount of damages per day of any such delay beyond the contract time has been determined on the basis of the cost of engineering and inspection according to the size of the project, and the total amount of liquidated damages shall be as calculated from the daily charge given in the table below, corresponding to the total original contract cost of the particular contract; provided, however, that the daily charge for liquidated damages, if any, given in the invitation for bids shall prevail over the requirements of the table below:

<i>Original contract amount:</i>	<i>Daily charge</i>
Up to \$25,000-----	\$10
\$25,000 to 50,000-----	20
\$50,000 to \$100,000-----	25
\$100,000 to \$500,000-----	50
\$500,000 to \$750,000-----	75

Art. 8.8 TERMINATION OF CONTRACTOR'S RESPONSIBILITY.—This contract will be considered complete when all work has been completed, the final inspection made, the work accepted by the engineer, and the final voucher and estimate approved for payment, and the date of said approval shall be the date of final completion. The contractor's responsibility shall then cease, except as set forth in the performance and payment bonds.

MEASUREMENT AND PAYMENT

Article 9.1 MEASUREMENT OF QUANTITIES.—All work completed under the contract shall be measured by the engineer according to United States Standard measures, unless otherwise agreed upon in writing. Unless otherwise shown on the original plans for the contract as awarded, all lengths and distances shall be measured horizontally. Unless otherwise shown on the plans, all cross sections for base courses, surface courses, and pavements show vertical design; check measurements for purposes of pay for work completed under the said items shall be vertical measurements for depth and thickness and horizontal measurements for longitudinal and transverse dimensions, including longitudinal measurements for areas of such items.

When the bid schedule calls for payment on a ton basis, the unit shall be the ton of 2,000 pounds.

Scales and weigh house.—When the bid schedule calls for payment on a ton basis, for base or surface course material or bituminous mixture, the contractor shall furnish platform scales and a weigh house which will remain his property upon completion of the work. The scales shall be satisfactory to the engineer and shall be sealed as often as the engineer may deem it necessary to insure their accuracy. The weigh house shall be constructed in such a manner as to protect the recording device of the scales and to provide space for storage of testing equipment. It shall be weatherproof and not less than 10 feet by 12 feet in plan, and shall have one sliding window facing the scale platform, one end window, and a shelf desk at least 2 feet wide and 6 feet long.

Art. 9.2 SCOPE OF PAYMENTS.—The quantities listed in the bid schedule do not govern final payment. Payments to the contractor will be made only for the actual quantities of contract items performed in accordance with the plans and specifications and if, upon completion of the construction, these actual quantities show either an increase or decrease from the quantities given in the bid schedule, the contract unit prices will still prevail, except as provided in article 9.3 or 9.4.

The contractor shall accept the compensation, as herein provided, in full payment for furnishing all materials, labor, tools, equipment and incidentals necessary to the completed work and for performing all work contemplated and embraced under the contract; also for all loss or damage arising from the nature of the work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the

prosecution of the work and until its final acceptance by the engineer, and for all risks of every description connected with the prosecution of the work; also for all expenses incurred in consequence of the suspension of the work as herein authorized.

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

The payment of any partial estimate or of any retained percentage, except by and under the approved final estimate and voucher, in no way shall affect the obligation of the contractor to repair or renew any defective parts of the construction, or to replace any defective materials used in the construction, or to be responsible for all damage due to such defects.

Art. 9.3 CHANGES AND ALTERED QUANTITIES AND EXTRA WORK.—(a) When the actual quantities of work ordered and performed vary from the corresponding quantities set out in the bid schedule but such variance is within the percentage limits hereinbefore agreed upon in article 4.3 (b) as "normal and expected," and whether or not there have been any changes in plans the contractor shall accept, as payment in full so far as contract items are concerned, payment at the original contract unit prices for the actual quantities of work done and no allowance or other adjustment will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits, suffered or claimed by the contractor resulting either directly from such alterations, or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefor or from any other cause, save the said payment for the actual quantity done at the original contract unit price.

(b) Whenever quantities vary from the original beyond the percentage limits recognized in article 4.3 (b), if demand is made by either contracting party, adjusted prices and terms (not more than 15 percent in excess of estimated cost) shall be agreed upon and stated in covering change orders or supplemental agreements, signed by both parties.

Art. 9.4 WORK ORDERS, EXTRA WORK ORDERS, SUPPLEMENTAL AGREEMENTS.—(a) *Work Orders.*—Written orders signed by the engineer, or by his designated representative, of a contractual status requiring performance by the contractor without negotiation of any sort. Work orders do not embrace any change of the character defined in article 4.3 (c) nor any extra work as defined in article 1.18.

Work orders are applicable in cases arising during construction where no payment of funds is involved but where

written instructions are necessary concerning features, payment for which has been, or is to be, otherwise made under the contract as follows:

1. Work orders are applicable where it is necessary to issue written orders to perform work or furnish material embraced under the original unchanged contract in cases where the said performance or furnishing is, by the terms of the specifications, included under the bid price for some contract item as a necessary or subsidiary element thereof and consequently is not eligible for direct measurement or payment, while the said contract item as a whole is eligible for direct payment by its measured quantities multiplied by its unit price. These cases may arise where the said work has not been brought to the attention of the contractor or has been neglected, overlooked or delayed by the contractor or for any other reason has been held by the engineer to require the issuance of a written order to secure its proper execution under the contract.

2. Work orders are used to require performance of any changes recognized by article 4.3 (b) and requiring written orders.

The term "work orders" also includes orders concerning the performance of work in connection with "Special detours" and in connection with maintenance work as authorized by articles 4.4 (b) and 7.11, whether by unit price, lump sum or by force account, provided that a contingent sum to cover has been set up in the bid schedule and is available.

Since in all cases where work orders as herein defined are used, automatic agreement on the part of the contractor is presumed as of the essence of the original contractual agreement, specific assent to such work orders is not necessary. No negotiation is involved save an understanding as to wages and rates, and such orders upon receipt are binding upon the contractor, who shall thereupon acknowledge them merely to establish the fact of receipt and proceed with the execution thereof.

(b) *Extra Work Orders.*—Extra work orders shall be issued for the following cases:

1. For the performance of any required extra work as defined in article 1.18 unless as more expedient the same is included by the engineer in a change order.

2. For all work performed on a force account basis except for the performance of work or the furnishing of material for which a contingent sum is set up on the bid schedule and when cost is not in excess of same.

3. For any work being performed or material being furnished under a work order when the contingent amount set up in the bid schedule for that work is exceeded.

Extra work orders shall be signed by the engineer and by the contractor and, if the amount is \$500 or more, must be approved by the contracting officer or his duly authorized representative. The order shall be so drawn as to indicate acceptance on the part

of the contractor, as evidenced by his signature, of the agreed prices, lump sum or other basis of payment provided therein.

The contractor shall not proceed with work under an extra work order until he has received an executed copy of the order.

(c) *Supplemental Agreement.*—Whenever the sum total cost of all items exceeds the original total contract cost by the percentage mentioned in article 4.3 (c)-1 if demand is made by either contracting party, an agreement shall be reached, establishing modified unit prices for all unconstructed major items whose quantities exceed the original quantities by 25 or more percent, and the contract correspondingly modified by a supplemental agreement which shall be a written agreement executed by the contracting officer or his duly authorized representative and the contractor. Where there are no major items changed more than 25 percent, adjustments shall apply to minor items changed more than 25 percent.

Agreed prices for any items in supplemental agreements shall not in any case be more than 15 percent in excess of cost as estimated by the engineer. If prices cannot be agreed upon, the supplemental agreement shall be drawn on a force account basis subject to the limitations set out in article 9.5 in these specifications.

Art. 9.5 FORCE ACCOUNT WORK.—All work performed or labor and materials furnished on a force account basis shall be paid for on the following basis:

(a) For all labor and teams, and for foremen in direct charge of the specific operations, the contractor shall be paid:

1. The actual cost of wages or team hire at rates agreed upon in writing before work is started.
2. The actual cost of Workmen's Compensation Insurance.
3. An amount equal to 15 percent of the actual cost of wages and Workmen's Compensation Insurance.
4. The actual cost of Social Security taxes to which cost no percentage shall be added.

(b) For all materials accepted by the engineer and used in the work, the contractor shall be paid the actual cost of such material, including transportation charges, to which cost shall be added a sum equal to 15 percent thereof.

(c) For any machine-power tools, special or heavy equipment used, the contractor shall be paid reasonable rentals at rates which shall include compensation for fuel and lubricants, and which shall be agreed upon in writing before starting work, and to which sum no percentage shall be added. No allowance shall be made for the use of small tools and manual equipment.

(d) No allowance shall be made for general superintendence.

(e) The contractor's representative and the engineer shall compare records of the work performed as ordered on a force account basis at the end of each day on which such work is performed. Copies of these records shall be made upon suitable

forms provided for this purpose and signed by both the engineer and the contractor's representative, one copy being retained by each party. All claims for work done on a force account basis shall be certified and submitted to the engineer by the contractor, and such statements shall be filed with the engineer not later than the 10th day of the month following that in which the work was actually performed.

Art. 9.6 PARTIAL PAYMENTS.—Pursuant to article 16 of Form 23, partial payments will be made. It is hereby mutually agreed that in case of planting operations no partial payments will be made on living or perishable plant materials until planted in place.

Art. 9.7 ACCEPTANCE AND FINAL PAYMENT.—When the final inspection and final acceptance have been duly made by the engineer as provided in article 5.8 and subject to the terms of article 8.8, the engineer shall prepare the final estimate and final voucher. Thereafter final payment and settlement will be made in accordance with article 16 (d) of Form 23.

DIVISION II.—CONSTRUCTION DETAILS

EARTHWORK

ITEM 20.—CLEARING AND GRUBBING

(Pay areas shown on plans)

DESCRIPTION

20-1.1 This item shall consist of clearing and grubbing in accordance with these specifications. The areas to be cleared and/or grubbed under this item shall be those areas specifically so denoted on the plans with locations and boundaries.

The clearing and grubbing shall consist of clearing the designated area of all trees, down timber, snags, brush, and other vegetation, rubbish, and all other objectionable material, and shall include grubbing stumps, roots, and matted roots, and disposing of all spoils material resulting from the clearing and grubbing.

CONSTRUCTION METHODS

20-3.1 CLEARING AND GRUBBING OPERATIONS.—The areas denoted on the plans to be cleared and grubbed under this item shall be staked on the ground by the engineer.

Such individual trees as the engineer may designate and mark within the areas staked for clearing shall be left standing and uninjured. In order to minimize damage to trees that are to be left standing, trees shall be felled toward the center of the area being cleared if so required by the engineer. When necessary to prevent injury to structures, or other trees or property, or to minimize danger to traffic, trees shall be cut in sections from the top downward.

All stumps, roots larger than 3 inches in diameter, and matted roots shall be dug out and removed from the area designated, except that stumps at points where embankment is to be more than 3 feet in height may be left in place, provided they do not extend more than 1 foot above the original ground and do not extend closer than 2 feet to any subgrade or slope surface. In cuts, the digging out and removal of all such stumps and roots shall be done to such depth that in no case will any portion remaining below grade extend closer than 18 inches to any subgrade, shoulder, or slope surface. On areas staked for clearing and grubbing beyond the road prism

slope lines, stumps may be cut flush with the ground in lieu of being removed, when so ordered by the engineer.

20-3.2 TIMBER USED BY CONTRACTOR.—Timber cut from the highway, meeting specification requirements, may be utilized by the contractor for constructing drainage or other structures required in the project and also for camp purposes, provided written authorization for such use is obtained from the Federal agency having jurisdiction over the area within which the highway is being constructed.

20-3.3 TIMBER TO BE SAVED.—(a) When required by the Forest Service, National Park Service, or other Federal agency having jurisdiction over the area through which the highway is being constructed, the contractor will be notified through the engineer that merchantable portions of the trees to be cut shall be trimmed of limbs and tops, sawed into suitable log lengths and neatly piled along the highway, separately from the piles to be burned or otherwise disposed of. The contractor will not be required to cut merchantable timber into lengths less than 10 feet.

(b) Eastern locust or eastern cedar trees, when located in the area to be cleared, shall be trimmed of limbs and tops, cut into 10-foot or 18-foot lengths and stored off the ground where and as directed by the engineer, provided that individual lengths having a minimum dimension of less than 6 inches under the bark shall not be saved.

20-3.4 DISPOSAL OF REFUSE.—All timber, except such timber as may be ordered used or saved as provided under 3.2 and 3.3 above, all logs, brush, stumps, roots, rotten wood, and other refuse from the clearing and grubbing operations shall be burned, provided, however, that when permitted in writing by the Forest Service, National Park Service, or other Federal agency having jurisdiction over the area through which the highway is being constructed, logs and large stumps may be disposed of without burning, at locations out of sight from the roadway. Such permit will state the conditions covering disposal of such logs and stumps and shall be obtained through the engineer.

Burning shall be done in accordance with the provisions of article 8.3. Piles for burning shall be placed either in the cleared area near the center or in adjacent open spaces, where no damage to trees or other vegetation will occur.

20-3.5 REHANDLING.—In the event that the contractor is ordered by the engineer not to start burning operations or to suspend such operations because of hazardous weather conditions or for other reasons, material to be burned which interferes with subsequent construction operations shall be moved by the contractor to temporary locations clear of construction operations and later, if ordered by the engineer, be placed on the constructed road or other designated spot and burned.

METHOD OF MEASUREMENT

20-4.1 The acreage to be paid for under this item shall be the number of acres and fractions thereof, of land contained in the areas specifically denoted on the plans with location and boundaries for clearing and grubbing under this item, provided that all the clearing and grubbing within those areas has been completed to the satisfaction of the engineer. The acreage for payment shall include areas for borrow pits selected by the engineer under BORROW and/or STRIPPING AND STORING TOPSOIL and for outlook points and for clear vision and similar areas only insofar as such acreage is within the said boundaries for this item as denoted on the plans or on the plans as duly altered by the engineer. Any areas cleared and grubbed for borrow pits selected by the contractor shall not be included in the measurement for payment.

BASIS OF PAYMENT

20-5.1 The acreage, determined as provided above, shall be paid for at the contract unit price per acre for "Clearing and Grubbing," which price and payment shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the item, except for the extra work of any rehandling, as stipulated under 3.5 above, not made necessary by fault or negligence of the contractor.

ITEM 21.—RANDOM CLEARING

(Pay areas limited by definition)

DESCRIPTION

21-1.1 This item shall consist of clearing in accordance with these specifications. The net areas to be cleared under this item shall be those areas determined by the engineer as requiring clearing within the terms of 4.1 below, when called for in the bid schedule.

21-1.2 The net areas for clearing shall be within the boundaries staked for ROADWAY AND DRAINAGE EXCAVATION, UNCLASSIFIED EXCAVATION FOR STRUCTURES, or within the boundaries (if staked) of 5-foot strips of land lying outside of, and contiguous to, the road prism slope lines or within the boundaries of borrow pits staked under case 1, BORROW, or within the boundaries of land staked for outlook points and clear vision or improvement areas, and/or within the boundaries of land staked for STRIPPING AND STORING TOPSOIL.

21-1.3 Clearing shall consist of clearing the net areas designated of all trees, down timber, snags, stumps required to be cut off but not grubbed, brush and other vegetation, rubbish and all other objectionable material and disposing of all spoils material resulting from the clearing.

CONSTRUCTION METHODS

21-3.1 CLEARING OPERATIONS.—The engineer shall stake out on the ground those net areas throughout which the clearing work to be required meets the definition of such work given in 4.1 below.

Such individual trees as the engineer may designate and mark within the areas staked for clearing shall be left standing and uninjured. In order to minimize damage to trees that are to be left standing, trees shall be felled toward the center of the area being cleared if so required by the engineer. When necessary to prevent injury to structures, or other trees or property, or to minimize dangers to traffic, trees shall be cut in sections from the top downward.

In clearing areas where grubbing is not ordered, the contractor shall leave no stump of a height greater than 3 feet above the ground or of such lesser height above the ground as may be prescribed on the original plans on which the contract was awarded.

In clearing areas, at points where embankment is to be more than 3 feet in height, all trees, snags, stumps, and bushes shall be cut off at a height not more than one foot above the ground.

21-3.2 TIMBER USED BY CONTRACTOR.—Timber cut from the highway, meeting specification requirements, may be utilized by the contractor for constructing drainage or other structures required in the project and also for camp purposes, provided written authorization for such use is obtained from the Federal agency having jurisdiction over the area within which the highway is being constructed.

21-3.3 TIMBER TO BE SAVED.—(a) When required by the Forest Service, National Park Service, or other Federal agency having jurisdiction over the area through which the highway is being constructed, the contractor will be notified through the engineer that merchantable portions of the trees to be cut shall be trimmed of limbs and tops, sawed into suitable log lengths and neatly piled along the highway, separately from the piles to be burned or otherwise disposed of. The contractor will not be required to cut merchantable timber into lengths less than 10 feet.

(b) Eastern locust or eastern cedar trees, when located in the area to be cleared, shall be trimmed of limbs and tops, cut into 10-foot or 18-foot lengths and stored off the ground where and as directed by the engineer, provided that individual lengths having a minimum dimension of less than 6 inches under the bark shall not be saved.

21-3.4 DISPOSAL OF REFUSE.—All timber, except such timber as may be ordered used or saved as provided under 3.2 and 3.3 above, all logs, brush, uprooted stumps, rotten wood, and other refuse from the clearing operations shall be burned, provided, however, that when permitted in writing by the Forest Service, National Park Service, or other Federal agency having jurisdiction over the area through which the highway is being built, logs and large stumps may be disposed of without burning, at locations out of sight from the roadway. Such permit will state the conditions covering disposal of such logs and stumps and shall be obtained through the engineer.

Burning shall be done in accordance with the provisions of article 8.3. Piles for burning shall be placed either in the cleared area near the center or in adjacent open spaces, where no damage to trees or other vegetation will occur.

21-3.5 REHANDLING.—In the event that the contractor is ordered by the engineer not to start burning operations or to suspend such operations because of hazardous weather conditions or for other reasons, material to be burned which interferes with subsequent construction operations shall be moved by the contractor to temporary locations clear of construction operations and later, if ordered by the engineer, be placed on the constructed road or other designated spot and burned.

METHOD OF MEASUREMENT

21-4.1 The unit of measurement for random clearing shall be the "clearing unit." The work of clearing, for purposes of payment only, shall be divided into two classes, "Random Clearing" and "Heavy Random Clearing." This distinction shall be as stated in (d) below.

The area of random clearing to be paid for shall be the number of clearing units acceptably cleared within the areas staked by the engineer under the terms set out in (a), (b), (c), and (d) below. The engineer shall determine the number of clearing units that are to be paid for.

(a) A normal clearing unit shall be a rectangle of ground, 50 feet in length in the direction parallel to the center line of the roadbed and 20 feet in width, coordinated and tied to the said center line of the roadbed in the manner set out herein. Clearing units in all cases shall be located from the center line of the roadbed as shown on the plans, or on the plans as duly altered by the engineer, as a base line. They shall be laid out contiguously, both in direction parallel and in direction perpendicular to the said center line, with the corners at even stations and half stations of the said center line, beginning with tiers on either side of the said center line and contiguous thereto, and proceeding outward to the boundaries of the area or areas to be cleared as determined and staked by the engineer.

(b) Any clearing unit shall be credited as though of normal size, whether it be larger or smaller, where (1) the dimensions are affected by adjustments for equations of center line stationing, (2) the dimensions are affected by center line curvature, and (3) the boundary of an area to be cleared, as staked by the engineer, intersects and divides any clearing unit, provided in any case that the actual area of the unit does not fall below 200 square feet. Units of less than 200 square feet in area shall be disregarded so far as payment is concerned. Bounding lines determining the lengths of units shall be normal to the center line at even stations and half stations, and widths of units shall be 20 feet measured along these normals.

(c) A clearing unit shall be counted for payment only when there has been performed within its confines the acceptable cutting and clearing of at least one 6-inch, or larger, tree or two 3-inch, or larger, trees; 6-inch trees or 3-inch trees are defined to mean standing or down trees respectively of 6-inch diameter or 3-inch diameter, when measured at a point one foot, as nearly as possible, above the average natural ground line.

(d) A clearing unit shall be counted for payment as "Heavy Random Clearing," only when there has been performed within its confines the acceptable cutting and clearing of at least one 18-inch, or larger, tree. An 18-inch tree is defined to mean a standing or down tree of 18-inch diameter when measured at a

point 3 feet, as nearly as possible, above the average natural ground line.

(c) Any unit or increment of area rendered eligible for payment only by the presence of a tree or snag paid for under SELECTIVE REMOVAL OF TREES AND SNAGS and any area denoted on the plans for inclusion under CLEARING AND GRUBBING shall be excluded from payment under this item.

BASIS OF PAYMENT

21-5.1 The number of clearing units, determined as provided above, shall be paid for at the contract unit price per clearing unit for "Random Clearing" or per clearing unit for "Heavy Random Clearing," as the case may be, which prices and payment shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete the item, except for extra work of any rehandling as stipulated under 3.5 above and not made necessary by fault or negligence of the contractor.

ITEM 21A.—RANDOM GRUBBING

(Pay areas limited by definition)

DESCRIPTION

21A-1.1 This item shall consist of grubbing in accordance with these specifications. The net areas to be grubbed under this item shall be those areas determined by the engineer as requiring grubbing within the terms of 4.1 below, when called for in the bid schedule.

21A-1.2 The net areas for grubbing shall be within the boundaries staked for ROADWAY AND DRAINAGE EXCAVATION, UNCLASSIFIED EXCAVATION FOR STRUCTURES, or within the boundaries (if staked) of the 5-foot strips of land lying outside of, and contiguous to, the road prism slope lines or within the boundaries of borrow pits staked under case 1, BORROW, or within the boundaries of land staked for out-look points and clear vision or improvement areas, and/or within the boundaries of land staked for STRIPPING AND STORING TOPSOIL.

21A-1.3 Grubbing shall consist of grubbing stumps from the net areas designated for grubbing and shall include grubbing roots and matted roots and disposing of all spoils material resulting from the grubbing.

CONSTRUCTION METHODS

21A-3.1 GRUBBING OPERATIONS.—The engineer shall stake out on the ground those net areas throughout which the grubbing work to be required meets the definition of such work given in 4.1 below.

All stumps and all roots larger than 3 inches in diameter and all matted roots shall be dug out and removed from the net area designated except any stumps at points where embankment is to be more than 3 feet in height. In cuts the digging out and removal of stumps and roots shall be done to such depth that in no case will any portion remaining below grade extend closer than 18 inches to any subgrade, shoulder or slope surface.

21A-3.2 DISPOSAL OF REFUSE.—All brush, stumps, roots, rotten wood and other refuse from the grubbing operations shall be burned, provided, however, that when permitted in writing by the Forest Service, National Park Service, or other Federal agency having jurisdiction over the area through which the highway is being built, large stumps may be disposed of without burning, at locations out of sight from the roadway.

Such permit will state the conditions covering disposal of such stumps and shall be obtained through the engineer.

Burning shall be done in accordance with the provisions of article 8.3. Piles for burning shall be placed either in the cleared area near its center or in adjacent open spaces, where no damage to trees or other vegetation will occur.

21A-3.3 REHANDLING.—In the event that the contractor is ordered by the engineer not to start burning operations or to suspend such operations because of hazardous weather conditions or for other reasons, material to be burned which interferes with subsequent construction operations shall be moved by the contractor to temporary locations clear of construction operations and later, if ordered by the engineer, be placed on the constructed road or other designated spot and burned.

METHOD OF MEASUREMENT

21A-4.1 The unit of measurement for random grubbing shall be the "grubbing unit." The work of grubbing, for purposes of payment only, shall be divided into two classes, "Random Grubbing" and "Heavy Random Grubbing." This distinction shall be as stated in (d) below.

The area of random grubbing to be paid for shall be the number of grubbing units acceptably grubbed within the areas staked by the engineer under the terms set out in (a), (b), (c), and (d) below. The engineer shall determine the number of grubbing units that are to be paid for.

(a) A normal grubbing unit shall be a rectangle of ground, 50 feet in length in the direction parallel to the center line of the roadbed and 20 feet in width, coordinated and tied to the said center line of the roadbed in the manner set out herein. Grubbing units in all cases shall be located from the center line of the roadbed, as shown on the plans or on the plans as duly altered by the engineer, as a base line. They shall be laid out contiguously, both in direction parallel and in direction perpendicular to the said center line, with corners at even stations and half stations of the said center line, beginning with tiers on either side of the said center line and contiguous thereto, and proceeding outward to the boundaries of the area or areas to be grubbed as determined and staked by the engineer.

(b) Any grubbing unit shall be credited as though of normal size, whether it be larger or smaller, where (1) the dimensions are affected by adjustments for equations of center line stationing, (2) the dimensions are affected by center line curvature, and (3) the boundary of an area to be grubbed, as staked by the engineer, intersects and divides any grubbing unit, provided in any case that the actual area of the unit does not fall below 200 square feet. Units of less than 200 square feet in area shall be disregarded so far as payment is concerned. Bounding lines determining the lengths of units

shall be normal to the center line at even stations and half stations, and widths of units shall be 20 feet measured along these normals.

(c) A grubbing unit shall be counted for payment only when there has been performed within its confines the acceptable grubbing of at least one 6-inch, or larger, standing stump or two 3-inch, or larger, standing stumps; 6-inch standing stumps or 3-inch standing stumps are defined to mean stumps respectively of 6-inch diameter or of 3-inch diameter, when measured at a point 1 foot, as nearly as possible, above the average natural ground line.

(d) A grubbing unit shall be counted for payment as "Heavy Random Grubbing," only when there has been performed within its confines the acceptable grubbing of at least one 18-inch, or larger, standing stump. An 18-inch standing stump is defined to mean a stump of 18-inch diameter when measured at a point 3 feet, as nearly as possible, above the average natural ground line.

(e) Any area denoted on the plans for inclusion under **CLEARING AND GRUBBING** shall be excluded from payment under this item.

BASIS OF PAYMENT

21A-5.1 The number of grubbing units, determined as provided above, shall be paid for at the contract unit price per grubbing unit for "Random Grubbing" or per grubbing unit for "Heavy Random Grubbing," as the case may be, which prices and payment shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete the item, except for extra work of any rehandling as stipulated under 3.3 above and not made necessary by fault or negligence of the contractor.

ITEM 22.—SELECTIVE REMOVAL OF TREES AND SNAGS

DESCRIPTION

22-1.1 This item shall consist of the removing and disposing of such isolated trees and snags standing or located beyond the lines parallel to, and 5 feet outside of, the road prism slope lines, as are shown on the plans or designated by the engineer for removal under this item. This item shall include the removal of trees that are leaning or otherwise dangerous and snags which, in the opinion of the engineer, are hazards to traffic.

CONSTRUCTION METHODS

22-3.1 The trees and snags shall be cut and disposed of as specified for trees and spoils under CLEARING AND GRUBBING. The trees and snags shall be cut flush with the natural ground and grubbing of the stumps will not be required.

METHOD OF MEASUREMENT

22-4.1 The unit of measurement shall be the square foot of basal area or the number of trees and snags of the several sizes, whichever is called for in the bid schedule. The quantity to be paid for shall be the summation of the number of square feet contained in the basal areas, or the number of the several sizes, of trees and snags removed and disposed of as ordered. No tree or snag shall be included, if it is found within any area designated by the engineer under ITEM 20, CLEARING AND GRUBBING or within any area designated as a borrow or material pit.

The basal areas or sizes of trees and snags shall be determined by measuring the trunks at a point 3 feet above the average natural ground line, as nearly as possible.

Where the bid schedule calls for payment by size, the size and designation under which each tree and snag shall be paid for shall be determined in accordance with the following schedule of sizes:

<i>Size of tree, diameter, breast height (D.B.H.):</i>	<i>Pay name Tree of—</i>
4-inch to 8-inch-----	6-inch size.
8-inch to 12-inch-----	10-inch size.
12-inch to 24-inch-----	18-inch size.
24-inch to 36-inch-----	30-inch size.
36-inch to 60-inch-----	48-inch size.
60-inch and over-----	60-inch size.

BASIS OF PAYMENT

22-5.1 The quantities, determined as provided above, shall be paid for at the contract unit prices per square foot of basal area, or per tree or snag, of the several sizes, as the case may be, for "Selective Removal of Trees and Snags," which prices and payments shall constitute full compensation for removing and disposing of the selected trees and snags, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 23.—STRIPPING AND STORING TOPSOIL

DESCRIPTION

23-1.1 This item shall consist of removing topsoil, and transporting and depositing it in storage piles, in accordance with these specifications.

CONSTRUCTION METHODS

23-3.1 The areas from which stripping of topsoil may be required shall be as indicated on the plans. The contractor shall remove topsoil from such portions of these areas and to such depths as the engineer may direct. No stripping of topsoil over any designated area shall be less than 6 inches in depth. The topsoil removed shall be transported and deposited in storage piles at locations designated by the engineer.

The topsoil shall be kept separate from other excavated materials and shall be completely removed to the required depth from any designated area prior to the beginning of regular excavation or embankment work in the area. If topsoil is removed to a greater depth than directed by the engineer, payment will be made only for the amount of topsoil directed to be removed.

METHOD OF MEASUREMENT

23-4.1 The yardage to be paid for shall be the number of cubic yards measured in original position and computed by average end area method, of topsoil acceptably stripped and stored as hereinabove prescribed.

BASIS OF PAYMENT

23-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Stripping and Storing Topsoil," which price and payment shall constitute full compensation for removing the topsoil, transporting and depositing in storage piles, and for all labor, equipment, tools, and incidentals necessary to complete the item, except OVERHAUL.

ITEM 24.—ROADWAY AND DRAINAGE EXCAVATION

DESCRIPTION

24-1.1 This item shall consist of excavating and grading the roadway, including gutters, ditches, outlooks, parking areas, intersections, approaches, and private entrances, excavating unsuitable subgrade material, excavating suitable subgrade material and/or road metalling found in the roadway and ordered reserved for later placement in the improvement, and disposing of all excavated material, all in accordance with these specifications and in conformity with the lines, grades, and dimensions as shown on the plans or as staked by the engineer. This item also shall include the removal and disposal of structures that obstruct, encroach upon, or otherwise obstruct the work.

24-1.2 This item shall include any necessary clearing and grubbing of the areas staked by the engineer for ROADWAY AND DRAINAGE EXCAVATION and, if so required by the engineer, of the areas outside of and contiguous to the road prism slope lines to a width of 5 feet, except any portion of such areas that is included within the boundaries staked for CLEARING AND GRUBBING and performed thereunder, and except any such work within such areas meeting the definition of RANDOM CLEARING and/or RANDOM GRUBBING where those items appear in the contract.

24-1.3 CLASSIFICATION.—(a) Unless the bid schedule calls for "Solid Rock Excavation" and/or "Common Excavation," all excavation under this item shall be considered "Unclassified Excavation" regardless of the nature of the material excavated, provided, however, that in projects where deemed by the engineer more practical, the plans will arbitrarily divide the project into appropriate sections or units; the excavation yardage in each section will then be identified as "Unclassified Excavation, Unit A," "Unclassified Excavation, Unit B," etc., all as set forth on the project plans and bid schedule.

(b) Solid rock excavation, when this classification is called for in the bid schedule, shall consist of the excavation, removal, and disposal of boulders, one-half cubic yard in volume or greater, and of all hard rock found in place which, in the opinion of the engineer, can be removed only by blasting.

(c) Common excavation, when this classification is called for in the bid schedule, shall consist of all excavation under this item not included in solid rock excavation.

CONSTRUCTION METHODS

24-3.1 UTILIZATION OF EXCAVATED MATERIALS.—

All suitable material removed from the excavations shall be used as far as practicable in the formation of the embankment, subgrade, shoulders, slopes, bedding, and backfill for pipe culverts, and elsewhere and at such other places as directed. No excavated material shall be wasted without written permission, and when material is to be wasted, it shall be disposed of as prescribed under DISPOSAL OF SURPLUS MATERIAL.

24-3.2 CLEARING AND GRUBBING.—Clearing and grubbing to be performed under this item shall include clearing the designated ground of all trees, down timber, snags, brush, and other vegetation, rubbish, and all other objectionable material, and shall include grubbing stumps, roots, and matted roots, and disposing and burning of all spoils material resulting from the clearing and grubbing. Designated trees shall be left standing and uninjured.

On areas staked for clearing and/or grubbing beyond the road prism slope lines, stumps may be cut flush with the ground in lieu of being removed, when so ordered by the engineer.

All stumps, bushes, roots over 3 inches in diameter, and matted roots shall be grubbed and removed to such depth that in no case will they extend closer than 18 inches to any subgrade or shoulder surface.

24-3.3 ROCK FOR SLOPE PROTECTION.—Where so required, coarse rock encountered in the excavation shall be conserved and used as directed for constructing the sides of embankments adjacent to or parallel with any stream or used where such material may serve as protection against slope or channel erosion.

24-3.4 CONSERVING CUSHION AND FINISHING MATERIAL.—During the progress of the excavation, material taken from the cuts and deemed suitable for subgrade cushion or for topping material or for road finishing shall be saved and utilized for those purposes as directed by the engineer.

24-3.5 CONSERVING TOPSOIL.—Where directed, suitable topsoil material shall be conserved during the normal excavation operation and used as cover material to facilitate regrowth of vegetation on embankments.

24-3.6 STREAM OBSTRUCTION.—Material deposited in any stream channel which in any way whatsoever obstructs or impairs the flow of the stream, thus endangering the roadway or stream bank, shall be removed as directed by the engineer and at the contractor's expense.

24-3.7 DITCHES.—"Ditches" shall be interpreted to mean roadway ditches and gutters, changes in channels of streams, inlet and outlet ditches to culverts and other structures, and ditches parallel to or in connection with the roadway, but

beyond the limits of the road prism as constructed, whether the excavation is dry or wet. Ditches also include any toe ditches which are to be excavated at the toes of embankments, as indicated on the plans. All ditches shall be excavated under this item, except such specific ditches as are denoted on the plans for performance under UNCLASSIFIED EXCAVATION FOR STRUCTURES AND FURROW DITCHES.

All material excavated from ditches and channel changes, except material shown on the plans to be placed in dikes, shall be placed in embankments, unless otherwise directed by the engineer. No excavation material or spoils material from a ditch shall be deposited or left within 3 feet of the edge of the ditch unless otherwise shown on the plans or ordered in writing by the engineer.

Gutters shall be cut accurately to cross section and grade as indicated by the plans. Care shall be taken not to excavate gutters below the grade contemplated and the engineer may order any such places brought to grade with suitable stone or cobble to form an adequate gutter paving.

All roots, stumps, and other foreign matter in the sides and bottoms of ditches and gutters shall be cut to conform to the slope, grade, and shape of the section shown. The contractor shall maintain and keep open and free from leaves, sticks, and other debris all ditches dug by him until final acceptance of the work.

24-3.8 PROTECTION OF ROADBED DURING CONSTRUCTION.—During the construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments or otherwise shall be so constructed as to avoid damage to embankments by erosion.

24-3.9 ROUNDING, WARPING, AND FINISHING SLOPES.—(a) *Rounding.*—The tops and bottoms of all slopes, including the slopes of drainage ditches, shall be rounded as indicated (in approximation) on the typical cross section where the material is other than solid rock. Rock such as sandstone and granite that is decomposed to such an extent that it has the same workability as earth shall be considered as earth. A layer of earth overlying rock shall be rounded above the rock as done in earth slopes.

(b) *Warping.*—Adjustments in slopes to avoid injury to standing trees or marring of weathered rock, or to harmonize with existing landscape features, shall be made and the transition to such adjusted slopes shall be gradual. At intersections of cuts and fills, slopes shall be adjusted and warped to flow into each other or into the natural ground surface without noticeable break.

(c) *Finishing.*—All earth slopes shall be finished to reasonably smooth surfaces that will merge with the adjacent terrain

without any noticeable break, and be in substantial accordance with the plane or other surfaces indicated by the lines and cross sections shown on the plans, with no variations therefrom readily discernible as viewed from the road.

Degree of finish for grading of slopes shall be that ordinarily obtainable either from blade grader or scraper operations or hand-shovel operations as the contractor may elect. The nicety of finish ordinarily associated with template and stringline or hand raking methods will not be required, except in the case of shoulders and gutters.

METHOD OF MEASUREMENT

24-4.1 The yardage to be paid for shall be the number of cubic yards measured in original position and computed by average end area method, of material acceptably excavated as hereinabove prescribed. The measurement shall not include the yardage of any material which is used for purposes other than those directed. The cross-sectional area measured shall not include water or other liquid, but shall include mud, muck, or similar semisolid material which has not been disturbed by the contractor and which cannot be drained away.

The measurement shall include overbreakage due to slides in common or unclassified excavation when not attributable to carelessness of the contractor, authorized excavation of rock below grade, and authorized excavation of unsuitable subgrade soil below grade. The measurement shall also include unavoidable overbreakage occurring in material which would classify as solid rock, whether the contract calls for classified or unclassified excavation, to an amount not to exceed 10 percent of the actual quantity contained within the lines shown on the plans for any 50-foot interval between a station and a half-station.

The measurement shall include the volume of loose scattered rocks and boulders collected as directed from the ground within the limits of the highway.

The measurement shall not include the yardage of any subgrade material or road metalling found in the roadbed and merely scarified in situ and later replaced in the improvement entirely by road mixing or similar in situ methods or operations.

BASIS OF PAYMENT

24-5.1 The yardage, measured as provided above, shall be paid for at the contract unit prices per cubic yard for "Unclassified Excavation" or "Unclassified Excavation, Unit A," "Unclassified Excavation, Unit B," etc, or "Solid Rock Excavation," and/or "Common Excavation," as the case may be, which prices and payment shall constitute full compensation for (a), (b), (c), and (d) below, and for all labor, equipment, tools,

and incidentals necessary to complete the item save the exceptions stated below.

(a) The excavating and hauling (except overhaul) and the forming and compacting of embankments, except as otherwise provided under **EMBANKMENT**.

(b) The bedding and backfilling for culverts, backfilling for structures other than pipe culverts, any "imperfect trench" backfilling required by the plans, and the disposing of surplus structures and materials.

(c) The preparing and completing of subgrade and shoulders, any conserving of cushion and topping material, salvaging of metalling, the finishing, rounding and warping of slopes, and for any conserving of topsoil when the bid schedule does not call for **STRIPPING AND STORING TOPSOIL**.

(d) Clearing and grubbing of any description necessary to the completion of this item or of other contract items subsidiary to it, the disposing and burning of the resulting spoils, except any such work performed as ordered within areas shown, located and bounded on the plans for **CLEARING AND GRUBBING**, and except any clearing as defined under **RANDOM CLEARING**, or any grubbing as defined under **RANDOM GRUBBING**, when the respective item is called for in the bid schedule.

ITEM 25.—UNCLASSIFIED EXCAVATION FOR STRUCTURES

DESCRIPTION

25-1.1 This item shall consist of the necessary excavating for the foundations of bridges, of pipe and box culverts, and of all other structures, where the item for the individual structure does not otherwise provide for the said excavating, and of the necessary excavating for underdrains, and the disposing of all excavated material, all in accordance with these specifications and in conformity with the requirements of the structures shown on the plans or as directed by the engineer.

This item shall include all necessary bailing, draining, sheeting, bracing, and the necessary construction of cribs and/or cofferdams and furnishing the materials therefor. This item shall also include any clearing and grubbing found necessary within the areas of the said excavations or within a 5-foot strip of land enclosing, and contiguous to, the areas of the said excavations except any portions of the said areas that are included within the boundaries staked for **CLEARING AND GRUBBING** and performed and accepted thereunder, and except any portion of the said areas included within the definition of **RANDOM CLEARING** and/or **RANDOM GRUBBING**, where those items appear in the contract.

No allowances will be made for classification, regardless of the material encountered.

CONSTRUCTION METHODS

25-3.1 EXCAVATION.—(a) The contractor shall notify the engineer a sufficient time in advance of the beginning of excavation for structures, so that cross-sectional elevations and measurements may be taken of the undisturbed ground. The natural ground adjacent to the structure shall not be disturbed without permission of the engineer.

(b) Trenches or foundation pits for structures or structure footings shall be excavated to the lines and grades or elevations shown on the plans or as staked by the engineer. They shall be of sufficient size to permit the placing of the full width and length of structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximate only and the engineer may order, in writing, such changes in dimensions or elevations of footings as may be deemed necessary to secure a satisfactory foundation.

(c) Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface, either level, stepped, or serrated, as directed by the engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When masonry is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until just before the masonry is to be placed, except as hereinafter provided under **FOUNDATION FILL**. Where foundation piles are used, the excavation of each pit shall be completed before the piles are driven. After the driving is completed all loose and displaced material shall be removed, leaving a smooth solid bed to receive the masonry.

(d) Where pipe culverts are to be placed in trenches excavated in embankments, the excavation of each trench shall be performed after the embankment has been constructed to a plane parallel to the proposed profile grade and to such height above the bottom of the pipe as is shown on the plans or required by the engineer.

25-3.2 UTILIZATION OF EXCAVATED MATERIALS.—All excavated material, so far as suitable, shall be utilized as backfill or embankment. The surplus material, whether or not temporarily allowed to be placed within the stream area, shall be disposed of finally in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure. No excavated material shall be deposited at any time so as to endanger the partly finished structure, either by direct pressure or indirectly by overloading banks contiguous to the operation, or other manner.

25-3.3 COFFERDAMS.—(a) Suitable and practically watertight cofferdams shall be used wherever water-bearing strata are encountered above the elevation of the bottom of the excavation. Upon request the contractor shall submit drawings showing his proposed method of cofferdam construction and other pertinent features not shown in detail on the plans. Such drawings shall be approved by the engineer before construction is started, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement.

(b) Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottoms of the footings and shall be well braced and as nearly watertight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or

enlarged so as to provide the necessary clearance and this shall be at the expense of the contractor.

(c) When conditions are encountered which render it impracticable, in his opinion, to unwater the foundation before placing masonry, the engineer may require the construction of a concrete foundation seal of such dimensions as he may consider necessary, and of such thickness as to resist any possible uplift. The concrete for such seal shall be placed as shown on the plans or as directed by the engineer. The foundation shall then be pumped out and the balance of the masonry placed in the dry. When weighted cribs are employed and the weight utilized to overcome partially the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as by the use of dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level as directed.

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

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

(f) Unless otherwise provided, cofferdams or cribs with all sheeting and bracing involved therewith shall be removed by the contractor after the completion of the substructure. Removal shall be effected in such manner as not to disturb or mar finished masonry.

25-3.4 CLEARING AND GRUBBING.—Clearing and grubbing to be performed under this item shall consist of clearing the ground designated of all trees, down timber, brush and other vegetation, rubbish and all other objectionable material, and shall include grubbing stumps, roots larger than 3 inches in diameter, and matted roots, and disposing and burning of all resulting spoils material. Trees so designated shall be left standing and uninjured.

On areas staked for clearing and/or grubbing beyond the road prism slope or structure lines, stumps may be cut flush with the ground in lieu of being removed, when so ordered by the engineer.

All stumps, bushes, roots over 3 inches in diameter, and matted roots shall be grubbed and removed to such depth that in no case will they extend closer than 18 inches to any subgrade or shoulder surface.

25-3.5 APPROVAL OF FOUNDATION.—After each excavation is completed, the contractor shall notify the engineer to that effect, and no masonry shall be placed until after the engineer has approved the depth of the excavation and the character of the foundation material.

METHOD OF MEASUREMENT

25-4.1 The yardage to be paid for shall be the number of cubic yards, measured in original position, of material acceptably excavated in conformity with the plans or as directed by the engineer, but in no case shall any yardage be included in the measurement for payment which is outside of a volume bounded by vertical planes 18 inches outside of and parallel to the neat lines of the footings. The cross-sectional area measured shall not include water or other liquid but shall include mud, muck, or similar semisolid material not resulting from construction operations and which cannot be pumped or drained away. The measurement shall not include the yardage of any excavation performed prior to the taking of elevations and measurements of the undisturbed ground.

Yardage of any material rehandled shall not be included in the measurement for payment, except that where the plans indicate or the engineer directs the excavation of trenches for culverts after embankment has been placed, the yardage of excavation for such culvert trenches shall be included in the measurement for payment under this item.

In the case of bridges and walls, yardage of excavation for footings ordered at a depth more than 5 feet below the lowest elevation for such footings shown on the original plans on which the contract was awarded shall not be included in the measurement for payment under this item.

BASIS OF PAYMENT

25-5.1 The yardage, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Unclassified Excavation for Structures," which price and payment shall constitute full compensation for (a), (b), (c), and (d) below, and for all labor, equipment, tools, and incidentals necessary to complete the item save the several exceptions as stated, and except for concrete in any concrete foundation seal. Such concrete shall be measured and paid for under CONCRETE.

(a) The forming and compacting of embankments except as otherwise provided under EMBANKMENT, the excavating and hauling except for overhaul, and (in the case of bridges and

walls) except for any excavation for footings ordered at a depth more than 5 feet below the lowest elevation for such footings shown on the original plans on which the contract was awarded. Such excavation below such 5-foot limit shall be paid for in the manner prescribed in articles 9.4 or 9.5.

(b) The bedding and backfilling for culverts and the backfilling for structures other than pipe culverts, any "imperfect trench" backfilling required by the plans, and the disposing of surplus structures and materials.

(c) The preparing and completing of subgrade and shoulders, any conserving of cushion and topping material, the finishing, rounding, and warping of slopes and the construction of any cofferdams or temporary cribs.

(d) The clearing and grubbing of any description necessary to the completion of this item or of other contract items subsidiary to it, the disposing and burning of the resulting spoils, except any such work performed as ordered within areas shown, located and bounded on the plans for **CLEARING AND GRUBBING**, and except any clearing as defined under **RANDOM CLEARING**, or any grubbing as defined under **RANDOM GRUBBING**, when the respective item is called for in the bid schedule.

ITEM 26.—BORROW

DESCRIPTION

26-1.1 This item shall consist of excavating approved material from borrow pits, when sufficient quantities of suitable material are not available from other excavations, and the disposing of all excavated material, all in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or as directed by the engineer.

26-1.2 Material to be used as topping for embankments, as a cushion for rock embankments, or for reinforcing unsatisfactory subgrade soil or for backfilling cuts, where excavation below grade is authorized, shall be obtained under this item when satisfactory material for the special purpose is not obtainable from other excavations.

26-1.3 SELECTION OF SOURCES.—Material for this item shall be obtained under the terms of case 1 and/or case 2 described below.

Case 1.—When case 1 is called for in the bid schedule, the sources of borrow material shall be indicated on the plans and/or designated by the engineer, and the contractor shall be relieved of the responsibility of obtaining the right to take the material from such sources.

Case 2.—When directed by the engineer to furnish material under case 2, the sources of borrow material shall be selected by the contractor and he shall obtain the right from the owners to procure material from such sources, shall pay all royalty and other charges involved, and shall bear all the expense of developing the sources, and of hauling and placing the material.

26-1.4 This item shall include any necessary clearing and grubbing of borrow pits and disposal and burning of the resulting spoils save where when case 1 governs the sites of such pits are included within the boundaries staked for **CLEARING AND GRUBBING** and performed thereunder, and save any such work on such pits included within the definition of **RANDOM CLEARING** and/or **RANDOM GRUBBING** where these items appear in the contract.

26-1.5 CLASSIFICATION.—No allowance will be made for classification, regardless of the material encountered.

MATERIALS

26-2.1 Material for this item shall be material selected by the engineer as meeting specifications for the particular embankment or backfill for which the material is intended. The material shall be obtained from the approved borrow sources.

CONSTRUCTION METHODS

26-3.1 The contractor shall notify the engineer sufficiently in advance of the opening of any borrow pit so that elevations and measurements of the undisturbed ground surface may be taken. Borrow pits, except when specifically permitted to the contrary, must not be visible from the completed road unless they are contiguous to, and in effect a part of, the road prism. Where practicable, borrow pits shall be so excavated that no water will collect or stand in them. Overburden and other spoils material shall be disposed of or used for special purposes as directed. Slopes of borrow pits shall be flattened and rounded. All borrow pits shall be neatly trimmed and left in such shape as to admit of accurate measurement after the excavation is completed.

METHOD OF MEASUREMENT

26-4.1 The yardage to be paid for shall be the number of cubic yards of material (including the yardage of overburden stripped from pits) measured in original position and computed by average end area method, excavated and acceptably disposed of in embankment, backfill or as otherwise ordered, except that when case 2 is called for in the bid schedule, the yardage of overburden stripped from pits (unless used as borrow material) shall not be included in the yardage to be paid for. The measurement shall not include the yardage of any excavation performed prior to the taking of elevations and measurements of the undisturbed ground.

BASIS OF PAYMENT

26-5.1 The yardage, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Unclassified Excavation for Borrow, Case 1," or "Unclassified Excavation for Borrow, Case 2," as the case may be, which price and payment shall constitute full compensation for (a), (b), (c), and (d) below, when case 1 governs the item, or full compensation for (e), (f), (g), and (h) below, when case 2 governs the item, and for all labor, equipment, tools, and incidentals necessary to complete the item save the several exceptions as stated.

(a) The excavating and hauling and the forming and compacting of embankments, except as otherwise provided under EMBANKMENT and except overhaul.

(b) The bedding and backfilling for culverts and the backfilling for structures other than pipe culverts, any "imperfect trench" backfilling required by the plans, and disposing of surplus materials.

(c) The preparing and completing of subgrade and shoulders, any conserving of cushion and topping material, the finishing, rounding, and warping of slopes, including any conserving of topsoil when the bid schedule does not call for STRIPPING AND STORING TOPSOIL.

(d) Clearing and grubbing of any description necessary to the completion of this item or of other contract items subsidiary to it and the disposing and burning of the resulting spoils, except any such work performed as ordered within areas shown, located and bounded on the plans for CLEARING AND GRUBBING, and except any clearing as defined under RANDOM CLEARING, or any grubbing as defined under RANDOM GRUBBING, when the respective item is called for in the bid schedule.

(e) The furnishing of the material, the excavating, hauling, overhauling, and the forming and compacting of embankments, except as otherwise provided under EMBANKMENT.

(f) The bedding and backfilling for culverts and the backfilling for structures other than pipe culverts, any "imperfect trench" backfilling required by the plans, and the disposing of surplus materials.

(g) The preparing and completing of subgrade and shoulders, any conserving of cushion and topping material, the finishing, rounding, and warping of slopes.

(h) Clearing and grubbing of any description necessary to the completion of this item or of other contract items subsidiary to it.

BASIS OF PAYMENT

27-5.1 The station-yards, determined as provided above, shall be paid for at the contract unit price per station-yard for "Overhaul (500 feet free haul)" or "Overhaul (1,000 feet free haul)," as the case may be, which price and payment shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 27.—OVERHAUL

(Station-yard basis)

DESCRIPTION

27-1.1 This item shall consist of authorized hauling, in excess of the free haul distance, of any material paid for under ROADWAY AND DRAINAGE EXCAVATION, BORROW (case 1), UNCLASSIFIED EXCAVATION FOR STRUCTURES, STRIPPING AND STORING TOPSOIL, or REPLACING TOPSOIL and disposed of under the various items prescribed for the disposal of such material; provided, however, that it shall not include the hauling of any material that is paid for under BORROW if the bid schedule includes an estimated quantity for SPECIAL OVERHAUL OF BORROW, or paid for under BORROW (case 2) in any event.

The free haul distance shall be 500 feet or 1,000 feet, whichever is called for in the bid schedule. Only one free haul distance shall be provided in any one contract.

METHOD OF MEASUREMENT

27-4.1 The number of station-yards of overhaul to be paid for shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance in feet, divided by 100. The overhauled material shall be the material comprehended within the terms of 1.1 above and hauled as directed more than the free haul distance (as designated in the bid schedule). The overhaul distance shall be the distance between the centers of volume of the overhauled material in its original position and after placing, less the free haul distance (as designated in the bid schedule).

The haul distance for material moved from outside the road prism shall be measured along the shortest route determined by the engineer as feasible and satisfactory. If the contractor chooses to haul the material over some other route, and such route is longer, the computations for payment shall be based on the haul distance measured along the route designated by the engineer. The haul distance for material obtained from the road prism and placed within the roadway shall be the distance measured along the center line of the road.

ITEM 28.—SPECIAL OVERHAUL OF BORROW

(Cubic-yard-mile basis)

DESCRIPTION

28-1.1 This item shall consist of authorized hauling in excess of the free haul distance of any material paid for under BORROW (case 1) and disposed of as required under the various items prescribed for the disposal of such material.

The free haul distance shall be 500 feet or 1,000 feet, whichever is called for in the bid schedule. Only one free haul distance shall be provided in any one contract.

METHOD OF MEASUREMENT

28-4.1 The number of cubic-yard-miles of special overhaul of borrow to be paid for shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance in miles and fractions thereof. The overhauled material shall be the material comprehended within the terms of 1.1 above and hauled as directed more than the free haul distance (as designated in the bid schedule). The overhaul distance shall be the distance between the centers of volume of the overhauled material in its original position and after placing, less the free haul distance (as designated in the bid schedule).

The haul distance shall be measured along the shortest route determined by the engineer as feasible and satisfactory. If the contractor chooses to haul the material over some other route, and such route is longer, the computations for payment shall be based on the haul distance measured along the route designated by the engineer.

BASIS OF PAYMENT

28-5.1 The cubic-yard-miles, determined as provided above, shall be paid for at the contract unit price per cubic-yard-mile for "Special Overhaul of Borrow (500 feet free haul)" or "Special Overhaul of Borrow (1,000 feet free haul)," as the case may be, which price and payment shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the item.

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ITEM 29.—EMBANKMENT

DESCRIPTION

29-1.1 This item shall consist of placing in embankments and in miscellaneous backfills, material excavated under ROADWAY AND DRAINAGE EXCAVATION, UNCLASSIFIED EXCAVATION FOR STRUCTURES OR BORROW, all in accordance with these specifications and in conformity with the lines, grades, cross section, and dimensions shown on the plans.

29-1.2 Embankment material shall be placed in accordance with the requirements of case 1 (subsection 3.3), except where the plans denote case 2 (subsection 3.4), case 3 (subsection 3.5) or case 4 (subsection 3.6).

MATERIALS

29-2.1 Material for embankments shall consist of suitable material approved by the engineer. Embankments and backfills shall contain no muck and no trees or tree boles, stumps, standing or matted brush, matted roots or rubbish, except that standing stumps, if they do not extend more than 1 foot above the original ground, may be left in fills provided they do not extend closer than 2 feet to any subgrade, shoulder, or slope surface.

29-2.2 OPTIMUM MOISTURE AND MAXIMUM DENSITY, Case 4.—The optimum moisture is the moisture content necessary for maximum compaction of a given material as determined by the compaction test, using A.A.S.H.O. Method T-99.

The maximum density for a given material is the density obtained by compacting a representative sample of a given material to maximum compaction, using A.A.S.H.O. Method T-99.

CONSTRUCTION METHODS

29-3.1 PREPARING GROUND SURFACE.—When embankment is to be placed upon an existing road, the existing surface shall be scarified to such degree as will provide ample bond between old and new material. Where shown on the plans, the entire existing ground surface on which an embankment is to be placed shall be plowed, stepped, or broken up in such manner that the embankment material will bond with the existing surface.

29-3.2 GENERAL REQUIREMENTS FOR PLACING.—(a) *Barriers at Embankment Toes.*—The contractor shall prevent fill material from escaping beyond the embankment slope stakes

by the erection of rock, boulder, earth, or log barriers at the toes of embankments, or by other suitable methods satisfactory to the engineer.

(b) *Topping Material*.—Suitable material shall be conserved for constructing the top portion of embankments and no rocks or hard lumps that cannot readily be broken up into pieces not over 6 inches in diameter shall be placed in the upper 12-inch layer.

(c) *Placing Over Swampy Ground*.—Where embankment is to be constructed across low swampy ground that will not support the weight of trucks or other hauling equipment, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers.

(d) *Trestles*.—Written permission from the engineer must be obtained before trestles may be used in the construction of embankments, and when trestles are so used and left in place, they must be cut off so that they do not extend closer than 2 feet to any subgrade, shoulder, or slope surface.

(e) *Backfills Outside the Slope Stakes*.—This item shall include the backfilling of all stump holes and the correction of all surface irregularities, as directed, in the area between the road prism slope lines and the staked outside boundary of clearing and grubbing.

29-3.3 LAYER PLACING WITHOUT ROLLING. (Case 1).—Except where placing under the requirements of case 2, 3, or 4 is indicated on the plans, embankments shall be placed by the following methods:

(a) Embankment material shall be placed in successive approximately horizontal layers for the full width of the roadway, except that in side hill fills the end dumping method shall be permitted where the horizontal distance from original ground surface to embankment slope line in any cross section is less than 8 feet; provided, however, that the upper 10 feet of all embankments shall be placed in successive layers.

(b) Embankments formed of "common" material, material consisting of gravel or small particles of rock, or containing by volume less than 25 percent of rock larger than 6 inches in greatest dimension, shall be constructed in layers not exceeding 12 inches in thickness before compaction.

(c) Embankments formed of material containing by volume 25 percent or more of rock larger than 6 inches in greatest dimension shall be placed in layers of sufficient depth to contain the maximum size of rock present in the material, provided, however, that in no case shall the thickness of layers before compaction exceed 24 inches. Material containing rock shall be deposited on the material being compacted and spread over the preceding layers by bulldozers or other methods satis-

factory to the engineer, and the interstices shall be filled with finer material to form a dense compact mass.

(d) Even though the general thickness of layers is limited, as provided under (b) and (c) above, the placing of individual rocks and boulders of a size not exceeding 48 inches in least dimension will be permitted provided they are carefully distributed and the interstices filled with finer material to form a dense, compact mass.

(e) Hauling and/or spreading equipment shall be operated over the full width of each layer.

29-3.4 SPECIAL PLACING OF ROCK MATERIAL. (Case 2).—Where indicated on the plans, the requirement for placing of rock material in layers, as prescribed under 3.3 above, will be waived and such rock material may be placed by the end dumping method or other methods satisfactory to the engineer, provided, however, that the rock must be prevented from escaping beyond the embankment slope stakes.

29-3.5 LAYER PLACING, EXTRA COMPACTION. (Case 3).—Where indicated on the plans, embankments shall be constructed with extra compaction in accordance with the following requirements:

(a) Material shall be placed as required under subsection 3.3 (case 1) above, except that the maximum thickness of layers for material containing less than 25 percent of rock larger than 6 inches in greatest dimension shall be 8 inches instead of 12 inches. Water shall be applied uniformly to each layer in the amounts set by the engineer, if and when he so directs.

(b) Where material is of such type as to require placing in layers not exceeding 8 inches in thickness, the layers shall be compacted by tamping rollers or by 3-wheel power rollers.

(c) Where material is of such type as to require placing in layers between 8 inches and 24 inches in thickness, the layers shall be compacted by 3-wheel power rollers. Where a layer is composed of all rock material, rolling will not be required.

(d) While embankment material is being placed in layers, the tamping or power rollers shall be operated continuously. The number of rollers required shall be proportional to the rate at which embankment material is being placed and shall be not less than one roller for each 125 cubic yards or less of material placed per hour. When several embankments, each of small area, are so isolated from one another that one roller cannot compact the areas satisfactorily, additional rollers shall be provided.

(e) Spreading and rolling equipment shall be powered or drawn by equipment with sufficient power adequately to insure efficient operation. In general, tractors drawing tamping rollers and tractors equipped with "bulldozer" and "cowdozer" units and used in spreading and compacting embankment material shall be not less than 50 horsepower manufacturer's rating. Three-wheel power rollers shall weigh not less than

10 tons. Tamping rollers shall consist of metal rollers, drums, or shells surmounted by metal studs with tamping feet projecting not less than 6 inches from the surface of the roller, drum, or shell. The cross-sectional area of each tamping foot, measured perpendicularly to the axis of the stud, shall be from 4 to 13 square inches. The roller shall be of such weight that the load upon each tooth when any one row of teeth is supporting the whole weight of the roller shall be not less than 1,100 pounds. Each tamping roller shall consist of 2 sections and the length of each section shall be not less than 4 feet.

29-3.6 LAYER PLACING, TEST CONTROLLED COMPACTION. (Case 4).—Where indicated on the plans, embankments shall be constructed with test controlled compaction in accordance with the following requirements:

(a) Embankment material shall be spread uniformly in successive, approximately horizontal layers not exceeding 8 inches in thickness before compaction. Where the material contains individual stones larger than 6 inches in greatest dimension, such stones shall be broken up before placing or shall be carefully placed individually in the embankment where and as directed by the engineer. Frozen material shall not be placed in the embankment, nor shall the embankment be placed on frozen material.

(b) Rollers for compacting each layer of material as herein-after provided under (c) and (d) shall consist of either tamping rollers or 3-wheel power rollers meeting the requirements of 3.5 (c) above.

(c) Water shall be applied uniformly to each layer when and in the amount directed by the engineer. Each layer shall be thoroughly compacted, by rolling, to not less than 95 percent of maximum density value as determined under 2.2 above.

29-3.7 SHRINKAGE AND MAINTENANCE.—The contractor shall construct all embankments so that after shrinkage and settlement and at the time of acceptance of the project, they shall have the required grade, width, and cross section at all points. The contractor shall be responsible for the stability of all embankments made under the contract until final acceptance of the work, and shall bear the expense of replacing any portions which have become displaced due to carelessness or negligent work on the part of the contractor or to damage resulting from natural causes, such as storms, etc., and not attributable, in the opinion of the engineer, to unavoidable movements of ground upon which the embankment is made.

29-3.8 PROTECTION OF STRUCTURES.—In all cases, proper precautions shall be taken to assure that the method of operation in embankment construction does not cause movement of or undue strain on any structure. Embankments over and around culverts, arches, and bridges shall be of selected

materials carefully placed, thoroughly tamped and compacted, and as required by the specifications for backfilling the several types of structures.

METHOD OF MEASUREMENT

29-4.1 Where extra compaction of embankment (case 3) or test controlled compaction of embankment (case 4) is to be paid for directly, the yardage to be paid for shall be the number of cubic yards, measured in final position and computed by average end area method, of embankment acceptably placed and compacted.

BASIS OF PAYMENT

29-5.1 Performance of this item under the contract is not payable directly, but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit prices per cubic yard for "Unclassified Excavation," "Solid Rock Excavation," "Common Excavation," "Unclassified Excavation for Structures," or "Unclassified Excavation for Borrow," as the case may be, except as provided under 5.2 and 5.3 below.

29-5.2 Compensation as provided under 5.1 above shall constitute full compensation for any required "extra" and "test controlled" compaction of embankment, except that where so called for in the bid schedule, direct payment shall be made at the contract unit prices per cubic yard for "Extra Compaction of Embankment (Case 3)" and/or "Test Controlled Compaction of Embankment (Case 4)," as the case may be.

29-5.3 Compensation as cited under 5.1 above shall constitute full compensation for any required watering of embankment, except that where the bid schedule contains an estimated quantity for "Watering of Embankment, Item 29," any water required for "extra" or "test controlled" compaction of embankment shall be paid for as provided under WATERING.

ITEM 30.—FOUNDATION FILL

DESCRIPTION

30-1.1 This item shall consist of special approved rock or gravel backfill material furnished and placed as required to replace material encountered and found unsuitable below the foundation elevation of culverts, bridges, and other structures, and shall be constructed in accordance with these specifications and where shown on the plans or directed by the engineer in writing.

MATERIALS

30-2.1 Foundation fill shall consist of suitably graded gravel or rock as required by the engineer.

CONSTRUCTION METHODS

30-3.1 After the unsuitable material has been excavated and removed as required by the engineer and piles driven, if called for, the foundation fill shall be placed and built up in uniform layers to the foundation elevation and thoroughly compacted. The layers shall not exceed 6 inches in depth unless otherwise permitted by the engineer.

METHOD OF MEASUREMENT

30-4.1 The yardage to be paid for shall be the number of cubic yards, measured in final position, of the special material actually furnished and placed as specified and directed, complete in place and accepted, except that no yardage will be included that is outside of the vertical planes limiting the payment under UNCLASSIFIED EXCAVATION FOR STRUCTURES.

BASIS OF PAYMENT

30-5.1 The yardage, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Foundation Fill," which price and payment shall constitute full compensation for furnishing, excavating, hauling, depositing, and compacting the material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 31.—STONE OR GRAVEL SHEATHING

DESCRIPTION

31-1.1 This item shall consist of gravel or crushed stone furnished and placed in layers against the inside faces of retaining walls, wing walls, back faces of abutments, and over the extrados of arches, in accordance with these specifications and in conformity with the requirements shown on the plans or as directed by the engineer.

MATERIALS

31-2.1 The gravel or crushed stone used shall consist of sound, durable particles, all of which shall pass a 3-inch sieve, and 90 to 100 percent of which shall be retained on a No. 4 sieve, using A. A. S. H. O. Method T-27.

CONSTRUCTION METHODS

31-3.1 When used against a mortar protection course of membrane waterproofing, sheathing shall not be placed until the mortar has aged for at least 3 days. The inlet ends of all weep holes and drains shall be covered first with large selected stones over which there shall be placed finer material in such manner as to provide free access for the drainage but prevent the leaching out of the filling material. The sheathing shall form a continuous covering over the entire designated surface, extending from the elevation of the bottom of weep holes and drains to the top of the wall. It shall be so placed that mingling with the fill will be prevented. Planks and other suitable separators that can be withdrawn as the work progresses shall be kept between the sheathing and the fill when working against vertical faces or slopes steeper than the angle of repose of the material. Where waterproofing is protected by roofing felt, a 4-inch layer of sand shall be placed between the sheathing and the wall. Unless specific thicknesses are shown or ordered, the layer of sheathing shall be 1 foot in thickness.

METHOD OF MEASUREMENT

31-4.1 The yardage to be paid for shall be the number of cubic yards of crushed stone or gravel, together with sand when involved, measured in final position, between the limits shown on the plans or directed by the engineer, complete in place and accepted.

BASIS OF PAYMENT

31-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Stone or Gravel Sheathing," which price and payment shall be full compensation for furnishing and placing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 32.—BACKFILL FOR STRUCTURES OTHER THAN PIPE CULVERTS

DESCRIPTION

32-1.1 This item shall consist of all backfilling in connection with the construction of bridges and other structures, that is not provided for under **BEDDING AND BACKFILL FOR PIPE CULVERTS** or under **FOUNDATION FILL** or under **STONE OR GRAVEL SHEATHING**. All work under this item shall be done in accordance with these specifications and in conformity with the design shown on the plans.

MATERIALS

32-2.1 The material used for backfill shall be selected material from excavation or borrow.

CONSTRUCTION METHODS

32-3.1 (a) After a structure has been completed, the areas around the foundations shall be filled with approved material, in horizontal layers not over 12 inches in depth, and compacted satisfactorily to the level of the original surrounding surface.

(b) No backfilling shall be placed against any abutment, wing wall, or culvert until permission is given by the engineer. In the case of concrete or other masonry, such permission preferably shall not be given until the masonry has been in place 21 days, or until tests made by the laboratory under the supervision of the engineer establish that the concrete has attained sufficient strength to withstand any pressure created by the methods used and materials placed without damage or strain beyond a safe factor. Adequate provision shall be made for thorough drainage. Drains shall be placed at weep holes.

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

(d) In backfilling against abutments, retaining walls, or other structures, the bed for a backfill shall be so prepared and

serrated and the backfill shall be so built up in horizontal layers that at all times there shall be a horizontal berm of thoroughly compacted material behind the structure for a distance at least equal to the height of the abutment or wall to be backfilled against except insofar as undisturbed material obtrudes upon this area. Each layer of this berm, if dry, shall be moistened and then compacted by tamping with mechanical rammers or by hand tamping with heavy iron tampers, the tamping faces of which do not exceed 25 square inches in area. The use of pile drop hammers, loaded or unloaded clam shell, or other similar equipment unsuitable for this purpose is prohibited within the berm area described above, as well as the dropping of any heavy weight more than 10 feet. Jetting of fills and/or other hydraulic methods involving or likely to involve liquid or semiliquid pressure within the berm area described above are prohibited for a distance from the structure equal to two and one-half times the height of the abutment or wall to be backfilled against.

METHOD OF MEASUREMENT

32-4.1 Backfill shall not be measured for direct payment.

BASIS OF PAYMENT

32-5.1 Performance of this item, under the contract, is not payable directly, but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit prices for "Unclassified Excavation for Structures," "Unclassified Excavation," "Solid Rock Excavation," "Common Excavation," or "Unclassified Excavation for Borrow", as the case may be.

ITEM 33.—BEDDING AND BACKFILL FOR PIPE CULVERTS

DESCRIPTION

33-1.1 This item shall consist of preparing bedding for pipe culverts, and backfilling to subgrade level after the pipes are installed, and when required by the plans shall include backfilling above the pipes by one of the "imperfect trench" methods hereinafter described. All work under this item shall be done in accordance with these specifications and in conformity with the plans or as stated by the engineer.

MATERIALS

33-2.1 The material used for bedding and backfill shall be selected material from excavation or borrow.

CONSTRUCTION METHODS

33-3.1 TRENCHES.—The width of a trench shall not be greater than necessary to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe, unless otherwise authorized due to unsuitable material encountered. The bedding surface shall provide a firm but slightly yielding foundation of uniform density throughout the entire length of the culvert, and shall in general be slightly cambered in direction parallel with the pipe center line to correct for expected settlement and insure tight joints in the lower half of the pipe. Recesses shall be excavated for any bells involved.

33-3.2 BEDDING.—The pipe shall be bedded in an earth foundation of uniform density and carefully shaped, by means of a template supported at the desired grade, to fit the lower part of the pipe exterior for at least 10 percent of its over-all height. Where rock in either ledge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such manner as to provide a compacted earth cushion having a thickness under the pipe of not less than ½-inch per foot height of fill over the top of the pipe, with a minimum allowable thickness of 8 inches.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, unless other special construction methods are called for on the plans, all of such unstable soil under the pipe and for a width of at

least one diameter on each side of the pipe shall be removed and replaced with gravel or other suitable selected material (as prescribed under 2.1 above) properly compacted to provide adequate support for the pipe.

33-3.3 INSTALLATION.—The installation of the pipe shall be as required in the detail specifications for the particular type of pipe to be installed and any special requirements therein given for bedding or backfilling shall be observed.

33-3.4 BACKFILLING.—After the bedding has been prepared and the pipe installed, selected material from excavation or borrow shall be placed alongside the pipe in layers not exceeding 6 inches in depth and compacted thoroughly so that on each side of the pipe there shall be a berm of thoroughly compacted material at least as wide as the external diameter of the pipe, except insofar as undisturbed material obtrudes upon this area. Each layer, if dry, shall be moistened and then compacted by rolling or by tamping with mechanical rammers, or by hand tamping with heavy iron tampers the tamping faces of which shall not exceed 25 square inches in area, special care being taken to compact the fill thoroughly under the haunches of the pipe. This method of filling and compacting shall be continued until the embankment has reached an elevation 8 inches above the top of the pipe, except as may be required where the "imperfect trench" methods are prescribed.

33-3.5 IMPERFECT TRENCH METHODS.—When the "imperfect trench" method is required on the plans, the pipe shall be bedded and the embankment placed and compacted to the level of the top of the pipe in the manner above described except that hand tamping shall be used only upon written permission. The imperfect trench method of backfill shall be performed by one of the methods described in (a), (b), or (c) below, and the backfilling completed to subgrade level.

(a) The embankment shall be constructed in 6-inch layers to a height above the top of the pipe equal to the external diameter of the pipe. Each layer shall be thoroughly compacted over the pipe, and for a width on each side equal to the external diameter of the pipe, by rolling or by tamping with mechanical rammers. The earth material in the prism directly over the pipe shall then be excavated and the trench backfilled with earth material deposited in the loosest possible condition.

(b) The embankment shall be placed in 6-inch layers. That portion of each layer which is directly above the pipe shall be left loose, but that portion of each layer which is not directly above the pipe but is within one diameter of the pipe shall be thoroughly compacted by rolling or by tamping with mechanical rammers. After the fill has been completed to a height above the top of the pipe equal to the external diameter of the pipe, any compacted earth in the prism directly over the pipe shall be removed and replaced in the loosest possible condition.

(c) Rigid side forms shall be placed on the fill in a vertical plane tangent to the sides of the pipe. The fill shall then be placed outside the forms to a height above the top of the pipe equal to the external diameter of the pipe in layers not exceeding 6 inches in depth. Each layer shall be compacted thoroughly by rolling or by tamping with mechanical rammers. The open space directly over the pipe between the forms shall then be filled with earth material deposited in the loosest possible condition and the forms withdrawn.

METHOD OF MEASUREMENT

33-4.1 Bedding and backfill shall not be measured for direct payment.

BASIS OF PAYMENT

33-5.1 Performance of this item, under the contract, is not payable directly, but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit prices for "Unclassified Excavation for Structures," "Unclassified Excavation," "Solid Rock Excavation," "Common Excavation," or "Unclassified Excavation for Borrow", as the case may be.

ITEM 34.—DISPOSAL OF SURPLUS MATERIAL

DESCRIPTION

34-1.1 This item shall consist of the disposal of all surplus excavated material and all waste material, including rocks brought to the surface by scarifying. The material shall be disposed of by widening embankments or by flattening slopes, or by depositing the material in such other places and for such other purposes as the engineer may direct, all in accordance with these specifications.

CONSTRUCTION METHODS

34-3.1 Large rocks brought to the surface by scarifying or otherwise shall be disposed of in such manner that they will not be noticeable from the completed roadway. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the engineer. The contractor shall not borrow and waste without written application to the engineer and written consent from him.

METHOD OF MEASUREMENT

34-4.1 Disposal of surplus material shall not be measured for direct payment.

BASIS OF PAYMENT

34-5.1 Performance of this item under the contract is not payable directly, but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit prices for "Unclassified Excavation," "Solid Rock Excavation," "Common Excavation," or "Unclassified Excavation for Structures," as the case may be. Under no circumstances shall the contractor be paid for excavation beyond the established line of the roadway prism, or for borrow, when such excavation or borrow results from the method of borrow and waste, nor shall he be paid for overhaul not actually required by the design or ordered by the engineer.

ITEM 35.—REPLACING TOPSOIL

DESCRIPTION

35-1.1 This item shall consist of removing topsoil from designated storage piles and hauling, depositing, and spreading it, in accordance with these specifications, on shoulders and slopes of the roadway or elsewhere within the highway in conformity with the lines, grades, and dimensions shown on the plans or as directed by the engineer.

CONSTRUCTION METHODS

35-3.1 Topsoil shall not be placed until the whole roadway, including surfacing, has been completed unless otherwise directed by the engineer, and in no case until permission is given in writing.

Topsoil shall be spread on the areas shown on the plans or designated by the engineer to a depth enough greater than that required by the plans to make the work conform to the lines, grades, and elevations shown on the plans after natural settlement has taken place.

Slopes designated by the engineer for covering with topsoil shall be scarified lightly or otherwise roughened just prior to the application of the topsoil. The scarifying shall be done by methods acceptable to the engineer.

The contractor shall take all reasonable precautions to avoid injury to existing or newly planted growth, or to structures or roadway surfacing.

During hauling operations the roadway surfacing shall be kept clean and any topsoil or other dirt which may be brought upon the surfacing shall be removed promptly and thoroughly before it can become compacted by traffic. The wheels of all vehicles shall be cleaned as frequently as necessary to prevent their bringing dirt upon the surfacing.

After the spreading of the topsoil all large stiff clods, hard lumps, large stones, brush, roots, stumps, litter, or other foreign material shall be raked up and removed from the topsoiled area. Spreading shall be completed in such a manner that seeding, sodding, or planting, if and as called for, can proceed after completion of this item without additional soil preparation of any nature.

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METHOD OF MEASUREMENT

35-4.1 The yardage to be paid for shall be the number of cubic yards of topsoil (measured in position in the storage piles prior to hauling), hauled from the storage piles, placed and spread, in the accepted work.

BASIS OF PAYMENT

35-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Replacing Topsoil," which price and payment shall be full compensation for loading, hauling, depositing, and spreading the topsoil, and for all labor, equipment, tools, and incidentals necessary to complete the item, except OVERHAUL.

ITEM 36.—TREE WELLS AND TREE ROOT PROTECTION

DESCRIPTION

36-1.1 This item shall consist of tree wells for the protection of selected trees, shrubs, or other woody plants and/or of porous material furnished and placed to protect the root system in accordance with these specifications and in conformity with the requirements shown on the plans or as directed by the engineer.

MATERIALS

36-2.1 The material for root protection shall be approved porous material ranging from $\frac{3}{8}$ to 5 inches in size and shall include sand or other suitable fine material for choking the top of the porous layer. The material may be any suitable porous material taken from the roadway excavation under the terms of article 4.6 and shall be broken to suitable size.

The materials for tree wells shall conform to the requirements of specifications for materials under DRY RUBBLE MASONRY or other masonry, as the case may be.

CONSTRUCTION METHODS

36-3.1 Tree wells shall be constructed in accordance with the dimensions and arrangement shown on the plans or as directed by the engineer. They shall be made of dry rubble masonry or other masonry as shown on the plans or directed by the engineer, provided, however, that dry rubble masonry only shall be used below the top of the contiguous porous root protection.

Where tree root protection is required, the porous material shall be placed to a depth ranging from 3 to 12 inches (or to such other depths as are indicated on the plans) over the root spread of the tree or trees designated by the engineer and before any other backfill is placed.

The area for tree root protection shall be considered as that over which the branches spread. It shall be cleaned thoroughly of all vegetation, and porous material shall be spread loosely over the required area to the depth directed.

Following the spreading of the porous material for tree root protection, a minimum of from 4 to 5 inches of topsoil shall be spread above the porous fill to bring the area to the finish grade lines designated by the engineer. Such topsoil shall be transported, handled, and placed as required under REPLACING

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TOPSOIL, OR FURNISHING AND PLACING LOAMY TOPSOIL, OR AS directed by the engineer.

Sufficient care shall be taken that trees or shrubs that are to be preserved in place are not scarred or damaged by the operations under this item.

METHOD OF MEASUREMENT

36-4.1 The yardage of porous material for tree root protection to be paid for shall be the number of cubic yards of approved porous material placed in tree root protection, measured in the vehicle at point of delivery, and accepted.

BASIS OF PAYMENT

36-5.1 The yardage of porous material for tree root protection, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Porous Material for Tree Root Protection," which price and payment shall constitute full compensation for cleaning the ground surface, for placing the porous fill, for procuring and delivering all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item, except masonry in tree wells and topsoil cover.

Masonry in tree wells, if involved, shall be paid for under and in accordance with the appropriate item or items therefor included in the bid schedule.

Topsoil cover shall be paid for under and in accordance with REPLACING TOPSOIL, OR FURNISHING AND PLACING LOAMY TOPSOIL, as the case may be, provided appropriate items therefor are included in the bid schedule, but if neither item is included therein, payment for the topsoil shall be considered included in the price and payment for excavation items of the contract.

ITEM 37.—FURROW DITCHES

DESCRIPTION

37-1.1 This item shall consist of furrow ditches constructed in accordance with these specifications and in conformity with the location and line shown on the plans or directed by the engineer.

CONSTRUCTION METHODS

37-3.1 Furrow ditches shall be formed by plowing a continuous furrow along the line indicated, provided, however, that two contiguous furrows shall be plowed where, because of the cross slope encountered, two are necessary to assure the prescribed depth. They shall be cleaned out by hand shovel work, by ditcher, or by some other suitable method, throwing all loose material on the downhill side so that the bottom of the finished ditch shall be approximately 18 inches below the crest of the loose material piled on the downhill side. Hand finish will not be required, but the flow lines shall be in satisfactory shape to provide drainage without overflow.

METHOD OF MEASUREMENT

37-4.1 The footage to be paid for shall be the number of linear feet of furrow ditch, whether single or double furrow, measured along the center line of the ditch, completed and accepted.

BASIS OF PAYMENT

37-5.1 The footage, measured as provided above, shall be paid for at the contract unit price per linear foot for "Furrow Ditches," which price and payment shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the item.

BASIS OF PAYMENT

38-5.1 The number of units, determined as provided above, shall be paid for at the contract price per unit for "Obliteration of Old Roadways," which price and payment shall constitute full compensation for all work specified herein and for all labor, equipment, tools, and incidentals necessary to complete the item, save for exceptions (a) and (b) below.

(a) Material obtained from the old roadway and used in construction of the new roadway shall be paid for under BORROW and OVERHAUL OR SPECIAL OVERHAUL OF BORROW, as the case may be.

(b) Suitable material, suitable topsoil, or humus obtained from the new roadway and used in obliteration of the old roadway shall be paid for under ROADWAY AND DRAINAGE EXCAVATION, OVERHAUL, DISPOSAL OF SURPLUS MATERIAL, STRIPPING AND STORING TOPSOIL, REPLACING TOPSOIL, OR FURNISHING LOAMY TOPSOIL, as the case may be.

38-5.2 When the bid schedule provides a contingent sum for obliteration of old roadway by force account, such obliteration shall be paid for as force account, save for the exceptions (a) and (b) above.

ITEM 38.—OBLITERATION OF OLD ROADWAYS

DESCRIPTION

38-1.1 This item shall consist of the obliteration, in accordance with these specifications, of such old roadways as are shown on the plans or designated by the engineer for obliteration.

CONSTRUCTION METHODS

38-3.1 (a) After designated sections of the old roadway are no longer needed for traffic, its ditches shall be filled and the roadway rough graded, to restore approximately the original contour of the ground or to produce a pleasing appearance by forming natural, rounded slopes. After the rough grading is completed, the area of the old roadbed shall be scarified or plowed to mix the remaining road metal thoroughly with earth and then shall be harrowed and smoothed.

(b) Old structures shall be broken down and buried or removed. Where shown on the plans or directed by the engineer, all material with salvage value shall be carefully removed to avoid damage. Any materials salvaged from the old roadway and meeting specifications for any items of the new roadway may be used in the construction thereof as provided in article 4.6.

(c) Where shown on the plans or directed by the engineer, borrow required for the new roadway shall be taken from the old roadway, and surplus material, suitable topsoil or humus from the new roadway shall be placed on the old roadway.

METHOD OF MEASUREMENT

38-4.1 The area for pay measurement shall be the number of units of old roadway acceptably obliterated. Where the bid schedule provides a lump sum for obliteration of old roadway by force account, no area shall be measured for payment under this item.

A unit shall consist of an area of 1,000 square feet measured horizontally on the roadway. The engineer shall determine the number of units that are to be measured for payment. Such number shall include only those units and fractions thereof which are outside the limits of the new roadway. Units of less than 200 square feet shall be disregarded so far as payment is concerned.

ITEM 39.—ROADSIDE CLEAN-UP

(Wooded areas)

DESCRIPTION

39-1.1 This item shall consist of cleaning up roadside areas in accordance with these specifications. The areas to be cleaned up shall be those areas so denoted on the plans and/or designated by the engineer, located in any case beyond the road prism slope lines.

Clean-up shall consist of clearing the designated ground of down timber, dead brush, logs, and debris, the felling and destroying of such snags and dangerous trees as ordered by the engineer within the designated area being cleaned up and the burning or other disposal of the spoils as ordered by the engineer. Clean-up shall also include the removal from cultivated or cropped areas of all dead plants and plant refuse and shall include living crop plants when so ordered by the engineer.

CONSTRUCTION METHODS

39-3.1 The neatness of cleaning up shall be relative, so as to be in character with the surroundings. Hand raking or any similar exaggerated degree of treatment shall not be required.

Intensity of clean-up shall be gradually diminished from the road prism construction outward to the clean-up limits or boundary designated by the engineer, so as to effect a natural transition in treatment, and so as to avoid sharp demarcation between the artificial and the natural.

As a general guide, the first 20-foot width nearest the roadway shall have practically all small sticks and other loose particles removed, except those of approximately 1 inch or less in thickness or diameter. The second 20-foot width shall be cleaned of substantially all sticks and loose particles exceeding approximately 2 inches in thickness or diameter, and the third 20-foot width shall be cleaned of substantially all sticks and loose particles exceeding approximately 3 inches in thickness or diameter.

Trees and snags designated for removal shall be cut flush with the ground. Stumps within the areas designated for clean-up shall also be cut flush with the ground.

Refuse from clean-up operations shall be disposed of as provided under **CLEARING AND GRUBBING**.

METHOD OF MEASUREMENT

39-4.1 The unit of measurement shall be the acre or the clean-up unit, whichever is called for in the bid schedule. In no case shall any area within the road prism slope lines as staked for clearing under subsection 21-1.2 be included in the measurement for payment.

39-4.2 When the bid schedule provides for payment on an acre basis, the area to be paid for shall be the number of acres and fractions thereof of land cleaned up as staked and ordered by the engineer and in accordance with these specifications. Acreage shall be computed from dimensions measured horizontally.

39-4.3 When the bid schedule calls for payment on the clean-up unit basis, the area to be paid for shall be the number of clean-up units of land cleaned up as ordered in accordance with these specifications. The engineer shall determine the number of clean-up units that are to be paid for.

(a) A normal clean-up unit shall be a rectangle of ground, 50 feet in length in the direction parallel to the center line of the roadbed and 20 feet in width, coordinated and tied to the said center line of the roadbed in the manner set out herein. Clean-up units in all cases shall be located using the center line of the roadbed as shown on the plans or on the plans as duly altered by the engineer, as a base line. They shall be laid out contiguously, both in direction parallel and in direction perpendicular to the said center line, with the corners on lines normal to the center line at even stations and half stations, beginning with tiers on either side of the center line between consecutive pairs of normal lines and at such 20-foot intervals (from the center line along the normal lines) that the first clean-up unit to be laid out on either side of the center line between any consecutive pair of normal lines, shall be that unit which contains within its confines any portion of the road prism slope line lying between the said pair of normal lines, or that unit which is contiguous to and immediately beyond the said slope line.

Clean-up units shall continue between said pairs of normal lines, proceeding outward to the boundaries of the area, or areas, to be cleaned up as denoted on the plans and/or designated by the engineer.

(b) Any clean-up unit shall be credited as though of normal size, whether it be larger or smaller, where (1) the dimensions are affected by adjustments for equations of center line stationing, (2) the dimensions are affected by center line curvature, and (3) the boundary of an area to be cleaned up, as staked by the engineer, intersects and divides any clean-up unit, provided in any case that the actual area of the unit does not fall below 200 square feet. Units of less than 200 square

feet in area shall be disregarded so far as payment is concerned. Bounding lines determining the lengths of units shall be normal to the center line at even stations and half stations, and widths of units shall be 20 feet measured along these normals.

(c) A clean-up unit shall be counted for payment only when within its confines clean-up as defined herein has been ordered, performed and accepted.

BASIS OF PAYMENT

39-5.1 The number of acres or of clean-up units, determined as provided above, shall be paid for at the contract unit price per acre or per clean-up unit, as the case may be, for "Roadside Clean-up," which price and payment shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the item, except for extra work of any rehandling of spoils materials due to delayed burning as ordered by the engineer, and not made necessary by fault or negligence of the contractor.

ITEM 40.—SPOT SUBGRADE REINFORCEMENT

DESCRIPTION

40-1.1 This item shall consist of approved subgrade reinforcement material placed, as directed by the engineer, in excavations made by the removal of soft, unstable, or other unsuitable subgrade materials or on fills, but only where material of the character ordered is not available under the terms of the items ROADWAY AND DRAINAGE EXCAVATION and/or BORROW within the bounds of areas specifically designated in writing. Work under this item shall be performed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or as directed by the engineer.

MATERIALS

40-2.1 The material to be used shall consist of one of the following types with necessary filler: Sound, tough, durable telford stone; knapped field or quarry stone; crushed stone; slag; quarry waste; or gravel. The telford stone shall be approximately 8 inches in depth; the field or quarry stones shall be not more than 5 inches in their largest dimensions after knapping; and the slag, gravel or crushed stone shall consist of pieces varying from 1 inch to 3½ inches in diameter. When a finer material is necessary for filler, quarry chips, gravel, or sand may be used to an amount not over 15 percent of the total. Material shall not be used until approved. The material shall be of the type or kind ordered.

CONSTRUCTION METHODS

40-3.1 Unsuitable subgrade materials shall be removed as directed and the bottom of the resulting excavation shaped uniformly and compacted firmly and provision made for drainage. The subgrade reinforcement material shall then be placed in the prepared excavation. If telford stones are used, they shall be laid at right angles to the center line of the roadway and rammed in layers of not more than 8 inches in depth; if knapped field or quarry stone, slag, gravel or crushed stone is used, it shall be spread and rammed in layers of not more than 5 inches. After the material has been placed in layers until level with the surrounding subgrade surface, the voids shall be filled with the finer material and the work rolled, or tamped if inaccessible to the roller, and the filling and rolling or tamping continued until the entire mass is compacted

thoroughly and satisfactorily. The surface shall be finished to conform accurately to the grade and cross section shown on the plans.

Where the engineer orders the placing of a stabilized cap or layer on a fill, such fill, on order, shall be constructed only to the appropriately lowered level and the stabilizing material placed thereon.

METHOD OF MEASUREMENT

40-4.1 The yardage to be paid for shall be the number of cubic yards, measured in the vehicle at the point of delivery, of subgrade reinforcement material furnished, hauled and placed as ordered.

BASIS OF PAYMENT

40-5.1 The yardage, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Spot Subgrade Reinforcement," which price and payment shall constitute full compensation for furnishing, hauling and placing the material required and for all labor, equipment, tools, and incidentals necessary to complete the item, provided, however, that unsuitable material encountered in the excavation or fill, through no fault of the contractor, and removed as ordered, shall be measured and paid for under ROADWAY AND DRAINAGE EXCAVATION, likewise in cases where a fill has been constructed to the full height, in accordance with instructions, and reexcavation is found necessary, the yardage of such reexcavation shall be measured and paid for under ROADWAY AND DRAINAGE EXCAVATION.

ITEM 41.—SUBGRADE

(Preparation of new subgrade)

DESCRIPTION

41-1.1 This item shall consist of the preparation and conditioning of the subgrade to the full width of the roadbed in accordance with these specifications and in conformity with the lines, grades, and cross section shown on the plans. The item shall be performed after the earthwork has been substantially completed and all adjacent drains and structures have been completed and backfilled. Where the plans indicate that a base course or surface course is to be placed, the contractor shall comply with any requirements as to subgrade contained in other such contract items.

CONSTRUCTION METHODS

41-3.1 GENERAL REQUIREMENTS.—All soft and unstable material and other portions of the subgrade that will not compact readily or serve the intended purpose shall be removed as directed. All boulders or ledge appearing in the excavation shall be removed or broken off to a depth of not less than 9 inches below the subgrade. The resulting areas and all other low sections, holes, or depressions shall be brought to grade with satisfactory selected cushion material and the entire subgrade shaped to line, grade, and cross section. Selected material reserved under ROADWAY AND DRAINAGE EXCAVATION shall be used insofar as deemed suitable by the engineer, supplemented as necessary by additional material obtained under BORROW; provided, however, that no yardage made necessary by unauthorized excavation below grade shall be paid for. In areas where satisfactory material is not available and the contract carries the item SPOT SUBGRADE REINFORCEMENT, material of the quality and characteristics necessary may be ordered in writing under such item.

41-3.2 RAILWAY INTERSECTIONS.—Where detail plans are not provided for the construction of the riding surface between the rails at grade crossings of railroad tracks intersecting the roadway, the contractor shall construct the roadway so that a commodious, smooth-riding, and satisfactory intersection is obtained, meeting the requirements of the railway company.

41-3.3 PROTECTION OF SUBGRADE.—At all times, ditches and drains along the subgrade shall be maintained so as to drain it effectively. Whenever ruts of 2 inches or more in depth are formed, the subgrade shall be brought to grade, and if necessary shall be reshaped and recompacted. In no case shall any base course, surface course, or pavement be placed on a frozen or muddy subgrade. Storage or stockpiling of materials on the subgrade will not be permitted. Until the subgrade has been checked and approved, no base course, surface course, or pavement shall be laid thereon.

41-3.4 SPECIAL COMPACTING.—Where indicated on the plans (as awarded), subgrade shall be prepared by special compacting in accordance with the following requirements:

After the subgrade has been shaped to line, grade, and cross section, it shall be thoroughly compacted by rolling with a power roller weighing not less than 8 tons. Water shall be applied uniformly to the subgrade prior to and during the rolling, when and in the amounts directed by the engineer. Any low spots that develop in the subgrade during rolling shall be brought to grade with additional material and rerolled.

METHOD OF MEASUREMENT

41-4.1 Preparation and conditioning of subgrade shall not be measured for direct payment.

BASIS OF PAYMENT

41-5.1 Performance of this item under the contract is not payable directly, but shall be considered as a subsidiary obligation of the contractor covered under the contract unit prices for "Unclassified Excavation," "Solid Rock Excavation," "Common Excavation," "Unclassified Excavation for Structures," "Unclassified Excavation for Borrow," or other pay items involved in the contract, as the case may be, excepting that where the bid schedule contains an estimated quantity for "Watering of Subgrade, Item 41" any watering required under special compacting shall be paid for as provided under WATERING.

ITEM 42.—FINISHING EARTH GRADED ROADS

(Special finishing of new subgrade)

DESCRIPTION

42-1.1 This item shall consist of the final finishing, ready for traffic, of the roadbed of an earth graded road when no surfacing other than earth or selected material is proposed. The work shall consist of shaping and dressing the roadbed in accordance with these specifications and in conformity with the "finish" lines, grades, and typical cross sections shown on the plans. The work required by this item shall be performed if and where indicated on the plans.

CONSTRUCTION METHODS

42-3.1 After the roadbed has been substantially completed, as provided under SUBGRADE, the entire surface of the roadbed shall be scarified with a scarifying machine to a depth of 6 inches and shall then receive a finish shaping with a grading machine, supplemented by hand work where necessary to obtain a smooth surface and a uniform cross section.

All rock sections and all other sections where the natural material is not deemed suitable by the engineer shall be brought to grade with a satisfactory cushion of selected material as provided under SUBGRADE and the entire roadbed shall be brought to the final elevation and shape indicated on the plans and dressed as directed by the engineer.

At intersections with other earth roads or trails a commodious, smooth riding roadway shall be constructed similarly and dressed as directed. No roots, sod, or other deleterious matter, or stones that would fail to pass a 2-inch square opening, shall be left within the top 4 inches of the finished road surface.

METHOD OF MEASUREMENT

42-4.1 The mileage of finishing to be paid for (subject to 5.1 below) shall be the number of miles of roadbed, measured along the center line, finished to the full width and accepted.

BASIS OF PAYMENT

42-5.1 When the bid schedule contains an estimated quantity for "Finishing Earth Graded Roads," the number of miles determined as provided above, shall be paid for at the contract

unit price per mile for "Finishing Earth Graded Roads," which price and payment shall constitute full compensation for all scarifying, shaping, removing of coarse material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

When the bid schedule does not contain an estimated quantity for "Finishing Earth Graded Roads," the mileage of this item shall not be paid for directly but shall be considered as a part of the obligation of the contractor covered under ROADWAY AND DRAINAGE EXCAVATION OR BORROW.

ITEM 43.—FINE GRADING SUBGRADE AND SHOULDERS

(Repreparation of previously constructed subgrades)

DESCRIPTION

43-1.1 This item shall consist of the repreparation of a previously graded roadway for immediate placement of base course, surface course, or pavement, in conformity with the lines, grades, and typical cross section shown on the plans or staked by the engineer.

CONSTRUCTION METHODS

43-3.1 GENERAL REQUIREMENTS.—All slide material shall be removed and those portions of the existing roadway, including parking areas, so directed by the engineer, shall be scarified, bladed, and shaped to conform accurately to the line, grade, and cross section shown on the plans or staked by the engineer. Any high places in the roadbed shall be cut to grade and the resulting material hauled and deposited on low areas or on fill slopes as directed by the engineer. Should there remain any depressions or narrow embankments, sufficient approved earth material shall be obtained and placed to bring the surface of the roadway to the exact lines, grades, and cross section established. The roadbed shall then be rebladed and reshaped. At intersections, the roadbed of the side road shall be treated similarly, for the distance ordered by the engineer or as governed by the grading performed, and so as to provide for proper joining of the proposed and existing riding surfaces. The roadbed shall be compacted and all work that may be necessary to produce a completed and acceptable foundation for the placement of the base course, surface course, or pavement shall be performed.

43-3.2 SPECIAL COMPACTING.—Where indicated on the plans, the subgrade shall be prepared with special compacting in accordance with the following requirements:

After the subgrade has been shaped to line, grade, and cross section, it shall be thoroughly compacted by rolling with a power roller weighing not less than 8 tons. Water shall be applied uniformly to the subgrade prior to and during the rolling, when and in the amounts directed by the engineer. Any low spots that develop during the rolling shall be brought to grade with additional material and rerolled.

METHOD OF MEASUREMENT

43-4.1 The mileage of fine grading to be paid for (subject to 5.1 below) shall be the number of miles of roadway measured along the center line thereof, fine graded to the required width and accepted.

BASIS OF PAYMENT

43-5.1 When the bid schedule contains an estimated quantity for "Fine Grading Subgrade and Shoulders," the number of miles, determined as provided above, shall be paid for at the contract unit price per mile for "Fine Grading Subgrade and Shoulders," which price and payment shall constitute full compensation for shaping, dressing, and compacting the subgrade and shoulders, and for all labor, equipment, tools, and incidentals necessary to complete the item, excepting that excavation below a point 0.3 foot under the existing roadbed surface, removal of all slides in excess of 5 cubic yards per station, and additional borrow material required to bring the roadway to the finished section shall be paid for at the contract unit prices for "Unclassified Excavation," "Common Excavation" or "Unclassified Excavation for Borrow" and "Overhaul," as the case may be, and provided that where the bid schedule contains an estimated quantity for "Watering of Subgrade, Item 43," any watering required under special compacting shall be paid for as provided under WATERING.

When the bid schedule does not contain an estimated quantity for "Fine Grading Subgrade and Shoulders," the mileage of this item shall not be paid for directly but shall be considered as a subsidiary part of the obligation of the contractor, covered under other contract items.

ITEM 44.—SHOULDERS**DESCRIPTION**

44-1.1 This item shall consist of shoulders constructed of approved materials in accordance with these specifications and in conformity with the lines, grades, and cross section shown on the plans.

The engineer may require construction or completion of shoulders by designated sections of road when he considers it to be of the best advantage to the work and public traffic.

44-1.2 Where shown on the plans and provided for in the bid schedule, the top portions of shoulders shall be constructed of base course or surface course material furnished and placed under the designated specification items; or, where shown on the plans, the top portion of a shoulder may be constructed as an integral part of the base course or surface course placed to a "feather-edge" section.

CONSTRUCTION METHODS

44-3.1 Before any subgrade shall be approved, the adjacent shoulders shall be constructed to the full width and at least to the level of the finished subgrade, but not necessarily to their final height and shape. In all cases where subgrade rolling is required, the rolling shall be extended to include the shoulders for a distance of at least 1 foot outside the base course, surface course, or pavement.

Before spreading base or surface course material, the adjacent shoulders shall be constructed to the height required for the finished surface and to a width sufficient to sustain the roller during rolling operations. Where macadam base courses or macadam pavements or any courses requiring trench method of construction are involved, the edges of the shoulders next to the edges of such surfaces shall be constructed approximately vertical.

All shoulder construction shall be done in proper sequence with any base or surface course construction, as directed. At all times construction shall be so carried on that the subgrade, shoulders, and adjacent slopes and ditches will be drained effectively and adequately. Any loose stones and rock fragments, larger than permitted by specifications, dragged to the surface during construction shall be deposited on the embankment slopes or as directed by the engineer.

Upon completion of any base or surface course (trench method of construction), the adjacent shoulders shall be given a final shaping, as directed. The completed shoulders shall be true to alinement and grade and shaped in conformity with the section shown on the plans. Completed shoulders shall be cleaned of any accumulations, reconditioned as necessary, and maintained until the final inspection.

METHOD OF MEASUREMENT

44-4.1 Shoulders shall not be measured for direct payment.

BASIS OF PAYMENT

44-5.1 Performance of this item under the contract is not payable directly, but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit prices for "Unclassified Excavation," "Solid Rock Excavation," "Common Excavation," "Unclassified Excavation for Structures," or "Unclassified Excavation for Borrow," or under other pay items involved in the contract, as the case may be.

ITEM 45.—WATERING

DESCRIPTION

45-1.1 This item shall consist of furnishing and applying water required in the compaction of embankments, subgrades, base courses, and surface courses, in accordance with the requirements of these specifications.

CONSTRUCTION METHODS

45-3.1 Water, when required, shall be applied at the locations, in the amounts and during the hours, including nights, as directed by the engineer. An adequate water supply shall be provided by the contractor. The equipment used for watering shall be of ample capacity and of such design as to assure uniform application of water in the amounts directed by the engineer.

METHOD OF MEASUREMENT

45-4.1 The units of watering to be paid for (subject to 5.1 below) shall be the number of 1,000-gallon units of water, measured by approved meter or in the vehicle at the point of delivery on the road and used as ordered.

BASIS OF PAYMENT

45-5.1 When the bid schedule contains an estimated quantity for any one of the pay names below, the units, measured as provided above, shall be paid for at the contract unit price per 1,000-gallon unit for "Watering of Embankment, Item 29," "Watering of Subgrade, Item ()," "Watering of Base Course, Item ()," or "Watering of Surface Course, Item ()," as the case may be, which price and payment shall be full compensation for furnishing, hauling, and placing and for all labor, equipment, tools, and incidentals necessary to complete the item, except furnishing water plants for the project, which shall be paid for at the lump sum bid for "Providing and Maintaining Water Plant or Plants." No payment shall be made for the latter unless installation is authorized in writing by the engineer.

When the bid schedule does not contain an estimated quantity for any one of the above pay names, the performance of this item including "Providing and Maintaining Water Plant or Plants," shall be considered as a subsidiary obligation of the contractor covered under pay items involved in the contract and no allowance shall be made for providing or maintaining a water plant.

BASE COURSES

ITEM 50.—SELECTED BORROW BASE COURSE

DESCRIPTION

50-1.1 This item shall consist of a foundation course composed of selected borrow obtained from sources designated in the special provisions or authorized sources supplementary thereto, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

50-2.1 Selected borrow base course material shall consist of pit-run gravel, talus rock, disintegrated granite, semi-gravel, sand, pebble soil, topsoil, caliche, shale, scoria, clinkers, cinders, or other similar materials selected under the direction of the engineer. The maximum dimension of any particle of the selected borrow base course material shall not be greater than two-thirds the required thickness of the layer in which it is placed. Oversize material, if present, shall be removed at the pit by screens, grizzlies, or hand picking, except that if the material is of such nature that it will break down under blading and rolling, the engineer may permit breaking down to the required size on the road, and provided that oversize may be crushed if the contractor so elects.

50-2.2 FILLER FOR BLENDING.—If filler in addition to that naturally present in the base course material is necessary for satisfactory bonding of the material, it shall be uniformly blended with the base course material on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from hard lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

CONSTRUCTION METHODS

50-3.1 PLACING AND SPREADING.—All base course material shall be placed on the prepared subgrade and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be de-

posited and spread in a uniform layer and without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described below shall apply similarly to each layer.

50-3.2 BLADING.—After the base course material has been spread, it shall be bladed to a smooth surface conforming to the cross section shown on the plans. A blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet shall be used for the blading.

50-3.3 ADDITIONAL FILLER FOR BLENDING.—This material, when not added at the plant, shall be spread in a uniform layer over the loosely spread base course layer, in the amounts set by the engineer, and shall then be blended thoroughly into the layer by blade-mixing, using a blade grader meeting the requirements given under 3.2 above. The entire layer shall be alternately bladed to the center and back to the edges of the road until the mixture is uniform. When uniform, the mixture shall again be spread smoothly to the cross section shown on the plans.

50-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade grader meeting the requirements given under 3.2 above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted base until any surface or treatment that may be provided for in the same contract is placed thereon, and until the final inspection. Along curbs, headers, and walls, and at all places not accessible to the roller, the base course material shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping, and blading when and if directed by the engineer.

50-3.5 STOCKPILING.—When indicated on the plans, base course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

50-4.1 The yardage of base course material to be paid for shall be the number of cubic yards of base course material (including all filler), placed, bonded, and accepted in the completed base course or placed in authorized stockpiles. The quantities of base course material and filler shall be measured in original position and computed by average end area method.

BASIS OF PAYMENT

50-5.1 The yardage of base course material, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Selected Borrow Base Course," which price and payment shall constitute full compensation for furnishing material and placing the same; for mixing, blading, and rolling; for reconditioning of subgrade, shoulders, and gutters; for clean-up of pits; for clearing, cleaning, and leveling stockpile sites; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Base Course, Item 50," any authorized watering shall be paid for as provided under WATERING.

ITEM 51.—STABILIZED SOIL BASE COURSE

DESCRIPTION

51-1.1 This item shall consist of a foundation course composed of naturally or artificially mixed soil material, type A or type B, as the case may be, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans. The base course material shall consist of either all new material (case 1), or a blend of new material and material present in the existing road (case 2), whichever is called for in the bid schedule.

MATERIALS

51-2.1 NEW MATERIAL.—(Case 1). New material for stabilized soil base course shall be of type A or type B whichever is called for in the bid schedule. Type A material in general shall consist of caliche, shell, cinders, scoria, shale, or other suitable material of the amorphous earth type. Type B material in general shall consist of disintegrated granite, sand, mixtures of soil and gravel or soil and screenings, or other suitable material of the granular type. The composite base course material shall be free from vegetable matter and lumps or balls of clay, and shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of material

Sieve designation	Percent by weight passing square mesh sieves (A.A.S.H.O. T-27)		
	Grading A	Grading B	Grading C
2-inch	100	-----	-----
¾-inch	70-100	100	100
No. 4	55-85	70-100	-----
No. 10	40-65	40-80	80-100
No. 40	25-50	25-50	35-70
No. 200	5-25	8-25	10-30

The amount of the fraction passing the No. 200 sieve shall be less than one half that of the fraction passing the No. 40 sieve. The fraction passing the No. 40 sieve shall have a

liquid limit of not more than 25, and a plasticity index of not more than 6, as determined by A.A.S.H.O. Methods T-89 and T-91, respectively.

51-2.2 BLENDED MATERIAL.—(Case 2). Blended material shall consist of a blend of new material and material present in the existing road.

New material for blending with the existing material shall conform to the grading requirements given in the special provisions for "Stabilized Soil Base Course, Grading (Special)."

Additional material having the grading called for shall be added to the material on the existing surface in the amounts directed by the engineer.

CONSTRUCTION METHODS

51-3.1 PLACING ALL NEW MATERIAL.—(Case 1). When all new material is called for, the base course material shall be placed on the prepared subgrade and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of size to such loose depth that when compacted the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When combining of materials from different sources is necessary, such combining may be done at the pits prior to delivery of the material, or the proper proportions of each material may be deposited on the road in successive spreadings such as will give the required grading and thickness of layer. When more than one layer is required, the construction procedure herein described shall apply similarly to each layer.

51-3.2 PREPARATION AND PLACING MATERIAL FOR BLENDING.—(Case 2). When blending of new material with material on the existing surface is called for, the existing surface shall first be scarified lightly and bladed to uniform grade and to the cross section shown on the plans. The reshaped surface shall then be scarified again to the depth ordered by the engineer and in such manner as to leave a foundation stratum of undisturbed material parallel, both in profile and cross section, to the proposed finished surface. The material thus loosened shall be pulverized by harrowing or disking. Over the material thus loosened and pulverized, new material of the grading called for shall be spread uniformly in the amounts directed by the engineer.

51-3.3 MIXING AND FINAL SPREADING.—Each base course layer, whether composed of all new material or of a

blend of material from the existing surface and new material, shall be thoroughly mixed by harrowing and turning with a blade grader. The initial mixing shall be done by harrowing with a disk or tooth harrow so controlled as to avoid cutting into the subgrade. Following the harrowing, the material shall be blade-mixed to the full depth of the layer by alternately blading the material to the center and back to the edges of the road. A blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet shall be used for the mixing, provided, however, that traveling mixers or traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. The material shall be watered during the mixing when and if directed by the engineer. When uniform, the mixture shall be spread smoothly to the cross section shown on the plans.

51-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons except as provided in 3.5 below. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under such rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade grader meeting the requirements given under 3.3 above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted base until any surface or treatment that may be provided for in the same contract is placed thereon, and until the final inspection. Along curbs, headers, and walls, and at all places not accessible to the roller, the base course material shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping, and blading when and if directed by the engineer.

51-3.5 TRAFFIC COMPACTION.—When so indicated on the plans, the base course shall be compacted by traffic instead of being rolled as required above. In such case, the depositing of material on the road shall start at the point nearest the point of loading, and compaction shall be accomplished by directing the hauling and public traffic over the full width of each layer. Continuous blading and dragging shall accompany traffic compaction, and the surface shall be kept free of corru-

gations and waves at all times until the surface or treatment that may be provided for in the same contract is placed thereon, or until the project is completed and accepted. The material shall be sprinkled with water during the blading and dragging, when and if directed by the engineer.

51-3.6 STOCKPILING.—When indicated on the plans, base course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

51-4.1 The yardage or tonnage of base course material to be paid for shall be the number of cubic yards or tons of base course material (placed either as a layer of all new material or blended with material from the existing surface) placed, bonded, and accepted in the completed base course or placed in authorized stockpiles. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

Measurement of mixing.—The unit of measurement for mixing stabilized soil base course shall be the mile or the square yard, whichever is called for in the bid schedule. The mileage or yardage to be paid for shall be the number of miles (measured horizontally along the center line of the road) or square yards of base course completed to the width shown on the plans and accepted. No additional allowance shall be made for required widening on curves or at intersections when measurement is by the mile.

BASIS OF PAYMENT

51-5.1 The yardage or tonnage of base course material, determined as provided in 4.1 above, shall be paid for at the contract unit price per cubic yard or per ton for "New Material for Stabilized Soil Base Course" and per mile or square yard for "Mixing Stabilized Soil Base Course," case 1 or 2, as called for, of the type and grading called for in the bid schedule, which prices and payments shall constitute full compensation for furnishing material and placing the same; for mixing, blading, and rolling; for reconditioning of subgrade, shoulders, and gutters; for clean-up of pits; for clearing, cleaning, and leveling stockpile sites; for furnishing and sealing of scales; for furnishing the weigh house; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The prices and payments stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Base Course, Item 51," any authorized watering shall be paid for as provided under WATERING.

ITEM 52.—GRAVEL BASE COURSE

DESCRIPTION

52-1.1 This item shall consist of a foundation course composed of gravel and filler, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

52-2.1 Gravel base course material (classes 1, 2, and 3) shall consist of hard, durable particles, or fragments of stone or gravel and a filler of sand or other finely divided mineral matter. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. Oversize material encountered in deposits from which gravel base course material is produced shall be removed by screening or shall be crushed to required size, whichever the contractor may elect. The composite base course material shall be free from vegetable matter and lumps or balls of clay, and shall meet the requirements for one of the following classes, whichever is called for in the bid schedule.

52-2.2 CLASS 1 MATERIAL (Coarse graded).—Class 1 material shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A	Grading B	Grading C	Grading D
3-inch	100			
2-inch		100		
1½-inch			100	
1-inch	35-65	50-80		100
No. 4	10-30	15-35	20-40	25-45
No. 200, less than			10	10

52-2.3 CLASS 2 MATERIAL (Intermediate graded).—Class 2 material shall meet the requirements for one of the gradings given in table 2, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 2.—Requirements for grading

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A-1	Grading B-1	Grading C-1	Grading D-1
3-inch.....	100			
2-inch.....		100		
1½-inch.....			100	
1-inch.....	45-75	50-80		100
No. 4.....	15-45	20-50	25-55	30-60
No. 10.....				20-50
No. 200, less than.....	10	12	12	12

That portion of the filler, including blended filler, for class 2 material passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

Coarse aggregate for class 2 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

52-2.4 CLASS 3 MATERIAL (Stabilized).—Class 3 material shall meet the requirements for one of the gradings given in table 3, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 3.—Requirements for grading

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A-2	Grading B-2	Grading C-2	Grading D-2
3-inch.....	100			
2-inch.....	65-100	100		
1½-inch.....		70-100	100	
1-inch.....	45-75	55-85	70-100	100
¾-inch.....		50-80	60-90	70-100
¾-inch.....	30-60	40-70	45-75	50-80
No. 4.....	25-50	30-60	30-60	35-65
No. 10.....	20-40	20-50	20-50	25-50
No. 40.....	10-25	10-30	10-30	15-30
No. 200.....	3-10	5-15	5-15	5-15

The amount of the fraction of class 3 material passing the No. 200 sieve shall be less than one-half that of the fraction passing the No. 40 sieve.

That portion of the filler, including blended filler, for class 3 material passing a No. 40 sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6, as determined by A.A.S.H.O. Methods T-89 and T-91 respectively.

Coarse aggregate for class 3 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

52-2.5 FILLER FOR BLENDING.—If filler in addition to that naturally present in the base course material is necessary for meeting the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the screening plant or on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from hard lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

CONSTRUCTION METHODS

52-3.1 PLACING AND SPREADING.—All base course material shall be placed on the prepared subgrade and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described below shall apply similarly to each layer.

52-3.2 MIXING.—After base course material has been spread, it shall be thoroughly blade-mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. A blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet shall be used for the mixing, provided, however, that traveling mixers or traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. The material shall be watered during the mixing when and if directed by the engineer. When uniform, the mixture shall again be spread smoothly to the cross section shown on the plans.

52-3.3 ADDITIONAL FILLER FOR BLENDING.—This material, when not added at the plant, shall be spread in a uniform layer over the loosely spread base course layer, in the amounts set by the engineer, and shall then be blended thoroughly into the layer by blade-mixing as described under 3.2 above. Additions of filler shall be such that the blend of added and original material placed shall meet grading and quality requirements in all respects.

52-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under such rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade grader meeting the requirements given under 3.2 above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted base until any surface or treatment that may be provided for in the same contract is placed thereon, and until the final inspection. Along curbs, headers, and walls, and at all places not accessible to the roller, the base course material shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping, and blading when and if directed by the engineer.

52-3.5 STOCKPILING.—When indicated on the plans, base course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

52-4.1 The yardage or tonnage of base course material to be paid for shall be the number of cubic yards or tons of base course material, including all filler, placed, bonded and accepted in the completed base course or placed in authorized stockpiles. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

BASIS OF PAYMENT

52-5.1 The yardage or tonnage of base course material, determined as provided in 4.1 above, shall be paid for at the contract unit price per cubic yard or per ton for "Gravel Base Course," of the class and grading called for in the bid schedule, which price and payment shall constitute full compensation for furnishing material, and placing the same; for mixing, blading,

and rolling; for reconditioning of subgrade, shoulders, and gutters; for clean-up of pits; for clearing, cleaning, and leveling stockpile sites; for furnishing and sealing of scales; for furnishing the weigh house; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Base Course, Item 52," any authorized watering shall be paid for as provided under WATERING.

ITEM 52A.—CRUSHED GRAVEL OR CRUSHED STONE BASE COURSE

DESCRIPTION

52A-1.1 This item shall consist of a foundation course composed of crushed gravel or crushed stone and filler, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

52A-2.1 Crushed gravel or crushed stone base course material (classes 1, 2, and 3) shall consist of hard, durable particles or fragments of stone or gravel crushed to required size and a filler of sand or other finely divided mineral matter. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. When produced from gravel, not less than 50 percent by weight of the coarse aggregate particles shall be particles having at least one fractured face, and if necessary to meet this requirement or to eliminate an excess of filler, the gravel shall be screened before crushing. The composite base course material shall be free from vegetable matter and lumps or balls of clay, and shall meet the requirements for one of the following classes, whichever is called for in the bid schedule.

52A-2.2 CLASS 1 MATERIAL (Coarse graded).—Class 1 material shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A	Grading B	Grading C	Grading D
3-inch.....	100			
2-inch.....		100		
1½-inch.....			100	
1-inch.....	35-65	50-80		100
No. 4.....	10-30	15-35	20-40	25-45
No. 200, less than.....			10	10

52A-2.3 CLASS 2 MATERIAL (Intermediate graded).—Class 2 material shall meet the requirements for one of the gradings given in table 2, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 2.—Requirements for grading

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A-1	Grading B-1	Grading C-1	Grading D-1
3-inch.....	100			
2-inch.....		100		
1½-inch.....			100	
1-inch.....	45-75	50-80		100
No. 4.....	15-45	20-50	25-55	30-60
No. 10.....				20-50
No. 200, less than.....	10	12	12	12

That portion of the filler, including blended filler, for class 2 material passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

Coarse aggregate for class 2 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

52A-2.4 CLASS 3 MATERIAL (Stabilized).—Class 3 material shall meet the requirements for one of the gradings given in table 3, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 3.—Requirements for grading

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A-2	Grading B-2	Grading C-2	Grading D-2
3-inch.....	100			
2-inch.....	65-100	100		
1½-inch.....		70-100	100	
1-inch.....	45-75	55-85	70-100	100
¾-inch.....		50-80	60-90	70-100
½-inch.....	30-60	40-70	45-75	50-80
No. 4.....	25-50	30-60	30-60	35-65
No. 10.....	20-40	20-50	20-50	25-50
No. 40.....	10-25	10-30	10-30	15-30
No. 200.....	3-10	5-15	5-15	5-15

The amount of the fraction of class 3 material passing the No. 200 sieve shall be less than one-half that of the fraction passing the No. 40 sieve.

That portion of the filler, including blended filler, for class 3 material passing a No. 40 sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6, as determined by A.A.S.H.O. Methods T-89 and T-91, respectively.

Coarse aggregate for class 3 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

52A-2.5 FILLER FOR BLENDING.—If filler in addition to that naturally present in the base course material is necessary for meeting the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the screening and crushing plant or on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from hard lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

CONSTRUCTION METHODS

52A-3.1 PLACING AND SPREADING.—All base course material shall be placed on the prepared subgrade and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described below shall apply similarly to each layer.

52A-3.2 MIXING.—After base course material has been spread, it shall be thoroughly blade-mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. A blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet shall be used for the mixing, provided, however, that traveling mixers or traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. The material shall be watered during the mixing when and if directed by the engineer. When uniform, the mixture shall again be spread smoothly to the cross section shown on the plans.

52A-3.3 ADDITIONAL FILLER FOR BLENDING.—This material, when not added at the plant, shall be spread in a uniform layer over the loosely spread base course layer, in the amounts set by the engineer, and shall then be blended thor-

oughly into the layer by blade-mixing as described under 3.2 above. Additions of filler shall be such that the blend of added and original material placed shall meet grading and quality requirements in all respects.

52A-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade grader meeting the requirements given under 3.2 above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted base until any surface or treatment that may be provided for in the same contract is placed thereon, and until the final inspection. Along curbs, headers, and walls, and at all places not accessible to the roller, the base course material shall be tamped thoroughly with mechanical tampers, or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping, and blading when and if directed by the engineer.

52A-3.5 STOCKPILING.—When indicated on the plans, base course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

52A-4.1 The yardage or tonnage of base course material to be paid for shall be the number of cubic yards or tons of base course material, including all filler, placed, bonded, and accepted in the completed base course or placed in authorized stockpiles. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

BASIS OF PAYMENT

52A-5.1 The yardage or tonnage of base course material, determined as provided above, shall be paid for at the contract unit price per cubic yard or per ton for "Crushed

Gravel or Crushed Stone Base Course," of the class and grading called for in the bid schedule, which price and payment shall constitute full compensation for furnishing material and placing the same; for mixing, blading, and rolling; for reconditioning of subgrade, shoulders, and gutters; for clean-up of pits and quarries; for clearing, cleaning, and leveling stockpile sites; for furnishing and sealing of scales; for furnishing the weigh house; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Base Course, Item 52A," any authorized watering shall be paid for as provided under WATERING.

ITEM 53.—TELFORD BASE COURSE

DESCRIPTION

53-1.1 This item shall consist of a foundation course composed of hand-laid telford stone, keyed in place with spalls and filler, the whole constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

53-2.1 STONE.—Telford stone shall consist of approved, sound, durable stone. The pieces shall be approximately rectangular in section and of depths equal to the thickness of the telford course, widths of from 2 to 6 inches, and lengths of from 6 to 12 inches. The spalls or small stone for wedging the large stone shall consist of material at least equal in quality to that of the large stone. The stone shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

53-2.2 FILLER.—The filler shall consist of screenings from stone of the quality prescribed above or of gravel and sand of approved quality. In any case, it shall meet the following grading requirement, using A.A.S.H.O. Method T-27.

<i>Sieve designation</i>	<i>Percentage by weight passing square mesh sieves (A.A.S.H.O., T-27)</i>
$\frac{3}{4}$ -inch	95-100
No. 4	0-15

CONSTRUCTION METHODS

53-3.1 PLACING.—The telford stone shall be placed by hand on the prepared subgrade course with the broad edges down and with the long dimensions at right angles to the center line of the road. They shall be laid with the depth axis perpendicular to the finished surface. They shall be laid in close contact with each other, breaking joints, and shall be wedged in their correct position by inserting and driving small stones of suitable size in all places where practicable. All projecting joints shall be knapped off.

When the telford is to be laid on clay, fine sand, or such soils as may be forced up into the voids, a layer of filler not less than one inch in thickness shall first be spread upon the prepared subgrade. This layer of filler shall not be considered as part of the depth of the base course.

53-3.2 ROLLING.—After the stone has been placed and wedged, the course shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and the entire course has been thoroughly keyed, all rocking and settlement have ceased, and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under such rolling shall be corrected by removing and replacing stone or adding filler until the surface is smooth and uniform. Base course shall not be laid or rolled when the subgrade is soft and yielding, or when rolling causes a wavelike motion in the base course or subgrade.

53-3.3 PLACING FILLER.—Filler shall be applied gradually to the surface and swept in as the rolling progresses until the entire course is a dense, compacted mass true to grade and cross section, and until the necessary leveling-up course has been built up over the entire surface so that each telford stone is blanketed by a thickness of not less than three-fourths of an inch.

53-3.4 RECONSTRUCTING DAMAGED AREAS.—Should the subgrade at any time become soft or become churned up with the base course material, the contractor shall, without additional compensation, remove the affected material, reshape, and compact the subgrade, and replace the removed materials with clean material meeting specifications and reconstruct the course to proper uniformity with the surrounding surface.

METHOD OF MEASUREMENT

53-4.1 The unit of measurement for the base course shall be the square yard or ton, whichever is called for in the bid schedule. The yardage to be paid for shall be the number of square yards of base course in place completed and accepted. The tonnage to be paid for shall be the number of tons of base course material (including filler) placed, bonded, and accepted in completed base course.

BASIS OF PAYMENT

53-5.1 The yardage or tonnage, determined as provided above, shall be paid for at the contract unit price per square yard or per ton, as the case may be, for "Telford Base Course," which price and payment shall constitute full compensation for furnishing and preparing all telford stone, for furnishing filler, for placing the materials, for rolling, for reconditioning of subgrade, shoulders, and gutters, for furnishing and sealing of scales, for furnishing the weigh house, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 54.—SLEDGED STONE BASE COURSE

DESCRIPTION

54-1.1 This item shall consist of a foundation course composed of sledged stone, keyed in place with spalls and filler, and constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades and typical cross section shown on the plans.

MATERIALS

54-2.1 STONE.—The stone for sledging shall be sound and durable and have a percent of wear of not more than 60 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

54-2.2 FILLER.—The filler shall consist of the fines resulting from the sledging of the stone, supplemented as necessary by other fines or screenings from stone of at least equal quality. In any case, it shall meet the following grading requirement using A.A.S.H.O. Method T-27.

Percentage by weight passing square mesh sieves (A.A.S.H.O., T-27)	
Sieve designation	
¾-inch	95-100
No. 4	50-100

CONSTRUCTION METHODS

54-3.1 PLACING.—The stone shall be dumped in piles or windrows either on the shoulder or on the prepared subgrade. The larger stones shall then be broken with sledges or by other means to a size that one man can readily handle. The stone shall be placed by hand on the prepared subgrade so that each stone shall have a natural bed and shall be wedged in position by inserting and driving small stones of suitable size in all places where practicable. The tops of all large stones shall be knapped off so that projections do not come within 2 inches of the proposed top surface or grade line of the sledged stone base course.

54-3.2 ROLLING.—After the stone has been placed and wedged, the course shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width

of such track, and shall continue until all the surface has been rolled by the rear wheels and the entire course has been thoroughly keyed, all rocking and settlement have ceased, and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under such rolling shall be corrected by removing and replacing stone or adding filler until the surface is smooth and uniform. Base course shall not be laid or rolled when the subgrade is soft or yielding, or when rolling causes a wavelike motion in the base course or subgrade.

54-3.3 PLACING FILLER.—Filler shall be applied gradually to the surface and swept or otherwise worked in as the rolling progresses until the entire course is a dense, compacted mass true to grade and cross section, and until the necessary leveling-up course has been built up over the entire surface so that the tops of all stones are covered by a thickness of not less than 2 inches.

54-3.4 RECONSTRUCTING DAMAGED BASE COURSE.—Should the subgrade at any time become soft or become churned up with the base course material the contractor, without additional compensation, shall remove the mixture from the affected portion, reshape and compact the subgrade and replace the removed materials with clean sledged stone which shall be rolled and filled until compacted satisfactorily and uniformly with the surrounding surface.

METHOD OF MEASUREMENT

54-4.1 The unit of measurement for the base course shall be the square yard or ton, whichever is called for in the bid schedule. The yardage to be paid for shall be the number of square yards of base course in place completed and accepted. The tonnage to be paid for shall be the number of tons of base course material (including filler) placed, bonded, and accepted in completed base course.

BASIS OF PAYMENT

54-5.1 The yardage or tonnage, determined as provided above, shall be paid for at the contract unit price per square yard or per ton, as the case may be, for "Sledged Stone Base Course," which price and payment shall constitute full compensation for furnishing and preparing all sledged stone, for furnishing filler, for placing the materials, for rolling, for reconditioning of subgrade, shoulders, and gutters, for furnishing and sealing of scales, for furnishing the weigh house, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 55.—DRY CHOKED STONE OR SLAG BASE COURSE

DESCRIPTION

55-1.1 This item shall consist of a foundation course composed of crushed stone or crushed slag, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

55-2.1 The material for the coarse aggregate and choker stone shall be either crushed stone or crushed slag.

Crushed stone shall consist of hard, durable particles or fragments of stone, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter, and shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled, blast furnace slag, and shall consist of angular fragments, reasonably uniform in density and quality, and reasonably free from thin, elongated, or glassy pieces, dirt or other objectionable matter. It shall weigh not less than 60 pounds per cubic foot, and shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed stone and crushed slag for coarse aggregate and choker stone shall meet the requirements for grading given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Method T-27.

TABLE 1.—Requirements for grading of material

Sieve designation	Stone and slag	
	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)	
	Coarse aggregate	Choker stone
2½-inch	100	100
2-inch	90-100	90-100
1½-inch	35-70	0-30
1-inch	0-15	
¾-inch		
½-inch		
No. 100		

CONSTRUCTION METHODS

55-3.1 PLACING AND SPREADING COARSE AGGREGATE.—All base course material shall be placed on the prepared subgrade and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. Material shall be deposited and spread in a uniform layer and without segregation of size to such loose depth that when compacted, making due allowance for the choker stone added, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described below shall apply similarly to each layer.

Coarse aggregate shall not be spread more than 500 feet in advance of the operations of applying choker stone and rolling, unless permitted by the engineer. Any ruts or soft, yielding places which occur in the subgrade by reason of any improper drainage conditions, traffic, or hauling, or from any other cause, shall be corrected and rolled until firm before the coarse aggregate is placed thereon.

55-3.2 ROLLING.—Immediately following the spreading of the coarse aggregate, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and has been thoroughly keyed, the interstices of the material reduced to a minimum, and until the coarse aggregate ceases to creep or wave ahead of the roller. Any irregularities or depressions that develop under such rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

The course shall not be rolled when the subgrade is soft or yielding or when the rolling causes a wave-like motion in the base course or subgrade. When the rolling develops irregularities that exceed three-fourths inch when tested with a 10-foot straightedge, the irregular surface shall be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required above.

55-3.3 APPLYING CHOKER STONE.—After the coarse aggregate has been thoroughly keyed and set by the rolling described above, choker stone in an amount that will completely fill the interstices shall be applied gradually over the

surface and rolling shall be continued while the choker stone is being spread, so that the jarring effect of the roller will cause the small stone to settle into the voids of the coarse aggregate. The choker stone shall not be dumped in piles on the coarse aggregate but shall be spread in thin layers, either by spreading motion with hand shovels, by mechanical spreaders, or directly from trucks. Trucks operated over the base course for the purpose of spreading choker stone shall be so equipped with pneumatic tires and so operated as not to disturb the coarse aggregate.

In no case shall the choker stone be applied so fast or thickly as to cake or bridge on the surface in such manner as to prevent the filling of all voids or prevent the direct bearing of the roller on the coarse aggregate. Hand brooms shall be used to sweep the choker stone into unfilled voids and to distribute the stone where needed. The spreading, sweeping, and rolling shall continue until no more choker stone can be forced into the voids. An excess of choker stone shall not be placed.

55-3.4 RECONSTRUCTING DAMAGED BASE COURSE.—Should the subgrade at any time become soft or become churned up with the base course material, the contractor, without additional compensation, shall remove the mixture from the affected portion, reshape and compact the subgrade and replace the removed materials with clean aggregate which shall then be rolled and filled until compacted satisfactorily and uniformly with the surrounding surface.

METHOD OF MEASUREMENT

55-4.1 The yardage or tonnage to be paid for shall be the number of cubic yards or tons of base course material, including all coarse aggregate and choker stone, placed, bonded, and accepted in the completed base course. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

BASIS OF PAYMENT

55-5.1 The yardage or tonnage, determined as provided above, shall be paid for at the contract unit price per cubic yard or per ton, as the case may be, for "Dry Choked Stone or Slag Base Course," which price and payment shall constitute full compensation for furnishing material, placing and rolling the same, for reconditioning of subgrade, shoulders, and gutters, for furnishing and sealing of scales, for furnishing the weigh house, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 56.—WATERBOUND MACADAM BASE COURSE**DESCRIPTION**

56-1.1 This item shall consist of a foundation course composed of crushed stone or crushed slag, water-bonded, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

56-1.2 QUANTITIES OF MATERIALS PER SQUARE YARD.—The aggregate shall be spread at rates in pounds per square yard shown in table 1 opposite the particular thickness shown on the plans for this item. At the beginning of construction and during its progress, the individual weights of coarse aggregate and of screenings (for voids) shall be varied and adjusted as directed by the engineer, but the total weight of combined coarse aggregate and screenings (for voids) shall be in all cases as stated in table 1. Screenings (for surface dressing) shall be applied as provided in 3.6 below.

TABLE 1.—Weights of aggregate per square yard of base course required for different thicknesses of surface

Thickness indicated on plans	Weight of aggregate required per square yard of base course			
	Coarse aggregate	Screenings (for voids)	Screenings (for surface dressing)	Total
Inches	Pounds per sq. yd.	Pounds per sq. yd.	Pounds per sq. yd.	Pounds per sq. yd.
4	345	105	20	470
5	435	130	20	585
6	520	155	20	695

The weights given in table 1 are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

MATERIALS

56-2.1 AGGREGATE.—The coarse aggregate and screenings shall be either crushed stone or crushed slag.

The crushed stone shall consist of hard, durable particles or fragments of stone, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt, or other objectionable matter, and shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

The crushed slag shall be air-cooled blast furnace slag, and shall consist of angular fragments, reasonably uniform in density and quality, and reasonably free from thin, elongated, or glassy pieces, dirt, and other objectionable matter. It shall weigh not less than 60 pounds per cubic foot, and shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed stone and crushed slag for coarse aggregate and screenings shall meet the requirements for grading given in table 2, using A.A.S.H.O. Method T-27.

TABLE 2.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)	
	Coarse aggregate	Screenings
3-inch.....	100	-----
2½-inch.....	90-100	-----
1½-inch.....	25- 60	-----
¾-inch.....	0- 10	-----
¾-inch.....	-----	100
No. 4.....	-----	85-100
No. 100.....	-----	5- 25

CONSTRUCTION METHODS

56-3.1 FORMS.—When no curbs are used, side forms of either timber or metal equal in depth to that of the loose aggregate and with their ends securely fastened together will be required. The side forms shall be set true to line, and to the grade of the top of the final layer of loose aggregate. Forms shall be securely staked, after which they shall be backed with earth or other suitable material on the berm side to a width of not less than 18 inches and to such height that the backing, after being thoroughly compacted, will conform

to the finish grade of the compacted base course. The forms shall not at any time vary from the true plane of the tops of the forms more than three-eighths of an inch in a 10-foot length.

The side forms shall be set not less than 400 feet in advance of the material being placed. The transverse distance between the side forms shall be the width of base course shown on the plans. Timber side forms shall be at least 2 inches thick. In general, the sections shall be 10 to 12 feet long except that 5-foot sections may be used on curves of 150 feet radius or less.

56-3.2 BLANKETING SUBGRADE.—When the water-bound base course is to be placed on a subgrade composed of clay, fine sand, or other soils that may be forced up into the coarse aggregate during the rolling operations, a layer of screenings in the amount of 50 pounds per square yard shall first be spread uniformly upon the subgrade. This layer shall be moistened and rolled to a smooth surface with a roller meeting the requirements given in 3.5 below.

56-3.3 SPREADING COARSE AGGREGATE.—The prepared subgrade shall be cleaned of all foreign substances. Any ruts or soft, yielding places that appear in the subgrade by reason of improper drainage conditions, traffic, or hauling, or from any other cause, shall be corrected and rolled until firm before the coarse aggregate is placed thereon.

The coarse aggregate shall be spread evenly upon the prepared subgrade at the rate shown in table 1 or as directed in writing by the engineer, by the use of approved devices that shall spread the aggregate in the required amount so as to avoid or minimize the need for hand manipulation. Dumping from vehicles in piles or windrows so as to require re-handling will not be permitted.

The base course shall be constructed in layers of not less than two and one-half inches of compacted thickness and not more than 4 inches of compacted thickness. Each layer shall be tested by templates resting on the side forms and also by depth blocks if the engineer so orders. No segregation of large or fine particles will be allowed, and the coarse aggregate as spread shall be of uniform grading with no pockets of fine materials. Coarse aggregate, unless otherwise permitted by the engineer, shall not be spread more than 500 feet in advance of the application of screenings and of rolling and not more than 1,000 feet in advance of water bonding by sprinkling and rolling.

56-3.4 REMOVING SIDE FORMS.—When the side forms are removed, the space between the aggregate and the earth backing shall be filled with earth shoulder material to such height as will compact to the final thickness of the course.

56-3.5 ROLLING.—Immediately following the spreading of the coarse aggregate, it shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons.

The rolling shall begin with the outside rear wheel covering equal parts of shoulder and coarse aggregate and the roller shall be run forward and backward until the shoulder and the metal are firmly bound together.

When shoulders and edges of the base course have been firmly rolled, the rolling shall progress gradually from the edges to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until the entire area of the course has been rolled by the rear wheels and become thoroughly keyed, the interstices of the metal reduced to a minimum and creeping of the stone ahead of the roller is no longer visible.

Where super-elevated curves are encountered, the rolling shall begin at the edges of the course as heretofore specified and continue until the stone and shoulders are firmly bound together. The rolling shall then be continued from the inner edge of the curve to the outer edge instead of from the edges to the center as heretofore specified.

The course shall not be rolled when the subgrade is soft or yielding or when the rolling causes a wavelike motion in the base course or subgrade. When the rolling develops irregularities that exceed three-fourths inch, when tested with a 10-foot straightedge, the irregular surface shall be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required above.

56-3.6 APPLYING SCREENINGS.—After the coarse aggregate has been thoroughly keyed and set by the rolling described above, screenings in an amount that will completely fill the interstices shall be applied gradually over the surface and dry rolling shall be continued while the screenings are being spread, so that the jarring effect of the roller will cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles on the coarse aggregate but shall be spread in thin layers, either by the spreading motion of hand shovels, by mechanical spreaders, or directly from trucks. Trucks operated over the base course for the purpose of spreading screenings shall be so equipped with pneumatic tires and so operated as not to disturb the coarse aggregate.

The roller used shall meet the requirements specified above and be equipped with a broom of an approved type. The screenings shall be applied in 3 or more applications and in no case shall they be applied so fast or thickly as to cake or bridge on the surface in such manner as to prevent the filling of all voids or prevent the direct bearing of the roller on the coarse aggregate. Hand brooms shall be used to sweep the screenings into unfilled voids and to distribute them where needed. The spreading and rolling shall be performed

on sections not to exceed 500 feet in length and shall continue until no more screenings will go in dry.

56-3.7 SPRINKLING AND GROUTING.—Immediately after the voids of a section of the course have been filled with screenings, the macadam shall be sprinkled until saturated, the sprinkler being followed by the roller. More screenings shall be added if necessary. In case of necessity, screenings provided for surface dressing may be used for this purpose. The sprinkling and rolling shall continue until a grout has been formed of the screenings and water that fills all voids and forms a wave of grout before the wheels of the roller. Hand brooms shall be used to sweep the wet screenings into the unfilled voids and to distribute them evenly. The macadam shall be puddled as many times as may be necessary to obtain satisfactory results.

When a section has been thoroughly filled and grouted as described above, it shall be left to dry out, before it is opened to travel. The process of water-binding shall be carried on in sections not to exceed 500 feet in length and each section shall be completed to the satisfaction of the engineer before another section is started.

After the completion of the base course as described above, the screenings for surface dressing shall be spread over its entire surface in a uniform layer.

56-3.8 STOCKPILING EXTRA SCREENINGS.—Extra screenings shall be stockpiled for future use in the amount directed by the engineer. Prior to stockpiling, the sites shall be cleared, cleaned, and leveled by the contractor.

56-3.9 RECONSTRUCTING DAMAGED MACADAM.—Should the subgrade at any time become soft or become churned up with the base course material the contractor shall, without additional compensation, remove the mixture from the affected portion, reshape and compact the subgrade, and replace the removed materials with clean aggregate which shall then be rolled and filled until compacted satisfactorily and uniformly with the surrounding surface.

56-3.10 MULTIPLE COURSES.—When it is necessary to construct the course in more than one layer to conform to the lines, grades, and cross sections indicated on the plans or as directed by the engineer, each layer shall be constructed as described above. The same degree of refinement shall be used in forming the surfaces of all component layers, and the smoothness and uniformity of the surface of each layer shall conform closely to the requirements for the surface of the final layer.

The surface of the base course shall be maintained in its finished condition until any surface course or pavement provided in the contract is placed thereon, and the contract is completed.

56-3.11 PROTECTION.—Dumping of ashes and cinders from fireboxes on the stone will not be allowed. Any litter that may be dropped on the stone must be removed before the surface is rolled. Work on stone base shall not be prosecuted during freezing temperature. When the temperature is below 40° F., completed base course shall be protected against freezing until it dries out by a sufficient covering of straw or by any other method which the contractor may desire to use and which has been approved by the engineer.

METHOD OF MEASUREMENT

56-4.1 The tonnage to be paid for shall be the number of tons of base course material, including all coarse aggregate and screenings, placed, bonded, and accepted in completed base course and including screenings placed in the blanket layer on the subgrade and screenings placed in authorized stockpiles.

BASIS OF PAYMENT

56-5.1 The tonnage determined as provided above, shall be paid for at the contract unit price per ton for "Waterbound Macadam Base Course," which price and payment shall constitute full compensation for furnishing material and placing the same, for rolling, grouting and bonding, for reconditioning of subgrade, shoulders, and gutters, for furnishing and sealing of scales, for furnishing the weigh house, and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Base Course, Item 56," any authorized watering shall be paid for as provided under WATERING.

ITEM 57.—RECONSTRUCTED STONE OR GRAVEL BASE COURSE

DESCRIPTION

57-1.1 This item shall consist of the scarifying and reshaping of an existing road, the adding of a required amount of new material, and the necessary working, shaping and compacting to form a base course. This base course shall be constructed in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

57-2.1 The material to be added shall consist of gravel or crushed stone, whichever is called for in the bid schedule. The gravel or crushed stone shall consist of hard, durable particles or fragments retained on the No. 4 sieve, and a filler. For gravel, the filler (that which passes a No. 4 sieve) shall consist of sand and clay or other finely divided mineral matter, and for crushed stone the filler shall consist of finely crushed stone. The composite material shall be free from vegetable matter and lumps or balls of clay and shall meet the following grading requirements, using A.A.S.H.O. Method T-27.

<i>Sieve designation</i>	<i>Percentage by weight passing square mesh sieves (A.A.S.H.O., T-27)</i>
1½-inch -----	100
¾-inch-----	55-45
No. 4-----	15-45

CONSTRUCTION METHODS

57-3.1 SCARIFYING AND RESHAPING.—The existing roadbed shall be scarified as directed to a uniform depth below the surface and for the full width of the base course sufficient to eliminate all depressions and to permit uniform reshaping. The scarified surface shall then be reshaped with a blade grader weighing not less than 3 tons and having a wheelbase not less than 15 feet long and a blade at least 10 feet long. The shoulders shall be built to conform to the edge of the base course and completed and shaped to the final height before compaction begins.

57-3.2 NEW MATERIAL.—If the engineer directs that material be added to the existing material on the roadbed to bring the

base course to the required thickness, such additional material shall be spread in a uniform layer over the existing material in the amounts set by the engineer, and shall then be smoothed and shaped with the blade grader.

57-3.3 ADDITIONAL FILLER FOR BLENDING.—If filler in addition to that naturally present in the base course material is necessary for satisfactory bonding of the material, it shall be uniformly blended with the base course material on the road. It shall be spread in a uniform layer over the loose material, in the amounts set by the engineer, and shall then be blended thoroughly into the material by blade-mixing as described under 3.1 above. Additions of filler shall be such that the blend of added and original material placed shall meet grading and quality requirements in all respects.

57-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with the blade grader. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted base until the base or surface is placed thereon.

Unless the materials contain sufficient moisture to insure proper compaction and bonding, the surfacing material shall be sprinkled with sufficient water to obtain proper compaction and bond when rolled.

57-3.5 TRAFFIC COMPACTION.—In lieu of rolling, when so indicated on the plans, the completed base course shall be compacted and maintained under traffic by repeated blading with a blade grader meeting the requirements given under 3.1 above, and dragging with an approved long base maintainer or drag, and by adding material where necessary, until thoroughly compacted. Such blading and dragging shall be continued at least twice daily or as may be directed by the engineer. Blading and dragging shall be performed at such times as to take advantage of weather conditions and to obtain maximum advantage of rainfall.

The contractor shall arrange to keep the traffic distributed over the entire width so that uniform compaction is obtained by effectively blocking off parts of the traveled width as designated by the engineer.

METHOD OF MEASUREMENT

57-4.1 The square yardage to be paid for shall be the number of square yards of reconstructed base course completed and accepted. The contractor will not be paid for any yardage of existing base course that the engineer deems satisfactory for use without disturbing or reshaping.

The cubic yardage or tonnage of additional base course material to be paid for shall be the number of cubic yards or tons of additional material placed, bonded, and accepted in the completed reconstructed base course. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

BASIS OF PAYMENT

57-5.1 The square yardage of reconstructed stone or gravel base course, determined as provided above, shall be paid for at the contract unit price per square yard for "Reconstructed Base Course," which price and payment shall constitute full compensation for all scarifying, shaping, blading, rolling and maintaining, for reconditioning of subgrade, shoulders, and gutters, and for all labor, equipment, tools, and incidentals necessary to complete the item except for additional base course material required.

The cubic yardage or tonnage of additional base course material, determined as provided above, shall be paid for at the contract unit price per cubic yard or per ton for "Reconstructed Base Course, Additional Gravel Material," or "Reconstructed Base Course, Additional Crushed Stone Material," as the case may be, which price and payment shall constitute full compensation for furnishing material, and placing the same, for furnishing and sealing of scales, and for furnishing the weigh house.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Base Course, Item 57," any authorized watering shall be paid for as provided under WATERING.

ITEM 58.—RECONDITIONING OF USED ROADBED

(Preparatory to bituminizing)

DESCRIPTION

58-1.1 This item shall consist of preparing the surface of an existing roadbed in accordance with these specifications immediately prior to the application of bituminous prime coat or to the placing of a bituminous base course or wearing surface.

CONSTRUCTION METHODS

58-3.1 The existing surface shall be prepared by one of the ~~two~~ following methods, whichever is directed by the engineer:

(a) Where the existing surface has not been previously bituminized, the surface, including shoulders, shall be lightly scarified and shaped to uniform grade and to the cross section shown on the plans. A blade grader, weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet, shall be used for shaping. The surface shall then be watered where directed and thoroughly compacted by rolling with a self-powered roller.

(b) Where a hard and compact surface is encountered, whether previously bituminized or not, which in the opinion of the engineer would be weakened or damaged by scarifying and blading, all depressions and breaks shall be corrected by patching and leveling. The engineer may order that either untreated aggregate or bituminized aggregate be used for the patching and leveling. The patching and leveling may involve placing and compacting untreated aggregate, plant-mixed bituminized aggregate, road-mixed bituminized aggregate taken from the windrow, or applications of bituminous material and spreadings of aggregate as directed, depending upon the materials and the type of construction called for in the surface course item involved. The materials used for patching and leveling shall be materials or mixtures for base or surface course items included in the contract.

(c)

METHOD OF MEASUREMENT

58-4.1 The mileage of reconditioning to be paid for (subject to 5.1) shall be the number of miles of roadbed reconditioned and accepted. No additional allowance shall be made for required widening on curves and at intersections.

Material or mixture used for patching and leveling shall be measured and the quantity duly included in the pay measurement for the contract item under which it is furnished.

BASIS OF PAYMENT

58-5.1 When the bid schedule contains an estimated quantity for "Reconditioning of Used Roadbed" the mileage, determined as provided above, shall be paid for at the contract unit price per mile for "Reconditioning of Used Roadbed," which price and payment shall be full compensation for scarifying, shaping, compacting, rolling, placing, and for any extra handling of materials required for patching and leveling, and for all labor, equipment, tools and incidentals necessary to complete the item.

Material or mixture used for patching and leveling shall be paid for at the contract unit price applicable under the contract item under which it is furnished.

When the bid schedule does not contain an estimated quantity for "Reconditioning of Used Roadbed," mileage of this item shall not be paid for directly but shall be considered as a subsidiary part of the obligation of the contractor covered under other contract items.

The above prices and payments shall constitute full compensation for all watering, except that where the bid schedule contains an estimated quantity for "Watering of Base Course, Item 58," any authorized watering shall be paid for as provided under WATERING.

ITEM 59.—BITUMINOUS MACADAM BASE COURSE

(Asphalt or tar)

DESCRIPTION

59-1.1 This item shall consist of a foundation course composed of bituminous macadam, constructed on the prepared subgrade or base course in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

59-1.2 **QUANTITIES OF MATERIALS PER SQUARE YARD.**—The base course shall consist of one or more courses of macadam as shown on the plans. Each course of macadam shall consist of bituminous material and aggregate placed in the amounts and sequence provided in table 1.

TABLE 1.—Sequence of placing operations and amounts of material required per square yard

	Bituminous material	Aggregate		
		Coarse	Key	Chips
	<i>Gals. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>
First spreading.....		285		
First application.....	1.85			
Second spreading.....			30	
Second application.....	.30			
Third spreading.....			25	
Supplemental stockpiles.....				10
Total.....	2.15		350	

The weights given in table 1 are those of aggregate having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The amounts given in table 1 for each application and spreading are approximate and the exact amounts shall be set by the engineer. Total amounts of bituminous material per square yard may be varied by the engineer as necessary to fit condi-

tions, but the total amount of aggregate per square yard shall be that required by the table, corrected only for specific gravity.

MATERIALS

59-2.1 AGGREGATE.—The coarse aggregate, key aggregate and chips shall be crushed stone or crushed slag, and shall meet the requirements for grading, given in table 2, using A.A.S.H.O. Method T-27.

TABLE 2.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)		
	Coarse aggregate	Key aggregate	Chips
3½-inch.....	100		
3-inch.....	90-100		
2-inch.....	0-15		
1½-inch.....		100	
1-inch.....		90-100	
¾-inch.....		0-15	100
½-inch.....			90-100
¼-inch.....			40-75
No. 4.....			0-15
No. 8.....			0-5

Crushed stone and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter, and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag reasonably uniform in density and quality, free from glassy pieces, and shall weight not less than 70 pounds per cubic foot.

Aggregate shall be free from clay balls and adherent films of clay or rock dust and shall be washed thoroughly if produced from moist material. Aggregate shall be of such nature that when thoroughly coated with the bituminous material to be used in the work, it will not slough its coating upon contact with water.

59-2.2 BITUMINOUS MATERIALS.—Asphalt or tar, whichever is called for in the bid schedule, shall be furnished. The grade shall be as called for in the bid schedule, provided, however, that when not so called for the grade used shall be one of the following selected by the engineer.

Asphalt shall be penetration grade 85-100, 100-120, or 120-150, conforming to the requirements of A.A.S.H.O. Specification M-20 or M-23.

Tar shall be grade RT-10, RT-11, or RT-12 conforming to requirements of A.A.S.H.O. Specification M-52.

When asphalt is called for, only one type shall be used under any one contract. No mineral matter other than that naturally contained in the asphalt shall be present.

Application temperatures shall be 275-350° F. for asphalt and 175-250° F. for tar.

CONSTRUCTION METHODS

59-3.1 WEATHER AND SEASONAL LIMITATIONS.—Base course shall be constructed only between May 1 and October 1, and application of bituminous material shall then be made only when the aggregate is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

59-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom or a power blower, aggregate spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, equipment for heating bituminous material, a pneumatic-tired motor grader having a wheelbase of not less than 15 feet, an approved drag at least 15 feet long, broom-dragging equipment, and powered rollers.

Rollers shall be of the self-powered 3-wheel type weighing not less than 12 tons each. The rear wheels shall produce a compression of at least 400 pounds per linear inch of tire width. A sufficient number of rollers shall be furnished on the work to provide one roller for each 25 tons of aggregate laid per hour.

59-3.3 CONDITIONING OF EXISTING BASE COURSE.—Immediately before spreading coarse aggregate, the prepared subgrade or other base shall be cleaned of all loose and foreign materials. Any existing waterbound base course shall be swept with a power broom until the embedded larger aggregate is exposed to a depth of approximately one-fourth inch. While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

59-3.4 SPREADING AND ROLLING COARSE AGGREGATE.—Coarse aggregate shall be spread in the required amount by means of dump boards, approved stone spreaders or by other approved mechanical methods. It shall be spread to a uniform depth and true to alinement and profile grade. A testing template, cut to the crown of the finished pavement, shall be furnished by the contractor at his expense and used to obtain uniformity of crown. Use of power graders for spreading the aggregate will not be permitted.

Any thin, flat, or oversized particles of aggregate that appear on the surface of the spread material shall be removed.

The coarse aggregate shall have a uniform distribution of sizes. All patches or areas of fine or undersized material shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking wherever ordered and shall be continued after initial rolling until the appearance and texture are uniform and all ridges are removed.

The coarse aggregate shall be dry rolled until compacted and keyed. Rolling shall progress gradually from the sides to the center, except that on superelevated curves rolling may progress from the lower to the upper edge, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track and shall continue until the aggregate does not creep or wave ahead of the roller. At the edges, the outside rear wheel of the roller shall cover equal portions of the spread aggregate and the shoulder. The roller shall run forward and backward until the shoulder is firmly compacted against the edge of the pavement.

Material which crushes under the roller in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with suitable aggregate. Any irregularities greater than three-eighths of an inch, as determined by testing the surface with a 10-foot straight-edge laid parallel to the center line of the pavement, shall be corrected by loosening and reshaping the aggregate and removing or adding aggregate as required, and by rerolling such areas. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade.

Along curbs, headers, and walls, and at other places not accessible to the roller, the aggregate shall be tamped thoroughly with hand tampers or with mechanical tampers giving equivalent compression. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches.

On depressed areas, a trench roller may be employed, or cleated compression strips may be used under the roller, to transmit compression to the depressed area.

No base course material shall be placed against the edge of a course or layer that has been rolled and has cooled, unless such edge is vertical or has been cut back to a vertical face, and in either case has received a brush coat of asphalt.

Any aggregate in this or any subsequent spreading which becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate, and rerolled.

After the coarse aggregate has been spread and rolled and prior to the application of bituminous material, the engineer shall check the uniformity of depth of aggregate in place by

means of as many test holes as he considers necessary. In general, series of 3 test holes each shall be dug at intervals of 200 feet, one test hole at the center and one near each edge or quarter point as the engineer may direct. Test holes shall be dug and refilled by the contractor under the direction of the engineer and at the expense of the contractor.

59-3.5 FIRST APPLICATION OF BITUMINOUS MATERIAL.—The first application of bituminous material shall be to the coarse aggregate spread as required above. The material shall be applied uniformly with the prescribed pressure distributor and in the amount per square yard determined by the engineer.

Bituminous material shall be so applied in this and subsequent applications that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper, and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be immediately removed and burned. Bituminous material shall be applied at the temperatures provided in the specifications for the particular bituminous material being used. During all applications of bituminous material the surfaces of adjacent structures and trees shall be protected to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

59-3.6 FIRST SPREADING OF KEY AGGREGATE.—Immediately following the first application of bituminous material, key aggregate shall be spread evenly over the surface until the voids are nearly filled. Care shall be taken in spreading the key aggregate to obtain uniformity of surface, and if directed by the engineer the surface shall be broomed with push brooms or drag brooms. Rolling of the surface shall start immediately after the spreading and smoothing of the key aggregate and while the bituminous binder is still warm, and shall continue until the pavement is thoroughly compacted and bonded. The adding of key aggregate in small amounts shall be continued as may be required during the rolling. The time, extent, and manner of rolling shall be subject to direction by the engineer.

59-3.7 SECOND APPLICATION OF BITUMINOUS MATERIAL.—After the first spreading of key aggregate has been rolled, the surface shall be swept clean of all loose material, and bituminous material for the second application shall be applied uniformly in the amount per square yard determined by the engineer.

59-3.8 SECOND SPREADING OF KEY AGGREGATE.—Immediately following the second application of bituminous material, key aggregate shall be spread evenly over the surface

at the rate determined by the engineer but not exceeding 25 pounds per square yard. A portion of the key aggregate may be reserved and then added as required while rolling and brooming are in progress. The spreading of key aggregate shall be followed by thorough rolling and brooming of the surface. Rolling and brooming shall be continued until all interstices in the coarse aggregate are filled and until the surface is of uniform texture throughout.

While the surface is being compacted and finished, the contractor shall shape and finish the shoulders and gutters to conform to the section shown on the plans.

59-3.9 MULTIPLE COURSES.—Where more than one course is shown on the plans, the construction methods herein prescribed shall apply to each course.

59-3.10 STOCKPILING.—Chips shall be stockpiled at the rate of 10 pounds per square yard of completed base course at locations and in piles of such forms and amounts as the engineer may direct. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

59-4.1 The tonnage of aggregate to be paid for shall be the number of tons of coarse aggregate, key aggregate, and chips actually used in the accepted work or placed in authorized stockpiles.

59-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage of bituminous material to be paid for shall be the number of gallons or tons of bituminous material used as ordered for the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F., in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

59-5.1 The quantities, determined as provided above, shall be paid for at the pertinent contract unit price per ton for "Bituminous Macadam Base Course Aggregate," or per gallon or ton for "Asphalt, Grade (), for Bituminous Macadam Base Course," or "Tar, Grade (), for Bituminous Macadam Base Course," as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, manipulating, and placing all materials, for all shaping, compacting and rolling, for finishing, for reconditioning subgrade, shoulders and gutters, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 60.—HOT BITUMINOUS CONCRETE BASE COURSE

DESCRIPTION

60-1.1 This item shall consist of a foundation course composed of bituminous concrete, constructed on the prepared subgrade or base course in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

The bituminous concrete base course shall be composed of a mixture of mineral aggregate and bituminous material. The mineral aggregate shall be a blend of a coarse material with fine materials as herein prescribed.

60-1.2 GENERAL COMPOSITION OF BASE COURSE MIXTURE.—The blended aggregate, prepared as herein required, shall be graded and combined to meet the following composition limits by weight, and shall meet the following requirements for grading, using A.A.S.H.O. Methods T-11 and T-27.

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O., T-27)
1½ inch-----	100
1 inch-----	75-90
½ inch-----	35-65
No. 4-----	25-40
No. 200-----	0-5

The proportion of bitumen to total aggregate by weight shall be: Bitumen (Sol. CS₂) 4.5 percent to 7 percent.

60-1.3 FORMULA FOR JOB MIX.—The general composition limits prescribed above are extreme limits of tolerance that must not be exceeded regardless of any formula which may be submitted.

Before starting work the contractor shall submit in writing, to the engineer, the formula for the mixture which he proposes to supply for the project. The formula so submitted shall include a single definite percentage of aggregate passing each required sieve size, a single definite percentage of bitumen to be added to the aggregate, and a single definite temperature at which the mixture is to be delivered on the road. The engineer shall make any adjustments desired in the formula submitted and set the job mix. Within the ranges permitted by 1.2 above, the job mix shall fix a single definite percentage of aggregate passing each required sieve size, a single definite percentage of bitumen to be added to the aggregate, and a single

definite temperature at which the material is to be delivered on the road.

After the job-mix formula is established as prescribed above, all mixture furnished for the project shall conform thereto within the following ranges of tolerance:

Passing 1-inch sieve.....	±7	percent.
Passing ½-inch sieve.....	±7	percent.
Passing No. 4 sieve.....	±4	percent.
Passing No. 200 sieve.....	±2	percent.
Bitumen	±0.4	percent.
Temperature of mixture on delivery.....	±20°	F.

Each day the engineer shall take as many samples as he considers necessary for checking the required uniformity of the mixture. When unsatisfactory results or changed conditions make it necessary, the engineer may establish a new job-mix.

Should a change in sources of materials be made, a new job-mix formula shall be submitted and approved before the mixture containing the new materials is delivered.

MATERIALS

60-2.1 COARSE AGGREGATE.—The portion of the aggregate retained on a No. 4 sieve shall be known as coarse aggregate and shall be crushed stone or crushed slag. Only one kind and type of coarse aggregate shall be used in carrying out any one contract except by written permission of the engineer.

Crushed stone and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt, or other objectionable matter, and shall have a percent of wear of not more than 45 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Coarse aggregate shall be free from clay balls and adherent films of clay and shall be of such nature that when thoroughly coated with the bituminous material to be used in the work it will not slough its coating upon contact with water.

60-2.2 FINE AGGREGATE.—The portion of the aggregate passing a No. 4 sieve shall be known as fine aggregate and shall be sand, or a blend of sand and stone screenings. Sand shall consist of grains of quartz or other hard, durable rock, moderately sharp and free from a coating of any injurious material. Fine aggregate shall be free from lumps of clay, loam, or other foreign matter.

60-2.3 BITUMINOUS MATERIAL.—Asphalt conforming to the requirements of A.A.S.H.O. Specification M-20 or M-22 shall

be furnished, but the penetration grade shall be 60-70 or 85-100 whichever is ordered by the engineer. Only one type shall be used under any one contract. No mineral matter other than that naturally contained in the asphalt shall be present.

60-2.4 SAMPLES.—When required by the engineer, the contractor shall furnish for test, samples cut from the completed work. The base course so removed shall be replaced with new mixture and refinished. No additional compensation will be allowed for furnishing test samples and replacing the base course removed.

CONSTRUCTION METHODS

60-3.1 WEATHER AND SEASONAL LIMITATIONS.—Bituminous concrete base course shall be constructed only between May 1 and October 1, and operations shall be carried on only when the subgrade or other base is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only if so directed by the engineer.

60-3.2 PLANT AND MACHINERY.—The plant used by the contractor in the preparation of the bituminous concrete shall conform to the following requirements:

(a) *Drier.*—The drier shall be of the rotating, cylindrical type suitably designed to heat and dry the aggregates to specification requirements without any direct flame coming in contact with the aggregate, and to agitate the aggregate continuously during heating. The drier shall be capable of preparing aggregate to the full rated capacity of the paving plant.

(b) *Screens.*—All plant screens shall be designed, constructed, and operated so as to screen all aggregates to the specified sizes and proportions and shall have capacities, when operated at normal speed, slightly in excess of the maximum capacity of the mixer.

(c) *Bins.*—The plant shall have a hot storage bin of sufficient capacity to furnish the necessary amount of all aggregates at a rate equal to the maximum rated capacity of the plant, with no periods of undue waiting for materials.

Bins shall be divided into at least 3 compartments so proportioned as to insure separate and adequate storage of appropriate fractions of the aggregate. To insure such storage, compartment spaces should be adjustable within reasonable limits. Each compartment shall be provided with an overflow pipe that shall be of such size and at such location as to prevent any backing up of material into other bins.

(d) *Weigh Box or Hopper.*—The plant shall have a weigh box capable of holding the maximum amount of aggregate for one batch. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be easily thrown out of alinement or adjustment. All edges,

ends and sides of the weighing hopper must be free from contact with any supporting rods or columns or other equipment that will in any way affect proper functioning of the hopper. Also, there must be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials. The discharge gate of the weigh box shall be so hung that the aggregates will not be segregated when dumped into the mixer. If necessary to correct any such tendency, baffles shall be inserted or other means provided to discharge the materials in a blended condition.

(c) *Scales*.—Scales for the weigh box may be of either the beam or springless dial type and shall be of a standard make and design, sensitive to one-half of one percent of the maximum load that may be required. When of the beam type, there shall be a separate beam for each size of aggregate. There shall be provided a "telltale" dial scale that will start to function when the load being applied is within 100 pounds of that desired. Sufficient vertical movement shall be provided for the beams to permit the "telltale" dial scale to function properly. Each beam shall have a locking device designed and so located that the beam can easily be suspended or thrown into action. Beam scales shall be balanced on knife edges and fulcrums and shall be so constructed that they cannot be easily thrown out of alignment and adjustment.

Dial scales shall be of a standard make and of such size that the numerals on the dial can be read at a distance of not less than 25 feet. The dials shall be of the compounding type having full complements of index pointers. Pointers so placed as to give excessive parallax errors shall not be used. Dial scales shall be substantially constructed, and those that easily get out of adjustment shall be replaced with other makes when so ordered. All dial scales shall be so located as to be plainly visible to the operator at all times.

Scales for the weighing of asphalt cement shall conform to the specifications for the scales for aggregate except that beam scales shall be equipped with tare beams and full capacity beams. The value of the minimum graduation shall not be greater than two pounds. Dial scales for weighing asphalt cement shall have capacities each of not more than twice the weight of the material to be weighed and shall read to the nearest pound.

The weighing equipment, in addition to complying with the requirements above, must be constructed with adjustable devices that will permit any part thereof that gets out of alignment or adjustment to be readjusted easily so that the weighing device will function properly.

The contractor shall provide and have at hand the necessary number of standard test weights for frequent testing of all scales.

(f) *Asphalt Weigh Bucket*.—The asphalt weigh bucket shall be steam jacketed and shall have a capacity equal to 12 percent of the maximum capacity of the mixer. It shall be supported on fulcrums and knife edges in the same manner as is the weigh box.

(g) *Kettles*.—Kettles for storage of asphalt cement shall have total capacities each sufficient for 1 day's run and shall be capable of heating the asphalt cement with an effective and positive control of the heat at all times to a temperature between 250° F. and 350° F. Heating of the asphalt cement by steam coils is preferred.

Under no circumstances will a flame from oil or other fuel be permitted to come in direct contact with the heating kettles. The asphalt circulating system shall be of adequate size to insure the proper and continuous circulation of asphalt cement during the entire operating period. All asphalt lines and fittings shall be steam jacketed.

(h) *Thermometers*.—An armored thermometer reading from 200° F. to 400° F. shall be fixed in the asphalt line at a suitable location near the weigh bucket discharge valve.

The plant shall be further equipped with an approved dial scale mercury actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically the temperature of the heated aggregates. This device shall be plainly visible to the drum fireman or head feeder.

The engineer reserves the right to pass upon the efficiency of the thermometric instrument and, for better regulation of the temperature of the aggregates, may direct replacement of the instrument by some approved temperature-recording apparatus and may further require daily charts of such regulator to be filed with him.

(i) *Mixer*.—A batch mixer shall be used. It shall be of the standard twin pugmill type, steam jacketed, or of an approved rotary drum type, steam jacketed, equipped with a sufficient number of paddles or blades set in proper order to produce properly mixed batches of any material required under these specifications. When the clearance in the twin pugmill is equal to or exceeds 2 inches, either the shortened blades or the worn liners (or both) shall be replaced to reduce the clearance to 2 inches or less. When the engineer finds that there is difficulty in obtaining the specified mixing time, he may require that the mixer be provided with an approved, accurate time lock that will lock the discharge gate of the weigh box after all the aggregates have been placed in the mixer, and that will not release the gate until the specified time has elapsed. To obtain proper mixing using the minimum mixing time of 45 seconds herein prescribed, the mixer capacity shall be a 1,500-pound batch, provided that when smaller mixers are approved no de-

crease in time of mixing will be allowed. If sufficient mixing and coating are not obtained, the right is reserved to increase the required mixing time as the engineer may judge necessary.

60-3.3 GRADE CONTROL FORMS.—(a) Forms shall be set at least 200 feet ahead of the place where the course is being placed. Enough forms shall be provided to make it unnecessary to remove any until at least one hour after all rolling and back finishing of the adjacent base course has been completed. The alinement and grade of all forms set shall be approved immediately prior to the placing of any material against them. Forms shall be cleaned thoroughly each time they are used.

(b) Except under conditions given in (1), (2), (3), and (4) below, and except as provided under 3.4 below, fixed side forms for grade control shall be provided along both projected edges of the base course and shall be of steel set to grade, whether the finishing machine, or the combined spreading and finishing machine, is of a type designed to ride entirely upon two side forms or is so designed that the side forms carry only the weight and pressure of a reciprocating screed assembly. String or wire lines staked to grade will not be accepted as an equivalent for grade control forms.

1. When a grade control form would come on a worn, hardened pavement or when conditions would be unfavorable to the setting of conventional side forms with stakes or when other reasons operate, narrow strips of bituminous concrete not less than 8 inches in width may be constructed and laid and compacted to exact grade, or to a surface parallel to the grade, and may be used as grade control forms. Such bituminous strips shall be constructed of materials meeting the requirements of the particular course of which they form a part. They shall be armored with protective bearing plates if necessary for satisfactory use with the type of equipment that is to ride upon them.

2. When a suitable abutting curb or header is available and is approved by the engineer as in conformance with the intended profile grade, it may be utilized as a grade control form. Curbs or headers shall be armored with appropriate bearing plates if necessary to produce satisfactory results.

3. When one end of the screed or strike-off assembly of a mechanical finisher or mechanical spreader and finisher is supported and controlled by a form and the other end can be positively controlled and held precisely at grade by an approved leveling device controlled by the operator, no form need be provided to carry the end of the assembly so controlled by the operator.

4. The requirements for grade control forms may be waived when the base course is being placed on a base that itself is parallel to the proposed finished surface of the course being laid and has been finished to the same surface tolerance as

is required for such course, provided that the finishing machine in use has a longitudinal wheelbase of approximately 10 feet or more in length or the screed or strike-off action is controlled by a moving support of approximately 10 feet or more in length measured parallel to the direction of advance of the machine and that such wheelbase or support, except as otherwise permitted below, is in contact with such finished base surface and advances along it so as to provide continuous and positive mechanical control of the screed or strike-off assembly, and so as to strike off the mixture to the exact grade and elevation intended without the aid of manual adjustment during operation.

Machines otherwise meeting all requirements and having the forward supports riding on and in contact with such finished base surface may have the rear supports arranged to ride on the newly struck surface if in practice it is found that such method of support does not introduce or add any element of nonuniformity or inaccuracy and does not result in injury to the base course due to sudden or severe application of power to such means of support riding on the newly struck course.

60-3.4 TIMBER FOR GRADE CONTROL FORMS.—Wood will not be permitted for grade control forms of 3 inches or less in depth. When conditions and the course being laid are such as to require grade control forms of 3 inches or less in depth, steel forms or bituminous strips shall be used unless other equivalents herein provided for are available and utilized. Wood may be used for grade control forms more than 3 inches in depth, and when so used shall meet the following specifications:

Timber grade control forms shall be made of common structural (or better), joist and plank grade timber, or of common structural (or better), beam and stringer grade timber, as the circumstances require. Pieces shall not be less than 16 feet long. When a form is set in position, the horizontal dimension shall not be less than 4 inches (nominal). The face next to the base course and the bottom and top faces shall be surfaced. Timber forms shall rest on the ground and on 2-inch by 3-inch supporting stakes not less than 8 inches long and not more than 4 feet apart and shall be secured by side stakes not more than 4 feet apart driven vertically at intermediate points between the supporting stakes; the side stakes shall be not less than 1½ inches by 3 inches, and not less than 18 inches long. Timber forms shall be spliced with sections of plank. The joints of timber forms shall be so placed as to provide a gap of ¼ inch between the ends of timbers, and shall rest upon supporting stakes of the size specified above.

The top edges of timber grade control forms shall be temporarily faced with steel strips during the passing of the

finishing machine. A steel strip shall be not less than $\frac{5}{8}$ inch by $2\frac{1}{2}$ inches in cross section and not less than 8 feet long. The strips shall be firmly attached to the tops of the forms and a sufficient number of strips shall be provided to keep the forms faced well ahead of operations and to prevent delay of the work. The steel strips may be removed after the equipment has passed.

60-3.5 RETAINING FORMS.—When the plan of construction and equipment and type of grade control forms in use are such that any edge of any bituminous course may be left unsupported during the construction operations, retaining forms of any suitable material and design shall be used so far as considered necessary to prevent lateral displacement or squeezing out or side shoving under the roller.

60-3.6 PREPARATION OF ASPHALT CEMENT.—The bituminous material shall be melted in kettles or tanks designed to heat the entire contents uniformly. The material shall be brought to a temperature between 250° F. and 350° F.

When refined asphalt is to be combined with a flux, the mixture shall be thoroughly agitated until a homogeneous asphalt cement of the required penetration is produced. The penetration of the asphalt shall be tested at suitable intervals to insure that it is maintained at a uniform consistency throughout the period of use.

60-3.7 PREPARATION OF MINERAL AGGREGATE.—The aggregate for the mixture shall be dried and heated at the paving plant before being placed in the mixer. The aggregates shall be heated to a temperature between 225° F. and 350° F. as determined on the mixing platform. When more than two ingredients enter into the composition of the mineral aggregate, they shall be combined as directed by the engineer.

The aggregates, immediately after heating, shall be screened into three or more fractions and conveyed into separate bins ready for batching and mixing with bituminous material.

60-3.8 PREPARATION OF BITUMINOUS CONCRETE MIXTURE.—The dried mineral aggregate, prepared as prescribed above, shall be combined in uniform batches by weighing and conveying into the mixer the proportionate amounts of each aggregate required to meet the job mix formula. The required quantity of hot asphalt cement for each batch shall be measured by weight, using scales attached to the asphalt cement bucket. The mixture shall be made by first charging the mixer with the mineral aggregates. After these have been thoroughly mixed, the asphalt cement shall be added and the mixing continued for a period of at least 45 seconds, but longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated. Each batch must be kept separate throughout the mixing operations.

The ingredients shall be heated and combined in such a

manner as to produce a mixture which, when discharged, shall be at a temperature of not less than 250° F. nor more than 350° F.

60-3.9 TRANSPORTATION AND DELIVERY OF MIXTURE.—The mixture shall be transported from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of all foreign materials. When directed by the engineer, each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from the weather. No loads shall be sent out so late in the day as to prevent completion of the spreading and compaction of the mixture during daylight, unless artificial light satisfactory to the engineer is provided. The mixture shall be delivered at a temperature of between 225° F. and 325° F. and within 20° F. of the temperature set in the job-mix formula.

60-3.10 DEPOSITING MIXTURE.—Prior to depositing the bituminous concrete mixture, the underlying course shall have been brought to exact line, grade, and cross section contour and shall have been cleaned of all loose and foreign materials. When the compacted thickness specified is greater than 3 inches, the base course shall be deposited, spread, and compacted in separate layers of not over 3 inches compacted depth each.

60-3.11 SPREADING AND FINISHING.—Upon arrival at the point of use, the mixture shall be spread and struck off between fixed grade control forms, or equivalents therefor as hereinbefore provided, exactly conforming to the profile grade or to a predetermined surface parallel thereto. Mechanical spreading and finishing equipment provided with a screed or strike-off assembly (either a combination machine or multiple units) shall be used to distribute the mixture either over the entire width or over such partial-width lanes as may be practicable, and to strike it off to the transverse crown required. The screed assembly shall be adjustable to give the cross section shape prescribed and shall be so designed and operated as to place the weight per square yard of base course required.

All spreading and finishing machines shall have floating screeds or strike-off assemblies arranged to ride directly upon or be controlled directly by the grade control forms or one of the equivalents hereinbefore permitted. Blade graders shall not be used. If during construction it is found that the spreading and finishing equipment in operation leaves in the new base course tracks or indented areas that are not satisfactorily corrected by the scheduled operations or if it produces other permanent blemishes, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the contractor.

The term "screed" includes any cutting, crowding, or other practical action that is effective in producing, from the mixture specified without tearing, shoving, or gouging, a finished surface of the evenness and texture specified.

A mechanical rake or its equivalent must be used in front of the finishing machine to loosen thoroughly the material and make possible uniform distribution. Where the spreader is integral with the screeding machine, such a rake will not be required.

On areas where irregularities or unavoidable obstacles make the use of the mechanical spreading and finishing equipment impracticable, in the determination of the engineer, the mixture shall be spread and screeded by hand. On such areas the mixture shall be dumped on steel dump boards and spread and screeded to leave the weight of material required.

The contractor shall provide suitable means for keeping all small tools clean and free from accumulations of bituminous material. He shall provide and have ready for use at all times enough tarpaulins or covers, as may be directed by the engineer, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may be dumped and not spread.

60-3.12 COMPACTION.—After placing and while still hot, the course shall be compacted thoroughly and uniformly by rolling. Two types of rollers shall be used for obtaining compaction. One shall be an 8- to 10-ton tandem roller and the other shall be a 10- to 12-ton 3-wheel power roller, however, the latter may be replaced by a 10-ton tandem roller upon written permission by the engineer. A sufficient number of rollers shall be furnished on the work to provide one roller for each 25 tons of bituminous mixture laid per hour. All rollers shall be kept in good condition, and each shall weigh not less than 250 pounds to the inch width of tread.

Each roller shall be operated by a competent, experienced roller operator, and, while the work is under way, must be kept as nearly as practicable in continuous operation. Ashes from the rollers must not be dumped upon the course. Rolling shall begin at the side and progress gradually to the center, except that on superelevated curves rolling may progress from the lower to the upper edge parallel with the center line of the road and uniformly lapping each preceding track, as directed by the engineer, until the entire surface has been rolled by the rear wheels. The course shall be subjected to a diagonal rolling in two directions, the second diagonal rolling crossing the lines of the first. If the width of course permits, it shall, in addition, be rolled at right angles to the center line. Rolling shall be continued until all roller marks are eliminated. The motion of the roller at all times shall be slow enough to avoid displacement of the hot mixture; and any displacement occurring as a result of the reversing of the direction of the roller, or from any other cause shall be corrected at once by the use of rakes and of fresh mixture when required. To prevent adhesion of the mixture to the roller the wheels shall be kept properly moistened but ex-

cess water or oil will not be permitted. Care shall be exercised in rolling not to displace the line and grade of the side forms.

Along forms, curbs, headers, and walls and at other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers or with mechanical tampers giving equivalent compression. Each hand tamper shall weigh not less than 25 pounds and shall have a tamping face area of not more than 50 square inches.

On depressed areas, a trench roller may be employed, or cleated compression strips may be used under the roller, to transmit compression to the depressed area.

No base course material shall be placed against the edge of a course or layer that has been rolled and has cooled, unless such edge is vertical or has been cut back to a vertical face, and in either case has received a brush coat of asphalt.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture that becomes loose and broken, mixed with dirt, or in any way defective prior to the application of the finish coat shall be removed and replaced with fresh hot mixture, which shall be immediately compacted to conform with the surrounding area. Any area of one square foot or more showing an excess of asphalt cement shall be removed and replaced.

60-3.13 JOINTS.—Placing of the course shall be as nearly continuous as possible; and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is to be discontinued for such length of time as to permit the mixture to become chilled. In all such cases, including the formation of joints as hereinafter specified, provision shall be made for proper bond with the new surface for the full specified depth of the course. Joints shall be formed by cutting back on the previous day's run so as to expose the full depth of the course. When the laying of the course is resumed, the exposed edge of the joint shall be painted with a thin coat of hot asphalt cement or asphalt cement thinned with naphtha; and the fresh mixture shall be raked against the joint, thoroughly tamped with hot tampers, and rolled.

60-3.14 PROTECTION OF THE WORK.—Sections of the newly finished base course shall be kept clean prior to laying the surface course or courses. No traffic except that in connection with laying the surface course or courses shall be permitted on the base course.

METHOD OF MEASUREMENT

60-4.1 The tonnage to be paid for shall be the number of tons of base course mixture, placed, bonded and accepted in the completed base course. The tonnage shall be actual weight.

BASIS OF PAYMENT

60-5.1 The tonnage, determined as provided above, shall be paid for at the contract unit price per ton for "Hot Asphalt Concrete Base Course, Stone Aggregate," or "Hot Asphalt Concrete Base Course, Slag Aggregate," which price and payment shall be full compensation for furnishing and placing all materials, for the preparation of all materials, for reconditioning subgrade, shoulders, and gutters, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

SURFACE COURSES AND PAVEMENTS**ITEM 100.—SELECTED BORROW SURFACE COURSE****DESCRIPTION**

100-1.1 This item shall consist of a surface course composed of selected borrow obtained from sources designated in the special provisions or authorized sources supplementary thereto, constructed on the prepared subgrade or base course in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

100-2.1 Selected borrow surface course material shall consist of pit-run gravel, talus rock, disintegrated granite, semi-gravel, sand, pebble soil, topsoil, caliche, shale, scoria, clinkers, cinders, or other similar materials selected under the direction of the engineer. The maximum dimension of any particle of the selected borrow surface course material shall not be greater than 1½ inches. Oversize material, if present, shall be removed at the pit by screens, grizzlies, or hand picking, except that if the material is of such nature that it will break down under blading and rolling, the engineer may permit breaking down to the required size on the road and provided that oversize material may be crushed if the contractor so elects.

100-2.2 **FILLER FOR BLENDING.**—If filler in addition to that naturally present in the surface course material is necessary for satisfactory bonding of the material, it shall be uniformly blended with the surface course material on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from hard lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

CONSTRUCTION METHODS

100-3.1 **PLACING AND SPREADING.**—All surface course material shall be placed on the prepared subgrade or base course and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade or base course, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread

in a uniform layer and without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described below shall apply similarly to each layer.

100-3.2 BLADING.—After the surface course material has been spread, it shall be bladed to a smooth surface conforming to the cross section shown on the plans. A blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet shall be used for the blading.

100-3.3 ADDITIONAL FILLER FOR BLENDING.—This material, when not added at the plant, shall be spread in a uniform layer, over the loosely spread surface course layer, in the amounts set by the engineer, and shall then be blended thoroughly into the layer by blade-mixing, using a blade grader meeting the requirements given under 3.2 above. The entire layer shall be alternately bladed to the center and back to the edges of the road until the mixture is uniform. When uniform, the mixture shall again be spread smoothly to the cross section shown on the plans.

100-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade grader meeting the requirements given under 3.2 above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted surface until the final inspection. Along curbs, headers, and walls, and at all places not accessible to the roller, the surface course material shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping, and blading when and if directed by the engineer.

100-3.5 TRAFFIC COMPACTION.—When so indicated on the plans, the surface course shall be compacted by traffic in-

stead of being rolled as required above. In such case, the depositing and spreading of material on the road shall start at the point nearest the point of loading, and compaction shall be accomplished by directing the hauling and public traffic over the full width of each layer. Blading and/or dragging shall accompany traffic compaction, and the surface shall be kept free of corrugations and waves at all times until the project is completed and accepted. The material shall be sprinkled with water during the blading and/or dragging, when and if directed by the engineer.

100-3.6 STOCKPILING.—When indicated on the plans, surface course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer.

Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

100-4.1 The yardage of surface course to be paid for shall be the number of cubic yards of surface course material, including all filler, placed, bonded, and accepted in the completed surface course or placed in authorized stockpiles. The quantities of surface course material and filler shall be measured in original position and computed by average end area method.

BASIS OF PAYMENT

100-5.1 The yardage of surface course material, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Selected Borrow Surface Course," which price and payment shall constitute full compensation for furnishing material, and placing the same; for mixing, blading, and rolling; for reconditioning of subgrade, shoulders, and gutters; for clean-up of pits; for clearing, cleaning, and leveling stockpile sites; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Surface Course, Item 100," any authorized watering shall be paid for as provided under WATERING.

ITEM 101.—GRAVEL SURFACE COURSE**DESCRIPTION**

101-1.1 This item shall consist of a surface course composed of gravel and filler, constructed on the prepared subgrade or base course in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

101-2.1 Gravel surface course material shall meet the requirements for one of the following classes, whichever is called for in the bid schedule:

101-2.2 CLASS 1 MATERIAL.—Class 1 material shall consist of coarse aggregate of hard, durable particles or fragments of stone or gravel and a filler of sand or other finely divided mineral matter. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. Oversize material encountered in deposits from which gravel surface course material is produced shall be removed by screening or shall be crushed to required size, whichever the contractor may elect. The composite surface course material shall be free from vegetable matter and lumps or balls of clay, and shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of material

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A	Grading B	Grading C	Grading D
1½-inch.....	100			
1-inch.....		100		
¾-inch.....			100	
½-inch.....	40-75			100
No. 4.....	30-60	40-75	45-80	
No. 10.....		25-60	25-60	25-60
No. 200, less than.....	12	12		12

101-2.3 CLASS 2 MATERIAL.—Class 2 material shall conform to one of the gradings A, B, C, or D of table 1, whichever is called for in the bid schedule, and shall conform to all other requirements as given above for class 1 material. Class 2 material shall also meet the following test requirements:

(a) Coarse aggregate for class 2 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

(b) For class 2 material the portion of the filler, including blended filler, passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

101-2.4 CLASS 3 MATERIAL.—Class 3 material shall conform to all the requirements as given above for class 1 material save that it shall meet the following grading requirements:

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O., T-27)
1 inch.....	100
¾ inch.....	85-100
½ inch.....	65-100
No. 4.....	55-85
No. 10.....	40-75
No. 40.....	25-45
No. 200.....	10-25

The fraction passing the No. 200 mesh sieve shall be less than two-thirds of the fraction passing the No. 40 sieve.

Class 3 material shall also meet the following test requirements:

(a) Coarse aggregate for class 3 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test.)

(b) For class 3 material the portion of the filler, including blended filler, passing a No. 40 sieve shall have a liquid limit of not more than 35 and a plasticity index of not less than 4 nor more than 9, as determined by A.A.S.H.O. Methods T-89 and T-91, respectively.

101-2.5 FILLER FOR BLENDING.—If filler in addition to that naturally present in the surface course material is necessary for meeting the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the surface course material at the screening plant or on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from hard lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

CONSTRUCTION METHODS

101-3.1 PLACING AND SPREADING.—All surface course material shall be placed on the prepared subgrade or base course and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade or base course, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described below shall apply similarly to each layer.

101-3.2 MIXING.—After the surface course material has been spread, it shall be thoroughly blade-mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. A blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet shall be used for the mixing, provided, however, that traveling mixers or traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. The material shall be watered during the mixing when and if directed by the engineer. When uniform, the mixture shall again be spread smoothly to the cross section shown on the plans.

101-3.3 ADDITIONAL FILLER FOR BLENDING.—This material, when not added at the plant, shall be spread in a uniform layer, over the loosely spread surface course layer, in the amounts set by the engineer, and shall then be blended thoroughly into the layer by blade-mixing as described under 3.2 above. Additions of filler shall be such that the blend of added and original material placed shall meet grading and quality requirements in all respects.

101-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rearwheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade grader meeting the requirements given under 3.2 above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted surface until the final inspection. Along curbs, headers, and walls, and at all places not accessible to the roller, the surface course material shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping, and blading when and if directed by the engineer.

101-3.5 TRAFFIC COMPACTION.—When so indicated on the plans, the surface course shall be compacted by traffic instead of being rolled as required above. In such case, the depositing and spreading of material on the road shall start at the point nearest the point of loading, and compaction shall be accomplished by directing the hauling and public traffic over the full width of each layer. Blading and/or dragging shall accompany traffic compaction, and the surface shall be kept free of corrugations and waves at all times until the project is completed and accepted. The material shall be sprinkled with water during the blading and/or dragging, when and if directed by the engineer.

101-3.6 STOCKPILING.—When indicated on the plans, surface course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

101-4.1 The yardage or tonnage of surface course to be paid for shall be the number of cubic yards or tons of surface course material, including all filler, placed, bonded, and accepted in the completed surface course or placed in authorized stockpiles. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

BASIS OF PAYMENT

101-5.1 The yardage or tonnage of surface course material, determined as provided in 4.1 above, shall be paid for at the contract unit price per cubic yard or per ton for "Gravel Surface Course," of the class and grading called for in the bid schedule, which price and payment shall constitute full compensation for furnishing material and placing the same; for mixing, blading, and rolling; for reconditioning of subgrade, shoulders, and gut-

ters; for clean-up of pits; for clearing, cleaning, and leveling stockpile sites; for furnishing and sealing of scales; for furnishing the weigh house; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Surface Course, Item 101," any authorized watering shall be paid for as provided under WATERING.

ITEM 102.—CRUSHED GRAVEL OR CRUSHED STONE SURFACE COURSE

DESCRIPTION

102-1.1 This item shall consist of a surface course composed of crushed gravel or crushed stone and filler, constructed on the prepared subgrade or base course in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

MATERIALS

102-2.1 Crushed gravel or crushed stone surface course material shall meet the requirements for one of the following classes, whichever is called for in the bid schedule:

102-2.2 CLASS 1 MATERIAL.—Class 1 material shall consist of coarse aggregate of hard, durable particles or fragments of stone or gravel crushed to required size and a filler of finely crushed stone, sand, or other finely divided mineral matter. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. The composite surface course material shall be free from vegetable matter and lumps or balls of clay, and shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of material

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Grading A	Grading B	Grading C	Grading D
1½-inch.....	100	-----	-----	-----
1-inch.....	-----	100	-----	-----
¾-inch.....	-----	-----	100	-----
½-inch.....	40-75	-----	-----	100
No. 4.....	30-60	40-75	45-80	-----
No. 10.....	-----	25-60	25-60	25-60
No. 200, less than.....	12	12	12	12

When produced from gravel, not less than 50 percent by weight of the coarse aggregate particles shall be particles having at least one fractured face, and if necessary to meet this require-

ment or to eliminate an excess of filler, the gravel shall be screened before crushing.

102-2.3 CLASS 2 MATERIAL.—Class 2 material shall meet one of the above gradings, A, B, C, or D, of table 1, whichever is called for in the bid schedule, and shall conform to all other requirements as given above for class 1 material. Class 2 material shall also meet the following test requirements.

(a) Coarse aggregate for class 2 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

(b) For class 2 material the portion of the filler, including blended filler, passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

102-2.4 CLASS 3 MATERIAL.—Class 3 material shall conform to all the requirements as given above for class 1 material save that it shall meet the following grading requirements.

<i>Sieve designation</i>	<i>Percentage by weight passing square mesh sieves (A.A.S.H.O., T-27)</i>
1 inch-----	100
¾ inch-----	85-100
⅝ inch-----	65-100
No. 4-----	55- 85
No. 10-----	40- 70
No. 40-----	25- 45
No. 200-----	10- 25

The fraction passing the No. 200 mesh sieve shall be less than two-thirds of the fraction passing the No. 40 sieve.

Class 3 material shall also meet the following test requirements:

(a) Coarse aggregate for class 3 material shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

(b) For class 3 material the portion of the filler, including blended filler, passing a No. 40 sieve shall have a liquid limit of not more than 35 and a plasticity index of not less than 4 nor more than 9, as determined by A.A.S.H.O. Methods T-89 and T-91, respectively.

102-2.5 FILLER FOR BLENDING.—If filler in addition to that naturally present in the surface course material is necessary for meeting the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the surface course material at the screening and crushing plant or on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from hard lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

CONSTRUCTION METHODS

102-3.1 PLACING AND SPREADING.—All surface course material shall be placed on the prepared subgrade or base course and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the prepared subgrade or base course, or on a completed layer, shall commence at the point furthest from the point of loading, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer shall have the required thickness. Spreading shall be from dump boards, spreader boxes, or from moving vehicles equipped to distribute the material in a uniform layer. When more than one layer is required, the construction procedure described below shall apply similarly to each layer.

102-3.2 MIXING.—After the surface course material has been spread, it shall be thoroughly blade-mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. A blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet shall be used for the mixing, provided, however, that traveling mixers or traveling plants of a type approved by the engineer may be used in lieu of blade-mixing. The material shall be watered during the mixing when and if directed by the engineer. When uniform, the mixture shall again be spread smoothly to the cross section shown on the plans.

102-3.3 ADDITIONAL FILLER FOR BLENDING.—This material when not added at the plant, shall be spread in a uniform layer over the loosely spread surface course layer, in the amounts set by the engineer, and shall then be blended thoroughly into the layer by blade-mixing as described under 3.2 above. Additions of filler shall be such that the blend of added and original material placed shall meet grading and quality requirements in all respects.

102-3.4 ROLLING.—Immediately following final spreading and smoothing, all material placed shall be compacted to the full width by rolling with a 3-wheel power roller weighing at least 8 tons. Rolling shall progress gradually from the sides to the center, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track, and shall continue until all the surface has been rolled by the rear wheels and compaction satisfactory to the engineer has been obtained. Any irregularities or depressions that develop under rolling shall be cor-

rected by loosening the material at these places and adding or removing material until the surface is smooth and uniform.

After the rolling described above has been completed, the surface shall be bladed with a blade grader meeting the requirements given under 3.2 above. Blading and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted surface until the final inspection. Along curbs, headers, and walls, and at all places not accessible to the roller, the surface course material shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches. The material shall be sprinkled with water during rolling, tamping, and blading when and if directed by the engineer.

102-3.5 TRAFFIC COMPACTION.—When so indicated on the plans, the surface course shall be compacted by traffic instead of being rolled as required above. In such case, the depositing and spreading of material on the road shall start at the point nearest the point of loading, and compaction shall be accomplished by directing the hauling and public traffic over the full width of each layer. Blading and/or dragging shall accompany traffic compaction, and the surface shall be kept free of corrugations and waves at all times until the project is completed and accepted. The material shall be sprinkled with water during the blading and/or dragging when and if directed by the engineer.

102-3.6 STOCKPILING.—When indicated on the plans, surface course material shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

102-4.1 The yardage or tonnage of surface course to be paid for shall be the number of cubic yards or tons of surface course material, including all filler, placed, bonded and accepted in the completed surface course or placed in authorized stockpiles. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

BASIS OF PAYMENT

102-5.1 The yardage or tonnage of surface course material, determined as provided in 4.1 above, shall be paid for at the contract unit price per cubic yard or per ton for "Crushed Gravel or Crushed Stone Surface Course," of the class and grading called for in the bid schedule, which price and payment shall constitute full compensation for furnishing material and placing the same; for mixing, blading, and rolling; for recon-

ditioning of subgrade, shoulders, and gutters; for clean-up of pits and quarries; for clearing, cleaning, and leveling stockpile sites; for furnishing and sealing of scales; for furnishing the weigh house; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering, except that when the bid schedule contains an estimated quantity for "Watering of Surface Course, Item 102," any authorized watering shall be paid for as provided under WATERING.

ITEM 110.—BITUMINOUS PRIME COAT

DESCRIPTION

110-1.1 This item shall consist of furnishing and applying bituminous material to a previously prepared base or road surface in accordance with these specifications and to the width shown on the typical cross section on the plans.

MATERIALS

110-2.1 BITUMINOUS MATERIALS.—(a) One of the following materials, whichever is called for in the bid schedule, shall be furnished.

Slow-curing liquid asphaltic material meeting the requirements of table 1, subsection 112-2.2. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent+, and proportion of bitumen soluble in carbon tetrachloride is 99.65 percent+.

Medium-curing cut-back asphalt meeting the requirements of table 2, subsection 112-2.2, save that if the penetration of the residue from distillation to 680° F. is more than 200, and its ductility at 77° F. is less than 100, the material will be acceptable if its ductility at 60° F. is greater than 100 centimeters.

Tar conforming to A.A.S.H.O. Specification M-52.

(b) Grades (with temperatures of application in degrees F.) shall be as follows:

Slow-curing asphalts—SC-1 (125-200), SC-2 (150-225); Cut-back asphalts—MC-0 (100-150), MC-1 (125-175), MC-2 (150-200); Tar—RT-1 and RT-2 (60-125), RT-3 (80-150).

The grade of material to be used shall be as called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

CONSTRUCTION METHODS

110-3.1 WEATHER AND SEASONAL LIMITATIONS.—Prime coat shall be applied only between May 1 and October 1 and application shall be made only when the surface to be treated is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only if so directed by the engineer.

110-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom or a power blower, a self-powered pressure bituminous material distributor, and equipment for heating bituminous material.

110-3.3 CLEANING SURFACE.—Immediately before applying the prime coat the full width of surface to be treated shall be swept with a power broom or, if not sufficiently bonded, shall be cleaned with a power blower. In any event, loose dirt and other objectionable material shall be removed.

110-3.4 APPLICATION OF BITUMINOUS MATERIAL.—Bituminous material shall be applied by means of a distributor at the rate or rates directed by the engineer, which will usually be from 0.25 to 0.5 gallon per square yard, and at the temperature stated in the specifications for the particular material being used. Any prescribed application may be divided into two applications to prevent flowing off the surface and additional bituminous material may be applied where surface conditions indicate it to be necessary if the engineer so directs.

The surfaces of structures and trees adjacent to the area being treated shall be protected in such manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

110-3.5 OPENING TO TRAFFIC AND MAINTENANCE.—After the prime coat has been applied, it shall be left undisturbed for a period of not less than 24 hours. If the weather is cool or if asphaltic prime material is used, a longer period may be necessary and shall be observed if required by the engineer. Any excess bituminous material remaining on the surface shall be blotted with sand or other approved material as directed by the engineer before the surface is opened to any kind of traffic. The contractor shall maintain the primed surface until the surfacing or next course has been placed. Maintenance shall include spreading any additional sand or other approved material necessary to prevent adherence of the prime coat to the tires of vehicles using the surface, and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become fouled by traffic, or otherwise, shall be cleaned before paving is placed thereon.

METHOD OF MEASUREMENT

110-4.1 The gallonage or tonnage of bituminous prime coat to be paid for shall be the number of gallons or tons of bituminous material used as ordered for the accepted work. The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

110-5.1 The quantity, determined as provided above, shall be paid for at the contract unit price per gallon or ton for "Slow-Curing Liquid Asphaltic Material, Grade (), for Prime Coat," "Medium-Curing Cut-Back Asphalt, Grade (), for Prime Coat," or "Tar, Grade (), for Prime Coat," as the case may be, which price and payment shall be full compensation for furnishing, delivering, and applying the material, for furnishing and spreading cover material, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 111.—BITUMINOUS TACK COAT**DESCRIPTION**

111-1.1 This item shall consist of furnishing and applying bituminous material to a previously prepared, bonded, and bituminized base or road surface, or concrete base or surface, in accordance with these specifications and to the full width of the proposed bituminous course to be superimposed.

MATERIALS

111-2.1 BITUMINOUS MATERIALS.—(a) One of the following materials, whichever is called for in the bid schedule, shall be furnished:

Rapid-curing cut-back asphalt meeting the requirements of table 3, subsection 113-2.3.

Emulsified asphalt conforming to A.A.S.H.O. Specification M-51.

Asphalt shall be penetration grade 150-200 conforming to A.A.S.H.O. Specifications M-20 or M-23, save that the penetration shall be 150 to 200. No mineral matter other than that naturally contained in the asphalt shall be present.

Tar conforming to A.A.S.H.O. Specification M-52.

(b) Grades (with temperatures of application in degrees F.) shall be as follows:

Cut-back asphalts—RC-2 (150-200), RC-3 (175-225), RC-4 (200-250); Emulsified asphalt (60-120); Asphalt, grade 150-200 (325-400); Tar—RT-4, RT-5, and RT-6 (80-150), RT-7, RT-8 and RT-9 (150-225).

The grade of material to be used shall be as called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

CONSTRUCTION METHODS

111-3.1 EQUIPMENT.—The equipment used by the contractor shall include a power broom, a pressure bituminous material distributor, and equipment for heating bituminous material.

If, in the opinion of the engineer, the use of the distributor prescribed is not practicable under the working conditions, other pressure distributing equipment approved by the engineer may be used.

111-3.2 CLEANING SURFACE.—Immediately before applying the tack coat, the full width of surface to be treated shall be swept with a power broom to remove loose dirt and other objectionable material. The surface to be treated shall be dry.

111-3.3 APPLICATION OF BITUMINOUS MATERIAL.—Bituminous material shall be applied at the rate or rates directed by the engineer, which will usually be from 0.1 to 0.25 gallon per square yard, and at the temperature provided in the specifications for the particular material being used.

The surfaces of structures and trees adjacent to the area being treated shall be protected in such manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

The surface shall be allowed to dry until it is in a proper condition of tackiness to receive the surface course. Tack coat shall be applied only so far in advance of surface course placement as is necessary to obtain this proper condition of tackiness. Until the surface course is placed, the contractor shall protect the tack coat from damage. Any breaks in the tack coat shall be repaired with bituminous material.

METHOD OF MEASUREMENT

111-4.1 The gallonage or tonnage of bituminous tack coat to be paid for shall be the number of gallons or tons of bituminous material furnished and used as ordered for the accepted tack coat. The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

111-5.1 The quantity, determined as provided above, shall be paid for at the contract unit price per gallon or per ton for "Rapid-Curing Cut-back Asphalt, Grade (), for Tack Coat," "Emulsified Asphalt for Tack Coat," "Asphalt, Grade (150-200), for Tack Coat," or "Tar, Grade (), for Tack Coat," as the case may be, which price and payment shall be full compensation for furnishing, delivering, and applying the material, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 112.—BITUMINOUS PRESERVATIVE TREATMENT

DESCRIPTION

112-1.1 This item shall consist of a double application of bituminous material, with a blotter cover, on earth graded roadbed, base or surface course in accordance with these specifications and to the width shown on the typical cross section on the plans.

MATERIALS

112-2.1 BLOTTER MATERIALS.—Blotter material shall be of one or more of the four following types as called for in the bid schedule:

(a) Type 1 blotter material shall consist of material windrowed from the surface that is to be treated.

(b) Type 2 blotter material shall consist of disintegrated granite, sand, or similar granular material. All of this material shall pass a $\frac{1}{2}$ -inch sieve and not more than 20 percent shall pass a No. 200 sieve.

(c) Type 3 blotter material shall consist of coarse sand or screened gravel. All of this material shall pass a $\frac{1}{2}$ -inch sieve, 25 percent to 60 percent shall pass a No. 10 sieve, and not more than 12 percent shall pass a No. 200 sieve.

(d) Type 4 blotter material shall consist of crushed stone or crushed gravel, with or without sand filler. All of this material shall pass a $\frac{1}{2}$ -inch sieve, 25 percent to 60 percent shall pass a No. 10 sieve, and not more than 12 percent shall pass a No. 200 sieve.

Conformity of all material to the grading requirements described above shall be determined by A.A.S.H.O. Methods T-11 and T-27.

For types 2, 3, and 4 blotter materials, that portion of the material passing a No. 40 sieve shall have a plasticity index of not more than 6 when tested in accordance with A.A.S.H.O. Method T-91. The blotter materials shall be free from clay balls and adherent films of clay or other matter that will prevent thorough coating with bituminous material and shall be of such nature that a thorough coating of the particular material to be used in the work applied to them will not slough off upon contact with water. Bituminous blotter material shall have a swell of not more than 1.5 percent when tested in accordance with method 1, A.A.S.H.O. Method T-101.

112-2.2 BITUMINOUS MATERIALS.—(a) One of the following materials, whichever is called for in the bid schedule, shall be furnished:

Slow-curing liquid asphaltic material meeting the requirements of table 1 below. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent+, and proportion of bitumen soluble in carbon tetrachloride is 99.65 percent+.

Medium-curing cut-back asphalt meeting the requirements of table 2 below, save that if the penetration of the residue from distillation to 680° F. is more than 200, and its ductility at 77° F. is less than 100, the material will be acceptable if its ductility at 60° F. is greater than 100 centimeters.

Tar conforming to A.A.S.H.O. Specification M-52.

(b) Grades (with temperatures of application in degrees F.) shall be as follows:

Slow-curing asphalts—SC-1 (125-200), SC-2 (150-225), SC-3 (175-250), SC-4 (200-275); Cut-back asphalts—MC-0 (100-150), MC-1 (125-175), MC-2 (150-200), MC-3 (175-225), MC-4 (200-250); Tar—RT-1 and RT-2 (60-125), RT-3 (80-150).

The grade of material to be used shall be as called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

Where more than one grade of bituminous material is called for, the lighter grade shall be used for the first application and the heavier grade for the second application.

TABLE 1.—Requirements for slow-curing liquid asphaltic material

A.A.S.H.O. test method	Grades							
	SC-1		SC-2		SC-3		SC-4	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Water, percent.....	.....	0.5	.....	0	.....	0	.....	0
Fuel vis:								
At 122° F.....	75	150	100	200	250	500	125	250
At 140° F.....	.....	.....	.....	.....	.....	.....	.....	.....
At 180° F.....	150	.....	175	.....	200	.....	225	.....
Flash pt. °F.....	.....	.....	.....	.....	.....	.....	.....	.....
Distillation:								
Total distillate to 680° F., percent by vol.....	10	30	5	25	2	15	60	10
Float test on residue at 122° F., sec.....	20	100	25	100	50	125	75	150
Asphalt residue of 100 pene., percent.....	50	.....	60	.....	70	.....	100	.....
Duct. asphalt residue at 77° F., cm.....	100	.....	100	.....	100	.....	100	.....
Percent sol. in CCl ₄ (Using CCl ₄ with T-44).....	99.5	.....	99.5	.....	99.5	.....	99.5	.....

TABLE 2.—Requirements for medium-curing cut-back asphalt

	A.A.S.H.O. test method	Grades							
		MC-0		MC-1		MC-2		MC-3	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Water, percent.			0				0		0
Flash point, °F.		100		100		150		150	
Tag., °F.									
Clave., °F.									
Pyrolysis:									
At 170° F.		75	150	75	150				
At 190° F.						100	250	250	500
At 150° F.									
Partial distillates (Ratio to distillate to 680° F.):									
To 457° F.			25		20		10		5
To 500° F.		40	70	25	65	15	55	5	40
To 600° F.		75	93	70	90	60	87	55	85
Residue from distillation to 680° F.:									
Pen., percent of sample by difference		50		60		67		73	
Duct., cm.		120	300	120	300	120	300	120	300
Percent sol. in CCl ₄		99.5		99.5		99.5		99.5	

CONSTRUCTION METHODS

112-3.1 WEATHER AND SEASONAL LIMITATIONS.—

Bituminous material shall be applied only between May 1 and October 1 and application shall be made only when the surface to be treated is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

112-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom, a tractor-drawn or self-powered blade grader weighing not less than 3 tons and having a blade at least 10 feet in length and a wheelbase of not less than 15 feet, broom dragging equipment, a power roller weighing not less than 5 tons, blotter spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, and equipment for heating bituminous material.

112-3.3 PREPARATION OF SURFACE FOR TREATMENT.—If in the opinion of the engineer the surface is well bonded and does not require blade shaping, or if the surface has been specially compacted, it shall be thoroughly swept with a power broom immediately prior to the first application of the bituminous material.

However, if it is necessary to remove corrugations or other irregularities, the surface to be treated shall be lightly scarified or disked immediately prior to the first application of bituminous material. When scarifying or diskings, care shall be taken not to disturb the base or subgrade to a depth greater than is necessary for blade shaping of the surface. In general, the depth loosened by scarifying or diskings shall not exceed 1 inch.

If type 1 blotter material is required by the bid schedule, such material shall be windrowed from the surface and deposited at the sides in two small windrows. In no case shall the combined cross sectional area of the windrows exceed 1 square foot. The surface shall then be bladed to a smooth finish conforming to the cross section shown on the plans.

Where indicated on the plans, the subgrade shall be prepared by special compacting as required under SUBGRADE OF FINE GRADING SUBGRADE AND SHOULDERS.

112-3.4 APPLICATION OF BITUMINOUS MATERIAL.—

Bituminous material shall be applied in two applications at the rates set by the engineer and at the temperature stated in the specifications for the particular material being used. The combined amount of the two applications shall be from 0.5 to 0.75 gallon per square yard. During the applications, the surfaces of all adjacent structures and trees shall be protected in such manner so as to prevent their being spattered or

marred. Bituminous material shall not be discharged into borrow pits or gutters.

After the first application of bituminous material has penetrated the surface, and not less than 24 hours after application, portions of the treated area that may not have fully absorbed the bituminous material shall be lightly covered with blotter material in just sufficient quantity to prevent adherence of the bituminous material to the tires of vehicles using the surface.

After the first application has cured for a period of not less than one week, any breaks in the treated surface shall be patched with bituminous material and blotter material. The second application of bituminous material shall then be made.

112-3.5 SPREADING BLOTTER MATERIAL.—When type 1 blotter material is called for, it shall be spread from the windrows by hand, in the amounts directed by the engineer, immediately following the second application of bituminous material. When type 2, 3, or 4 blotter material is called for, it shall be spread immediately following the second application in amounts of from 5 to 30 pounds per square yard as directed. Trucks shall be operated backward to permit the covering of the newly applied bituminous material before truck wheels run over it. The moisture content of blotter material shall not be more than 3 percent of the dry weight of the material at the time of application.

112-3.6 BROOMING AND ROLLING.—Following spreading of blotter material, the treated surface shall be smoothed by brooming and rolled with a power roller. The blotter material shall be kept smooth under traffic by daily brooming for a period of not less than 5 days.

112-3.7 STOCKPILING.—When indicated on the plans, blotter material of the type called for shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Prior to stockpiling the material the sites shall be cleared, cleaned, and leveled by the contractor.

When indicated on the plans and called for in the bid schedule, all or a portion of the stockpiled blotter material shall be treated with bituminous material of the type used in the base preservative treatment. The bituminous material shall be applied to dry blotter material in the amounts set by the engineer and the two materials shall be mixed thoroughly by turning with a blade grader or a portable mixer or by other methods satisfactory to the engineer. After treatment the stockpiles shall be shaped as directed.

METHOD OF MEASUREMENT

112-4.1 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage of bituminous material to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted treatment, including material used for patching and for treating stockpiles. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

112-4.2 The yardage or tonnage to be paid for shall be the number of cubic yards or tons of type 2, 3, or 4 blotter material used as ordered for the accepted work, and including untreated material placed in authorized stockpiles. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

When bituminous treatment of stockpiled blotter material is called for, the yardage or tonnage to be paid for shall be the number of cubic yards or tons of blotter material stockpiled and treated as ordered, measured before treatment as provided above. Material so treated shall not be included in the quantity of untreated material to be paid for.

The quantity of windrowing and spreading of type 1 blotter material to be paid for shall be the length in miles and fractions thereof of road surface treated to the width shown on the plans, including any widening ordered at curves and at intersections. The length shall be measured horizontally along the center line of the road.

BASIS OF PAYMENT

112-5.1 The quantities of blotter material and bituminous material, determined as provided in 4.1 and 4.2 above, shall be paid for at the contract unit price per mile for "Windrowing and Spreading Type 1 Blotter Material for Bituminous Preservative Treatment," per cubic yard or ton for "Type 2 Blotter Material for Bituminous Preservative Treatment," "Type 3 Blotter Material for Bituminous Preservative Treatment," "Type 4 Blotter Material for Bituminous Preservative Treatment," or "Bituminous Treated Stockpiled Blotter Material" and per gallon or per ton for "Slow-Curing Liquid Asphaltic Material, Grade (), for Bituminous Preservative Treatment," "Medium-Curing Cut-back Asphalt, Grade (), for Bituminous Preservative Treatment," or "Tar, Grade (), for Bituminous Preservative Treat-

ment," as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, and placing all materials, for preparation of surface including blading, for brooming, for compacting including rolling, for reconditioning of subgrade, shoulders, and gutters, for cleaning up pits and quarries, for furnishing and sealing of scales, for furnishing the weigh house, for clearing, cleaning, and leveling stockpile sites, for treating stockpiled material, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

The price and payment stipulated above shall constitute full compensation for all watering except that when the bid schedule contains an estimated quantity for "Watering of Surface Course Item 112," any authorized watering shall be paid for as provided under WATERING.

ITEM 113.—CLASS A SEAL COATS

DESCRIPTION

113-1.1 This item shall consist of a seal coat of bituminous material with or without cover aggregate or of a seal coat of bituminous material with base choker and cover aggregate, constructed on a previously bituminized road surface in accordance with these specifications and to the width shown on the typical cross section on the plans.

113-1.2 QUANTITIES OF MATERIALS PER SQUARE YARD.—The approximate amounts of materials per square yard for seal coats of the several types shall be as provided in table 1. The exact amounts to be used shall be set by the engineer.

TABLE 1.—Quantities of materials for seal coats

	Type 1	Type 2	Type 3	Type 4
Base choker aggregate (lb. per sq. yd.).....	None	None	None	5-10
Bituminous material (gal. per sq. yd.).....	0.10-0.16	0.16-0.25	0.16-0.33	0.16-0.33
Cover aggregate (lb. per sq. yd.)..	None	5-10	10-20	10-20

MATERIALS

113-2.1 COVER AGGREGATE.—Cover aggregate for types 2 and 4 seal coat shall meet the particular grading given for these types in table 2. Cover aggregate for type 3 seal coat shall meet the requirements for either grading A or grading B under type 3 in table 2, whichever is called for in the bid schedule. The test for grading in all cases shall be made using A.A.S.H.O. Methods T-11 and T-27.

TABLE 2.—Requirements for grading of aggregate for seal coats

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Type 2	Type 3		Type 4	
	Cover aggregate	Cover aggregate		Base choker aggregate	Cover aggregate
		Grading A	Grading B		
¼ inch.....			100		100
¾ inch.....	100	100	90-100	100	90-100
No. 4.....	85-100	75-100	10-30	75-100	10-30
No. 8.....	0-35	0-10	0-8	0-10	0-8
No. 20.....	0-5	0-2	0-2	0-2	0-2

Cover aggregate for type 2 seal shall consist of sand or fine screenings free from dirt or organic matter.

Cover aggregate for types 3 and 4 seal shall be screenings of crushed stone, crushed gravel, or crushed slag. It shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt, or other objectionable matter and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag, reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Crushed gravel shall consist of the product obtained by crushing and screening gravel that has first been screened in such manner that not less than 90 percent of the material for crushing, when tested by laboratory methods, is retained on a sieve having openings one-half inch square.

Crushed cover aggregate shall be free from clay balls and adherent films of clay or rock dust and shall be washed thoroughly if produced from moist material. Aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water.

113-2.2 BASE CHOKER AGGREGATE.—Base choker aggregate for type 4 seal coat shall conform to the grading for this type shown in table 2, when tested according to A.A.S.H.O. Method T-11 and T-27.

Base choker aggregate shall be screenings of crushed stone, crushed gravel, or crushed slag and shall meet the requirements given above for cover aggregate for types 3 and 4.

113-2.3 BITUMINOUS MATERIALS.—(a) One of the following materials, whichever is called for in the bid schedule, shall be furnished:

Rapid-curing cut-back asphalt meeting the requirements of table 3 below.

Emulsified asphalt conforming to A.A.S.H.O. Specification M-51.

90+ asphaltic material meeting the requirements of table 4 below. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent plus, and proportion of bitumen soluble in carbon tetrachloride is 99.65 percent plus.

Asphalt shall be penetration grade 150-200 conforming to A.A.S.H.O. Specifications M-20 or M-23, save that penetration shall be 150 to 200. No mineral matter other than that naturally contained in the asphalt shall be present.

Tar conforming to A.A.S.H.O. Specification M-52.

(b) Grades (with temperatures of application in degrees F.) shall be as follows:

Cut-back asphalts—RC-0 (100-150), RC-1 (125-175), RC-2 (150-200), RC-3 (175-225), RC-4 (200-250), RC-5 (225-275); Emulsified asphalt (60-120); 90+ asphaltic material (300-375); Asphalt, grade 150-200 (325-400); Tar RT-7, RT-8, and RT-9 (150-225), RT-10, RT-11, and RT-12, (175-250).

For the several uses, materials and grades are as follows as called for in the bid schedule or selected by the engineer:

Type 1 seal coat, RC-0 or RC-1.

Type 2 seal coat, RC-2 or emulsified asphalt.

Types 3 and 4 seal coats, any appearing in the above lists.

TABLE 3.—Requirements for rapid-curing cut-back asphalt

A. A. S. H. O. test method	Grades							
	RC-0		RC-1		RC-2		RC-3	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Water, percent.....	—	0	—	0	—	0	—	0
Flash pt., $^{\circ}$ F., Tag., $^{\circ}$ F.....	—	—	—	—	—	—	—	—
Furol vis.: At 122 $^{\circ}$ F.....	75	150	75	150	—	—	—	—
At 140 $^{\circ}$ F.....	—	—	—	—	—	—	—	—
At 180 $^{\circ}$ F.....	—	—	—	—	—	—	—	—
Partial distillates (Ratio to distillate to 680 $^{\circ}$ F.): To 374 $^{\circ}$ F.....	15	—	10	—	—	—	—	—
To 437 $^{\circ}$ F.....	55	—	50	—	—	—	—	—
To 500 $^{\circ}$ F.....	75	—	70	—	40	—	25	—
To 600 $^{\circ}$ F.....	90	—	88	—	65	—	55	—
Residue from distillation to 680 $^{\circ}$ F.: Vol. percent of sample by difference.....	50	—	60	—	67	—	73	—
Pene. cm.....	100	120	80	120	80	120	80	120
Duct. cm.....	99.5	—	100	—	100	—	100	—
Percent sol. in CCl_4	—	—	99.5	—	99.5	—	99.5	—

TABLE 4.—Requirements for 90+ asphaltic material

	A. A. S. H. O. test method	Min.	Max.
Water, percent.....	T-55.....	—	0
Furol vis., at 210 $^{\circ}$ F.....	T-72.....	250	500
Flash pt., $^{\circ}$ F.....	T-48.....	275	—
Distillation: Total distillate to 680 $^{\circ}$ F., percent by vol.....	T-78.....	—	2
Float test on residue at 122 $^{\circ}$ F., sec.....	T-50.....	150	350
Asphalt residue of 100 pene., percent.....	T-56.....	90	—
Duct. asphalt residue at 77 $^{\circ}$ F., cm.....	T-51.....	100	—
Percent sol. in CCl_4 (Using CCl_4 with T-44).....	—	99.5	—

CONSTRUCTION METHODS

113-3.1 WEATHER AND SEASONAL LIMITATIONS.—

Seal coats shall be applied only between May 1 and October 1 and operations shall be carried on only when the existing surface is dry, when the atmospheric temperature is above 60 $^{\circ}$ F., and when the weather is not foggy or rainy. The seasonal and temperature requirements may be waived, but only when so directed by the engineer.

113-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom or a power blower, broom dragging equipment, a powered roller weighing between 5 and 8 tons, aggregate spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, and equipment for heating bituminous material.

113-3.3 CLEANING EXISTING SURFACE.—Prior to placing the seal coat, loose dirt and other objectionable material shall be removed from the existing surface. If so directed by the engineer, the surface shall be cleaned with a power broom or power blower.

113-3.4 SPREADING BASE CHOKER AGGREGATE.—After the existing surface has been cleaned, and prior to the application of bituminous material for type 4 seal coat, base choker aggregate shall be spread over the surface in an amount sufficient only to fill the voids in the existing surface without any excess. The aggregate shall be forced into the surface interstices by brooming.

113-3.5 APPLICATION OF BITUMINOUS MATERIAL.—Bituminous material shall be so applied that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that

flow through sprays may be started and stopped on the paper and so that all sprays will operate properly over the entire length being treated. Building paper so used shall be immediately removed and burned. Application temperatures shall be as provided in the specifications for the particular bituminous material being used. During all applications the surfaces of adjacent structures and trees shall be protected in such manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

Type 1 seal coat shall be allowed to penetrate undisturbed for a period of not less than 24 hours. Any spots of excess bituminous material remaining at the end of that period shall then be lightly covered at the contractor's expense with sand or other approved local material and the surface opened to traffic.

113-3.6 SPREADING COVER AGGREGATE.—Spreading of cover aggregate for types 2, 3, and 4 shall immediately follow application of bituminous material. Initial spreading shall be done with the aggregate spreading equipment specified. Trucks spreading aggregate shall be operated backward so that bituminous material will be covered before truck wheels pass over it. Supplemental spreading and smoothing shall be done with a broom drag, and by hand methods where necessary.

113-3.7 BROOMING AND ROLLING.—Type 2 seal coat shall be intermittently broom dragged under traffic until the surface is uniform in texture and the cover aggregate is evenly distributed. Rolling shall not be required for seal coats of this type.

Types 3 and 4 seal coats shall be alternately broom dragged and rolled until the cover aggregate is uniformly and thoroughly bonded over the full width.

113-3.8 STOCKPILING.—When type 2, 3, or 4 seal coat is called for in the bid schedule, cover aggregate of the type called for shall be stockpiled at the rate of 10 tons per mile at such locations and in piles of such forms and amounts as the engineer may direct. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

113-4.1 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered for the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

113-4.2 The yardage or tonnage to be paid for shall be the number of cubic yards or tons of aggregate used as ordered for the accepted work or placed in authorized stockpiles. When the bid schedule calls for payment on a cubic yard basis, measurement shall be made in the vehicles at the point of delivery.

BASIS OF PAYMENT

113-5.1 The quantities of aggregate and/or bituminous material, determined as provided in 4.1 and 4.2 above, shall be paid for at the contract unit price per cubic yard or per ton for "Cover Aggregate for Type 2 Seal Coat," "Cover Aggregate for Type 3 Seal Coat Grading ()," or "Base Choker and Cover Aggregate for Type 4 Seal Coat," as the case may be, and/or per gallon or per ton for "Rapid-Curing Cut-back Asphalt, Grade (), for Seal Coat," "Emulsified Asphalt for Seal Coat," "90+ Asphaltic Material for Seal Coat," "Asphalt, Grade (150-200), for Seal Coat," or "Tar, Grade (), for Seal Coat," as the case may be, which prices and payments shall constitute full compensation for furnishing and placing all materials, for brooming, compacting, and rolling, for covering excess bituminous material, for reconditioning of subgrade, shoulders, and gutters, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 114.—CLASS A SURFACE TREATMENTS

DESCRIPTION

114-1.1 This item shall consist of a wearing surface composed of one or more applications of bituminous material and spreadings of aggregate, constructed on a previously bituminized surface in accordance with these specifications and to the width shown on the typical cross section on the plans.

114-1.2 **QUANTITIES OF MATERIALS PER SQUARE YARD.**—Table 1 covers six wearing surfaces identified respectively by designations AT-25, AT-35, AT-50, AT-60, AT-70, and AT-110 using, as called for in the bid schedule, cut-back asphalt, 90+ asphaltic material, 150-200 penetration asphalt or tar. The figures in the designations indicate the total weight of aggregate prescribed per square yard of the respective wearing surface completed. Table 1 specifies the approximate amounts per square yard of each successive application of bituminous material and spreading of aggregate. Table 2 is similar to table 1, except that the bituminous material used is emulsified asphalt.

In each table the left side captions specify the particular grading of aggregate that must be used with each successive spreading for each respective wearing surface.

Each wearing surface shall have one or more layers, as shown in sequence. The operations for each layer are also shown in sequence.

TABLE 1.—Quantities per square yard for 6 different wearing surfaces. (Using cut-back asphalt, 90+ asphaltic material, 150-200 penetration asphalt or tar)

Aggregate gradings and sequence of operations	Applications and spreadings					
	AT-25	AT-35	AT-50	AT-60	AT-70	AT-110
First layer:						
Apply bituminous material (gal.)	0.30	0.22	0.25	0.15	0.30	0.20
Spread aggregate—						
Grading E (lbs.)	25					
Grading D (lbs.)		25				
Grading C (lbs.)			35			
Grading B (lbs.)				40	50	
Grading A (lbs.)						70
Second layer:						
Apply bituminous material (gal.)		0.13	0.25	0.30	0.35	0.40
Spread aggregate—						
Grading F (lbs.)		10	15			
Grading D (lbs.)				12		
Grading E (lbs.)					20	
Grading C (lbs.)						20

TABLE 1.—Quantities per square yard for 6 different wearing surfaces. (Using cut-back asphalt, 90+ asphaltic material, 150-200 penetration asphalt or tar)—Continued

Aggregate gradings and sequence of operations	Applications and spreadings					
	AT-25	AT-35	AT-50	AT-60	AT-70	AT-110
Third layer:						
Apply bituminous material (gal.)				0.15		0.20
Spread aggregate—						
Grading F (lbs.)				8		12
Fourth layer:						
Apply bituminous material (gal.)						0.20
Spread aggregate—						
Grading G (lbs.)						8
Totals:						
Bituminous material (gal.)	0.30	0.35	0.50	0.60	0.65	1.00
Aggregate (lbs.)	25	35	50	60	70	110

TABLE 2.—Quantities per square yard for 6 different wearing surfaces. (Using emulsified asphalt)

Aggregate gradings and sequence of operations	Applications and spreadings					
	E-25	E-35	E-50	E-60	E-70	E-110
First layer:						
Apply bituminous material (gal.)	0.35	None	None ^a	None	None	None
Spread aggregate—						
Grading E (lbs.)	25					
Grading D (lbs.)		25				
Grading C (lbs.)			30			
Grading B (lbs.)				36	40	
Grading A (lbs.)						70
Second layer:						
Apply bituminous material (gal.)		0.45	0.35	0.45	0.50	0.40
Spread aggregate—						
Grading F (lbs.)		10	10			
Grading E (lbs.)				16	20	20
Third layer:						
Apply bituminous material (gal.)			0.25	0.25	0.25	0.45
Spread aggregate—						
Grading F (lbs.)			10	8	10	12
Fourth layer:						
Apply bituminous material (gal.)						0.25
Spread aggregate—						
Grading G (lbs.)						8
Totals:						
Bituminous material (gal.)	0.35	0.45	0.60	0.70	0.75	1.10
Aggregate (lbs.)	25	35	50	60	70	110

The weights given in tables 1 and 2 are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown in table 1 or table 2 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The amounts given in tables 1 and 2 are approximate and the exact amounts shall be set by the engineer for each application and spreading. Total amounts of bituminous material per square yard may be varied by the engineer as necessary to fit conditions, but the total amount of aggregate per square yard, after adjustment for specific gravity, shall not be changed, except that the engineer may order that a portion of it be placed in stockpiles, and, similarly, he may order some of the apportionment for stockpiling used in the surface treatment.

MATERIALS

114-2.1 AGGREGATE.—Aggregates in the several designations of surface treatments shall be crushed gravel, crushed stone, or crushed slag, and shall meet the requirements for gradings given in table 3, as called for by table 1 or 2, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 3.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)						
	Grading A	Grading B	Grading C	Grading D	Grading E	Grading F	Grading G
1½-inch-----	100						
1-inch-----	90-100	100					
¾-inch-----		90-100	100				
½-inch-----	0-15	20-55	90-100	100	100		
⅜-inch-----		0-15	40-75	90-100	90-100	100	100
No. 4-----			0-15	0-20	10-30	75-100	85-100
No. 8-----			0-5	0-5	0-8	0-10	60-100
No. 200-----	0-2	0-2	0-2	0-2	0-2	0-2	0-10

Crushed gravel, crushed stone, and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt, or other objectionable matter, and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag, reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Crushed gravel shall consist of the product obtained by crushing and screening gravel that has first been screened in such manner that not less than 90 percent of the material for crushing, when tested by laboratory methods, is retained on a sieve having square openings of the size required in the following tabulation:

- ½ inch for designations AT-25, E-25, AT-35, and E-35.
- ¾ inch for designations AT-50 and E-50.
- 1 inch for designations AT-60, E-60, AT-70, and E-70.
- 1½ inches for designations AT-110 and E-110.

Finer fractions of suitable uncrushed gravel aggregate passing the scalping screen may be used only for the top layers of multiple-layer treatments.

Aggregate shall be free from clay balls and adherent films of clay or rock dust and shall be thoroughly washed if produced from moist material. Aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water.

114-2.2 BITUMINOUS MATERIALS.—(a) One of the following materials, whichever is called for in the bid schedule, shall be furnished.

Rapid-curing cut-back asphalt meeting the requirements of table 3, subsection 113-2.3.

90+ asphaltic material meeting the requirements of table 4, subsection 113-2.3. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent +, and proportion of bitumen soluble in carbon tetrachloride is 99.65 percent +.

Asphalt shall be grade 150-200 conforming to A.A.S.H.O. Specifications M-20 or M-23, save that the penetration shall be 150 to 200. No mineral matter other than that naturally contained in the asphalt shall be present.

Emulsified asphalt conforming to A.A.S.H.O. Specification M-51.

Tar conforming to A.A.S.H.O. Specification M-52.

(b) Grades (with temperatures of application in degrees F.) shall be as follows:

Cut-back asphalts—RC-2 (150-200), RC-3 (175-225), RC-4 (200-250), RC-5 (225-275); 90+ asphaltic material (300-375); Asphalt, grade 150-200 (325-400); Emulsified asphalt (60-120); Tar—RT-5 and RT-6 (80-150), RT-7, RT-8, and RT-9 (175-250).

The grade of material to be used shall be as called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

CONSTRUCTION METHODS

114-3.1 WEATHER AND SEASONAL LIMITATIONS.—

Surface treatments shall be applied only between May 1 and October 1 and operations shall be carried on only when the existing surface is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

114-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom or a power blower, dragging equipment, a powered roller weighing between 5 and 8 tons, aggregate spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, and equipment for heating bituminous material. For designations AT-60 AT-70, AT-110, E-60, E-70, and E-110 the equipment shall also include a pneumatic-tired motor grader having a wheelbase of not less than 15 feet, or an approved multiple blade drag.

114-3.3 SEQUENCE OF OPERATIONS.—Bituminous surface treatment shall be applied using quantities and in the sequence of operations as outlined in 1.2 above. Each spreading of aggregate shall immediately follow application of bituminous material, except where the first spreading is required to be placed directly on the previously bituminized surface.

In the case of designations AT-110 and E-110 surface treatment, an interval of at least 24 hours shall elapse between application of the third layer and that of the fourth, during which period the surface shall be opened to traffic and maintained by the contractor by brooming and rolling.

114-3.4 CLEANING EXISTING SURFACE.—Prior to placing the first layer of surface treatment loose dirt and other objectionable material shall be removed from the existing surface. If so directed by the engineer the surface shall be cleaned with a power broom or power blower.

114-3.5 APPLICATION OF BITUMINOUS MATERIAL.—Bituminous material shall be so applied that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be removed immediately and burned. Application temperatures shall be as provided in the specifications for the particular bituminous material being used. During all applications the surfaces of

adjacent structures and trees shall be protected in such manner as to prevent their being spattered or marred.

114-3.6 SPREADING AND SHAPING AGGREGATE.—Initial spreading of each layer of aggregate for all designations of surface treatment shall be done with the aggregate spreading equipment specified. Trucks spreading aggregate shall be operated backward so that bituminous material will be covered before truck wheels pass over it. Supplemental spreading and smoothing of the first layer of designations AT-60, AT-70, AT-110, E-60, E-70, and E-110 shall be done with the motor grader or approved drag specified. All other supplemental spreading and smoothing shall be done with a broom drag, and by hand methods where necessary.

114-3.7 ROLLING AND BROOMING.—Following spreading and smoothing each layer of aggregate shall be rolled as directed. Except where a motor grader, or approved drag is used for supplemental shaping and smoothing, broom dragging shall accompany rolling. The final layer of treatment in all cases shall be alternately broom dragged and rolled thoroughly until the surface is fully compacted and bonded to full width.

114-3.8 STOCKPILING.—Aggregate of grading E or aggregate of grading D in the amount of 30 tons per mile, shall be stockpiled at such locations and in piles of such forms and amounts as the engineer may direct. Prior to stockpiling the material, the sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

114-4.1 The yardage or tonnage to be paid for shall be the number of cubic yards or tons of aggregate used as ordered for the accepted work or placed in authorized stockpiles. When the bid schedule calls for payment by the cubic yard, measurement shall be made in the vehicles at the point of delivery.

114-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered for the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

114-5.1 The quantities of aggregate and bituminous material, determined as provided in 4.1 and 4.2 above, shall be paid for at the contract unit price per cubic yard or per ton for "(Class A Pavement) Aggregate for Designation AT — Surface Treatment," or "(Class A Pavement) Aggregate for Designation E —

Surface Treatment," and per gallon or per ton for "Rapid-Curing Cut-back Asphalt, Grade (), for Class A Surface Treatment," "90+ Asphaltic Material for Class A Surface Treatment," "Asphalt, Grade (150-200), for Class A Surface Treatment," "Emulsified Asphalt for Class A Surface Treatment," or "Tar, Grade (), for Class A Surface Treatment," as the case may be, which prices and payments shall constitute full compensation for furnishing and placing all materials, for all blading, shaping, brooming, compacting, and rolling, for reconditioning of subgrade, shoulders, and gutters, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 120.—CLASS B-1, DENSE GRADED ROAD-MIX SURFACE COURSE

DESCRIPTION

120-1.1 This item shall consist of a wearing course composed of aggregate and bituminous material mixed in place on the prepared roadbed and constructed in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans. Aggregate shall consist of either all new aggregate (case 1), a blend of new aggregate and aggregate present in the existing road (case 2), or aggregate present in the existing road (case 3), whichever is called for in the bid schedule.

120-1.2 DETERMINATION OF PERCENTAGE OF BITUMINOUS MATERIAL.—The percentage of bituminous material by weight, to be added to the aggregate shall be between $3\frac{1}{2}$ and 7 percent of the weight of the dry aggregate. The exact percentage to be used shall be fixed by the engineer on the basis of preliminary laboratory tests and field sieve analysis of the aggregates furnished or in place.

120-1.3 JOB GRADING AND ALLOWABLE TOLERANCES.—The bid schedule indicates the particular grading given in table 1 to which new aggregate, if used, must conform. The grading of new aggregate furnished for any "run" (one full day's mixing operations) shall be of such uniformity that percentages of material passing the Nos. 4, 10, and 200 sieves for any one sample shall not vary from the average of all samples for the "run" by more than the following tolerances:

<i>Material passing—</i>	<i>Percent</i>
No. 4 sieve.....	±5
No. 10 sieve.....	±5
No. 200 sieve.....	±2

MATERIALS

120-2.1 NEW AGGREGATE.—(Case 1). New aggregate for gradings A, B, C, and D shall consist of coarse aggregate of gravel, crushed to size as necessary, or crushed stone, in either case composed of hard, durable pebbles or stone fragments, and a filler of finely crushed stone, sand, or other finely divided mineral matter. New aggregate for grading E shall consist of fine gravel and sand, disintegrated granite, or other similar granular materials. The portion of the material retained on a

No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. The composite material shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A. A. S. H. O. T-27)				
	Grading A	Grading B	Grading C	Grading D	Grading E
1-inch.....	100	100	100	100	100
3/4-inch.....	75-100	75-100	85-100	85-100	85-100
No. 4.....	30-45	40-60	45-65	50-70	60-95
No. 10.....	20-35	25-45	30-50	35-55	45-80
No. 200.....	2-7	3-8	5-10	5-12	5-15

New aggregate shall be so graded within the limits given in table 1 that at least 10 percent of the total aggregate shall pass a No. 4 sieve and be retained on a No. 10 sieve. No intermediate sizes of aggregate shall be removed for use in the seal coat or for other purposes without the written consent of the engineer.

When one of the gradings A, B, C or D is specified, the coarse aggregate shall have a percent of wear of not more than 50 at 500 revolutions, as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

For all gradings, that portion of the filler, including any blended filler, passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

The composite new aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter that will prevent thorough coating with bituminous material. The aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water. The bituminized aggregate shall have a swell of not more than 1.5 percent, as determined by method 1 of A.A.S.H.O. Method T-101.

120-2.2 BLENDED AGGREGATE.—(Case 2). Blended aggregate shall consist of a blend of aggregate present in the existing road, and added aggregate. New aggregate for blending shall meet the requirements given in the special provisions for “(Class B-1 Pavement) New Road-Mix Aggregate, Grading (Special).” Additional aggregate having the grading called for shall be added to the aggregate from the existing surface in the amounts directed by the engineer.

120-2.3 AGGREGATE FROM THE EXISTING SURFACE.—(Case 3). Where all aggregate required for the road-mix surface course is already in place, the contractor shall not be responsible for its grading or quality except for removal of oversize pieces. In general, salvaged aggregate to be used for road-mix surface course will consist of material meeting the requirements given above for new aggregate or may consist of selected granular material of other gradings. Any particles of salvaged aggregate that will not pass a 1½-inch sieve shall be removed by the contractor at his expense.

120-2.4 FILLER FOR BLENDING.—If filler in addition to that naturally present in new aggregate is necessary, it shall be uniformly blended with the aggregate at the crushing and screening plant. If the blended aggregate needs additional filler, blending shall be performed on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

120-2.5 BITUMINOUS MATERIAL.—Slow-curing liquid asphaltic material meeting the requirements of table 1, subsection 112-2.2 shall be furnished. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent +, and proportion of bitumen soluble in carbon tetrachloride is 99.65 percent +.

The grade (with temperatures of application in degrees F.) shall be SC-2 (150-225), SC-3 (175-250), or SC-4 (200-275) as called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

CONSTRUCTION METHODS

120-3.1 WEATHER AND SEASONAL LIMITATIONS.—Surface course shall be constructed only between May 1 and October 1 and operations shall be carried on only when the surface is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

120-3.2 EQUIPMENT.—The equipment used by the contractor shall include scarifying, mixing, spreading, finishing, and compacting equipment, a self-powered bituminous material distributor, and equipment for heating bituminous material.

Scarifiers shall be of the 4-wheel type and shall have wheel-bases of not less than 15 feet. Blade graders for mixing shall be either self-powered or tractor drawn and shall have wheel-bases of not less than 15 feet. Crawler-type tractors used shall have street plates or flat treads. Disk, spike-tooth, and spring-tooth harrows shall be so designed that cutting into subgrade

can be avoided. Blade graders for laying, shaping, and finishing the mixture shall be of the self-powered type, and shall have blades not less than 10 feet long and wheelbases of not less than 15 feet. Such graders shall be not less than 3 tons in weight and shall be equipped with pneumatic tires. Rollers for compacting the surface shall be of the self-powered tandem type weighing not less than 8 tons each.

Either traveling or stationary mixing plants or other equipment of proved performance may be used by the contractor in lieu of the specified equipment if advance written approval is given by the engineer, and if the contractor complies with such requirements as the engineer may consider necessary to insure results that shall be at least equal to results which would be obtained by use of the specified equipment.

120-3.3 PREPARATION OF BASE AND NEW AGGREGATE.—(Case 1). When all new aggregate is to be used for the road-mix surface course, the existing base shall be scarified lightly and bladed to uniform grade and to the cross section shown on the plans and shall then be rolled, or watered and rolled, as directed. If so ordered by the engineer, depressions shall first be filled and weak portions of the base strengthened by patching with new aggregate. If shown on the plans and called for in the bid schedule, a prime coat shall be applied to the prepared base as described under BITUMINOUS PRIME COAT, before the new aggregate is deposited on the road. New aggregate shall be deposited along one side of the road from vehicles equipped or supplemented with suitable spreading devices. It shall then be windrowed. The aggregate shall be so deposited that each windrow will be of uniform section and will contain the correct quantity of aggregate to provide surfacing of the required width and thickness.

120-3.4 PREPARATION OF BASE AND BLENDED AGGREGATE.—(Case 2). When aggregate in the existing road surface is to be salvaged and used for blending with additional aggregate, the surface shall first be scarified lightly and bladed to uniform grade and to the cross section shown on the plans. The reshaped surface shall then be scarified again to such depth as is ordered by the engineer and in such manner as to leave a foundation stratum of undisturbed material parallel, both in profile and cross section, to the proposed finished surface. To the material thus loosened, additional aggregate of the grading called for shall be added in the amounts directed by the engineer. The added aggregate shall be blended thoroughly with the loosened salvaged material by harrowing and/or turning with a blade grader. The entire blended aggregate shall be bladed aside and the undisturbed understratum rolled, or watered and rolled, as directed. If so ordered by the engineer, depressions shall first be filled and weak portions of the base strengthened by patching with additional aggregate. The material bladed aside shall be formed into a windrow at the side of the road.

If shown on the plans and called for in the bid schedule, a prime coat shall be applied to the undisturbed stratum as described under BITUMINOUS PRIME COAT.

120-3.5 PREPARATION OF BASE AND OF SALVAGED AGGREGATE.—(Case 3). When material in the existing road surface is to be used for mixing without the addition of new material, the surface shall first be scarified lightly and bladed to uniform grade and to the cross section shown on the plans. The reshaped surface shall then be scarified again to such depth as is ordered by the engineer and in such manner as to leave a foundation stratum of undisturbed material parallel, both in profile and cross section, to the proposed finished surface. The loosened material shall be bladed aside and the undisturbed understratum rolled, or watered and rolled, as directed. The material bladed aside shall be formed into a windrow at the side of the road. If shown on the plans and called for in the bid schedule, a prime coat shall be applied to the undisturbed stratum as described under BITUMINOUS PRIME COAT.

120-3.6 WINDROWING AND SAMPLING.—Care shall be exercised to prevent the aggregate, whether new, blended, or salvaged, from becoming mixed with earth or shoulder material. Windrows of aggregate shall be shaped uniformly and trimmed so that accurate measurements of volume may be taken by the engineer. The uniform windrows shall be left undisturbed until measuring and sampling are completed. At least one day shall be allowed for measuring and sampling each run.

120-3.7 DRYING AGGREGATE ON THE ROAD.—Immediately prior to bituminizing, the aggregate to be treated shall be tested for moisture. If the moisture content is more than 2 percent of the dry weight of aggregate, the aggregate shall be turned by blades or disk harrows, or otherwise aerated, until the moisture content is reduced to 2 percent or less. The prepared aggregate shall then be spread smoothly and uniformly over half the road or other convenient width of surface ready for the application of bituminous material.

120-3.8 APPLICATION AND PARTIAL MIXING.—The bituminous material shall be distributed uniformly in 3 applications, each of approximately one-third of the total required amount as determined by the engineer. It shall be applied uniformly at the temperature prescribed in the specifications for the particular material. Immediately behind the distributor shall follow an assemblage of double disk or other harrows or equivalent equipment, partially to mix the aggregate and bituminous material and to leave as little free bituminous material as possible. The intervals between applications shall be as ordered by the engineer.

During all applications, the surfaces of adjacent structures and trees shall be protected in such manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

120-3.9 MIXING.—After the last application and partial mixing, the entire mass of bituminized aggregate shall be windrowed near the center of the road and then mixed by the assemblage of mixing units specified, by blading the treated material from side to side of the road, or by manipulations producing equivalent results until all particles are coated with the bituminous material and the whole mass has a uniform color. During the mixing, care shall be taken to avoid cutting into the underlying base or contaminating the bituminous mixture with earth or other extraneous matter. When so directed, the mixing process shall be confined to part of the width or area of the road so as to allow a convenient passage for traffic.

Before it is spread, the windrowed mixture shall be examined by the engineer who shall determine whether the mixing is complete, the bituminous content correct, and the moisture removal satisfactory. Should the mixture show an excess, deficiency, or uneven distribution of bituminous material, the unsatisfactory condition shall be corrected by the addition of the required aggregate or bituminous material, and by remixing. If the moisture content exceeds 2 percent of the dry weight of aggregate, the contractor shall blade and reblade the material and allow it to dry out. If necessary, the material shall be harrowed or disked and all compressed masses of material broken up. No spreading shall be done, except when authorized in writing by the engineer, or, when the base to be covered is wet.

At the end of each day's work, or when work is interrupted by weather conditions, all loose material shall be bladed into a windrow, whether the mixing is complete or not, and it shall not be allowed to remain spread on the road over night or until the resumption of work.

120-3.10 PROCEDURE WITH THICKENED EDGE.—If required by the approved typical section, provision shall be made for a thickened edge of the surfacing. A triangular cut shall be made with a blade grader at each edge of the road. In making the cut, the excavated material shall be thrown to the shoulder in a small windrow against which the bituminized material shall be spread.

120-3.11 LAYING, COMPACTING, AND FINISHING.—(a) *Spreading and Blade Finishing.*—After the mixing has been completed, the mixed material shall be spread from the windrow to the required width by a self-powered, pneumatic-tired blade grader. After approximately one-half of the material has been laid, the remaining material shall be windrowed and that already laid shall be rolled once and then planed with the blade grader to remove inequalities. The remaining material shall then be spread. During compaction, the surface shall be dragged or bladed as necessary to fill any ruts and to

remove incipient corrugations, waves, or other irregularities. The intervals between placing successive layers shall be as directed by the engineer. In spreading from the windrow, care shall be taken to prevent cutting into the underlying base. If necessary to prevent such cutting, a layer of the mixture approximately one-half inch thick shall be left at the bottom of the windrow.

(b) *Rolling Finished Surface.*—After all layers have been placed, the surface shall be rolled. Rolling shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center, except that on superelevated curves rolling may progress from the lower to the upper edge. Blading shall continue during the rolling only if so ordered by the engineer. Rolling shall continue until the surfacing is of uniform texture and degree of compaction, and is true to grade and cross section. Under no circumstances shall the center of the surface course be rolled first.

(c) *Shaping Edges.*—While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

120-3.12 IMPROVING UNSATISFACTORY AREAS.—If, at any time after the engineer has authorized spreading of the mixture, unsatisfactory areas develop that require additional bituminous material, additional aggregate, or additional road mixing and consequent relaying, recompacting, and refinishing, the work shall be done by the contractor when ordered in writing by the engineer.

120-3.13 SEAL COAT.—If shown on the plans and called for in the bid schedule, a seal coat of the type called for shall be applied to the finished road-mix surface, as described under CLASS A SEAL COATS. In such event, the surface shall be open to traffic for at least 2 weeks before the seal coat is applied.

120-3.14 STOCKPILING.—When indicated on the plans, road-mix aggregate shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Material for stockpiling shall be obtained by shoveling from the completely mixed windrow just prior to its being laid, shovelfuls of material being taken, one at a time, at such intervals as will produce the required quantity. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

120-4.1 The unit of measurement for surfacing laid shall be the mile or the square yard, whichever is called for in the bid schedule. The mileage or yardage to be paid for shall be the number of miles (measured horizontally along the center line of the road) or square yards of surfacing completed to the width shown on the plans and accepted. When measurement is by the mile, no additional allowance shall be made for required widening on curves or at intersections.

When the engineer orders in writing the reworking and refinishing of unsatisfactory portions of previously approved surface, as provided under 3.12 above, the lengths of such portions in miles or the areas in square yards, as the case may be, shall be measured by the engineer and added to the mileage or yardage that would have been paid for had no reworking and refinishing been ordered in writing.

120-4.2 The yardage or tonnage to be paid for shall be the number of cubic yards or tons of new or additional aggregate, including all filler, of the grading called for in the bid schedule and used for the accepted work or placed in authorized stockpiles. When the bid schedule calls for payment by the cubic yard, measurement shall be made in the vehicles at the point of delivery.

120-4.3 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

120-5.1 The quantities of surfacing mixture and of materials, determined as provided in 4.1, 4.2, and 4.3 above, shall be paid for at the contract unit price per mile or per square yard for "(Class B-1 Pavement) Road-Mix Surfacing Laid, Case ()" and per cubic yard or per ton for "(Class B-1 Pavement) New Road-Mix Aggregate, Grading ()," and per gallon or per ton for "Slow-Curing Liquid Asphaltic Material, Grade (), for Class B-1," as the case may be, which prices and payments shall constitute full compensation for preparing base or subgrade, for furnishing, handling, mixing, manipulating, and placing all materials, for all shaping, compacting, and rolling, for finishing, for improving unsatisfactory areas, for reconditioning subgrade, shoulders and gutters, for stockpiling road-mix aggregate, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item, except any prime coat or seal coat.

The prices and payment stipulated above shall constitute full compensation for all watering of base or subgrade, except that when the bid schedule contains an estimated quantity for "Watering of Surface Course, Item 120," any authorized watering shall be paid for as provided under WATERING.

ITEM 121.—CLASS B-2, DENSE GRADED PLANT-MIX SURFACE COURSE

DESCRIPTION

121-1.1 This item shall consist of a wearing course composed of aggregate and bituminous material mixed in a central plant, constructed on the prepared roadbed in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

121-1.2 DETERMINATION OF PERCENTAGE OF BITUMINOUS MATERIAL.—The percentage of bituminous material by weight, to be added to the aggregate shall be between 3½ and 7 percent of the weight of the dry aggregate. The exact percentage to be used shall be fixed by the engineer on the basis of preliminary laboratory tests and field sieve analyses of the aggregate furnished.

121-1.3 JOB GRADING AND ALLOWABLE TOLERANCES.—The bid schedule indicates the particular grading given in tables 1, 2, and 3 to which aggregate must conform. The grading of aggregate shall meet the further limitation that any one 8-hour "run" shall be held to such uniformity that percentages of material passing the Nos. 4, 10, and 200 sieves for any one sample shall not vary from the averages of all samples for the "run" by more than the following tolerances:

<i>Material passing—</i>	<i>Percent</i>
No. 4 sieve.....	±5
No. 10 sieve.....	±5
No. 200 sieve.....	±2

MATERIALS

121-2.1 AGGREGATE.—Aggregate for gradings A, B, C, and D shall consist of coarse aggregate of gravel, crushed to size as necessary, or crushed stone, in either case composed of hard, durable pebbles or stone fragments, and a filler of finely crushed stone, sand, or other finely divided mineral matter. Aggregate for grading E shall consist of fine gravel and sand, disintegrated granite, or other similar granular materials. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. The composite material shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Grading A	Grading B	Grading C	Grading D	Grading E
1-inch.....	100	100	100	100	100
¾-inch.....	75-100	75-100	85-100	85-100	85-100
No. 4.....	30-45	40-60	45-65	50-70	60-95
No. 10.....	20-35	25-45	30-50	35-55	45-80
No. 200.....	2-7	3-8	5-10	5-12	5-15

TABLE 2.—Requirements for grading of aggregate

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Grading A-1	Grading B-1	Grading C-1	Grading D-1	Grading E-1
¾-inch.....	100	100	100	100	100
No. 4.....	35-50	45-65	50-70	55-75	60-95
No. 10.....	25-40	30-50	35-55	40-60	45-80
No. 200.....	2-7	3-8	5-10	5-12	5-15

TABLE 3.—Requirements for grading of aggregate

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Grading A-2	Grading B-2	Grading C-2	Grading D-2	Grading E-2
½-inch.....	100	100	100	100	100
No. 4.....	40-55	50-70	55-75	60-80	65-100
No. 10.....	30-45	35-55	40-60	45-65	50-85
No. 200.....	2-7	3-8	5-10	5-12	5-15

Aggregate shall be so graded within the limits given in table 1 that at least 10 percent of the total aggregate shall pass a No. 4 sieve and be retained on a No. 10 sieve. No intermediate sizes of aggregate shall be removed for use in the seal coat or for other purposes without the written consent of the engineer.

When one of the gradings A, B, C, or D is specified, the coarse aggregate shall have a percent of wear of not more than 50 at 500 revolutions, as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

For all gradings, that portion of the filler, including any blended filler, passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

The composite aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter that will prevent thorough coating with bituminous material. The aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water. The bituminized aggregate shall have a swell of not more than 1.5 percent, as determined by method 1 of A.A.S.H.O. Method T-101.

121-2.2 FILLER FOR BLENDING.—Additional filler for blending with aggregate at the mixing plant, if needed, shall be obtained from sources approved by the engineer. The material for such purpose shall be free from lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

121-2.3 BITUMINOUS MATERIAL.—Slow-curing liquid asphaltic material conforming to the requirements of table 4 below shall be furnished. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent+, and proportion of bitumen soluble in carbon tetrachloride is 99.65 percent +.

The grade shall be SC-4 or SC-5, whichever is called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

TABLE 4.—Requirements for slow-curing liquid asphaltic material

	A.A.S.H.O. test method	Grades			
		SC-4		SC-5	
		Min.	Max.	Min.	Max.
Water, percent.....	T-55	-----	0	-----	0
Furol vis., at 180° F.....	T-72	125	250	300	600
Flash pt. °F.....	T-48	225	-----	250	-----
Distillation: Total distillate to 680° F., percent by vol.....	T-78	-----	10	-----	5
Float test on residue at 122° F., sec.....	T-50	60	150	75	200
Asphalt residue of 100 pene., percent.....	T-56	75	-----	80	-----
Duct. asphalt residue at 77° F., cm.....	T-51	100	-----	100	-----
Percent sol. in CCl ₄ (using CCl ₄ with T-44).....		99.5	-----	99.5	-----

CONSTRUCTION METHODS

121-3.1 WEATHER AND SEASONAL LIMITATIONS.—

Surface course shall be constructed only between May 1 and October 1 and operations shall be carried on only when the surface is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

121-3.2 EQUIPMENT.—(a) *Mixing Plant.*—The plant shall have storage bins, protected from the weather, of sufficient capacity to furnish the necessary amount of all aggregates when operating at the maximum rated capacity of the plant, with no periods of undue waiting for material. The bins shall be divided into at least two compartments so proportioned as to insure adequate storage of appropriate fractions of the aggregate. Each compartment shall be provided with an overflow pipe that shall be of such size and at such location as to prevent any backing up of material into other compartments.

The plant shall contain a drier suitably designed to heat and dry the aggregate to specification requirements and to agitate it continuously during heating. The drier shall be capable of preparing aggregates at a rate equal to the full rated capacity of the plant. The mixer shall be of adequate capacity, preferably a pugmill type. Accurate thermometers shall be furnished, suitable for determining the temperature of the mix.

The plant shall be provided with weighing, volumetric or other gaging equipment of sufficient and satisfactory capacity. The equipment shall be constructed with devices that will permit easy readjustment of any working part thereof that gets out of adjustment and make the equipment function properly and accurately. Where the bituminous material is weighed, scales for weighing shall be attached to the bucket. All weighing equipment shall be sealed as often as the engineer may deem it necessary to insure accuracy.

Equipment for heating bituminous material shall consist of a retort or steam coils so designed that steam will not be introduced into the material.

(b) *Placing Equipment.*—Equipment for spreading the mixture shall consist of approved adjustable type spreader boxes or similar equipment. Blade graders for laying, shaping, and finishing the mixture shall be of the self-powered type, and shall have blades not less than 10 feet long and wheelbases of not less than 15 feet. Such graders shall be of not less than 3 tons in weight and shall be equipped with pneumatic tires. Rollers for compacting the surface shall be of the self-powered tandem type weighing not less than 8 tons each.

121-3.3 PREPARATION OF AGGREGATE.—If the moisture content of the aggregate is more than 1 percent of the dry weight of aggregate, the aggregate shall be dried before being conveyed to the plant bins for proportioning. The aggregate shall be screened into at least two fractions and conveyed into separate compartments ready for proportioning and mixing.

Additional filler, if required to meet the grading requirements, shall be proportioned and blended with the mineral aggregate before being screened into the separate compartments. Filler may be added to the aggregate at the mixing plant by premixing it thoroughly with the other fine aggregates or by feeding it into either the hot or cold elevator. Spreading filler over the tops of the aggregate pits or dumping it into the hoppers at crushing plants will not be permitted.

121-3.4 PREPARATION OF BITUMINOUS MIXTURE.—Before being delivered to the road, the aggregate shall be mixed with the bituminous material at a central mixing plant.

The dry aggregates, prepared as prescribed above, shall be combined in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading. Where a batching plant is used, the engineer shall determine the quantity of bituminous material for each batch. In any case, the bituminous material shall be measured or gaged and introduced into the mixer in the proportionate amount determined by the engineer and at the temperature prescribed by the engineer for the particular material being used. When the bituminous material being used is SC-5, aggregate shall be introduced into the mixer at a temperature between 175° and 250° F. In no case shall aggregate be introduced into the mixer at a temperature of more than 25° F. above the temperature of the bituminous material. The mixing shall continue for at least 30 seconds, and for such longer period as may be necessary to coat all the particles.

121-3.5 TRANSPORTATION AND DELIVERY OF MIXTURE.—The mixture shall be transported from the mixing plant to the point of use in pneumatic-tired vehicles having tight bodies previously cleaned of all foreign materials. When directed by the engineer, each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from the weather.

121-3.6 SPREADING, LAYING, COMPACTING, AND FINISHING.—(a) *Preparation for Placing.*—Immediately before placing the bituminous mixture, the existing surface shall be cleaned of loose or deleterious material by sweeping with a power broom, supplemented by hand brooming if necessary.

Placing shall commence at the point or points furthest from the mixing plant, and progress continuously toward the plant, unless otherwise ordered by the engineer. Hauling over material already placed will not be permitted until the material has been compacted thoroughly in the manner specified.

(b) *Spreading and Blade Finishing.*—The bituminous mixture shall be deposited, by the spreading equipment specified, on one side of the road and to a uniform depth sufficient to obtain the required thickness of surface over the full width that the course will have when compacted. The material shall then be formed into a uniform windrow. Before the mixture is spread, the engineer shall test the windrow for moisture. If the moisture content of the mixture is more than $1\frac{1}{2}$ percent of the dry weight of aggregate, the contractor shall blade and reblade the material and allow it to dry out. If necessary, the material shall be harrowed or disked and all compressed masses of material broken up. No spreading shall be done when the base to be covered is wet or prior to authorization by the engineer.

At the end of each day's work, or when work is interrupted by weather conditions, all mixture not completely spread shall be bladed into a windrow. It shall not be allowed to remain in a partially spread condition on the road over night or until the resumption of work. When the bituminous material used is SC-5, the mixture shall be laid at a temperature of not less than 150° F. and it shall not be allowed to remain in the windrow over night.

The mixed material shall be spread from the windrow to the required width by the self-powered, pneumatic-tired blade grader specified. After approximately one-half of the material has been laid, the remaining material shall be windrowed and that already laid shall be rolled once and then planed with the blade grader to remove inequalities. The remaining material shall then be spread. During compaction, the surface shall be dragged or bladed as necessary to fill any ruts and to remove incipient corrugations, waves, or other irregularities. The intervals between placing successive layers shall be as directed by the engineer. In spreading from the windrow, care shall be taken to prevent cutting into the underlying base. If necessary to prevent such cutting, a layer of the mixture approximately one-half inch thick shall be left at the bottom of the windrow.

(c) *Rolling Finished Surface.*—After all layers have been placed to full width, the surface shall be rerolled. Rolling shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center, except that on superelevated curves rolling may progress from the lower to the upper edge. Blading shall continue during the rolling only if so ordered by the engineer. Rolling shall continue until the surfacing is of uniform texture and degree of compaction and is true to grade and cross section. Under no circumstances shall the center of the surface course be rolled first.

(d) *Shaping Edges.*—While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

121-3.7 **SEAL COAT.**—If shown on the plans and called for in the bid schedule, a seal coat of the type called for shall be applied to the finished plant-mix surface, as described under CLASS A SEAL COATS. In such event, the surface shall be open to traffic for at least 2 weeks before the seal coat is applied.

121-3.8 **STOCKPILING.**—When indicated on the plans, bituminous mixture shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

121-4.1 The tonnage to be paid for shall be the number of tons of bituminous mixture of the grading called for in the bid schedule and used in the accepted work, including mixture placed in authorized stockpiles. The bituminous treated material shall be weighed after mixing and no deduction shall be made for the weight of bituminous material in the mixture.

121-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

121-5.1 The quantities of surfacing mixture and bituminous material, determined as provided in 4.1 and 4.2 above, shall be paid for at the contract unit price per ton for "(Class B-2 Pavement) Plant Mixture, Grading ()," and per gallon or per ton for "Slow-Curing Liquid Asphaltic Material, Grade (), for Class B-2," as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, mixing, manipulating, and placing all materials, for all shaping, compacting, and rolling, for finishing, for reconditioning subgrade, shoulders and gutters, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item excepting any seal coat.

ITEM 122.—CLASS C-1, DENSE GRADED ROAD-MIX SURFACE COURSE

DESCRIPTION

122-1.1 This item shall consist of a wearing course composed of aggregate and bituminous material mixed in place on the prepared roadbed, constructed in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans. Aggregate shall consist of either all new aggregate (case 1), a blend of new aggregate and aggregate present in the existing road (case 2), or aggregate present in the existing road (case 3), whichever is called for in the bid schedule.

122-1.2 DETERMINATION OF PERCENTAGE OF BITUMINOUS MATERIAL.—The percentage of bituminous material by weight, to be added to the aggregate shall be between 3½ and 7 percent of the weight of the dry aggregate. The exact percentage to be used shall be fixed by the engineer on the basis of preliminary laboratory tests and field sieve analyses of the aggregate furnished.

122-1.3 JOB GRADING AND ALLOWABLE TOLERANCES.—The bid schedule indicates the particular grading given in table 1 to which new aggregate, if used, must conform. The grading of new aggregate furnished for any "run" (one full day's mixing operations) shall be of such uniformity that percentages of material passing the Nos. 4, 10, and 200 sieves for any one sample shall not vary from the averages of all samples for the "run" by more than the following tolerances:

<i>Material passing—</i>	<i>Percent</i>
No. 4 sieve.....	±5
No. 10 sieve.....	±5
No. 200 sieve.....	±2

MATERIALS

122-2.1 NEW AGGREGATE.—(Case 1). New aggregate for gradings A, B, C, and D shall consist of coarse aggregate of gravel, crushed to size as necessary, or crushed stone, in either case composed of hard, durable pebbles or stone fragments, and a filler of finely crushed stone, sand, or other finely divided mineral matter. New aggregate for grading E shall consist of fine gravel and sand, disintegrated granite, or other similar granular materials. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a

No. 4 sieve shall be known as filler. The composite material shall meet the requirements for one of the gradings given in table 1, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Grading A	Grading B	Grading C	Grading D	Grading E
1-inch.....	100	100	100	100	100
¾-inch.....	75-100	75-100	85-100	85-100	85-100
No. 4.....	30-45	40-60	45-65	50-70	60-95
No. 10.....	20-35	25-45	30-50	35-55	45-80
No. 200.....	2-7	3-8	5-10	5-12	5-15

New aggregate shall be so graded within the limits given in table 1 that at least 10 percent of the total aggregate shall pass a No. 4 sieve and be retained on a No. 10 sieve. No intermediate sizes of aggregate shall be removed for use in the seal coat or for other purposes without the written consent of the engineer.

When one of the gradings A, B, C, or D is specified, the coarse aggregate shall have a percent of wear of not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

For all gradings, that portion of the filler, including any blended filler, passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

The composite new aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter that will prevent thorough coating with bituminous material. The aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water. The bituminized aggregate shall have a swell of not more than 1.5 percent as determined by method 1 of A.A.S.H.O. Method T-101.

122-2.2 BLENDED AGGREGATE.—(Case 2). Blended aggregate shall consist of a blend of aggregate present in the existing road and added aggregate. New aggregate for blending shall meet the requirements given in the special provisions for "(Class C-1, Pavement), New Road-Mix Aggregate Grading (Special)." Additional aggregate having the grading called for shall be added to the surface in the amounts directed by the engineer.

122-2.3 AGGREGATE FROM THE EXISTING SURFACE.—(Case 3). Where all aggregate required for the road-mix surface course is already in place, the contractor shall not be responsible for its grading or quality except for removal of oversize pieces. In general, salvaged aggregate to be used for road-mix surface course will consist of material meeting the requirements given above for new aggregate or may consist of selected granular material of other gradings. Any particles of salvaged aggregate that will not pass a 1½ inch sieve shall be removed by the contractor at his expense.

122-2.4 FILLER FOR BLENDING.—If filler in addition to that naturally present in new aggregate is necessary, it shall be uniformly blended with the aggregate at the crushing and screening plant. If the blended aggregate needs additional filler, blending shall be performed on the road. The material for such purpose shall be obtained from sources approved by the engineer, shall be free from lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

122-2.5 BITUMINOUS MATERIALS.—Medium-curing cut-back asphalt shall be furnished. It shall meet the requirements of table 2, subsection 112-2.2 save that if the penetration of the residue from distillation to 680° F. is more than 200, and its ductility at 77° F. is less than 100, the material will be acceptable if its ductility at 60° F., is greater than 100 centimeters.

The grade (with temperatures of application in degrees F.) shall be MC-2 (150-200), MC-3 (175-225) or MC-4 (200-250) as called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

CONSTRUCTION METHODS

122-3.1 WEATHER AND SEASONAL LIMITATIONS.—Surface course shall be constructed only between May 1 and October 1, and operations shall be carried on only when the surface is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

122-3.2 EQUIPMENT.—The equipment used by the contractor shall include scarifying, mixing, spreading, finishing, and compacting equipment, a self-powered bituminous material distributor, and equipment for heating bituminous material.

Scarifiers shall be of the 4-wheel type and shall have wheelbases of not less than 15 feet. Blade graders for mixing shall be either self-powered or tractor drawn and shall have wheelbases of not less than 15 feet. Crawler type tractors used shall have street plates or flat treads. Disk, spike-tooth, and spring-tooth harrows shall be so designed that cutting into subgrade can be avoided. Blade graders for laying, shaping, and finishing the

mixture shall be of the self-powered type, and shall have blades not less than 10 feet long and wheelbases of not less than 15 feet. Such graders shall be not less than 3 tons in weight and shall be equipped with pneumatic tires. Rollers for compacting the surface shall be of the self-powered tandem type weighing not less than 8 tons each.

Either traveling or stationary mixing plants or other equipment of proved performance may be used by the contractor in lieu of the specified equipment if advance written approval is given by the engineer, and if the contractor complies with such requirements as the engineer may consider necessary to insure results that shall be at least equal to results which would be obtained by use of the specified equipment.

122-3.3 PREPARATION OF BASE AND NEW AGGREGATE.—(Case 1.) When all new aggregate is to be used for the road-mix surface course, the existing base shall be scarified lightly and bladed to uniform grade and to the cross section shown on the plans and shall then be rolled, or watered and rolled, as directed. If so ordered by the engineer, depressions shall first be filled and weak portions of the base strengthened by patching with new aggregate. If shown on the plans and called for in the bid schedule, a prime coat shall be applied to the prepared base as described under BITUMINOUS PRIME COAT, before the new aggregate is deposited on the road. New aggregate shall be deposited along one side of the road from vehicles equipped or supplemented with suitable spreading devices. It shall then be windrowed. The aggregate shall be so deposited that each windrow will be of uniform section and will contain the correct quantity of aggregate to provide surfacing of the required width and thickness.

122-3.4 PREPARATION OF BASE AND BLENDED AGGREGATE.—(Case 2.) When aggregate in the existing road surface is to be salvaged and used for blending with additional aggregate, the surface shall first be scarified lightly and bladed to uniform grade and to the cross section shown on the plans. The reshaped surface shall then be scarified again to such depth as is ordered by the engineer and in such manner as to leave a foundation stratum of undisturbed material parallel, both in profile and cross section, to the proposed finished surface. To the material thus loosened, additional aggregate of the grading called for shall be added in the amounts directed by the engineer. The added aggregate shall be blended thoroughly with the loosened salvaged material by harrowing and/or turning with a blade grader. The entire blended aggregate shall be bladed aside and the undisturbed understratum rolled, or watered and rolled, as directed. If so ordered by the engineer, depressions shall first be filled and weak portions of the base strengthened by patching with additional aggregate. The material bladed aside shall be formed into a windrow at

the side of the road. If shown on the plans and called for in the bid schedule, a prime coat shall be applied to the undisturbed stratum as described under BITUMINOUS PRIME COAT.

122-3.5 PREPARATION OF BASE AND SALVAGED AGGREGATE.—(Case 3.) When material in the existing road surface is to be used for mixing without the addition of new material, the surface shall first be scarified lightly and bladed to uniform grade and to the cross section shown on the plans. The reshaped surface shall then be scarified again to such depth as is ordered by the engineer and in such manner as to leave a foundation stratum of undisturbed material parallel, both in profile and cross section, to the proposed finished surface. The loosened material shall be bladed aside and the undisturbed understratum rolled, or watered and rolled, as directed. The material bladed aside shall be formed into a windrow at the side of the road. If shown on the plans and called for in the bid schedule, a prime coat shall be applied to the undisturbed stratum as described under BITUMINOUS PRIME COAT.

122-3.6 WINDROWING AND SAMPLING.—Care shall be exercised to prevent the aggregate, whether new, blended, or salvaged, from becoming mixed with earth or shoulder material. Windrows of aggregate shall be shaped uniformly and trimmed so that accurate measurements of volume may be taken by the engineer. The uniform windrows shall be left undisturbed until measuring and sampling are completed. At least one day shall be allowed for measuring and sampling each run.

122-3.7 DRYING AGGREGATE ON THE ROAD.—Immediately prior to bituminizing, the aggregate to be treated shall be tested for moisture. If the moisture content is more than 2 percent of the dry weight of aggregate, the aggregate shall be turned by blades or disk harrows, or otherwise aerated, until the moisture content is reduced to 2 percent or less. The prepared aggregate shall then be spread smoothly and uniformly over half the road or other convenient width of surface ready for the application of bituminous material.

122-3.8 APPLICATION AND PARTIAL MIXING.—The bituminous material shall be distributed uniformly in three applications, each of approximately one-third of the total required amount as determined by the engineer. It shall be applied uniformly at the temperature prescribed in the specifications for the particular material. Immediately behind the distributor shall follow an assemblage of double disk or other harrows or equivalent equipment, partially to mix the aggregate and bituminous material and to leave as little free bituminous material as possible. The intervals between applications shall be as ordered by the engineer.

During all applications, the surfaces of adjacent structures and trees shall be protected in such manner as to prevent their being

spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

122-3.9 MIXING.—After the last application and partial mixing, the entire mass of bituminized aggregate shall be windrowed near the center of the road and then mixed by the assemblage of mixing units specified, by blading the treated material from side to side of the road, or by manipulations producing equivalent results until all particles are coated with the bituminous material and the whole mass has a uniform color. During the mixing, care shall be taken to avoid cutting into the underlying base or contaminating the bituminous mixture with earth or other extraneous matter. When so directed, the mixing process shall be confined to part of the width or area of the road so as to allow a convenient passage for traffic.

Before it is spread, the windrowed mixture shall be examined by the engineer who shall determine whether the mixing is complete, the bituminous content correct, and the moisture removal satisfactory. Should the mixture show an excess, deficiency, or uneven distribution of bituminous material, the unsatisfactory condition shall be corrected by the addition of the required aggregate or bituminous material, and by remixing. If the moisture content exceeds 2 percent of the dry weight of aggregate, the contractor shall blade and reblade the material and allow it to dry out. If necessary, the material shall be harrowed or disked and all compressed masses of material broken up. No spreading shall be done, except when authorized in writing by the engineer, or when the base to be covered is wet.

At the end of each day's work, or when work is interrupted by weather conditions, all loose material shall be bladed into a windrow, whether the mixing is complete or not, and it shall not be allowed to remain spread on the road over night or until the resumption of work.

122-3.10 PROCEDURE WITH THICKENED EDGE.—If required by the approved typical section, provision shall be made for a thickened edge of the surfacing. A triangular cut shall be made with a blade grader at each edge of the road. In making the cut, the excavated material shall be thrown to the shoulder in a small windrow against which the bituminized material shall be spread.

122-3.11 LAYING, COMPACTING, AND FINISHING.—(a) *Spreading and Blade Finishing.*—After the mixing has been completed, the mixed material shall be spread from the windrow, to the required width by a self-powered, pneumatic-tired blade grader. After approximately one-half of the material has been laid, the remaining material shall be windrowed and that already laid shall be rolled once and then planed with the blade grader to remove inequalities. The remaining material shall then be spread. During compaction, the surface shall be dragged or bladed as necessary to fill any ruts and to remove

incipient corrugations, waves, or other irregularities. The intervals between placing successive layers shall be as directed by the engineer. In spreading from the windrow, care shall be taken to prevent cutting into the underlying base. If necessary to prevent such cutting, a layer of the mixture approximately one-half inch thick shall be left at the bottom of the windrow.

(b) *Rolling Finished Surface.*—After all layers have been placed, the surface shall be rolled. Rolling shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center, except that on superelevated curves rolling may progress from the lower to the upper edge. Blading shall continue during the rolling only if so ordered by the engineer. Rolling shall continue until the surfacing is of uniform texture and degree of compaction, and is true to grade and cross section. Under no circumstances shall the center of the surface course be rolled first.

(c) *Shaping Edges.*—While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

122-3.12 IMPROVING UNSATISFACTORY AREAS.—If, at any time after the engineer has authorized spreading of the mixture, unsatisfactory areas develop that require additional bituminous material, additional aggregate, or additional road mixing and consequent relaying, recompacting, and refinishing, the work shall be done by the contractor when ordered in writing by the engineer.

122-3.13 SEAL COAT.—If shown on the plans and called for in the bid schedule, a seal coat of the type called for shall be applied to the finished road-mixed surface, as described under CLASS A SEAL COATS. In such event, the surface shall be open to traffic for at least 2 weeks before the seal coat is applied.

122-3.14 STOCKPILING.—When indicated on the plans, road-mixed aggregate shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Material for stockpiling shall be obtained by shoveling from the completely mixed windrow just prior to its being laid, shovelfuls of material being taken one at a time at such intervals as will produce the required quantity. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

122-4.1 The unit of measurement for surfacing laid shall be the mile or the square yard, whichever is called for in the bid schedule. The mileage or yardage to be paid for shall be the number of miles (measured horizontally along the center line of the road) or square yards of surfacing completed to the width shown on the plans and accepted. When measurement is by the mile, no additional allowance shall be made for required widening on curves and at intersections.

When the engineer orders in writing the reworking and refinishing of unsatisfactory portions of previously approved surface, as provided under 3.12 above, the lengths in miles or the area in square yards of such portions, as the case may be, shall be measured by the engineer and added to the mileage or yardage that would have been paid for had no reworking and refinishing been ordered in writing.

122-4.2 The yardage or tonnage to be paid for shall be the number of cubic yards or tons of new or additional aggregate, including all filler, used in the accepted work or placed in authorized stockpiles. When the bid schedule calls for payment by the cubic yard, measurement shall be made in the vehicles at the point of delivery.

122-4.3 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

122-5.1 The quantities of surfacing mixture and of materials, determined as provided in 4.1, 4.2 and 4.3 above, shall be paid for at the contract unit price per mile or per square yard for "(Class C-1 Pavement) Road-Mix Surfacing Laid, Case ()" and per cubic yard or per ton for "(Class C-1 Pavement) New Road-Mix Aggregate, Grading ()," and per gallon or per ton for "Medium-Curing Cut-back Asphalt, Grade (), for Class C-1," as the case may be, which prices and payments shall constitute full compensation for preparing base or subgrade, for furnishing, handling, mixing, manipulating, and placing all materials, for all shaping, compacting, and rolling, for finishing, for improving unsatisfactory areas, for reconditioning subgrade, shoulders, and gutters, for stockpiling road-mixed aggregate, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic and for all labor, equipment, tools, and incidentals necessary to complete the item, except any prime coat or seal coat.

The prices and payments stipulated above shall constitute full compensation for all watering of base or subgrade, except that when the bid schedule contains an estimated quantity for "Watering of Surface Course, Item 122," any authorized watering shall be paid for as provided under WATERING.

ITEM 123.—CLASS C-2, OPEN GRADED ROAD-MIX SURFACE COURSE

DESCRIPTION

123-1.1 This item shall consist of a wearing course composed of open-graded aggregate mixed in place with bituminous material; and of key aggregate, and a seal coat, the whole constructed on the prepared roadbed in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

123-1.2 QUANTITIES OF MATERIAL PER SQUARE YARD.—Table 1 covers three different wearing surfaces differentiated by poundage figures,—120, 150, and 200,—in the respective designations. For each of the three wearing surfaces, one or more sets of gradings for the aggregate are specified in the table; the selection of the particular set is governed by the letters—CK, CO, or CC—appearing in the designation number. The poundage figures—120, 150, and 200—indicate the total poundage of aggregate prescribed per square yard of each respective wearing surface, exclusive of the seal coat.

The table specifies the approximate amounts per square yard of each successive application of bituminous material and spreading of aggregate. The sequence of operations for each respective wearing surface shall be as set in table 1.

TABLE 1.—Quantities per square yard for 3 different wearing surfaces

Aggregate gradings and sequence of operations	120		150		200		
	CK	CO	CK	CO	CK	CC	CO
Coarse aggregate for mixing:							
Grading A (lbs.)					175		
Grading B (lbs.)	105		125			175	
Grading C (lbs.)		120		150			200
Bituminous material for mixing:							
Using cut-back asphalt or tar:							
First application (gal.)	0.30	0.40	0.35	0.45	0.40	0.40	0.55
Second application (gal.)	0.25	0.40	0.30	0.45	0.40	0.40	0.55
Using emulsified asphalt:							
First application (gal.)	0.30	0.45	0.35	0.50	0.40	0.40	0.60
Second application (gal.)	0.25	0.45	0.30	0.50	0.40	0.40	0.60
Key aggregate:							
Grading D (lbs.)					25		
Grading E (lbs.)	15		25			25	

TABLE 1.—Quantities per square yard for 3 different wearing surfaces—Continued

Aggregate gradings and sequence of operations	120		150		200		
	CK	CO	CK	CO	CK	CO	CO
Bituminous material for penetration:							
Using cut-back asphalt or tar (gal.)	0.25		0.25		0.30	0.30	
Using emulsified asphalt (gal.)	0.35		0.35		0.40	0.40	
Total quantities exclusive of seal coat:							
Aggregate (lbs.)	120	120	150	150	200	200	200
Bituminous material:							
Using cut-back asphalt or tar (gal.)	0.80	0.80	0.90	0.90	1.10	1.10	1.10
Using emulsified asphalt (gal.)	0.90	0.90	1.00	1.00	1.20	1.20	1.20
Seal coat:							
Choker, Grading F (lbs.)		5		5			5
Bituminous material (gal.)		0.10		0.10			0.10
Choker, Grading F (lbs.)		7		7			7
Cover, Grading G (lbs.)	15		15		15	15	
Bituminous material (gal.)	0.30	0.25	0.30	0.25	0.30	0.30	0.25
Cover, Grading G (lbs.)	12	15	12	15	12	12	15
Total seal coat quantities:							
Aggregate (lbs.)	27	27	27	27	27	27	27
Bituminous material (gal.)	0.30	0.35	0.30	0.35	0.30	0.30	0.35

The weights given in table 1 are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The amounts given in table 1 are approximate and the exact amounts shall be set by the engineer for each application and spreading. Total amounts of bituminous material per square yard may be varied by the engineer as necessary to fit conditions, but the total amount of aggregate per square yard, after adjustment for specific gravity, shall not be changed, except that the engineer may order a portion of it to be placed in stockpiles, and, similarly, he may order some of the apporportionment for stockpiling used on the road.

MATERIALS

123-2.1 AGGREGATE.—Aggregate shall be crushed gravel, crushed stone, or crushed slag and shall meet the requirements for grading given in table 2, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 2.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)						
	Coarse			Key		Choker	Cover
	Grad- ing A	Grad- ing B	Grad- ing C	Grad- ing D	Grad- ing E	Grad- ing F	Grad- ing G
2½-inch.....	100	-----	-----	-----	-----	-----	-----
2-inch.....	90-100	-----	-----	-----	-----	-----	-----
1½-inch.....	35- 70	100	-----	-----	-----	-----	-----
1-inch.....	0- 15	90-100	100	-----	-----	-----	-----
¾-inch.....	-----	-----	90-100	100	-----	-----	-----
½-inch.....	-----	0- 15	-----	90-100	100	-----	-----
¼-inch.....	-----	-----	20- 55	40- 75	90-100	-----	100
No. 4.....	-----	-----	0- 10	0- 15	10- 30	100	75-100
No. 8.....	-----	-----	0- 5	0- 5	0- 8	85-100	0- 10
No. 200.....	0- 2	0- 2	0- 2	0- 2	0- 2	-----	0- 2

Crushed gravel, crushed stone, and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt, or other objectionable matter, and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag, reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Crushed gravel shall consist of the product obtained by crushing and screening gravel that has first been screened in such manner that not less than 90 percent of the material for crushing, when tested by laboratory methods, is retained on a sieve having 1½-inch square openings.

Aggregate shall be free from clay balls and adherent films of clay or other matter that will prevent a thorough coating of the particles with bituminous material. Aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water.

Choker aggregate shall consist of a crushed product and shall be produced during the crushing and screening of the aggregate for road-mix and seal coat.

123-2.2 BITUMINOUS MATERIALS.—(a) One of the following materials, whichever is called for in the bid schedule, shall be furnished:

Rapid-curing cut-back asphalt meeting the requirements of table 3, subsection 113-2.3.

Emulsified asphalt, mixing grade, conforming to A.A.S.H.O. Specification M-48.

Emulsified asphalt, penetration grade, conforming to

A.A.S.H.O. Specification M-51.

Tar conforming to A.A.S.H.O. Specification M-52.

(b) Grades (with temperatures of application in degrees F.) shall be as follows:

Cut-back asphalts—RC-3 (175-225), RC-4 (200-250); Emulsified asphalt (60-120); Tar—RT-5 and RT-6 (80-150), RT-7, RT-8, and RT-9 (150-225).

The grade of cut-back asphalt or tar shall be as called for in the bid schedule, provided, however, that when the grade is not so fixed one of the above grades shall be selected by the engineer.

When emulsified asphalt is called for in the bid schedule, mixing grade shall be used for mixing applications and penetration grade shall be used for the penetration and seal applications.

CONSTRUCTION METHODS

123-3.1 WEATHER AND SEASONAL LIMITATIONS.

Surface course shall be constructed only between May 1 and October 1, and operations shall be carried on only when the surface is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

123-3.2 EQUIPMENT.—The equipment used by the contractor shall include mixing, spreading, finishing, brooming, and compacting equipment, a self-powered bituminous material distributor, and equipment for heating bituminous material.

Aggregate spreading equipment shall be adjustable so that it will spread uniformly the required amounts per square yard. Blade graders for mixing, laying, and finishing shall be of the self-powered type, and shall have blades not less than 10 feet long and wheelbases of not less than 15 feet. Such graders shall be of not less than 3 tons in weight and shall be equipped with pneumatic tires. Rollers for compacting the surface shall be of the self-powered tandem or 3-wheel type weighing not less than 8 tons each.

Either traveling or stationary mixing plants or other equipment of proved performance may be used by the contractor in lieu of the specified equipment if advance written approval is given by the engineer, and if the contractor complies with such requirements as the engineer may consider necessary to insure results that shall be at least equal to results which would be obtained by use of the specified equipment.

123-3.3 SPREADING ROAD-MIX AGGREGATE.—Immediately before placing the aggregate, the existing surface shall be cleaned of loose or deleterious material by sweeping with a power broom, supplemented by hand brooming if necessary. Road-mix aggregate of the grading and in the amount called for shall be spread uniformly on the prepared surface. Aggregate shall not be spread within 18 inches of the proposed pavement edges.

Immediately before the first application of bituminous material, the engineer shall test the road-mix aggregate for moisture. If the moisture content is more than 2 percent of the dry weight of aggregate, the contractor shall turn the material with blade graders or otherwise aerate it until the moisture content is 2 percent or less. The aggregate shall then be respread as provided above.

123-3.4 FIRST APPLICATION OF BITUMINOUS MATERIAL.—When the aggregate has been spread as required above, the bituminous material shall be applied to it uniformly with the prescribed pressure distributor and in the amount per square yard determined by the engineer.

Bituminous material shall be so applied that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be immediately removed and burned. Application temperatures of bituminous material shall be as provided in the specifications for the particular bituminous material being used. During all applications of bituminous material the surfaces of adjacent structures and trees shall be protected to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

123-3.5 PARTIAL ROAD MIXING.—Immediately following the application of bituminous material, it and the aggregate shall be mixed by blading from side to side of the road, or by manipulations producing equivalent results, until all particles are coated with the bituminous material and the whole mass has a uniform color. During the mixing, care shall be taken to avoid disturbing the underlying base or contaminating the mixture with earth or other extraneous matter. When so directed the mixing process shall be confined to part of the width or area of the road so as to allow a convenient passage for traffic.

After the mixing, the bituminized mixture shall be again spread in place to receive the second application of bituminous material.

123-3.6 SECOND APPLICATION AND ROAD MIXING.—Immediately after the first mixing and before the bituminous material is entirely dried or set, the second application shall be made in the required amount per square yard as determined by the engineer and shall be thoroughly road-mixed as required for the first application. The mixing shall continue until all particles are thoroughly and uniformly coated with bituminous material. The mixture shall then be spread and bladed to the specified width and cross section.

123-3.7 INITIAL ROLLING AND PLANING.—As soon as the mixture has been shaped the whole surface shall be rolled, each trip of the roller slightly overlapping its previous path. The roller wheels shall be kept oiled or moistened to prevent picking up the mixture. Any area that tends to ravel shall be repaired with premixed material. After one rolling, any irregularities in the surface shall be corrected by planing with the blade grader or other approved equipment and rerolling if so directed by the engineer.

123-3.8 SPREADING KEY AGGREGATE AND THIRD APPLICATION.—After the surface has been allowed to cure properly, key aggregate, if called for, shall be spread uniformly in the required amount per square yard as determined by the engineer. The surface shall be broomed or broomdragged, or both, until the surface voids are filled. Only the amount of key aggregate necessary to fill the surface voids shall be used. The surface shall not be "blinded" and the mixed aggregate shall remain partly visible through the key aggregate. As soon as the key aggregate is in place, the third or penetration application of bituminous material shall be made in the amount determined by the engineer.

123-3.9 PLACING CHOKER AGGREGATE AND APPLICATION OF SEAL.—After initial rolling and planing have been completed and before the mixture has set, choker aggregate, if called for, shall be spread uniformly at a rate of approximately 5 pounds per square yard. The surface shall be hand broomed or drag broomed, or both, until surface voids are uniformly filled. Bituminous material shall then be applied at a rate of approximately 0.1 gallon per square yard and additional choker aggregate spread uniformly at a rate of approximately 7 pounds per square yard, after which the surface shall be alternately broomed and rolled until the road-mix aggregate and the choker aggregate are thoroughly bonded. Any excess choker aggregate shall then be removed and the surface again rolled until hard and compact. Exact rates of application of bituminous material and choker screenings shall be as ordered by the engineer. The moisture content of choker aggregate shall not be more than 3 percent of the dry weight of aggregate.

123-3.10 ROLLING OF KEYED OR CHOKED SURFACE.—Rolling of the keyed or choked surface shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress to the center of the road, overlapping each preceding passage by an amount not less than one-third the width of the roller, except that on super-elevated curves rolling may progress from the lower to the upper edge. Under no circumstances shall the center of the road be rolled first. Rolling shall be continued until the surface is thoroughly compacted. If ordered by the engineer rolling of the keyed surface shall be continued at proper intervals for several days.

123-3.11 SHAPING EDGES.—While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

123-3.12 APPLICATION OF FINAL SEAL COAT.—Where key aggregate is used, the keyed surface shall be sealed not less than 24 hours after completion of the rolling. Where choker aggregate is used, the choked surface shall be open to traffic for at least 2 weeks before the seal coat is applied. Immediately before placing the seal coat, the choked surface shall be cleaned of loose or deleterious material by sweeping with a power broom, supplemented by hand brooming if necessary.

In the case of seal coat for the keyed surface, a spreading of cover aggregate shall be made first, followed by an application of bituminous material and a second spreading of cover aggregate. The seal coat for the choked surface shall consist of an application of bituminous material followed by a single spreading of cover aggregate. In either case, the bituminous material applied shall be covered immediately with cover aggregate. The exact quantities of materials for seal coat shall be determined by the engineer.

Bituminous material shall be applied as provided in 3.4 above. Initial spreading of the cover aggregate shall be done with the aggregate spreading equipment specified. Trucks spreading aggregate shall be operated backward so that bituminous material will be covered before truck wheels pass over it. Supplemental spreading and smoothing shall be done with a broom drag, and by hand methods where necessary. The surface shall be alternately broom-dragged and rolled until the cover aggregate is uniformly and thoroughly bonded over the full width.

123-3.13 STOCKPILING.—Cover aggregate shall be stockpiled at the rate of 15 tons per mile at locations and in piles of such forms and amounts as the engineer may direct. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

123-4.1 The yardage or tonnage of aggregate to be paid for shall be the number of cubic yards or tons of primary course aggregate, choker aggregate, and cover aggregate actually used in the accepted work or placed in authorized stockpiles. When key aggregate is required, the yardage or tonnage of primary course aggregate shall be the combined yardages or tonnages of coarse aggregate and key aggregate. When the bid schedule calls for payment by the cubic yard, measurement shall be made in the vehicles at the point of delivery.

123-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the

bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

123-5.1 The quantities of materials, determined as provided in 4.1 and 4.2 above, shall be paid for at the contract unit price per cubic yard or per ton for “(Class C-2 Pavement) Road-Mix Primary Course Aggregate, Designation (),” “(Class C-2 Pavement) Choker Aggregate,” or “(Class C-2 Pavement) Cover Aggregate” and per gallon or per ton for “Rapid-Curing Cut-back Asphalt, Grade (), for Class C-2,” “Emulsified Asphalt for Class C-2,” or “Tar, Grade (), for Class C-2,” as the case may be, which prices and payment shall constitute full compensation for furnishing, handling, mixing, manipulating, and placing all materials, for all shaping and compacting including rolling, for finishing, for reconditioning subgrade, shoulders, and gutters, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 130.—CLASS D, TYPE D-1, MOSAIC MACADAM PAVEMENT

(Asphalt or tar)

DESCRIPTION

130-1.1 This item shall consist of a pavement composed of successive spreadings of crushed stone or crushed slag and two penetration applications of bituminous material, constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

130-1.2 QUANTITIES OF MATERIALS PER SQUARE YARD.—The sequence of placing operations and the approximate amounts of materials per square yard for the macadam pavement shall be as provided in table 1.

TABLE 1.—Sequence of placing operations and amounts of materials required per square yard

	Bituminous material	Aggregate	
		Coarse	Key
	<i>Gal. per sq. yd.</i>	<i>Lb. per sq. yd.</i>	<i>Lb. per sq. yd.</i>
First spreading.....	1.85	285	30
First application.....			
Second spreading.....	.30		25
Second application.....			10
Third spreading.....			
Supplemental stockpiles.....			
Totals.....	2.15	350	

The weights given in table 1 are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The total and individual amounts of bituminous material and the amounts of individual spreadings of aggregate, given in table 1, are approximate and the exact amounts shall be

set by the engineer for each application and spreading. The total amount of bituminous material per square yard may be varied by the engineer as necessary to fit conditions. The total amount of aggregate per square yard, adjusted for specific gravity, shall not be varied but shall be as provided in the table.

MATERIALS

130-2.1 AGGREGATE.—The aggregate shall be crushed stone or crushed slag and shall meet the requirements for grading given in table 2, using A.A.S.H.O. Method T-27. Aggregate shall be of the “extra hard” or “hard” variety, whichever is called for in bid schedule.

TABLE 2.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieve (A.A.S.H.O. T-27)			
	“Extra hard” aggregate		“Hard” aggregate	
	Coarse	Key	Coarse	Key
3½-inch.....			100	
3-inch.....			90-100	
2½-inch.....	100			
2-inch.....	90-100		0-15	
1½-inch.....	5-25			
1¼-inch.....	0-5	100		100
1-inch.....		90-100		90-100
¾-inch.....		40-75		40-75
No. 4.....		0-15		0-15
No. 8.....		0-5		0-5

Crushed stone shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter. “Extra hard” aggregate shall have a percent of wear of not more than 25 at 500 revolutions and “hard” aggregate a percent of wear of not more than 40 at 500 revolutions, as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test). Crushed stone for coarse aggregate and key aggregate shall be produced from the same source.

Crushed slag shall be air cooled blast furnace slag reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Aggregate shall be free from clay balls and adherent films of clay or rock dust and shall be washed thoroughly if produced from moist material. Aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water.

130-2.2 BITUMINOUS MATERIALS.—Asphalt or tar, whichever is called for in the bid schedule, shall be furnished. The grade shall be as called for in the bid schedule, provided, however, that when not so called for the grade used shall be one of the following selected by the engineer:

Asphalt shall be penetration grade 85-100, 100-120, or 120-150, conforming to the requirements of A.A.S.H.O. Specification M-20 or M-23.

Tar shall be grade RT-10, RT-11, or RT-12 conforming to requirements of A.A.S.H.O. Specification M-52.

When asphalt is called for, only one type shall be used under any one contract. No mineral matter other than that naturally contained in the asphalt shall be present.

Application temperatures shall be 275-350° F. for asphalt and 175-250° F. for tar.

CONSTRUCTION METHODS

130-3.1 WEATHER AND SEASONAL LIMITATIONS.—Pavement shall be constructed only between May 1 and October 1, and application of bituminous material shall then be made only when the aggregate is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

130-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom or a power blower, aggregate spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, equipment for heating bituminous material, broom-dragging equipment, and powered rollers.

Rollers shall be of the self-powered 3-wheel type weighing not less than 12 tons each. The rear wheels shall produce a compression of at least 400 pounds per linear inch of tire width. A sufficient number of rollers shall be furnished on the work to provide one roller for each 25 tons of pavement aggregate laid per hour.

130-3.3 CONDITIONING OF EXISTING BASE COURSE AND SHOULDERS.—Immediately before spreading coarse aggregate, the base course upon which the pavement is to be constructed shall be swept thoroughly. In the case of a water-bound base course the sweeping shall be continued until the embedded larger aggregate is exposed to a depth of approximately one-fourth inch. While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

130-3.4 SPREADING AND ROLLING COARSE AGGREGATE.—Coarse aggregate shall be spread in the required amount from dump boards, by approved stone spreaders, or by other

approved mechanical methods. It shall be spread to a uniform depth and true to alignment and profile grade. A testing template, cut to the crown of the finished pavement, shall be furnished by the contractor at his expense and used to obtain uniformity of crown. Use of power graders for spreading aggregate will not be permitted.

Any thin, flat, or oversized particles of aggregate that appear on the surface of spread material shall be removed. The coarse aggregate shall be uniformly distributed in respect to size. All patches or areas of fine or undersized material shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking wherever ordered and shall be continued after initial rolling until the appearance and texture are uniform and all ridges are removed.

The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed. Rolling shall progress gradually from the sides to the center, except that on superelevated curves rolling may progress from the lower to the upper edge, parallel with the center line of the road and overlapping uniformly each preceding rear-wheel track by one-half the width of such track and shall continue until the aggregate does not creep or wave ahead of the roller. At the edges, the outside rear wheel of the roller shall cover equal portions of the spread aggregate and the shoulder. The roller shall run forward and backward until the shoulder is firmly compacted against the edge of the pavement.

Material which crushes under the roller in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with suitable aggregate. Any irregularities greater than three-eighths of an inch, as determined by testing the surface with a 10-foot straightedge laid parallel to the center line of the pavement, shall be corrected by loosening and reshaping the aggregate and removing or adding aggregate as required, and by rerolling such areas. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade.

Along curbs, headers, and walls, and at all places not accessible to the roller, the aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spreading that becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate, and rerolled.

After the coarse aggregate has been spread and rolled and prior to the application of bituminous material, the engineer shall check the uniformity of depth of aggregate in place by

means of as many test holes as he considers necessary. In general, series of 3 test holes each shall be dug at intervals of 200 feet, one test hole at the center and one near each edge or quarter point as the engineer may direct. Test holes shall be dug and refilled by the contractor under the direct supervision of the engineer and at the expense of the contractor.

130-3.5 FIRST APPLICATION OF BITUMINOUS MATERIAL.—The first application of bituminous material shall be to the coarse aggregate spread as required above. The material shall be applied uniformly with the prescribed pressure distributor and in the amount per square yard determined by the engineer.

Bituminous material shall be so applied in this and subsequent applications that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be immediately removed and burned. Application temperatures of bituminous material shall be as provided in the specifications for the particular bituminous material being used. During all applications of bituminous material the surfaces of adjacent structures and trees shall be protected to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

130-3.6 FIRST SPREADING OF KEY AGGREGATE.—Immediately following the first application of bituminous material, key aggregate shall be spread evenly over the surface until the voids are nearly filled. The adding of key aggregate in small amounts shall be continued as may be required during the rolling. Care shall be taken in spreading the key aggregate to obtain uniformity of surface, and if directed by the engineer the surface shall be broomed with push brooms or drag brooms. Rolling of the surface shall start immediately after the spreading and smoothing of the key aggregate and while the bituminous binder is still warm, and shall continue until the pavement is thoroughly compacted and bonded. The time, extent, and manner of rolling shall be subject to direction by the engineer.

130-3.7 SECOND APPLICATION OF BITUMINOUS MATERIAL.—After the first spreading of key aggregate has been rolled, the surface shall be swept clean of all loose material, and bituminous material for the second application shall be applied uniformly in the amount per square yard determined by the engineer.

130-3.8 SECOND SPREADING OF KEY AGGREGATE.—Immediately following the second application of bituminous material, key aggregate shall be spread evenly over the surface at

the rate of approximately 25 pounds per square yard. The spreading of key aggregate shall be followed by thorough rolling. If the engineer so directs, the surface shall be broomed during rolling.

While the surface is being compacted and finished the contractor shall shape and finish the shoulders and gutters to conform to the section shown on the plans.

130-3.9 STOCKPILING.—Key aggregate shall be stockpiled at the rate of 10 pounds per square yard of completed pavement at locations and in piles of such forms and amounts as the engineer may direct. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

130-4.1 The tonnage of aggregate to be paid for shall be the number of tons of coarse aggregate and key aggregate actually used in the accepted work or placed in authorized stockpiles.

130-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

130-5.1 The quantities of materials determined as provided above, shall be paid for at the contract unit price per ton for "(Class D Pavement, Type D-1), 'Extra hard' Macadam Aggregate" or "(Class D Pavement, Type D-1) 'Hard' Macadam Aggregate" and per gallon or per ton for "Asphalt, Grade (), for Type D-1," or "Tar, Grade () for Type D-1," as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, manipulating, and placing all materials, for all shaping, compacting, rolling, and finishing, for reconditioning subgrade, shoulders, and gutters, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 131.—CLASS D, TYPE D-2, THREE APPLICATION MACADAM PAVEMENT

(Asphalt or tar)

DESCRIPTION

131-1.1 This item shall consist of a pavement composed of successive spreadings of crushed stone or crushed slag and three penetration applications of bituminous material, constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

131-1.2 **QUANTITIES OF MATERIALS PER SQUARE YARD.**—The sequence of placing operations and the approximate amounts of materials per square yard for the macadam pavement shall be as provided in table 1.

TABLE 1.—Sequence of placing operations and amounts of material required per square yard

	Bituminous material	Aggregate		
		Coarse	Key	Chips
	Gals. per sq. yd.	Lbs. per sq. yd.	Lbs. per sq. yd.	Lbs. per sq. yd.
First spreading	1.50	270		
First application			30	
Second spreading	.50		25	
Second application				15
Third spreading	.30			10
Third application				
Fourth spreading				
Supplemental stockpiles				
Total	2.30		350	

The weights given in table 1 are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The total and individual amounts of bituminous material and the amounts of individual spreadings of aggregate, given in table 1, are approximate and the exact amounts shall be set by the engineer for each application and spreading. The total amount of bituminous material per square yard may be varied by the engineer as necessary to fit conditions. The total amount of aggregate per square yard, adjusted for specific gravity, shall not be varied but shall be as provided in the table.

MATERIALS

131-2.1 **AGGREGATE.**—The aggregate shall be crushed stone or crushed slag and shall meet the requirements for grading given in table 2, using A.A.S.H.O. Method T-27.

TABLE 2.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)		
	Coarse aggregate	Key aggregate	Chips
3-inch	100		
2½-inch	90-100		
2-inch	35-70		
1½-inch	0-15		
1-inch		100	
¾-inch		90-100	
½-inch			100
¼-inch		20-55	90-100
⅛-inch		0-10	10-30
No. 4		0-5	0-8
No. 8			

Crushed stone and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter, and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Aggregate shall be free from clay balls and adherent films of clay or rock dust and shall be washed thoroughly if produced from moist material. Aggregate shall be of such nature that a thorough coating of bituminous material to be used in the work applied to it will not slough off upon contact with water.

131-2.2 **BITUMINOUS MATERIALS.**—Asphalt or tar, whichever is called for in the bid schedule, shall be furnished,

The grade shall be as called for in the bid schedule, provided, however, that when not so called for the grade used shall be one of the following selected by the engineer.

Asphalt shall be penetration grade 85-100, 100-120, or 120-150, conforming to the requirements of A.A.S.H.O. Specification M-20 or M-23.

Tar shall be grade RT-10, RT-11, or RT-12 conforming to requirements of A.A.S.H.O. Specification M-52.

When asphalt is called for, only one type shall be used under any one contract. No mineral matter other than that naturally contained in the asphalt shall be present.

Application temperatures shall be 275-350° F. for asphalt and 175-250° F. for tar.

CONSTRUCTION METHODS

131-3.1 WEATHER AND SEASONAL LIMITATIONS.—

Pavement shall be constructed only between May 1 and October 1, and application of bituminous material shall then be made only when the aggregate is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

131-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom or a power blower, aggregate spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, equipment for heating bituminous material, a pneumatic-tired motor grader having a wheelbase of not less than 15 feet, an approved drag at least 15 feet long, broom-dragging equipment, and powered rollers.

Rollers shall be of the self-powered 3-wheel type weighing not less than 10 tons each. A sufficient number of rollers shall be furnished on the work to provide one roller for each 25 tons of pavement aggregate laid per hour.

131-3.3 CONDITIONING OF EXISTING BASE COURSE AND SHOULDERS.—Immediately before spreading coarse aggregate, the base course upon which the pavement is to be constructed shall be swept thoroughly. In the case of a water-bound base course the sweeping shall be continued until the embedded larger aggregate is exposed to a depth of approximately one-fourth inch. While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

131-3.4 SPREADING AND ROLLING COARSE AGGREGATE.—Coarse aggregate shall be spread in the required amount from dump boards, by approved stone spreaders, or by other approved mechanical methods. It shall be spread to a

uniform depth and true to alinement and profile grade. A testing template, cut to the crown of the finished pavement, shall be furnished by the contractor at his expense and used to obtain uniformity of crown. When required by the engineer, a drag at least 15 feet long shall be used after the spreading to level and improve the uniformity and regularity of the spread.

Any thin, flat, or oversized particles of aggregate that appear on the surface of spread material shall be removed. The coarse aggregate shall be uniformly distributed in respect to size. All patches or areas of fine or undersized material shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking wherever ordered and shall be continued after initial rolling until the appearance and texture are uniform and all ridges are removed.

The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed. Rolling shall progress gradually from the sides to the center, except that on superelevated curves rolling may progress from the lower to the upper edge, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track and shall continue until the aggregate does not creep or wave ahead of the roller. At the edges, the outside rear wheel of the roller shall cover equal portions of the spread aggregate and the shoulder. The roller shall run forward and backward until the shoulder is firmly compacted against the edge of the pavement.

Material which crushes under the roller in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with suitable aggregate. Any irregularities greater than three-eighths of an inch, as determined by testing the surface with a 10-foot straightedge laid parallel to the center line of the pavement, shall be corrected by loosening and reshaping the aggregate and removing or adding aggregate as required, and by rerolling such areas. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade.

Along curbs, headers, and walls, and at all places not accessible to the roller, the aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spreading that becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate, and rerolled.

After the coarse aggregate has been spread and rolled and prior to the application of bituminous material, the engineer

shall check the uniformity of depth of aggregate in place by means of as many test holes as he considers necessary. In general, series of 3 test holes each shall be dug at intervals of 200 feet, one test hole at the center and one near each edge or quarter point as the engineer may direct. Test holes shall be dug and refilled by the contractor under the supervision of the engineer and at the expense of the contractor.

131-3.5 FIRST APPLICATION OF BITUMINOUS MATERIAL.—The first application of bituminous material shall be to the coarse aggregate spread as required above. The material shall be applied uniformly with the prescribed pressure distributor and in the amount per square yard determined by the engineer.

Bituminous material shall be so applied in this and subsequent applications that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper, and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be immediately removed and burned. Application temperatures of bituminous material shall be as provided in the specifications for the particular bituminous material being used. During all applications of bituminous material the surfaces of adjacent structures and trees shall be protected to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

131-3.6 FIRST SPREADING OF KEY AGGREGATE.—Immediately following the first application of bituminous material, key aggregate shall be spread evenly over the surface until the voids are nearly filled. The adding of key aggregate in small amounts shall be continued as may be required during the rolling. Care shall be taken in spreading the key aggregate to obtain uniformity of surface, and if directed by the engineer the surface shall be broomed with push brooms or drag brooms. Rolling of the surface shall start immediately after the spreading and smoothing of the key aggregate and while the bituminous binder is still warm, and shall continue until the pavement is thoroughly compacted and bonded. The time, extent, and manner of rolling shall be subject to direction by the engineer.

131-3.7 SECOND APPLICATION OF BITUMINOUS MATERIAL.—After the first spreading of key aggregate has been rolled, the surface shall be swept clean of all loose material, and bituminous material for the second application shall be applied uniformly in the amount per square yard determined by the engineer.

131-3.8 SECOND SPREADING OF KEY AGGREGATE.—Immediately following the second application of bituminous

material, key aggregate shall be spread evenly over the surface at the rate determined by the engineer but not exceeding 25 pounds per square yard. A portion of the key aggregate may be reserved and then added as required while rolling and brooming are in progress. The spreading of key aggregate shall be followed by thorough rolling and brooming of the surface. Rolling and brooming shall be continued until all interstices in the coarse aggregate are filled and until the surface is of uniform texture throughout.

131-3.9 THIRD APPLICATION OF BITUMINOUS MATERIAL AND SPREADING OF CHIPS.—After the second spreading of key aggregate has been rolled and broomed, the surface shall be swept clean of all loose material, and bituminous material shall be applied uniformly in the amount determined by the engineer. The bituminous material shall be covered immediately with chips, and the surface shall be rolled and broomed until the chips are bonded thoroughly and uniformly over the full width of the surface.

While the surface is being compacted and finished, the contractor shall shape and finish the shoulders and gutters to conform to the section shown on the plans.

131-3.10 STOCKPILING.—Chips shall be stockpiled at the rate of 10 pounds per square yard of completed pavement at locations and in piles of such forms and amounts as the engineer may direct. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

131-4.1 The tonnage of aggregate to be paid for shall be the number of tons of coarse aggregate, key aggregate, and chips actually used in the accepted work or placed in authorized stockpiles.

131-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered for the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 203-36.

BASIS OF PAYMENT

131-5.1 The quantities of materials determined as provided above, shall be paid for at the contract unit price per ton for "(Class D Pavement, Type D-2) Macadam Aggregate" and per gallon or per ton for "Asphalt, Grade (), for Type D-2," or "Tar, Grade (), for Type D-2," as the case may be, which prices and payments shall constitute full compensation for fur-

nishing, handling, manipulating, and placing all materials, for all shaping, compacting, rolling, and finishing, for reconditioning subgrade, shoulders, and gutters, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 132.—CLASS E-1, MACADAM PAVEMENT, PLANT-MIX SEAL COAT

(Asphalt or tar)

DESCRIPTION

132-1.1 This item shall consist of a pavement composed of a macadam bottom course and a plant-mix seal coat, constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans. The macadam bottom course shall be composed of successive spreadings of crushed stone or *crushed slag and two penetration applications of bituminous materials*. The plant-mix seal coat shall consist of hot asphaltic concrete or cold asphaltic concrete, whichever is called for in the bid schedule, and it shall be applied at a rate of 50 pounds per square yard.

132-1.2 QUANTITIES OF MATERIALS PER SQUARE YARD FOR MACADAM COURSE.—The sequence of placing operations and the approximate amounts of materials per square yard for the macadam course shall be as provided in table 1.

TABLE 1.—Sequence of placing operations and amounts of materials required per square yard

	Bituminous material	Aggregate	
		Coarse	Key
	<i>Gals. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>
First spreading.....		190	
First application.....	1.20		
Second spreading.....			25
Second application.....	.30		
Third spreading.....			15
Totals.....	1.50	230	

The weights given in table 1 are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the

corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The total and individual amounts of bituminous material and the amounts of individual spreadings of aggregate, given in table 1, are approximate and the exact amounts shall be set by the engineer for each application and spreading. The total amount of bituminous material per square yard may be varied by the engineer as necessary to fit conditions. The total amount of aggregate per square yard, adjusted for specific gravity, shall not be varied but shall be as provided in the table.

132-1.3 GENERAL COMPOSITION OF SEAL COAT.—The seal coat, prepared as herein required, shall be combined to meet the composition limits given in table 2. The aggregate for seal coat shall meet the requirements for grading given in table 2, using A.A.S.H.O. Methods T-11 and T-27. To the aggregate shall be added bitumen, liquefier and hydrated lime in the following percentages by weight (table 2).

TABLE 2.—Requirements for composition of seal coat, aggregate and bituminous material

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)	
	Hot asphaltic concrete	Cold asphaltic concrete
¾-inch.....	95-100	95-100
No. 4.....	30-60	30-60
No. 10.....	20-35	15-35
No. 20.....	10-25	7-20
No. 40.....	8-20	3-10
No. 80.....	4-15	0-5
No. 200.....	2-4	0-2
Bitumen (sol. CS ₂).....	4.5-7.0	5.0-7.0
Liquefier.....	.....	0.2-1.5
Hydrated Lime.....	.....	0.5-1.0

132-1.4 FORMULA FOR JOB MIX FOR SEAL COAT.—The general composition limits prescribed in table 2 for seal coat mixture are extreme limits of tolerance that must not be exceeded regardless of any formula which may be submitted.

Before starting work, the contractor shall submit in writing, to the engineer, the formula for the mixture which he proposes to supply for the project. The formula so submitted shall include a single definite percentage of aggregate passing each required sieve size, a single definite percentage of bitumen to be added to the aggregate, and a single definite temperature at which the mixture is to be delivered on the road. The

engineer shall make any adjustments desired in the formula submitted and set the job mix. Within the ranges permitted by 1.3 above, the job mix shall fix a single definite percentage of aggregate passing each required sieve size, a single definite percentage of bitumen to be added to the aggregate, and a single definite temperature at which the material is to be delivered on the road.

After the job-mix formula is established as prescribed above, all mixture furnished for the project shall conform thereto within the following ranges of tolerance:

Passing Nos. 4, 10, 20, and 40 sieves.....	±4	percent.
Passing No. 80 sieve.....	±2	percent.
Liquefier	±0.2	percent.
Bitumen	±0.25	percent.
Temperature of mixture on delivery.....	±20°	F.

Each day the engineer shall take as many samples as he considers necessary for checking the required uniformity of the mixture. When unsatisfactory results or changed conditions makes it necessary, the engineer may establish a new job-mix.

Should a change in sources of materials be made, a new job-mix formula shall be submitted and approved before the mixture containing the new materials is delivered.

MATERIALS

132-2.1 MACADAM AGGREGATE.—The aggregate for the bituminous macadam course shall be crushed stone or crushed slag and shall meet the requirements for grading given in table 3, whichever is called for in the bid schedule, using A.A.S.H.O. Method T-27.

TABLE 3.—Requirements for grading of macadam aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)	
	Coarse aggregate	Key aggregate
2¼-inch.....	100	.....
2-inch.....	90-100	.....
1½-inch.....	35-70	.....
1-inch.....	0-15	.....
¾-inch.....	.....	100
½-inch.....	.....	90-100
¼-inch.....	.....	40-75
No. 4.....	.....	0-15
No. 8.....	.....	0-5

Crushed stone and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter, and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Aggregate shall be free from clay balls and adherent films of clay or rock dust and shall be washed thoroughly if produced from moist material. Aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water.

132-2.2 SEAL COAT AGGREGATE.—Seal coat aggregate shall be produced from stone or slag meeting the quality requirements of 2.1 above and shall meet the grading requirements of table 2, for the type of mixture called for.

132-2.3 BITUMINOUS MATERIALS.—Asphalt or tar, whichever is called for in the bid schedule, shall be furnished for the macadam. Asphalt shall be furnished for the seal coat.

Asphalt, for macadam, shall be penetration grade 85-100, 100-120, or 120-150 conforming to the requirements of A.A.S.H.O. Specification M-20 or M-23.

Tar shall conform to the requirements of A.A.S.H.O. Specification M-52, grade RT-10, RT-11, or RT-12.

Asphalt, for hot seal coat, shall conform to the requirements of A.A.S.H.O. Specification M-20 or M-22, save that the penetration grade shall be 85-100.

Asphalt, for cold seal coat, shall be penetration grade 85-100, conforming to the requirements of A.A.S.H.O. Specification M-20 or M-23.

When asphalt is called for, only one type shall be used under any one contract. No mineral matter other than that naturally contained in the asphalt shall be present.

The grade of asphalt or tar for macadam shall be as called for in the bid schedule, provided, however, when the grade is not so fixed, one of the above grades shall be selected by the engineer.

Application temperatures for macadam shall be 275-350° F. for asphalt and 175-250° F. for tar.

Liquefier, for cold seal coat, for use during warm weather shall be a petroleum naphtha which, when distilled in accordance with A.S.T.M. Designation D 86-35, shall have an initial boiling point of not more than 220° F. and an end point of not more than 450° F. At least 45 percent and not more than 55 percent of the distillate shall be distilled off at 325° F.

Liquefier, for cold seal coat, for use during cold weather shall be a petroleum naphtha which, when distilled in accordance

with A.S.T.M. Designation D 86-35, shall have an initial boiling point of not more than 270° F. and an end point between 425° F. and 450° F. The distillate shall pass off continuously at regular intervals between 275° F. and the end point so as to give a nearly straight line on the distillation graph.

132-2.4 HYDRATED LIME.—Hydrated lime for use in cold asphaltic concrete seal coat shall meet the requirements of the standard specification, A.S.T.M. Designation C 6-34-T.

CONSTRUCTION METHODS

132-3.1 WEATHER AND SEASONAL LIMITATIONS.—Pavement shall be constructed only between May 1 and October 1, and application of bituminous material and placing of seal coat shall be done only when the aggregate and surface are dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

132-3.2 EQUIPMENT FOR MACADAM CONSTRUCTION.—The equipment used by the contractor shall include a power broom or a power blower, aggregate spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, equipment for heating bituminous material, a pneumatic-tired motor grader having a wheelbase of not less than 15 feet, an approved drag at least 15 feet long, broom-dragging equipment, and powered rollers.

Rollers shall be of the self-powered 3-wheel type weighing not less than 10 tons each. A sufficient number of rollers shall be furnished on the work to provide one roller for each 25 tons of macadam aggregate laid per hour.

132-3.3 EQUIPMENT FOR PLANT-MIX SEAL COAT.—(a) *Mixing Plant.*—The plant used by the contractor in the preparation of the asphaltic concrete seal coat shall conform to the following requirements:

Drier.—For both hot and cold seal coats the plant shall include a drier capable of preparing aggregate at a rate equal to the full rated capacity of the mixer. For hot asphaltic concrete the drier shall be of the rotating, cylindrical type suitably designed to heat the aggregates to specification requirements, without any direct flame coming in contact with the aggregate, and to agitate the aggregate continuously during heating. Where cold asphaltic concrete is called for, both the drier for drying the aggregate and reducing the moisture to the limit prescribed by these specifications and the equipment for the mechanical cooling of the dried aggregate to the temperature prescribed for mixing shall be capable of supplying prepared material for the mixer when

it is operating at full capacity. However, in plants provided with dry enclosed silos or similar storage space and with mechanical aerating equipment adequate to accomplish satisfactorily the cooling of dried aggregates without "sweating" or other "deconditioning," the requirement for a full capacity drier may be waived in favor of equipment of smaller capacity provided such equipment meets all other requirements for driers and can charge the silo at a satisfactory rate. The requirement for mechanical cooling of the aggregate while it is being stored may be waived in the case of material entering the storage space at atmospheric temperature.

Screens.—Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities slightly in excess of the full capacity of the mixer, shall be provided.

Bins.—The plant shall include hot or cold storage bins (as required) of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be divided into at least three compartments arranged to insure separate and adequate storage of appropriate fractions of the aggregate. Each compartment shall be provided with an overflow pipe that shall be of such size and at such location as to prevent any backing up of material into other bins.

Weigh box or hopper.—The plant shall have a weigh box capable of holding the maximum amount of aggregate for one batch. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be easily thrown out of alinement or adjustment. All edges, ends, and sides of weighing hoppers must be free from contact with any supporting rods or columns or other equipment that will in any way affect proper functioning of the hopper. Also, there must be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials. The discharge gate of the weigh box shall be so hung that the aggregates will not be segregated when dumped into the mixer.

Scales.—Scales for the weigh box may be of either the beam or springless dial type and shall be of a standard make and design, sensitive to one-half of 1 percent of the maximum load that may be required. When of the beam type, there shall be a separate beam for each size of aggregate. A "telltale" dial scale that will start to function when the load being applied is within 100 pounds of that desired shall be attached to each beam. Sufficient vertical movement shall be provided for the beams to permit the "telltale" dial scale to function properly. Each beam shall have a locking device designed and so located that the beam can easily be suspended or thrown into action. Beam scales shall be balanced on knife edges and fulcrums and shall be so constructed that they cannot be easily thrown out of alinement and adjustment.

Dial scales shall be of such size that the numerals on the dial can be read at a distance of not less than 25 feet. The dials shall be of the compounding type having full complements of index pointers. No pointers so placed as to give excessive parallax errors shall be used. Dial scales shall be substantially constructed, and those that easily get out of adjustment shall be replaced with other makes when so ordered by the engineer. All scales shall be so located as to be plainly visible to the operator at all times.

Scales for the weighing of asphalt shall conform to the specifications for the scales for aggregate except that beam scales shall be equipped with tare beams and full capacity beams. The value of the minimum graduation shall not be greater than 2 pounds. Dial scales for weighing asphalt shall have capacities each of not more than twice the weight of the material to be weighed and shall read to the nearest pound.

The contractor shall provide and have at hand the necessary number of standard test weights for frequent testing of all scales.

Asphalt weigh bucket.—The asphalt weigh bucket shall be steam jacketed and shall have a capacity equal to 12 percent of the maximum capacity of the mixer. It shall be supported on fulcrums and knife edges in the same manner as is the weigh box.

Kettles.—Kettles for storage of asphalt shall have total capacities each sufficient for 1 day's run and shall be capable of heating the asphalt with an effective and positive control of the heat at all times to a temperature between 250° and 350° F. Heating of the asphalt by steam coils is preferred.

Under no circumstances will a flame from oil or other fuel be permitted to come in direct contact with the heating kettles. The asphalt circulating system shall be of adequate size to insure the proper and continuous circulation of asphalt during the entire operating period. All asphalt lines and fittings shall be steam jacketed.

Thermometers.—An armored thermometer reading from 200° to 400° F. shall be fixed in the asphalt line at a suitable location near the weigh bucket discharge valve.

The plant shall be further equipped with an approved dial scale mercury actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically the temperature of the heated aggregates. This device shall be plainly visible to the drum fireman or head feeder.

The engineer reserves the right to pass upon the efficiency of the thermometric instrument and, for better regulation of the temperature of the aggregates, may direct replacement of the instrument by some approved temperature-recording apparatus and may further require daily charts of such regulator to be filed with him.

Mixer.—A batch mixer shall be used. It shall be of the standard twin pugmill type, steam jacketed, equipped with a sufficient number of paddles or blades set in proper order to produce properly mixed batches of any material required under these specifications. When the clearance in the twin pugmill is equal to or exceeds 2 inches, either the shortened blades or the worn liners (or both) shall be replaced to reduce the clearance to 2 inches or less. When the engineer finds that there is difficulty in obtaining the specified mixing time, he may require that the mixer be provided with an approved, accurate time lock that will lock the discharge gates of the mixer after all the aggregates have been placed in the mixer, and that will not release the gates until the specified time has elapsed. To obtain proper mixing, using the minimum mixing time herein prescribed, the mixer capacity shall be a 1,500-pound batch, provided that when smaller mixers are approved no decrease in time of mixing will be allowed. If sufficient mixing and coating are not obtained, the right is reserved to increase the required mixing time as the engineer may judge necessary. The mixer used for hot asphaltic concrete seal coat may be of an approved rotary drum type.

Volumetric proportioning and continuous mixing may be substituted for weight proportioning and batch mixing, provided the equipment to be used as an established background of service, satisfactory to the engineer, in accomplishing the required gradation control of aggregate and uniformity of mix.

(b) **Placing Equipment.**—Equipment for spreading, shaping, and finishing the seal coat shall consist of an approved self-contained power machine operating in such manner that no supplemental spreading will be required to produce a seal coat surface which will comply with the requirement for smoothness contained herein. Rollers for compacting the seal coat shall be either of the self-powered tandem type or the 3-wheel type and shall weigh not less than 8 tons each.

132-3.4 CONDITIONING OF EXISTING BASE COURSE AND SHOULDERS.—Immediately before spreading coarse aggregate, the base course upon which the pavement is to be constructed shall be swept thoroughly. In the case of a water-bound base course the sweeping shall be continued until the embedded larger aggregate is exposed to a depth of approximately one-fourth inch. While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

132-3.5 SPREADING AND ROLLING COARSE AGGREGATE.—Coarse aggregate shall be spread in the required amount from dump boards, by approved stone spreaders, or by other approved mechanical methods. It shall be spread to a uniform depth and true to alignment and profile grade. A testing template, cut to the crown of the finished pavement, shall be furnished by the contractor at his expense and used to

obtain uniformity of crown. When required by the engineer, a drag at least 15 feet long shall be used after the spreading to level and improve the uniformity and regularity of the surface.

Any thin, flat, or oversized particles of aggregate that appear on the surface of spread material shall be removed. The coarse aggregate shall be uniformly distributed in respect to size. All patches or areas of fine or undersized material shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking wherever ordered and shall be continued after initial rolling until the appearance and texture are uniform and all ridges are removed.

The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed. Rolling shall progress gradually from the sides to the center, except that on superelevated curves rolling may progress from the lower to the upper edge, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track and shall continue until the aggregate does not creep or wave ahead of the roller. At the edges, the outside rear wheel of the roller shall cover equal portions of the spread aggregate and the shoulder. The roller shall run forward and backward until the shoulder is firmly compacted against the edge of the pavement.

Material which crushes under the roller in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with suitable aggregate. Any irregularities greater than three-eighths of an inch, as determined by testing the surface with a 10-foot straightedge laid parallel to the center line of the pavement, shall be corrected by loosening and reshaping the aggregate and removing or adding aggregate as required, and by rerolling such areas. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade.

Along curbs, headers, and walls, and at all places not accessible to the roller, the aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spreading that becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate, and rerolled.

After the coarse aggregate has been spread and rolled and prior to the application of bituminous material, the engineer shall check the uniformity of depth of aggregate in place by means of as many test holes as he considers necessary. In general, series of 3 test holes each shall be dug at intervals of

200 feet, one test hole at the center and one near each edge or quarter point as the engineer may direct. Test holes shall be dug and refilled by the contractor under the direct supervision of the inspector and at the expense of the contractor.

132-3.6 FIRST APPLICATION OF BITUMINOUS MATERIAL.—The first application of bituminous material shall be to the coarse aggregate spread as required above. The material shall be applied uniformly with the prescribed pressure distributor and in the amount per square yard determined by the engineer.

Bituminous material shall be so applied in this and subsequent applications that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be immediately removed and burned. Application temperatures of bituminous material shall be as provided in the specifications for the particular bituminous material being used. During all applications of bituminous material the surfaces of adjacent structures and trees shall be protected to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

132-3.7 FIRST SPREADING OF KEY AGGREGATE.—Immediately following the first application of bituminous material, key aggregate shall be spread evenly over the surface until the voids are nearly filled. The adding of key aggregate in small amounts shall be continued as may be required during the rolling. Care shall be taken in spreading the key aggregate to obtain uniformity of surface, and if directed by the engineer the surface shall be broomed with push brooms or drag brooms. Rolling of the surface shall start immediately after the spreading and smoothing of the key aggregate and while the bituminous binder is still warm, and shall continue until the pavement is thoroughly compacted and bonded. The time, extent, and manner of rolling shall be subject to direction by the engineer.

132-3.8 SECOND APPLICATION OF BITUMINOUS MATERIAL.—After the first spreading of key aggregate has been rolled, the surface shall be swept clean of all loose material, and bituminous material for the second application shall be applied uniformly in the amount per square yard determined by the engineer.

132-3.9 SECOND SPREADING OF KEY AGGREGATE.—Immediately following the second application of bituminous material, key aggregate shall be spread evenly over the surface

in the amount of approximately 15 pounds per square yard. The spreading of key aggregate shall be followed by thorough rolling and brooming of the surface.

132-3.10 PREPARATION AND TRANSPORTATION OF HOT ASPHALTIC CONCRETE SEAL COAT.—(a) *Preparation of Bituminous Material.*—The bituminous material shall be melted in kettles or tanks designed to give uniform heating of the entire contents. The material shall be brought to a temperature between 250° and 350° F.

When refined asphalt is to be combined with a flux, the mixture shall be thoroughly agitated until a homogeneous asphalt of the required penetration is produced. The penetration of the asphalt shall be tested at suitable intervals to insure that it is maintained at a uniform consistency throughout the period of use.

(b) *Preparation of Aggregate.*—The aggregate for the mixture shall be dried and heated at the plant before it is put into the mixer. The aggregate shall be heated to temperatures between 225° and 350° F. as determined on the mixing platform. When more than two ingredients enter into the composition of the mineral aggregate they shall be combined as directed by the engineer.

The aggregates, immediately after heating, shall be screened into three or more fractions and conveyed into separate bins, ready for batching and mixing with bituminous material.

(c) *Preparation of Mixture.*—The dried mineral aggregate, prepared as prescribed above, shall be combined in uniform batches by weighing and conveying into the mixer the proportionate amount of each aggregate required to meet the job-mix formula. The required quantity of hot asphalt cement for each batch shall be measured by weight using scales attached to the asphalt bucket. The mixture shall be made by first charging the mixer with the mineral aggregates. After these have been thoroughly mixed, the asphalt shall be added and the mixing continued for a period of at least 45 seconds or longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are coated uniformly. Each batch shall be kept separate throughout the mixing operations.

The ingredients shall be heated and combined in such a manner as to produce a mixture which, when discharged, shall be at a temperature of not less than 250° F. nor more than 350° F.

(d) *Transportation of Mixture.*—The mixture shall be transported from the plant to the point of use in tight vehicles previously cleaned of all foreign materials. When directed by the engineer, each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from the weather. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight unless artificial light, satisfactory to the engineer, is provided. The mixture shall be delivered at

a temperature between 225° and 325° F. and within 20° F. of the temperature set in the job-mix formula.

132-3.11 PREPARATION AND TRANSPORTATION OF COLD ASPHALTIC CONCRETE SEAL COAT.—(a) *Preparation of Bituminous Material.*—The bituminous material shall be heated in the melting kettles or tanks so that the entire mass is heated evenly. Temperatures used shall be between 200° F. and 300° F.

(b) *Preparation of Aggregates.*—All aggregate shall be dried until it has no surface moisture and not more than four-tenths percent of contained moisture. Mixing temperatures of the aggregate shall at no time be less than 45° F. nor more than 110° F., except that when using slag aggregate, the engineer may direct that the upper limit be raised to 125° F. After drying, all aggregate shall be screened into 3 sizes and the fractions shall be held or stored separately in their respective bins or compartments for feeding into the weigh box.

(c) *Preparation of Mixture.*—The separated fractions of dried mineral aggregate, prepared as prescribed above, shall be combined into uniform batches by weighing and conveying into the mixer the proportionate amount of each fraction required to meet the job-mix formula. After these fractions have been thoroughly mixed, liquefier shall be sprayed over the aggregate and mixing shall be continued until all the stone is coated. The quantity or character of liquefier used shall be varied within the limits prescribed, and shall depend on weather, time, and the distance the material is to be transported. The liquefier shall be used in such manner as will insure the desired consistency of the mixture when it is delivered and deposited on the road.

The asphalt and hydrated lime shall then be successively introduced and the mixing continued until the mixture is thoroughly uniform and homogeneous. The dry mixing period shall be set by the engineer after he has considered the nature of the aggregate used. The total mixing time shall be varied according to the nature of the aggregates and the capacity of the mixer but in no case shall the mixing time, after the introduction of the asphalt, be less than 2 minutes. The mixture shall be so prepared that it may be unloaded and applied at the prevailing air temperature (which must be above 45° F.) without application of heat. The details of plant operation shall be arranged to meet the above requirements and at the same time produce the workability of mix and thickness of film coating found most advantageous. Each batch shall be kept separate throughout the mixing operations.

The mixture shall be uniform in composition, free from lumps or balls of material containing an excess quantity of asphalt and free from pockets containing less than the required amount of asphalt.

(d) *Transportation of Mixture.*—All cars shall be in good condition and preferably without pockets. All projecting spikes, nails, foreign material, and other obstructions likely to interfere with efficient unloading shall be removed from cars. The bottoms of the cars shall be covered with thin layers of clean sand or screenings. Loaded cars shall be covered with paper or other suitable material, trucks shall be covered with waterproof canvas covers when so ordered. The inside surfaces of trucks may be thinly coated with soapy water, or a mixture of water with not more than 10 percent of lubricating oil. The use of kerosene, gasoline, or similar products will not be permitted.

A shipment found to contain a surplus amount of bituminous material in the bottom of the car or truck will be rejected upon arrival.

132-3.12 PLACING AND COMPACTING SEAL COAT.—Immediately before placing the seal coat mixture, the macadam course shall be cleaned of all loose or deleterious material by sweeping with a power broom, supplemented by hand brooming if necessary.

The seal-coat mixture shall be spread, shaped, and finished with the specified power machine.

Rolling of the seal coat shall start as soon after spreading as, in the opinion of the engineer, the mixture is at the proper temperature and condition for rolling. Rolling shall be longitudinal and shall commence at the outer edges of the road and progress towards the center of the road, except that on superelevated curves rolling may progress from the lower to the upper edge, overlapping each preceding passage an amount not less than one-half the width of the roller. The completed plant-mix seal coat shall be compact, smooth, and even, true to grade and cross section, and shall be free from ruts, bumps, or irregularities.

METHOD OF MEASUREMENT

132-4.1 The tonnage to be paid for shall be the number of tons of coarse aggregate, key aggregate, and plant-mix seal coat actually used in the accepted work.

132-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered for the accepted macadam course. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36. Bituminous material used in the plant-mix seal coat shall not be measured and paid for directly, and payment therefor shall be considered as included in the price paid per ton for plant-mix seal coat mixture.

BASIS OF PAYMENT

132-5.1 The quantities of materials, determined as provided above, shall be paid for at the contract unit price per ton for "(Class E-1 Pavement) Macadam Aggregate," per gallon or per ton for "Asphalt, Grade (), for Class E-1 Macadam" or "Tar, Grade (), for Class E-1 Macadam," and per ton for "Hot Asphaltic Concrete (Stone Aggregate) Seal Coat for Class E-1," "Hot Asphaltic Concrete (Slag Aggregate) Seal Coat for Class E-1," "Cold Asphaltic Concrete (Stone Aggregate) Seal Coat for Class E-1," or "Cold Asphaltic Concrete (Slag Aggregate) Seal Coat for Class E-1," as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, manipulating, and placing all materials, for all shaping, compacting, rolling, and finishing, for reconditioning subgrade, shoulders and gutters, for furnishing and sealing scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 133.—CLASS E-2, TYPE EM, FOUR APPLICATION MACADAM PAVEMENT

(Emulsified asphalt)

DESCRIPTION

133-1.1 This item shall consist of a pavement composed of successive spreadings of crushed stone or crushed slag and four penetration applications of emulsified asphalt, constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

133-1.2 QUANTITIES OF MATERIALS PER SQUARE YARD.—The sequence of placing operations and the approximate amounts of materials per square yard for the macadam pavement shall be as provided in table 1.

TABLE 1.—Sequence of placing operations and amounts of materials required per square yard

	Bituminous material	Aggregate			
		Coarse	Choker	Filler	Chips
	<i>Gals. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>	<i>Lbs. per sq. yd.</i>
First spreading.....					
Second spreading.....			15		
First application.....	0.90				
Third spreading.....				15	
Second application.....	1.00				
Fourth spreading.....					10
Third application.....	.30				
Fifth spreading.....				25	
Fourth application.....	.20				
Sixth spreading.....					15
Supplemental stockpiles.....					10
Totals.....	2.40			290	

The weights given in table 1 are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The total and individual amounts of bituminous material and the amounts of individual spreadings of aggregate, given in table 1, are approximate and the exact amounts shall be set by the engineer for each application and spreading. The total amount of bituminous material per square yard may be varied by the engineer as necessary to fit conditions. The total amount of aggregate per square yard, adjusted for specific gravity, shall not be varied but shall be as provided in the table.

MATERIALS

133-2.1 AGGREGATE.—The aggregate shall be crushed stone or crushed slag and shall meet the requirements for grading given in table 2, using A.A.S.H.O. Method T-27.

TABLE 2.—Requirements for grading of aggregates

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)			
	Coarse aggregate	Choker aggregate	Filler aggregate	Chips
2½-inch.....	100			
2-inch.....	90-100			
1½-inch.....	35- 70			
1-inch.....	0- 15			
¾-inch.....			100	
½-inch.....			90-100	
⅜-inch.....		100	20- 55	
⅜-inch.....		90-100	0- 15	100
No. 4.....		0- 20		35-100
No. 8.....		0- 5		0-

Crushed stone and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter, and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Aggregate shall be free from clay balls and adherent films of clay or rock dust and shall be washed thoroughly if produced from moist material. Aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water.

133-2.2 BITUMINOUS MATERIAL.—Emulsified asphalt, conforming to the requirements of A.A.S.H.O. Specification M-51, shall be furnished.

Application temperature shall be 60-120° F.

CONSTRUCTION METHODS

133-3.1 WEATHER AND SEASONAL LIMITATIONS.—Pavement shall be constructed only between May 1 and October 1, and application of bituminous material shall then be made only when the aggregate is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

133-3.2 EQUIPMENT.—The equipment used by the contractor shall include a power broom or a power blower, aggregate spreading equipment that can be so adjusted as to spread accurately the given amounts per square yard, a self-powered pressure bituminous material distributor, equipment for heating bituminous material, a pneumatic-tired motor grader having a wheelbase of not less than 15 feet, an approved drag at least 15 feet long, broom-dragging equipment, and powered rollers.

Rollers shall be of the self-powered 3-wheel type weighing not less than 10 tons each. A sufficient number of rollers shall be furnished on the work to provide one roller for each 25 tons of pavement aggregate laid per hour.

133-3.3 CONDITIONING OF EXISTING BASE COURSE AND SHOULDERS.—Immediately before spreading coarse aggregate, the base course upon which the pavement is to be constructed shall be swept thoroughly. In the case of a water-bound base course the sweeping shall be continued until the embedded larger aggregate is exposed to a depth of approximately one-fourth inch. While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

133-3.4 SPREADING AND ROLLING COARSE AGGREGATE.—Coarse aggregate shall be spread in the required amount from dump boards, by approved stone spreaders, or by other approved mechanical methods. It shall be spread to a uniform depth and true to alinement and profile grade. A testing template, cut to the crown of the finished pavement, shall be furnished by the contractor at his expense and used to obtain uniformity of crown. When required by the engineer, a drag at least 15 feet long shall be used after the spreading to level and improve the uniformity and regularity of the surface.

Any thin, flat, or oversized particles of aggregate that appear on the surface of spread material shall be removed. The coarse aggregate shall be uniformly distributed in respect to size. All patches or areas of fine or undersized material shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking wherever ordered and shall be continued after initial rolling until the appearance and texture are uniform and all ridges are removed.

The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed. Rolling shall progress gradually from the sides to the center, except that on superelevated curves the rolling may progress from the lower to the upper edge, parallel with the center line of the road and lapping uniformly each preceding rear-wheel track by one-half the width of such track and shall continue until the aggregate does not creep or wave ahead of the roller. At the edges, the outside rear wheel of the roller shall cover equal portions of the spread aggregate and the shoulder. The roller shall run forward and backward until the shoulder is firmly compacted against the edge of the pavement.

Material which crushes under the roller in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with suitable aggregate. Any irregularities greater than three-eighths of an inch, as determined by testing the surface with a 10-foot straightedge laid parallel to the center line of the pavement, shall be corrected by loosening and reshaping the aggregate and removing or adding aggregate as required, and by re-rolling such areas. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade.

Along curbs, headers, and walls, and at all places not accessible to the roller, the aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spreading that becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate, and rerolled.

133-3.5 SPREADING CHOKER AGGREGATE.—After the coarse aggregate has been spread and compacted, choker aggregate, in the amount of approximately 15 pounds per square yard, shall be spread evenly over the surface until the voids are filled to approximately one inch below the surface. Following spreading of the choker aggregate, the surface shall be lightly broomed and, if ordered by the engineer, lightly rolled.

After the coarse aggregate has been spread, rolled, and choked, and prior to the application of bituminous material, the engineer shall check the uniformity of depth of aggregate in place by means of as many test holes as he considers necessary. In general, series of 3 test holes each shall be dug at intervals of 200 feet, one test hole at the center and one near each edge or quarter point as the engineer may direct. Test holes shall be dug and refilled by the contractor under the supervision of the engineer and at the expense of the contractor.

133-3.6 FIRST APPLICATION OF BITUMINOUS MATERIAL.—The first application of bituminous material shall be to the coarse aggregate, spread, rolled, and choked as required above. The material shall be applied uniformly with the prescribed pressure distributor and in the amount per square yard determined by the engineer.

Bituminous material shall be so applied in this and subsequent applications that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper, and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be immediately removed and burned. Application temperatures of bituminous material shall be as provided in the specifications for the particular bituminous material being used. During all applications of bituminous material the surfaces of adjacent structures and trees shall be protected to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

133-3.7 FIRST SPREADING OF FILLER AGGREGATE.—After the application of emulsion described above has broken and attained sufficient tackiness, filler aggregate in an amount of approximately 15 pounds per square yard shall be spread evenly over the surface and broom dragged and rolled thoroughly. The adding of filler aggregate in small amounts shall be continued as may be required during the rolling until the coarse aggregate is filled and keyed firmly.

133-3.8 SECOND APPLICATION OF BITUMINOUS MATERIAL.—After the first spreading of filler aggregate has been rolled, and not less than 8 hours after the first application of emulsion, emulsion for the second application shall be applied uniformly in the amount per square yard determined by the engineer.

133-3.9 FIRST SPREADING OF CHIPS.—After the second application of emulsion has broken and attained sufficient tackiness, chips shall be spread evenly over the surface at the rate of approximately 10 pounds per square yard. A portion of the chips shall be reserved, if the engineer so directs, and then added as required while rolling and brooming are in progress. The spreading of chips shall be followed by broom dragging and thorough rolling of the surface, including shoulders. The time, extent, and manner of rolling shall be subject to direction by the engineer.

133-3.10 FIRST SEAL COAT.—Not less than 24 hours after the rolling of the first application of chips the surface shall be swept clean and emulsified asphalt shall be applied uniformly in the amount per square yard determined by the en-

gineer. As soon as the emulsion breaks it shall be covered evenly with filler aggregate spread in the approximate amount of 25 pounds per square yard. The filler aggregate shall be broom dragged and rolled as directed. If the filler aggregate shows excessive crushing under the roller, the engineer may order that this rolling be omitted.

133-3.11 SECOND SEAL COAT.—Before traffic is allowed over the first seal coat, a second seal coat shall be applied. Emulsion shall be applied uniformly in the amount determined by the engineer and covered immediately with chips spread evenly in the amount of approximately 15 pounds per square yard. The surface shall then be broom dragged and thoroughly rolled. The finished surface shall be uniform in texture.

While the surface is being compacted and finished, the contractor shall shape and finish the shoulders and gutters to conform to the section shown on the plans.

133-3.12 STOCKPILING.—Chips shall be stockpiled at the rate of 10 pounds per square yard of completed pavement at locations and in piles of such forms and amounts as the engineer may direct. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

133-4.1 The tonnage of aggregate to be paid for shall be the number of tons of coarse aggregate, choker aggregate, filler aggregate, and chips actually used in the accepted work or placed in authorized stockpiles.

133-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered for the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

133-5.1 The quantities of materials, determined as provided above, shall be paid for at the contract unit price per ton for "(Class E-2 Pavement, Type EM) Macadam Aggregate" and per gallon or per ton for "Emulsified Asphalt for Type EM," as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, manipulating, and placing all materials, for all shaping, compacting, rolling, and finishing, for reconditioning subgrade, shoulders and gutters, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 140.—CLASS F, TYPE F-1, DENSE GRADED PLANT-MIX SURFACE COURSE

DESCRIPTION

140-1.1 This item shall consist of a wearing course composed of aggregate and bituminous material mixed in a central plant, constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

When called for on the plans the item shall be constructed in 2 courses, a binder or leveling course and a wearing course, each of full width and of the weight per square yard required by the plans. The leveling or binder course shall be rolled and finished before the placement of the wearing course, in the manner hereinafter specified for the latter.

140-1.2 DETERMINATION OF PERCENTAGE OF BITUMINOUS MATERIAL.—The percentage of bituminous material, by weight, to be added to the aggregate shall be between 3½ and 7 percent of the weight of the dry aggregate. The exact percentage to be used shall be fixed by the engineer on the basis of preliminary laboratory tests and field sieve analyses of the aggregate furnished.

140-1.3 JOB GRADING AND ALLOWABLE TOLERANCES.—The bid schedule indicates the particular grading given in table 1 to which aggregate must conform. The grading of aggregate shall meet the further limitation that any one 8-hour "run" shall be held to such uniformity that percentages of material passing the Nos. 4, 10, and 200 sieves for any one sample shall not vary from the average of all samples for the "run" by more than the following tolerances:

<i>Material passing:</i>	<i>Percent</i>
No. 4 sieve.....	±5
No. 10 sieve.....	±5
No. 200 sieve.....	±2

MATERIALS

140-2.1 AGGREGATE.—Aggregate for all gradings, except E, E-1, and E-2 shall consist of coarse aggregate of crushed gravel or crushed stone, in either case composed of hard, durable pebbles or stone fragments, and a filler of finely crushed stone, sand, or other finely divided mineral matter. Aggregate for grading E, E-1, and E-2 shall consist of fine gravel and sand,

disintegrated granite, or other similar granular materials. The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as filler. The composite material shall meet the requirements for one of the gradings given in tables 1, 2, or 3, whichever is called for in the bid schedule, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of aggregate

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Grading A	Grading B	Grading C	Grading D	Grading E
1-inch.....	100	100	100	100	100
¾-inch.....	75-100	75-100	85-100	85-100	85-100
No. 4.....	30- 45	40- 60	45- 65	50- 70	60- 95
No. 10.....	20- 35	25- 45	30- 50	35- 55	45- 80
No. 200.....	2- 7	3- 8	5- 10	5- 12	5- 15

TABLE 2.—Requirements for grading of aggregate

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Grading A-1	Grading B-1	Grading C-1	Grading D-1	Grading E-1
¾-inch.....	100	100	100	100	100
No. 4.....	35- 50	45- 65	50- 70	55- 75	60- 95
No. 10.....	25- 40	30- 50	35- 55	40- 60	45- 80
No. 200.....	2- 7	3- 8	5- 10	5- 12	5- 15

TABLE 3.—Requirements for grading of aggregate

Sieve designation	Percentages by weight passing square mesh sieves (A.A.S.H.O. T-27)				
	Grading A-2	Grading B-2	Grading C-2	Grading D-2	Grading E-2
½-inch.....	100	100	100	100	100
No. 4.....	40- 55	50- 70	55- 75	60- 80	65-100
No. 10.....	30- 45	35- 55	40- 60	45- 65	50- 85
No. 200.....	2- 7	3- 8	5- 10	5- 12	5- 15

Aggregate shall be so graded within the limits given in tables 1, 2, and 3, that at least 10 percent of the total aggregate shall pass a No. 4 sieve and be retained on a No. 10 sieve. No intermediate sizes of aggregate shall be removed for use in the seal coat or for other purposes without the written consent of the engineer.

If crushed gravel is used, not less than 50 percent by weight of the coarse aggregate particles shall be particles having at least one fractured face.

Coarse aggregate shall have a percent of wear of not more than 50 at 500 revolutions, as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test), except that this requirement shall not apply to coarse aggregate for gradings E, E-1, and E-2.

For all gradings, that portion of the filler, including any blended filler, passing a No. 40 sieve shall have a plasticity index of not more than 6, as determined by A.A.S.H.O. Method T-91.

The composite aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter that will prevent thorough coating with bituminous material. The aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water. The bituminized aggregate shall have a swell of not more than 1.5 percent as determined by method 1 of A.A.S.H.O. Method T-101.

140-2.2 FILLER FOR BLENDING.—Additional filler for blending with aggregate at the mixing plant, if needed, shall be obtained from sources approved by the engineer. The material for such purpose shall be free from lumps, and shall not contain more than 15 percent of material retained on a No. 4 sieve.

140-2.3 BITUMINOUS MATERIALS.—One of the following materials, whichever is called for in the bid schedule, shall be furnished. The grade shall be as called for in the bid schedule, provided, however, that when not so called for the grade used shall be one of the following selected by the engineer.

Rapid-curing cut-back asphalt shall be grade RC-3, RC-4, or RC-5 conforming to the requirements of table 3, subsection 113-2.3.

Medium-curing cut-back asphalt shall be grade MC-4 or MC-5 conforming to the requirements of table 4 below for the grade required, save that if the penetration of the residue from distillation at 680° F., is more than 200, and its ductility at 77° F., is less than 100, the material will be acceptable if its ductility at 60° F., is greater than 100 centimeters.

90+ asphaltic material shall meet the requirements of table 4, subsection 113-2.3. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent +, and proportion of bitumen soluble in carbon tetrachloride is 99.65 percent +.

Asphalt shall be grade 85-100, 100-120, 120-150, or 150-200 conforming to A.A.S.H.O. Specifications M-20, M-22, or M-23, save that the penetrations shall be 85-100, 100-120, 120-150, or 150-200. No mineral matter other than that naturally contained in the asphalt shall be present.

TABLE 4.—Requirements for medium-curing cut-back asphalt material

	A.A.S.H.O. test method	Grades			
		MC-4		MC-5	
		Min.	Max.	Min.	Max.
Water, percent.....			0		0
Flash pt., Cleve., ° F.....	T-48.....	150		150	
Furol vis., at 180° F.....	T-72.....	125	250	300	600
Partial distillates (Ratio to distillate to 680° F.):					
To 500° F.....	T-78.....	{ 40	30	{ 20	75
To 600° F.....			80		
Residue from distillation to 680° F:					
Vol., percent of sample by difference.....		78		82	
Pene.....	T-49.....	120	300	120	300
Duct. cm.....	T-51.....	100		100	
Percent sol. in CCl ₄	T-44.....	99.5		99.5	

CONSTRUCTION METHODS

140-3.1 WEATHER AND SEASONAL LIMITATIONS.—

Surface course shall be constructed only between May 1 and October 1 and operations shall be carried on only when the surface is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

140-3.2 EQUIPMENT.—(a) *Mixing Plant.*—The plant shall have storage bins, protected from the weather, of sufficient capacity to furnish the necessary amount of all aggregates when operating at the maximum rated capacity of the plant, with no periods of undue waiting for material. The bins shall be divided into at least two compartments so proportioned as to insure adequate storage of appropriate fractions of the aggregate. Each compartment shall be provided with an overflow pipe that shall be of such size and at such location as to prevent any backing up of material into other compartments.

The plant shall contain a drier suitably designed to heat and dry the aggregate to specification requirements and to agitate it continuously during heating. The drier shall be capable of preparing aggregates at a rate equal to the full rated capacity of the plant. The mixer shall be of adequate capacity, preferably a pugmill type. Accurate thermometers shall be furnished, suitable for determining the temperature of the mix.

The plant shall be provided with weighing, volumetric or other gaging equipment of sufficient and satisfactory capacity. The equipment shall be constructed with devices that will permit easy readjustment of any working part thereof that gets out of adjustment and make the equipment function properly and accurately. Where the bituminous material is weighed, scales for weighing shall be attached to the bucket. All weighing equipment shall be sealed as often as the engineer may deem it necessary to insure accuracy.

Equipment for heating bituminous material shall consist of a retort or steam coils so designed that steam will not be introduced into the material.

(b) *Placing Equipment.*—Equipment for spreading mixtures containing cut-back asphalt shall consist of approved adjustable type spreader boxes or similar equipment. Blade graders of the self-powered type, with blades not less than 10 feet long, wheelbases of not less than 15 feet, weights of not less than 3 tons each, and equipped with pneumatic tires, shall be used for laying, shaping, and finishing mixtures containing cut-back asphalt.

When the specified bituminous material is 90+ asphaltic material or asphalt, grade (85-200), equipment for spreading, shaping, and finishing shall consist of an approved self-contained power machine operating in such manner that no supplemental spreading, shaping, or finishing will be required to provide a surface which will comply with the requirements for smoothness contained herein. This self-contained power machine may be used, at the option of the contractor, when the specified bituminous material is rapid-curing cut-back asphalt, but shall not be used when medium-curing cut-back asphalt is specified.

Rollers for compacting the surface shall be of the self-powered tandem type weighing not less than 8 tons each.

140-3.3 PREPARATION OF AGGREGATE.—If the moisture content of the aggregate is more than 1 percent of the dry weight of aggregate, the aggregate shall be dried before being conveyed to the plant bins for proportioning. The aggregate shall be screened into at least two fractions and conveyed into separate compartments ready for proportioning and mixing.

Additional filler, if required to meet the grading requirements, shall be proportioned and blended with the mineral aggregate before being screened into the separate compartments. Filler may be added to the aggregate at the mixing plant by premixing it thoroughly with the other fine aggregates or by feeding it into either the hot or cold elevator. Spreading filler over the tops of the aggregate pits or dumping it into the hoppers at crushing plants will not be permitted.

140-3.4 PREPARATION OF BITUMINOUS MIXTURE.—Before being delivered to the road, the aggregate shall be mixed with the bituminous material at a central mixing plant.

The dry aggregates, prepared as prescribed above, shall be combined in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading. Where a batching plant is used, the engineer shall determine the quantity of bituminous material for each batch. In any case, the bituminous material shall be measured or gaged and introduced into the mixer in the proportionate amount determined by the engineer and at the temperature prescribed by the engineer for the particular material being used. When the bituminous material being used is 90+ asphaltic material or asphalt, grade (85-200), aggregate shall be introduced into the mixer at a temperature between 250° F. and 325° F. In no case shall aggregate be introduced into the mixer at a temperature of more than 25° F. above the temperature of the bituminous material. The mixing shall continue for at least 30 seconds, and for such longer period as may be necessary to coat all the particles.

140-3.5 TRANSPORTATION AND DELIVERY OF MIXTURE.—The mixture shall be transported from the mixing plant to the point of use in pneumatic-tired vehicles having tight bodies previously cleaned of all foreign materials. When directed by the engineer, each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from the weather.

When 90+ asphaltic material is used, the plant mixture shall be delivered on the road at a temperature of not less than 235° F., and when asphalt, grade (85-200), is used the mixture shall be delivered on the road at a temperature of not less than 260° F. When the mixture is being placed during warm weather and the engineer has determined that satisfactory results can be obtained at lower temperatures, he may direct that the mixture be mixed and delivered at lower temperatures than those specified above.

140-3.6 SPREADING, LAYING, COMPACTING, AND FINISHING.—(a) *Preparation for Placing.*—Immediately before placing the bituminous mixture, the existing surface shall be cleaned of loose or deleterious material by sweeping with a power broom, supplemented by hand brooming if necessary.

Placing shall commence at the point or points furthest from the mixing plant, and progress continuously toward the plant, unless otherwise ordered by the engineer. Hauling over material already placed will not be permitted until the material has been compacted thoroughly in the manner specified.

(b) *Spreading and Blade Finishing.*—Unless a self-contained power spreading and finishing machine is used, bituminous mixture shall be deposited, by the spreading equipment specified, on one side of the roadbed and to a uniform depth sufficient to obtain the required thickness of wearing course over the full width that the course will have when compacted. The material shall then be formed into a uniform windrow. Before the

mixture is spread, the engineer shall test the windrow for moisture. If the moisture content of the mixture is more than 1½ percent of the dry weight of aggregate, the contractor shall blade and reblade the material and allow it to dry out. If necessary, the material shall be harrowed or disked and all compressed masses of material broken up. No spreading shall be done when the base to be covered is wet or prior to authorization by the engineer.

At the end of each day's work, or when work is interrupted by weather conditions, all mixture not completely spread shall be bladed into a windrow. It shall not be allowed to remain partially spread on the roadway over night or until the resumption of work. When bituminous mixture containing rapid-curing cut-back asphalt is being laid with a blade grader, care shall be taken that the laying is completed before the mixture hardens.

The mixed material shall be spread from the windrow to the required width by the self-powered, pneumatic-tired blade grader specified. It shall be spread in successive, uniform layers. After approximately one-half of the material has been laid, the remaining material shall be windrowed and that already laid shall be rolled once and then planed with the blade grader to remove inequalities. The remaining material shall then be spread. During compaction, the surface shall be dragged or bladed as necessary to fill any ruts and to remove incipient corrugations, waves, or other irregularities. The intervals between placing successive layers shall be as directed by the engineer. In spreading from the windrow, care shall be taken to prevent cutting into the underlying course. If necessary to prevent such cutting, a layer of the mixture approximately one-half inch thick shall be left at the bottom of the windrow.

(c) *Machine Spreading and Finishing.*—When the self-contained power-machine is used, placing and compaction of the bituminous mixture shall progress in sections of not more than 1 mile in length. The bituminous mixture shall be spread, shaped, and finished with the power-machine specified. The mixture shall be placed one-half width at a time. The 6-inch strip of the first half-width adjacent to the center line of the road shall not be rolled until the second half-width has been placed. After the first width has been compacted, the second width shall be placed, finished, and compacted as provided for the first width except that rolling shall be extended to include the 6 inches of the first width not previously compacted. Where machine spreading in two layers is indicated on the plans, the procedure herein described under (c), shall apply similarly to each layer.

(d) *Rolling Finished Surface.*—After all layers have been placed to full width, the wearing surface shall be rerolled. Rolling shall be longitudinal and shall commence at the outer edges of

the road, overlapping the shoulders, and progress toward the center, except that on superelevated curves, rolling may progress from the lower to the upper edge. Blading shall continue during the rolling only if so directed by the engineer. Rolling shall continue until the surface is of uniform texture and degree of compaction and is true to grade and cross section. Under no circumstances shall the center of the surface course be rolled first.

(c) *Shaping Edges*.—While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

140-3.7 SEAL COAT.—If shown on the plans and called for in the bid schedule, a seal coat of the type called for shall be applied to the finished plant-mix surface, as described under CLASS A SEAL COATS. In such event, the surface shall be open to traffic for at least 2 weeks before the seal coat is applied.

140-3.8 STOCKPILING.—When indicated on the plans, bituminous mixture containing medium-curing cut-back asphalt shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the engineer. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

140-4.1 The tonnage to be paid for shall be the number of tons of bituminous mixture of the grading called for in the bid schedule and used in the accepted work, including mixture placed in authorized stockpiles. The bituminous treated material shall be weighed after mixing and no deduction shall be made for the weight of bituminous material in the mixture.

140-4.2 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

140-5.1 The quantities of surfacing mixture and bituminous material, determined as provided in 4.1 and 4.2 above, shall be paid for at the contract unit price per ton for "(Class F Pavement, Type F-1) Plant Mixture, Grading ()," and per gallon or per ton for "Medium-Curing Cut-back Asphalt, Grade (), for Type F-1," "Rapid-Curing Cut-back Asphalt, Grade (), for Type F-1," "90+ Asphaltic Material for Type F-1," or "Asphalt, Grade (), for Type F-1," as the case may be, which prices and payments shall constitute full compensation for

furnishing, handling, mixing, manipulating, and placing all materials, for all shaping, compacting, rolling, and finishing, for reconditioning subgrade, shoulders and gutters, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item, excepting that any required seal coat shall be paid for as provided for under CLASS A SEAL COATS.

ITEM 141.—CLASS F, TYPE F-2, OPEN GRADED PLANT-MIX SURFACE COURSE

DESCRIPTION

141-1.1 This item shall consist of a wearing course composed of a primary course of open-graded aggregate and bituminous material mixed in a central plant, an application of choker aggregate, and a seal coat, constructed on the prepared base in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

141-1.2 QUANTITIES OF MATERIALS PER SQUARE YARD.—The approximate amounts of materials per square yard of open-graded plant-mix surface course (identified by designation 150-B or 200-C) and the sequence of placing operations shall be as follows:

Plant-mixed aggregate-----	150 pounds for designation 150-B, and 200 pounds for designation 200-C plus weight of bituminous material.
Choker aggregate-----	5 pounds.
Bituminous material (choker)-----	0.10 gallon.
Choker aggregate-----	5 to 10 pounds.
Bituminous material (seal coat)-----	0.16 to 0.33 gallon.
Cover aggregate (seal coat)-----	10 to 20 pounds.

The weights given above are those of aggregates having a bulk specific gravity of 2.65, as determined by A.A.S.H.O. Method T-85. Proportionate corrections shall be made when the aggregate furnished on the job (job aggregate) have bulk specific gravities above 2.75 or below 2.55. In such case the corrected amount shall be the product of the number of pounds shown above multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

The amount of bituminous material to be added to the plant-mix aggregate shall be set by the engineer and shall be between 3.0 percent and 5.0 percent, by weight, of the aggregate. The minimum amount of bituminous material used shall be within the above limits and shall be such that the amount of bitumen in the asphaltic or tar residue left on the stone will not be less than 2.75 percent, by weight, of the aggregate.

MATERIALS

141-2.1 AGGREGATE.—Aggregate shall be crushed gravel, crushed stone, or crushed slag and shall meet the requirements for grading given in table 1, using A.A.S.H.O. Methods T-11 and T-27.

TABLE 1.—Requirements for grading of aggregates

Sieve designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)		
	Primary course plant-mix aggregate	Choker aggregate	Seal coat cover aggregate
1-inch-----	100	-----	-----
¾-inch-----	90-100	-----	-----
¾-inch-----	20- 55	-----	100
No. 4-----	0- 10	100	75-100
No. 8-----	0- 5	85-100	0- 10
No. 200-----	0- 2	-----	0- 2

Crushed gravel, crushed stone, and crushed slag shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter, and shall have a percent of wear of not more than 40 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed slag shall be air-cooled blast furnace slag, reasonably uniform in density and quality, free from glassy pieces, and shall weigh not less than 70 pounds per cubic foot.

Crushed gravel shall consist of the product obtained by crushing and screening gravel that has first been screened in such manner that not less than 90 percent of the material for crushing, when tested by laboratory methods, is retained on a sieve having 1½ inch square openings.

Aggregate shall be free from clay balls and adherent films of clay or other matter that will prevent a thorough coating of the particles with the bituminous material. Aggregate shall be of such nature that a thorough coating of the bituminous material to be used in the work applied to it will not slough off upon contact with water.

Choker aggregate shall consist of a crushed product and shall be produced during the crushing and screening of the aggregate for plant mix and seal coat.

141-2.2 BITUMINOUS MATERIALS.—(a) One of the following materials, whichever is called for in the bid schedule, shall be furnished.

Rapid-curing cut-back asphalt meeting the requirements of table 3, subsection 113-2.3.

Emulsified asphalt conforming to A.A.S.H.O. Specification M-47.

90+ asphaltic material meeting the requirements of table 4, subsection 113-2.3. If the material fails to meet the requirements for solubility, it will be acceptable if its solubility in carbon disulphide is 99 percent +, proportion of bitumen soluble in carbon tetrachloride is 99.65 percent +.

Asphalt shall be grade 150-200 conforming to A.A.S.H.O. Specifications M-20 or M-23, save that the penetration shall be 150 to 200. No mineral matter other than that naturally contained in the asphalt shall be present.

Tar conforming to A.A.S.H.O. Specification M-52.

(b) The grade of asphalt shall be RC-3, RC-4, or RC-5, and the grade of tar shall be RT-7, RT-8 or RT-9, whichever is called for in the bid schedule, provided, however, that when the grade is not so fixed, one of the above grades shall be selected by the engineer.

CONSTRUCTION METHODS

141-3.1 WEATHER AND SEASONAL LIMITATIONS.—

Surface course shall be constructed only between May 1 and October 1, and operations shall be carried on only when the surface is dry, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature and seasonal requirements may be waived, but only when so directed by the engineer.

141-3.2 EQUIPMENT.—(a) *Mixing Plant.*—The plant shall have storage bins, protected from the weather, of sufficient capacity to furnish the necessary amount of all aggregates when operating at the maximum rated capacity of the plant, with no periods of undue waiting for material. The bins shall be divided into at least two compartments so proportioned as to insure adequate storage of appropriate fractions of the aggregate. Each compartment shall be provided with an overflow pipe that shall be of such size and at such location as to prevent any backing up of material into other compartments.

The plant shall contain a drier suitably designed to heat and dry the aggregate to specification requirements and to agitate it continuously during heating. The drier shall be capable of preparing aggregates at a rate equal to the full rated capacity of the plant. The mixer shall be of adequate capacity, preferably a pugmill type. Accurate thermometers shall be furnished, suitable for determining the temperature of the mix.

The plant shall be provided with weighing, volumetric or other gaging equipment of sufficient and satisfactory capacity. The equipment shall be constructed with devices that will permit easy readjustment of any working part thereof that gets out of adjustment and make the equipment function properly and

accurately. Where the bituminous material is weighed, scales for weighing shall be attached to the bucket. All weighing equipment shall be sealed as often as the engineer may deem it necessary to insure accuracy.

(b) *Placing Equipment.*—Equipment for spreading, shaping, and finishing the bituminous mixture shall consist of an approved self-contained power machine, operating in such manner that after choking and rolling, no supplemental spreading will be required to provide a surface which will comply with the requirements for smoothness contained herein.

Rollers shall be of the self-powered tandem type weighing not less than 8 tons each.

A power broom, broom-dragging equipment, and aggregate spreading equipment for the cover aggregate shall be furnished. The aggregate spreading equipment shall be adjustable so that it will spread accurately the given amounts per square yard.

141-3.3 PREPARATION OF AGGREGATE.—If the moisture content of the aggregate is more than 1 percent of the dry weight of aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be dried before being conveyed to the plant bins for proportioning. The aggregate shall be screened into at least two fractions and conveyed into separate compartments ready for proportioning and mixing.

141-3.4 PREPARATION OF BITUMINOUS MIXTURE.—Before being delivered to the road, the plant-mix aggregate shall be mixed with the bituminous material at a central mixing plant.

The dry plant-mix aggregates, prepared as prescribed above, shall be combined in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading. Where a batching plant is used, the engineer shall determine the quantity of bituminous material for each batch. In any case, the bituminous material shall be measured or gaged and introduced into the mixer in the proportionate amount determined by the engineer and at the temperature prescribed by the engineer for the particular material being used. When the bituminous material being used is 90+ asphaltic material or asphalt, grade (150-200), aggregate shall be introduced into the mixer at a temperature between 250° F. and 325° F. In no case shall aggregate be introduced into the mixer at a temperature of more than 25° F. above the temperature of the bituminous material. The mixing shall continue for at least 30 seconds, and for such longer period as may be necessary to coat all the particles completely.

141-3.5 TRANSPORTATION AND DELIVERY OF MIXTURE.—The mixture shall be transported from the mixing plant to the point of use in pneumatic-tired vehicles having tight bodies previously cleaned of all foreign materials. When

directed by the engineer, each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from the weather.

When 90+ asphaltic material is used, the plant mixture shall be delivered on the road at a temperature of not less than 235° F., and when asphalt, grade (150-200), is used the mixture shall be delivered on the road at a temperature of not less than 260° F.

When the mixture is being placed during warm weather and the engineer has determined that satisfactory results can be obtained at lower temperatures, he may direct that the mixture be mixed and delivered at lower temperatures than those specified above.

141-3.6 PLACING AND COMPACTING BITUMINOUS MIXTURE.—Immediately before the placing of the bituminous mixture, the existing surface shall be cleaned of loose or deleterious material by sweeping with a power broom, supplemented by hand brooming if necessary.

The placing and compacting of the bituminous mixture shall progress in sections of not more than 1 mile in length. Placing and compacting shall commence at the point or points furthest from the mixing plant, and progress continuously toward the plant, unless otherwise ordered by the engineer. Hauling over material already placed will not be permitted until choker aggregate has been applied and the material has been compacted thoroughly in the manner specified.

The bituminous mixture shall be spread, shaped, and finished with the self-contained power machine specified. The mixture shall be placed one-half width at a time. The 6-inch strip of the first half-width adjacent to the center line of the road shall not be rolled until the second half-width has been placed. After the first width has been completed, the second width shall be placed, finished, and compacted as provided for the first width except that rolling shall be extended to include the 6 inches of the first width not previously compacted.

Care shall be taken at all times to prevent segregation in the mixture of areas of fine and coarse material and any portions where such segregation occurs shall be removed and replaced by the contractor.

After the bituminous mixture has been spread and finished it shall be initially rolled without appreciable overlap.

141-3.7 PLACING CHOKER.—After initial rolling and before the mixture has set, choker aggregate shall be spread uniformly at a rate of approximately 5 pounds per square yard. The surface shall be hand broomed, or broom dragged, or both, until surface voids are filled uniformly. Bituminous material shall then be applied at a rate of approximately 0.1 gallon per square yard and additional choker aggregate spread uniformly at a rate of from 5 to 10 pounds per square yard,

after which the surface shall be alternately broomed and rolled until the plant-mixed aggregate and the choker aggregate are thoroughly bonded. Any excess choker aggregate shall then be removed and the surface again rolled until hard and compact. Exact rates of application of bituminous material and choker aggregate shall be as ordered by the engineer. The moisture content of choker aggregate shall not be more than 3 percent of the dry weight of aggregate.

141-3.8 ROLLING FINISHED SURFACE.—Rolling of the choked surface shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center of the road overlapping each preceding passage by an amount not less than one-third the width of the roller, except that on superelevated curves, rolling may progress from the lower to the upper edge. Under no circumstances shall the center of the surface course be rolled first.

141-3.9 SHAPING EDGES.—While the surface is being compacted and finished, the contractor shall trim the edges neatly to line.

141-3.10 SEAL COAT.—(a) *Preparation of Surface.*—The plant-mixed surface course shall be open to traffic for at least 2 weeks before the seal coat is applied. Immediately before the placing of the seal coat, the surface shall be cleaned of loose or deleterious material, by sweeping with a power broom, supplemented by hand brooming if necessary.

(b) *Application of Bituminous Material.*—Bituminous material shall be so applied that uniform distribution is obtained at all points. Unless the distributor is so equipped as to obtain this result at the junctions of applications, building paper shall be spread on the surface for a sufficient distance back from the end of each application so that flow through sprays may be started and stopped on the paper and so that all sprays will operate properly on the entire length being treated. Building paper so used shall be removed immediately and burned. Application temperatures shall be as provided in the specifications for the particular bituminous material being used. During all applications the surfaces of adjacent structures and trees shall be protected in such manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

(c) *Spreading Cover, Brooming, and Rolling.*—Spreading of cover aggregate shall immediately follow application of bituminous material. Initial spreading shall be done with the aggregate spreading equipment specified. Trucks spreading aggregate shall be operated backward so that bituminous material will be covered before truck wheels pass over it. Supplemental spreading and smoothing shall be done with a broom drag and by hand methods where necessary.

The surface shall be alternately broom dragged and rolled until the cover aggregate is uniformly and thoroughly bonded over the full width.

141-3.11 STOCKPILING.—Cover aggregate shall be stockpiled at the rate of 15 tons per mile at locations and in piles of such forms and amounts as the engineer may direct. Stockpile sites shall be cleared, cleaned, and leveled by the contractor.

METHOD OF MEASUREMENT

141-3.11 STOCKPILING.—Cover aggregate shall be stockpiled of tons of bituminous mixture used in the accepted work. The bituminous treated material shall be weighed after mixing and no deduction shall be made for the weight of bituminous material in the mixture.

141-4.2 The tonnage to be paid for shall be the number of tons of choker and cover aggregate used in the accepted work, including cover aggregate placed in authorized stockpiles.

141-4.3 The unit of measurement for bituminous material shall be the gallon or the ton, whichever is called for in the bid schedule. The gallonage or tonnage to be paid for shall be the number of gallons or tons of bituminous material used as ordered in the accepted work. Gallonage shall be determined by measuring the material at a temperature of 60° F., or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with A.S.T.M. Designation D 206-36.

BASIS OF PAYMENT

141-5.1 The quantities of surfacing mixture and of materials, determined as provided in 4.1, 4.2, and 4.3 above, shall be paid for at the contract unit price per ton for "(Class F Pavement, Type F-2) Plant Mixture," "(Class F Pavement, Type F-2) Choker Aggregate" and "(Class F Pavement, Type F-2) Cover Aggregate," and per gallon or per ton for "Rapid-Curing Cut-back Asphalt, Grade (), for Type F-2," "90+ Asphaltic Material for Type F-2," "Asphalt, Grade (150-200), for Type F-2," "Emulsified Asphalt for Type F-2," or "Tar, Grade (), for Type F-2," as the case may be, which prices and payments shall constitute full compensation for furnishing, handling, mixing, manipulating, and placing all materials, for all shaping, compacting, rolling, and finishing, for reconditioning subgrade, shoulders, and gutters, for cleaning up pits and quarries, for clearing, cleaning, and leveling stockpile sites, for furnishing and sealing of scales, for furnishing the weigh house, for facilitating and controlling traffic, and for all labor, equipment, tools, and incidentals necessary to complete the item.

STRUCTURES

ITEM 200.—CONCRETE AND STONE MASONRY BRIDGES

DESCRIPTION

200-1.1 This item shall consist of concrete, concrete and stone, and stone masonry bridges, and the concrete and masonry portions of steel, timber, log, and composite bridges, constructed in conformity with the lines, grades, and dimensions shown on the plans or ordered in writing by the engineer, and in accordance with this and other specification items involved.

MATERIALS

200-2.1 The materials to be furnished and used shall be those prescribed under the several items involved.

CONSTRUCTION METHODS

200-3.1 FOUNDATIONS.—All foundations shall be prepared as specified under UNCLASSIFIED EXCAVATION FOR STRUCTURES, and concrete or other masonry shall not be placed until the foundation area upon which it is to rest has been inspected and approved by the engineer. All foundations shall be poured in the "dry," except as provided under UNCLASSIFIED EXCAVATION FOR STRUCTURES AND CONCRETE. Cofferdams shall be furnished and prepared as provided under UNCLASSIFIED EXCAVATION FOR STRUCTURES.

200-3.2 PLACING ANCHOR BOLTS.—All necessary anchor bolts in piers, abutments, or pedestals shall be accurately set either in the concrete masonry as it is being placed or in holes formed while the concrete is being placed or in holes drilled after the concrete has set. If set in the masonry as it is being placed, a bolt shall be placed in a section of standard black pipe, at least 2 inches larger in diameter than the bolt, and shall be anchored by passing it through a heavy steel washer at the bottom of the pipe. Holes may be formed by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves, or other approved devices and withdrawing them after the concrete has partially set. Holes so formed shall be at least 4 inches in diameter. If drilled, holes shall be at least 1 inch larger in diameter than the bolts used. Bolts shall be set accurately and fixed with grout completely filling the holes. The

grout shall consist of one part portland cement to one part fine grained sand.

Unless otherwise stipulated on the plans, holes for anchor bolts shall be prepared and bridge seats finished to exact grade when the concrete is placed, ready for later setting of the anchor bolts and steel when the superstructure is being erected.

Anchor bolts used in connection with expansion shoes, rollers, and rockers shall be located with due regard to the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of the span shall be adjusted to permit free movement of the span.

200-3.3 SETTING SHOES AND BEARING PLATES.—Bridge seat bearing areas shall preferably be finished high and rubbed to grade. Shoes and bearing plates shall be set as provided under STEEL BRIDGES.

200-3.4 LOADING PIERS AND ABUTMENTS.—No superstructure load shall be placed upon finished bents, piers, or abutments until the engineer so directs, but the minimum time allowed for the hardening of concrete in the substructure before any load of the superstructure is placed thereon shall be 7 days when portland cement is used and 2 days when high-early-strength cement is used.

200-3.5 CONCRETE COLUMNS.—Concrete in columns shall be placed in one continuous operation unless otherwise ordered by the engineer. The concrete shall be allowed to set at least 12 hours before caps are placed.

200-3.6 CONCRETE SLAB AND GIRDER SPANS.—Slabs and girders having spans of 30 feet or less shall be poured in one continuous operation.

Girders spanning more than 30 feet may be poured in two operations, the first operation being the pouring of the girder stems to the bottom of the slab haunches. Shear keys shall be provided for by inserting oiled timber blocks to a depth of at least 1½ inches in the fresh concrete at the top of each girder stem. Sufficient blocks shall be used to cover uniformly about one-half the top surface of the girder stem and the blocks shall be removed as soon as the concrete has set sufficiently to retain its shape. The period between the first or girder pour and the second or slab pour shall be at least 24 hours. Immediately before the second pouring, the contractor shall check all falsework for shrinkage and settlement and shall tighten all wedges to insure minimum deflection of the stems due to the added weight of the slab.

Concrete in girder haunches less than 3 feet in height shall be placed at the same time as that in the girder stem. Whenever any haunch or fillet has a vertical height of 3 feet or more, the abutment or columns, the haunch, and the girder shall be placed in 3 successive stages; first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

The under surface of cantilever brackets and overhanging slabs shall be provided with a V-groove ½ inch in depth at a point not more than 6 inches from the outside face for the purpose of arresting the flow of mixture.

200-3.7 ARCHES.—Arch centering shall be constructed in accordance with plans approved by the engineer. Suitable wedges shall be provided for raising or lowering the forms to exact elevation and for taking up any settlement occurring during loading. Centering shall be lowered gradually and symmetrically so as to avoid overstresses in the arch.

When directed, centering shall be placed upon approved jacks in order to take up and correct any slight settlement which may occur after the placing of masonry has begun. In general, centering shall be struck and the arch made self-supporting before the railing or coping is placed. For filled spandrel arches such portions of the spandrel walls shall be left for construction subsequent to the striking of centers as may be necessary to avoid jamming of the expansion joints.

For filled spandrel arches the filling shall be carefully placed in such manner as to load the ring uniformly and symmetrically. The filling material shall be acceptable to the engineer and shall be placed in horizontal layers, carefully tamped, and brought up simultaneously from both haunches. Wedge shaped sections of filling material against spandrels, wings or abutments will not be permitted.

Concrete in arch rings and ribs shall be placed in the order shown on the plans. Generally, keys shall be placed at laps in reinforcing steel.

When permitted by the engineer, arch rings may be cast in a single continuous operation.

Masonry arches shall be constructed in accordance with the requirements for masonry of the class called for in the bid schedule. The masonry shall be built up symmetrically with reference to the crown.

Backfilling for spandrel-filled arches shall be placed symmetrically with reference to the crown and as provided under BACKFILL FOR STRUCTURES OTHER THAN PIPE CULVERTS.

200-3.8 CONCRETE SUBFLOOR OR WEARING SURFACE.—Concrete subfloor or wearing surface shall be as called for on the plans.

On steel truss spans, the concrete shall be placed symmetrically about the center line of the span beginning at the center and working simultaneously toward each end or beginning at the ends and working simultaneously toward the center.

200-3.9 CONCRETE RAILINGS AND PARAPETS.—In no case shall concrete railings be placed until the centering or false work for the span has been released. Special care shall be exercised to obtain smooth and tight-fitting forms which can be held rigidly to line and grade and can be removed

without injury to the concrete. All moldings, panel work, and bevel strips shall be constructed, according to the detail plans, with neatly mitered joints. All corners in the finished work shall be true, sharp, and clean-cut and shall be free from cracks, spalls, or other defects.

Precast railing members shall be cast in mortar-tight forms. The precast members shall be removed from the molds as soon as the concrete is sufficiently hard and shall then be kept covered with burlap saturated with water, or tarpaulin, for at least 3 days. After this treatment the curing shall be completed by immersion in water or by spraying not less than twice a day for a period of not less than 7 days.

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

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

200-3.10 EXPANSION JOINTS.—Expansion joints shall be so constructed as to permit freedom of movement. After all other work is completed, all loose or thin shells of mortar likely to spall under movement shall be carefully removed from all expansion joints by the use of a sharp chisel.

200-3.11 WATERPROOFING AND DAMP-PROOFING.—Where indicated on the plans, waterproofing shall be placed as provided under **WATERPROOFING**, and damp-proofing shall be placed as provided under **DAMP-PROOFING**.

200-3.12 CLEANING-UP.—Upon completion and before final acceptance, the contractor shall remove all false work, false-work piling down to 2 feet below the finished ground line, excavated or useless materials, rubbish and temporary buildings. He shall replace or renew any fences damaged and restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the engineer. All excavated material or false work placed in the stream channel during construction shall be removed by the contractor before final acceptance.

METHOD OF MEASUREMENT

200-4.1 The quantities of concrete and other contract pay items which constitute the completed and accepted structure shall be measured for payment in the manner prescribed in the several items involved.

BASIS OF PAYMENT

200-5.1 The quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items, which prices and payments shall be full compensation for furnishing and placing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item. Such payment shall constitute full payment for the completed structure, ready for use, and no additional allowance shall be made for cofferdam construction, falsework, form lumber, or other erection expenses.

ITEM 201.—STEEL BRIDGES**DESCRIPTION**

201-1.1 This item shall consist of steel bridges, including but not limited to superstructures to be placed on concrete, masonry, steel, or timber substructures, constructed in conformity with the lines, grades, and dimensions shown on the plans or ordered in writing by the engineer, and in accordance with this and other specification items involved.

MATERIALS

201-2.1 The materials to be furnished and used shall be those prescribed under the several items involved.

CONSTRUCTION METHODS

201-3.1 The construction methods used shall be those prescribed under the several items required for the structure and in particular shall conform to the requirements for fabrication and erection, as prescribed under **STRUCTURAL STEEL**.

201-3.2 ERECTION OF STRUCTURE.—The contractor shall provide the false work and all tools, machinery, and appliances, including driftpins and fitting-up bolts, necessary for the expeditious handling of the work, and shall erect the metalwork, remove the temporary construction, and do all work necessary to complete the bridge or bridges as required by the contract and in accordance with the plans and these specifications.

If stipulated in the contract, the contractor shall dismantle the old structure on the bridge site. Unless otherwise provided, the old structure shall remain the property of the Government. If the old structure is to be reerected, it shall be dismantled without unnecessary damage and the parts match marked and carefully piled where directed. If the old structure is not to be reerected, it shall be disposed of by the contractor in the immediate vicinity of the bridge site and where the engineer may direct.

Before starting work, the contractor shall submit for the approval of the engineer, full information on the method of erection, the amount and character of equipment he proposes to use, and, if required, plans for false work or for changes in an existing structure necessary for maintaining traffic. Approval of the contractor's plans shall not be considered as relieving the contractor of the responsibility for the safety of

his methods or equipment, or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the engineer's approval.

201-3.3 PLACING ANCHOR BOLTS.—Anchor bolts shall be placed as provided under **CONCRETE AND STONE MASONRY BRIDGES**.

201-3.4 SETTING SHOES AND BEARINGS.—Shoes and bearing plates shall not be placed on bridge seat bearing areas that are improperly finished, that are deformed or irregular. They shall be set level in exact position and shall have full and even bearing. The shoes and bearing plates may be set by either of the following methods:

(a) The bridge seat bearing area shall be heavily coated with red-lead paint and then covered with three layers of 12- to 14-ounce duck, each layer being coated thoroughly on its top surface with red-lead paint. The shoes and bearing plates shall be placed in position while the paint is plastic.

(b) The shoes and bearing plates shall be properly supported and fixed with grout. No load shall be placed on them until the grout has set for at least 96 hours, adequate provision being made to keep the grout well moistened during this period. The grout shall consist of one part portland cement to one part of fine-grained sand.

201-3.5 CLEANING-UP.—Upon completion and before final acceptance, the contractor shall remove all false work, false-work piling down to 2 feet below the finished ground line, excavated or useless materials, rubbish, and temporary buildings. He shall replace or renew any fences damaged and restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the engineer. All excavated material or false work placed in the stream channel during construction shall be removed by the contractor before final acceptance.

METHOD OF MEASUREMENT

201-4.1 The quantities of structural steel and other contract pay items which constitute the completed and accepted structure shall be measured for payment in the manner prescribed in the several items involved.

BASIS OF PAYMENT

201-5.1 The quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items which prices and payments shall be full compensation for furnishing, preparing, fabricating, transporting, placing, and erecting all structural steel and all other materials for the

complete structure; for all shop work, painting, and field work; for all labor, equipment, tools, and incidentals necessary to complete the item. Such payment shall constitute full payment for the completed structure ready for use, and no allowance shall be made for cofferdam construction, false work, or other erection expenses.

ITEM 202.—TIMBER BRIDGES

DESCRIPTION

202-1.1 This item shall consist of timber bridges (except log bridges), constructed in conformity with the lines, grades, and dimensions shown on the plans or ordered in writing by the engineer, and in accordance with this and other specification items involved.

MATERIALS

202-2.1 TIMBER AND LUMBER.—All timber and lumber shall be of the species and grades called for on the plans and as prescribed under TREATED AND UNTREATED TIMBER. Untreated timber used for mud blocks shall be heart cedar, heart cypress, redwood, or other durable species.

202-2.2 STRUCTURAL SHAPES, RODS, AND PLATES.—All structural shapes, rods, and plates shall be of structural steel or wrought iron, as specified or indicated on the plans, meeting the respective requirements prescribed under STRUCTURAL STEEL. All eyebars and castings shall conform to the requirements therefor prescribed under STRUCTURAL STEEL. No welds will be permitted in truss-rods, or in main members of trusses or girders.

202-2.3 HARDWARE.—Machine bolts, driftbolts, and dowels may be either wrought iron or medium steel. Washers shall be cast ogee gray iron castings or malleable castings, unless washers cut from medium steel or wrought iron plate are indicated on the plans.

Machine bolts shall have square heads and nuts, unless otherwise stipulated. Nails shall be cut or round of standard form. Spikes shall be cut, wire, or boat spikes.

All nails, spikes, bolts, dowels, washers, lag screws, and other hardware shall be galvanized.

Ring or shear plate timber connectors shall be of approved design and made of noncorrosive metal.

CONSTRUCTION METHODS

202-3.1 STORAGE OF MATERIALS.—All lumber and timber on the site of the work shall be stacked to prevent warping. Untreated material shall be open-stacked at least 12 inches above the ground surface and so piled as to shed water. When required by the engineer, it shall be protected from the weather by suitable covering. Creosoted timber shall be

close-stacked, and when required by the engineer, the stacks shall be covered with a 2-inch layer of earth. The ground underneath and in the vicinity of all stacks shall be cleared of weeds and rubbish.

202-3.2 WORKMANSHIP.—All framing shall be true and exact. Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient reason for removal of the workman causing them.

202-3.3 TREATED TIMBER.—Treated timbers shall be framed before treatment and shall be handled carefully without sudden dropping, breaking of outer fibres, or bruising or penetrating the surface with tools. Cant dogs, peaveys, hooks, or pike poles shall not be used. In water infested by marine borers, cutting and boring below high-water mark shall be avoided.

All cuts in treated piles or timbers, and all abrasions, after having been carefully trimmed, shall be coated with two applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or shall be brush coated with at least three applications of hot creosote oil and covered with hot roofing pitch.

Before driving bolts, all holes bored after treatment shall be impregnated with hot creosote oil by means of an approved bolt hole treater. Any unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

202-3.4 UNTREATED TIMBER.—In structures of untreated timber, except cedar, heart cypress, or redwood, the surfaces named below shall be coated thoroughly with two coats of hot creosote oil before the timbers are assembled: ends, tops, and all contact surfaces of posts, sills, caps, floor beams and stringers, all ends, joints, and contact surfaces of bracing and truss members. All surfaces of timber bumpers, the back faces of bulkheads, and all other timber which is to be in contact with earth shall be similarly treated.

202-3.5 HOLES FOR BOLTS, DOWELS, RODS, AND LAG SCREWS.—Holes for round driftbolts and dowels shall be bored with a bit one-sixteenth inch smaller in diameter than the bolt or dowel to be used. The diameters of holes for square driftbolts or dowels shall be equal to the least dimension of the bolt or dowel. Holes for machine bolts shall be bored with a bit of the same diameter as that of the bolt. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

202-3.6 BOLTS AND WASHERS.—Washers of the size and type specified shall be used under all bolt heads or nuts that would otherwise be in contact with wood. Cast-iron washers shall have a thickness equal to the diameter of the bolt, and

the diameter of the washer shall be four times its thickness. For malleable or plate washers the diameter or side size of the square shall be equal to four times the diameter of the bolt, and the thickness shall be equal to one-half the diameter of the bolt. Cast-iron washers shall be used when the timber is in contact with the earth. All nuts shall be checked effectually after being finally tightened.

202-3.7 COUNTERSINKING.—Countersinking shall be done wherever smooth faces are required. Recesses formed for countersinking, except in railings, shall be painted with hot creosote oil, and, after bolts or screws are in place, shall be filled with hot pitch.

202-3.8 FRAMING.—All lumber and timber shall be accurately cut and framed to a close fit so that the joints will have even bearing over the entire contact surfaces without shimming.

202-3.9 PILE BENTS.—The piles for any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of various sizes to secure uniform strength and rigidity in the bents of any given structure.

Cut-offs shall be made accurately to insure perfect bearing between the caps and piles of bents.

202-3.10 FRAMED BENTS.—Mud blocks shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals for the support of framed bents shall be finished carefully so that sills or posts will take even bearing on them. Dowels for anchoring sills and posts shall be set when the concrete is cast and shall project at least 6 inches above the tops of the pedestals.

Sills shall have true and even bearing on mud blocks, piles, or pedestals. They shall be driftbolted with bolts extending into the mud blocks or piles at least 6 inches. When possible, all earth shall be removed from contact with sills so that there will be a free circulation of air around the sills.

202-3.11 CAPS FOR ALL BENTS.—Timber caps shall be placed to obtain even and uniform bearing over the tops of the supporting posts or piles and with their ends in alignment. All caps shall be secured by driftbolts, set approximately at the center and extending at least 9 inches into the posts or piles.

202-3.12 BRACING.—Bracing shall be bolted through at intersections to the pile, post, cap, or sill.

202-3.13 STRINGERS.—Stringers shall be sized at bearings and shall be placed in position so that knots near the edges will be in the top portions of the stringers. The lapped ends of untreated stringers shall be separated at least one-half inch. All stringers shall be securely fastened to caps by driftbolts. When stringers are two panels in length the joints shall be staggered. Cross bridging between stringers shall be neatly

and accurately framed and securely toe-nailed with at least two nails at each end.

202-3.14 PLANK FLOORS.—Roadway and sidewalk floor plank, unless otherwise stipulated, shall be surfaced one side and one edge (S1S1E). The planks shall be laid heart-side down, with one-fourth inch openings between them for seasoned material and with tight joints for unseasoned material. Each plank shall be spiked securely to each joist or supporting member. The planks shall be graded carefully as to thickness, and so laid that no two adjacent planks shall vary in thickness by more than one-sixteenth inch.

202-3.15 LAMINATED OR STRIP FLOORS.—Plank for laminated or strip floors shall have a nominal thickness of 2 inches and shall be surfaced to a uniform width (S1E), and when so specified, to a uniform thickness (S1S). Unless otherwise stipulated, no splicing of plank will be allowed.

Planks shall be laid with the surfaced edge down and each plank shall be toe-nailed to each alternate stringer with twenty-penny nails. The nailing of successive planks shall be staggered so that the spacing of nails along each stringer shall not be less than 4 inches. In addition, each piece shall be nailed horizontally to adjacent pieces with forty-penny nails at eighteen inch centers and staggered both horizontally and vertically with nails in adjacent pieces. All floors shall be cut to a straight line along the sides of the roadway.

202-3.16 RAILINGS.—Railings shall be built as shown on the plans and shall be constructed in a workmanlike and substantial manner. All railing material shall be surfaced on four sides (S4S). All rails shall be squarely butt-joined at the posts and the rails shall break joints.

202-3.17 DRAINS.—Drains shall be provided where indicated on the plans. They shall be constructed with galvanized iron linings and shall be arranged to discharge free of the structure.

202-3.18 PAINTING.—Rails and rail posts shall be painted with three coats of white paint unless otherwise specified on the plans. Other parts of the structure shall be painted when so designated on the plans.

202-3.19 CLEANING-UP.—Upon completion and before final acceptance, the contractor shall remove all false work, false-work piling down to 2 feet below the finished ground line, excavated or useless materials, rubbish, and temporary buildings. He shall replace or renew any fences damaged and restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the engineer. All excavated material or false work placed in the stream channel during construction shall be removed by the contractor before final acceptance.

METHOD OF MEASUREMENT

202-4.1 The quantities of timber and other contract pay items which constitute the completed and accepted structure shall be measured for payment in the manner prescribed in the several items involved.

BASIS OF PAYMENT

202-5.1 The quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items, which prices and payments shall be full compensation for procuring, furnishing, and delivering all lumber and timber, for preparing, framing, assembling, erecting, and painting, including also all structural steel, iron, castings, hardware, and other metal parts, and for all labor, equipment, tools, and incidentals necessary to complete the item. Such payment shall constitute full payment for the completed structure ready for use, and no allowance shall be made for cofferdam construction, false work, or other erection expenses.

ITEM 203.—LOG BRIDGES

DESCRIPTION

203-1.1 This item shall consist of log bridges, constructed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or ordered in writing by the engineer.

MATERIALS

203-2.1 LOGS.—The logs used in constructing log bridges shall be of the species indicated on the plans. The logs, if taken from Government land, shall be obtained subject to the conditions given under **CLEARING AND GRUBBING**.

The logs shall be straight, sound, out of wind, and free from defects of all kinds that impair their strength enough to make them unsuitable for the use intended. They shall be cut from live trees not less than 30 days and not more than 1 year before use, and shall be seasoned with the bark on. Immediately before use in the work all bark shall be peeled and the logs shall be trimmed smooth of all knots and projections.

203-2.2 LUMBER.—All lumber for flooring, railings, etc., shall be of the species, grade, and dimensions indicated on the plans and shall conform to the requirements stipulated in the specifications for **TREATED AND UNTREATED TIMBER** that are applicable.

203-2.3 HARDWARE.—The contractor shall furnish all necessary bolts, driftbolts, spikes, nails, and other material or hardware called for on the plans or in the specifications. All hardware shall be galvanized.

CONSTRUCTION METHODS

203-3.1 The contractor shall provide ample and suitable equipment and tools for performing the work and shall follow only well recognized methods in preparing the timber and framing and erecting the structure.

The provisions for preservative treatment, if called for, painting timber, and construction methods as specified for **TIMBER BRIDGES** and for **TREATED AND UNTREATED TIMBER**, shall apply to log bridges and log trestles.

Log abutments shall be built according to the specifications for log cribbing and as shown on the plans.

METHOD OF MEASUREMENT

203-4.1 The quantities to be paid for shall be the number of log trestle spans of the several lengths shown on the plans, the number of linear feet of logs in log bents, the number of square feet of log cribbing and the number of thousand board-feet of sawn timber in bents, flooring, railings, etc., all completed and accepted. Each span of log trestle shall include caps and all parts of the bridge except abutments, piers, timber bents, and supplementary floor wearing tops otherwise provided for. The quantity of logs in log bents paid for shall be the linear feet of logs used in bents as sills, columns, posts, and bracing as shown on the plans or ordered in writing by the engineer.

BASIS OF PAYMENT

203-5.1 The quantities, measured as provided above, shall be paid for at the contract unit prices per span for "Log Trestle Spans Complete" of the several lengths and per linear foot for "Logs in Log Bents," respectively, which prices and payment shall be full compensation for the substructures and superstructures complete in place including all preservative treatment, painting bridge timber, iron, and rails, and all materials, labor, equipment, tools, and incidentals necessary to complete the item, except sawn timber and log cribbing, concrete or masonry piers and abutments, or other similar items for which separate payment is provided.

203-5.2 Sawn timber shall be measured and paid for as provided under **TREATED AND UNTREATED TIMBER**.

203-5.3 Log cribbing shall be measured and paid for as provided under **TIMBER AND LOG CRIBBING**.

ITEM 204.—LOG CULVERTS

DESCRIPTION

204-1.1 This item shall consist of log culverts, constructed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or ordered in writing by the engineer.

MATERIALS

204-2.1 The materials required shall be as specified under LOG BRIDGES and TIMBER AND LOG CRIBBING.

CONSTRUCTION METHODS

204-3.1 The construction methods shall be as specified under LOG BRIDGES and TIMBER AND LOG CRIBBING.

METHOD OF MEASUREMENT

204-4.1 The footage to be paid for shall be the number of linear feet of over-all length measured along the center lines of the barrels of culverts of the several sizes, completed and accepted.

BASIS OF PAYMENT

204-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Log Culverts" of the several sizes, which prices and payments shall constitute full compensation for the completed structures, including furnishing and placing all material, and for all labor, equipment, tools, and incidentals necessary to complete the item, except that any wing or end wall of 50 square feet area or more shall be measured and paid for as provided under LOG CRIBBING.

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ITEM 205.—CULVERTS AND RETAINING WALLS

DESCRIPTION

205-1.1 This item shall consist of concrete and masonry culverts, pipe culverts, end walls, and retaining walls, constructed in conformity with the lines, grades, and dimensions shown on the plans or ordered by the engineer and in accordance with this and other specification items involved.

MATERIALS

205-2.1 The materials to be furnished and used shall be those prescribed under the several items involved.

CONSTRUCTION METHODS

205-3.1 EXCAVATION, BEDDING, AND BACKFILLING.—All excavation, bedding, and backfilling involved shall be performed and all foundations shall be prepared as specified under UNCLASSIFIED EXCAVATION FOR STRUCTURES, BACKFILL FOR STRUCTURES OTHER THAN PIPE CULVERTS, and BEDDING AND BACKFILL FOR PIPE CULVERTS.

205-3.2 CONCRETE AND MASONRY.—The construction of concrete and masonry culverts and retaining walls and the construction of culvert head walls shall be in accordance with the specifications for concrete and masonry items.

205-3.3 PIPE.—The installation of pipe for pipe culverts shall be in accordance with the specification requirements for the type of pipe culvert specified.

METHOD OF MEASUREMENT

205-4.1 The quantities of the various pay items which constitute the completed and accepted structures shall be measured for payment in the manner prescribed in the several items involved.

BASIS OF PAYMENT

205-5.1 The quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items, which prices and payments shall be full compensation for furnishing, hauling, and incorporating all prescribed and necessary material in the structures, and for all labor, equipment, tools, and incidentals necessary to complete the item. Such payment shall constitute full payment for the completed structures, ready for use, and no allowance will be made for cofferdam construction, false work, form lumber, or other erection expenses.

ITEM 206.—CONCRETE

(Classes A, B, D, and S)

DESCRIPTION

206-1.1 This item shall consist of concrete composed of portland cement, fine aggregate, coarse aggregate, and water, prepared and constructed, in accordance with these specifications, at the locations, and of the form, dimensions, and class shown on the plans or ordered in writing by the engineer.

206-1.2 COMPOSITION AND PROPORTIONING OF CONCRETE.—The contractor shall put into each batch the number of bags of cement and amount of water and weigh into each batch the respective weights of fine and coarse aggregate designated by the engineer for the particular job materials being used and the class of concrete being made; provided, however, that in batching aggregates for structures containing less than 50 cubic yards of concrete, the contractor may substitute approved volumetric measuring devices in lieu of the weighing devices. In such latter event, weighing will not be required but the volumes of coarse aggregate and of fine aggregate put in each batch shall be those designated by the engineer.

206-1.3 JOB MIXES.—The proportions of the job materials, portland cement, fine aggregate, coarse aggregate, and water designated by the engineer shall be termed the "Job Mix." A job mix shall be determined and designated for each class of concrete involved in the contract. Materials furnished on the job for this item by the contractor, meeting specifications and accepted by the engineer, shall be termed "job materials."

206-1.4 DETERMINATION OF TOTAL AGGREGATE IN JOB MIX.—The engineer shall base his determination of the job mix on the requirements of table 1. Subject to the correction due to specific gravity specified in 1.7 below, the weight of fine aggregate per bag of cement plus the weight of coarse aggregate per bag of cement for a given class of concrete shall equal the weight shown in the last column of table 1 for the particular type of aggregate and class of concrete.

The determinations of job mixes shall be based on representative samples of the materials to be used. "Coarse Aggregate" shall be taken to mean all the aggregate in the given mix which would be retained on the No. 4 sieve, and "Fine Aggregate" shall be taken to mean all the aggregate in the mix which would pass the said sieve using A.A.S.H.O. Method T-27.

206-1.5 DETERMINATION OF FINE AGGREGATE IN JOB MIX.—Table 1 gives the allowable range in weights for fine aggregate for each respective class of concrete. Within this range, the engineer shall designate that weight of fine aggregate which is found to require the least amount of water in producing a workable job mix of the consistency herein required.

TABLE 1.—*Master proportions of materials for concrete*

Class	When coarse aggregate used is—	Weight of fine aggregate per bag of cement		Fixed total weight of aggregate (surface dry) per bag of cement
		Minimum	Maximum	
		<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
A	{Gravel.....	180	220	580
	{Stone.....	216	264	
B	{Gravel.....	216	264	750
	{Stone.....	270	330	
D	{Gravel.....	135	165	470
	{Stone.....	170	210	
S	{Gravel.....	120	140	430
	{Stone.....	155	185	

206-1.6 DETERMINATION OF COARSE AGGREGATE IN JOB MIX.—For each respective class of concrete, the weight of coarse aggregate per bag of cement shall be the difference between the total weight of aggregate per bag of cement determined as prescribed in 1.4 above and the weight of fine aggregate as determined in 1.5 above.

206-1.7 CORRECTION FOR SPECIFIC GRAVITY.—The weights given in table 1 are weights of aggregates having a bulk specific gravity of 2.65 as determined by A.A.S.H.O. Methods T-84 and T-85. Proportionate corrections of the prescribed weights shall be made when the job aggregates have bulk specific gravities above 2.70 or below 2.60. In any such case the corrected amount shall be the product of the number of pounds shown in table 1 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

206-1.8 NEW OR ADJUSTED JOB MIXES.—After the job mix has been designated, no change in the source, character, or grading of the materials shall be made without due notice to the engineer. No new aggregate, nor any aggregate found to differ in quality or properties from the pertinent sample on which the job mix has been based shall be used until the engineer has determined its conformity with specifications and has designated a new job mix based on the new or altered material.

206-1.9 CLASSIFICATION.—Concrete will be classified as class A, class B, class D, or class S. Each class of concrete shall be used where indicated on the plans, or where ordered by the engineer. The following requirements shall govern unless otherwise specified on the plans:

Class A concrete shall be used (except where class D is required) for all superstructures and all arch rings, and for all parts of substructures having any dimension less than one foot and for all reinforced concrete except footings.

Class B concrete shall be used (except as provided above and except where class S is required) for substructures, for footings, and for unreinforced concrete.

Class D concrete shall be used for railings, posts, slabs, beams, girders, and curbs.

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

The contractor may, at his option, use class A concrete instead of class B concrete, but in all cases payment will be made at the contract unit price for the class specified or ordered by the engineer.

MATERIALS

206-2.1 CEMENT.—The cement used in the work shall be a standard brand of portland cement, a standard brand of high-early-strength portland cement or a standard brand of moderate sulphate-resisting cement. Portland cement shall conform to Federal Specification SS-C-191a. High-early-strength portland cement shall conform to Federal Specification SS-C-201. Moderate sulphate-resisting cement shall conform to A.A.S.H.O. Specification M 60-38. Only one brand of each shall be used on any one job, except by specific written permission from the engineer.

Where so indicated on the plans, high-early-strength portland cement shall be used instead of portland cement. When high-early-strength cement is used, concreting operations shall not be carried on if the atmospheric temperature is below or may be expected to drop below 60° F. except upon written authorization from the engineer. If the contractor, in order to facilitate his own operations, chooses to use high-early-strength cement in portions of the work other than those where its use is required, written permission must be obtained from the engineer.

The contractor shall provide suitable means for storing cement and protecting it from dampness. Different grades of cement shall be stored separately, and shall not be mixed.

Bags of cement, in which for any reason the cement has become partially set or which contain lumps of caked cement, shall be rejected. Use of cement salvaged from discarded or used bags will not be permitted.

206-2.2 WATER.—All water used in concrete shall be subject to the engineer's approval, shall be reasonably clear and free of oil, acid, alkali, and vegetable substances, and shall not be brackish or salty. Water of doubtful quality shall be tested by comparison with distilled water. Comparison shall be made by standard tests for soundness, time of setting, and 1:3 mortar-strength. Standard sand and the same grade of cement shall be used in all such tests. Any indication of unsoundness, marked change in time of setting, or a variation of more than 10 percent in strength from results obtained with mixtures containing distilled water shall be sufficient cause for rejection of the water that is being tested.

206-2.3 FINE AGGREGATE.—The fine aggregate for concrete shall consist either of sand, or of approved inert materials having similar characteristics, or of a combination thereof. The material used shall consist of hard, strong, durable particles.

When subjected to five cycles of the sodium sulphate soundness test, using A.A.S.H.O. Method T-104 the fine aggregate shall have a total loss not greater than 10 percent by weight. Instead of the soundness test mentioned above, the contractor may provide evidence, satisfactory to the engineer, that the fine aggregate has been exposed to natural weathering, either directly or in concrete, for a period of at least 5 years without appreciable disintegration.

Fine aggregate shall contain not more than 3 percent of material removable by a decantation test using A.A.S.H.O. Method T-11 nor more than 1 percent of clay lumps, or 1 percent of shale as determined by A.A.S.H.O. Method T-10. The total of coal, clay lumps, shale, soft fragments, and other local deleterious substances shall not be more than 5 percent.

The percentage of clay lumps shall be determined by examining the various fractions that remain after the material has been tested for grading. Any particles that can be broken up with the fingers shall be classified as clay lumps and the total percentage by weight of all clay lumps shall be determined on the basis of the total original weight of the sample.

All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric test for organic impurities, A.A.S.H.O. Method T-21, and producing a color darker than the standard shall be rejected unless they pass the mortar strength test herein required.

The fine aggregate shall be well graded from fine to coarse and shall meet the following grading requirements, using A.A.S.H.O. Method T-27.

Sieve designation—	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)
No. 4-----	95-100
No. 16-----	45- 80
No. 30-----	25- 55
No. 50-----	5- 30
No. 100-----	0- 10

Mortar specimens made with the fine aggregate shall have a compressive strength, using A.A.S.H.O. Method T-71, at 28 days of at least 90 percent of the strength of similar specimens made with Ottawa sand having a fineness modulus of 2.40 ± 0.10 .

For the purpose of controlling the grading of fine aggregate from any one source, the contractor shall submit, prior to actual deliveries, a preliminary sample which shall be representative of the material which he proposes to furnish. Any shipment of fine aggregate made during the progress of the work that varies in fineness modulus more than 0.20 from the fineness modulus of the preliminary sample shall be rejected or, at the discretion of the engineer, may be accepted subject to such changes in the proportions used as he may direct.

The fineness modulus of fine aggregate shall be determined by adding the total percentages by weight retained on U. S. standard sieves Nos. 4, 8, 16, 30, 50, 100, and dividing by 100.

206-2.4 COARSE AGGREGATE.—The coarse aggregate for concrete shall consist of crushed stone, gravel, slag, or other approved materials, conforming to the following requirements:

The coarse aggregate shall have a percentage of wear not more than 50 at 500 revolutions as determined by A.A.S.H.O. Method T-96 (Los Angeles Rattler Test).

Crushed stone shall consist of clean, hard, tough, durable, uncoated fragments reasonably free from thin or flat pieces. The crushed stone shall not show evidence of disintegration nor show a total loss greater than 15 percent when subjected to five cycles of the sodium sulphate accelerated soundness test using A.A.S.H.O. Method T-104.

Gravel shall consist of clean, hard, tough, durable, uncoated particles of stone reasonably free from thin or flat particles. The gravel shall not show evidence of disintegration nor show a total loss greater than 15 percent when subjected to five cycles of the sodium sulphate accelerated soundness test using A.A.S.H.O. Method T-104.

Slag shall be air-cooled, blast furnace slag, and shall consist of angular fragments reasonably uniform in density and

quality and reasonably free from thin, elongated, or glassy pieces, dirt or other objectionable matter. The slag shall have a weight per cubic foot of not less than 75 pounds, using A.A.S.H.O. Method T-19.

Instead of the abrasion and soundness tests specified above for crushed stone and gravel the contractor may provide evidence, satisfactory to the engineer, that the crushed stone or gravel has proved satisfactory as coarse aggregate in concrete that has been subjected for a period of 5 years to essentially the same service, exposure, and other conditions as those to which the structure in which the material is to be used will be subjected.

The coarse aggregate shall not have more than 1 percent of material removable by the decantation test, using A.A.S.H.O. Method T-11, nor more than 1 percent of shale using A.A.S.H.O. Method T-10, nor more than 5 percent of soft fragments, using A.A.S.H.O. Method T-8, nor more than one-fourth of 1 percent of clay lumps, using the method given under 2.3 above for fine aggregate. The total of shale, coal, clay lumps, and soft fragments shall not be more than 5 percent.

Different types of coarse aggregate, if tested and approved, may be mixed prior to use but shall not be used alternately in any one class of construction.

Coarse aggregate of the sizes designated shall conform to the requirements of table 2. The size or shape of aperture specified has no relation to the size or shape of aperture used in production of the material.

TABLE 2.—Requirements for grading of coarse aggregate

Size designation	Percentage by weight passing square mesh sieves (A.A.S.H.O. T-27)						
	2½-inch	2-inch	1½-inch	1-inch	¾-inch	½-inch	No. 4
1 to 2 inches-----	100	90-100	35- 70	0- 15	-----	-----	-----
¾ to 1½ inch-----	-----	100	90-100	20- 55	0- 15	-----	-----
No. 4 to 2½ inch-----	100	70- 85	-----	40- 75	-----	-----	0- 5
No. 4 to 2 inches-----	100	95-100	-----	35- 70	-----	10- 30	0- 5
No. 4 to 1½ inch-----	-----	100	95-100	-----	35- 70	-----	0- 5
No. 4 to 1 inch-----	-----	-----	100	90-100	-----	25- 60	0-10
No. 4 to ¾ inch-----	-----	-----	-----	100	90-100	-----	20-55
No. 4 to ½ inch-----	-----	-----	-----	-----	100	90-100	40-75

Aggregate of size designation "No. 4 to ½-inch" shall not contain more than 5 percent of fine material that will pass the standard A.A.S.H.O. No. 8 sieve.

Coarse aggregate of the following size designations shall be used for the respective classes of concrete:

Class A.—No. 4 to 1½ inches.

Class B.—No. 4 to 2½ inches.

Class D.—No. 4 to 1½ inches.

Class S.—No. 4 to 1½ inches.

If the contractor so elects, the No. 4 to ¾-inch size or the No. 4 to 1-inch size aggregate may be used for class A concrete and the No. 4 to 1½-inch size or the No. 4 to 2-inch size coarse aggregate may be used for class B concrete, provided that the amount of cement used in the mix is increased as directed by the engineer. Such increase shall be at the expense of the contractor. For railings and sections less than 8 inches thick, the No. 4 to ¾-inch size shall be used when required by the engineer. When separated sizes of coarse aggregate are to be used, the sizes to be combined for the various classes shall be as designated in the special provisions. The contractor may, at his option, use class A concrete instead of class B concrete, but in all cases payment will be made at the contract unit price for the class specified or ordered in writing by the engineer.

206-2.5 PREMOLDED FILLER FOR EXPANSION JOINTS.—(a) Premolded expansion joint filler shall be of one of the types described below: A, B, C, D, and E. Unless otherwise indicated on the plans, the contractor shall furnish material of type A, B, or C. Type D or type E may be used only where specifically indicated on the plans.

1. *Type A, cork.*—This joint filler shall consist of preformed strips that have been made of clean granulated cork particles securely bound together by an insoluble synthetic resin. The granulated cork shall be relatively free from hard particles or dust and shall not have been exposed in the process of manufacture to a temperature exceeding 300° F. The filler shall meet the test requirements given below under (b) 5, 6, 7, and 8.

2. *Type B, self-expanding cork.*—This joint filler shall consist of preformed strips that have been made of clean granulated cork particles securely bound together by an insoluble synthetic resin. The granulated cork shall be relatively free from hard particles or dust and shall not have been exposed in the process of manufacture to a temperature exceeding 300° F. The filler shall meet the test requirements given below under (b) 4, 5, 6, 7, and 8.

3. *Type C, cork-rubber.*—This joint filler shall consist of preformed strips that have been made of clean granulated cork particles securely bound together by a durable, elastic rubber compound. The granulated cork shall be relatively free from hard particles or dust and shall not have been ex-

posed in the process of manufacture to a temperature exceeding 300° F. The filler shall meet the test requirements given below under (b) 5, 6, and 7.

4. *Type D, bituminous (fiber impregnated with bitumen).*—This joint filler shall consist of preformed strips which have been made of cane or other suitable cellular fibers securely bound together and uniformly impregnated with a suitable asphaltic binder. The filler shall meet the test requirements given below under (b) 1, 5, 6, and 7.

5. *Type E, bituminous (including stiffener and inert filler).*—This joint filler shall consist of preformed strips of a composition which shall contain asphalt or tar uniformly impregnated with a suitable filler, and may contain thin strips of suitable stiffener. The preformed material shall be of such character that it will not be deformed by ordinary handling during the hot summer months or become hard and brittle in cold weather. The filler shall meet the test requirements given below under (b) 1, 2, and 3.

(b) *Test Requirements.*—When tested in accordance with A.A.S.H.O. Method T-42, premolded expansion joint fillers shall meet such of the following test requirements as are specifically indicated for the particular types to which they belong:

1. *Absorption.*—Type D filler shall not absorb water in greater amount than 15 percent by volume, and type E filler shall not absorb water in greater amount than 5 percent of its dry weight.

2. *Brittleness.*—Type E filler shall not crack or shatter in the brittleness test.

3. *Distortion.*—Type E filler shall not deflect more than 1 inch in the distortion test.

4. *Expansion in boiling water.*—After immersion in boiling water for 1 hour, type B filler shall have a final thickness not less than 140 percent of its thickness before the test.

5. *Recovery.*—Types A, B, and C fillers shall show not less than 90 percent recovery, and type D filler shall show not less than 70 percent recovery when tested for recovery.

6. *Compression load.*—The load required to compress types A, B, C, and D fillers to 50 percent of their thickness before the test shall be not less than 100 pounds nor greater than 750 pounds per square inch.

7. *Extrusion.*—Types A, B, C, and D fillers shall not show more than ¼-inch extrusion when tested for extrusion.

8. *Boiling in hydrochloric acid.*—Types A and B fillers shall show no evidence of disintegration after having been boiled for 1 hour in concentrated hydrochloric acid. Discoloration, or a small amount of swelling, shall not be considered as failure.

9. *Optional weathering test.*—At the option of the engineer, types A, B, C, and D fillers shall be subjected to the acceler-

ated weathering test and when so tested shall show no signs of disintegration.

At the option of the engineer, samples that have been subjected to the weathering test shall be tested for recovery, compression, and extrusion and samples so tested shall meet the requirements given under 5, 6, and 7 above.

(c) *Dimensions*.—The dimensions of premolded filler shall be as shown on the plans. Tolerances of $\pm\frac{1}{16}$ -inch thickness, $\pm\frac{1}{8}$ -inch depth, and $\pm\frac{1}{4}$ -inch length shall be permitted.

(d) *Samples*.—A sample of each thickness of filler shall be submitted from each shipment of 1,000 lineal feet or less and shall consist of a representative section at least 2 feet in length and the full depth of the joint to be filled. Samples shall be packed for transportation in such a manner that there will be no danger of distortion or breakage.

(e) *Packing*.—The self-expanding cork type filler shall be packed at the plant in sizes convenient for handling on the job and shall be wrapped in waterproof paper and sealed in a manner that will prevent entrance of moisture.

206-2.6 METAL EXPANSION JOINT FILLERS.—Metal expansion joint fillers shall consist of folded metal sheets of the form, dimensions, and design shown on the plans. Copper sheets shall be made of 24-ounce weight. Zinc sheets shall be of 12-ounce weight. Sheet lead used in joints shall be at least one-eighth inch thick. The weight of metal at thin spots shall be at least 90 percent of that specified and the total weight of a strip shall be at least 95 percent of that specified.

CONSTRUCTION METHODS

206-3.1 FOUNDATIONS.—Preparation of foundations shall conform to the requirements under UNCLASSIFIED EXCAVATION FOR STRUCTURES. The elevations of the bottoms of footings as shown on the plans are approximate only and the engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to obtain satisfactory foundations and will revise the plans for abutments, walls, piers, or bents accordingly.

206-3.2 FALSE WORK.—False work shall be built on foundations of sufficient strength to carry the loads without appreciable settlement. False work that cannot be founded on solid footings must be supported by ample false work piling. False work shall be designed to carry the full loads coming upon it.

All spans shall be given a temporary camber of one-fortieth inch per foot of clear span to allow for shrinkage and settlement. Bridges shall have a permanent camber only when such camber is shown on the plans. If appreciable settlement occurs in the false work, the work shall be stopped, any masonry affected shall be removed, and the false work rebuilt.

In general, double wedges or other suitable means shall be provided for maintaining false work and forms to correct lines.

If requested by the engineer, detail drawings of the false work shall be submitted to the engineer for approval, but such approval shall not relieve the contractor of any of his responsibility under the contract for the successful completion of the structure. Arch centering shall be so constructed as to permit its being lowered gradually and uniformly or released after the arch ribs or rings are poured.

206-3.3 FORMS.—Forms shall be so designed and constructed that they may be removed without injuring the concrete.

Unless otherwise specified, forms for exposed surfaces shall be made of plywood, hard-pressed fiberboard, sized and dressed tongue and groove lumber, or metal in which all bolt and rivet holes are countersunk, so that in either case a plane smooth surface of the desired contour is obtained. Rough lumber may be used for surfaces which will not be exposed in the finished structure. All lumber shall be free from knotholes, loose knots, cracks, splits, warps, or other defects affecting the strength or appearance of the finished structure. All forms shall be free of bulge and warp, and shall be cleaned thoroughly before being used a second time. When column forms are constructed of wood, the minimum dressed thickness of the material shall be $1\frac{1}{4}$ inches.

In designing forms and centering, concrete shall be regarded as a liquid. In computing vertical loads a weight of 150 pounds per cubic foot shall be assumed, and not less than 85 pounds per cubic foot shall be assumed in computing horizontal pressure.

The forms shall be so designed that portions covering concrete that is required to be finished, may be removed without disturbing other portions that are to be removed later. As far as practicable, form marks shall conform to the general lines of the structure. Form marks on columns shall be vertical and symmetrically placed.

When possible, forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit of free access to the forms for the purpose of inspecting, working, and spading the concrete.

The forms shall be built to line and made unyielding by substantial bracing. Wires for tying forms shall not extend through faces of concrete that will be exposed in the finished work. In general, forms shall be tied together with bolts that can be removed. The forms shall be mortar tight (using joint filler if necessary) and if of wood shall be soaked thoroughly with water the day before the concrete is placed. Forms for re-entrant angles shall be chamfered and forms for edges shall be filleted. The interior surfaces of forms shall be adequately

oiled, greased, or soaped to insure nonadhesion of mortar. Forms shall be inspected by the engineer immediately prior to the placing of concrete. Dimensions shall be checked carefully and any bulging or warping shall be remedied and all dirt, sawdust, shavings, or other debris within the forms shall be removed. Special attention shall be paid to ties and bracing, and where forms appear to be insufficiently braced, or unsatisfactorily built, either before or during construction of the concrete masonry, the engineer shall order the work stopped until the defects have been corrected to his satisfaction. Forms shall be so constructed that the finished concrete shall be of the form and dimensions shown on the plans, and true to line and grade. Clean-out ports shall be provided at construction joints.

206-3.4 HANDLING, MEASURING, AND BATCHING OF MATERIALS.—Concrete of the class indicated shall be composed of accepted material batched in the proportions set by the engineer. Corrections necessitated by variations in the moisture content of the raw materials or for other reasons shall be made as directed by the engineer.

Coarse and fine aggregates shall be handled and measured separately. Aggregates shall be stockpiled clear of passing vehicles and in such manner as to avoid segregation or contamination with dust, dirt, leaves, or other foreign matter.

Both bulk cement and bagged cement are permissible. When cement is measured by the bag, the average weight of the bags of cement in each batch shall not be less than 94 pounds per bag. Whenever the average weight of the bags of cement in a batch is found, by weighting, to be less than 94 pounds per bag, the contractor shall be required to weigh all bags of cement for each batch so long as this condition exists, and to adjust the mix so that it will have the required cement content.

When the cement is gaged by the bag, no batch shall be run requiring fractional bags of cement. When the cement is weighed, the batch shall be gaged by the stipulated proportions.

When bulk cement is used it shall be proportioned by an approved weighing device. The weighing hopper and scales shall be entirely encased and shall be equipped with locks. The discharge chute shall be so arranged that cement will not lodge in it nor leak from it.

The hopper discharge mechanism shall be interlocked as follows: Against opening before the full batch is in the hopper and the scales balanced, against opening while the hopper is being filled, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening if the batch in the hopper is either over or under weight by more than 1 percent of the amount specified.

The discharge chute of the weighing hopper shall be suspended from the encasement and not from the weighing hopper proper.

Water shall be measured either by volume or by weight. The allowable error in accuracy of the water-measuring equipment on the mixer shall be not more than 2 percent. Preferably, the equipment shall include an auxiliary tank from which the measuring tank should be filled. Water-measuring equipment shall be so arranged that accuracy of measurement will not be affected by variations in pressure in the water supply line.

Allowable error in the accuracy of weighing equipment for aggregates shall be not more than one-half of 1 percent for all loads.

All weighing equipment shall be arranged to permit the making of compensations for changes in the weights of moisture contained in the aggregates and to permit the convenient removal of excess material from the weighing hopper.

Weighing equipment shall be so arranged that the operator has convenient access to all controls. The weighing beam and auxiliary weighing device shall be plainly visible to the operator who is manipulating the gates which deliver material to the weighing hopper.

The scales shall be of either the beam type or the springless dial type. A graduated beam or dial shall be used to register at least the last 100 pounds of each of the kinds of aggregate used in the batch. The value of the minimum graduation shall not be greater than 2 pounds. If the aggregate is measured by volume, the contractor shall use satisfactory hoppers or boxes which, when filled and struck off, will give the exact volume of aggregate specified.

206-3.5 CONSISTENCY.—The quantity of mixing water used shall not be changed without the consent of the engineer. The consistencies of the various classes of concrete shall be such as to give slumps within the following ranges, using A.S.T.M. Designation, D138-32-T.

Class A.—2- to 4-inch slump.

Class B.—2- to 3-inch slump.

Class D.—4- to 6-inch slump.

Class S.—6- to 8-inch slump.

The above ranges represent the extreme limits of allowable slump, except that where vibrators are used the engineer may order that slightly lower slumps than the above minima be used in certain cases. The amount of water used in any concrete shall be the minimum necessary to obtain required workability within the range of slump specified for concrete of its class.

206-3.6 MIXING.—(a) *Mixing at Site of Concrete Construction.*—Concrete shall be mixed thoroughly in a batch mixer

of approved type and capacity for a period of not less than $1\frac{1}{2}$ minutes after all component materials, including water, are in the drum. The charging of water into the mixer shall begin before the cement enters and shall continue for a period which may extend to the end of the first one-third of the specified mixing time. During mixing, the drum shall be operated at drum speeds specified by the manufacturer and shown on his nameplate on the machine. The entire contents of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein. Preferably the mixer shall be equipped with mechanical means for preventing the addition of aggregates after mixing has commenced.

The mixer shall be equipped with an approved timing device to insure mixing for the minimum time specified. The volume of a batch shall not exceed the manufacturer's rated capacity of the mixer used. No mixer whose rated capacity is less than a one-bag batch shall be used.

The concrete shall be mixed only in such quantities as are required for immediate use. Retempering of concrete will not be allowed.

Upon cessation of mixing for any considerable length of time, the mixer shall be cleaned thoroughly. Upon resumption of mixing, the first batch of concrete material placed in the mixer shall contain sufficient sand, cement, and water to coat the inside surface of the drum without diminishing the required mortar content of the mix.

(b) *Ready Mixed*.—Ready-mixed concrete may be used, provided that the materials are handled, measured, and batched as specified in subsection 3.4 above, and provided that the methods described below are used and the requirements given below are complied with.

Delivery of concrete shall be so regulated that placing is at a continuous rate unless delayed by the placing operations. The intervals between delivery of batches shall not be so great as to allow the concrete in place to harden partially, and in no case shall such an interval exceed 30 minutes.

1. *Central-plant mixing*.—Concrete may be mixed at a central plant. When mixed at a central plant, the mixer and methods used shall be in accordance with the requirements in (a) above and those contained in the following provisions:

Mixed concrete shall be transported from the central mixing plant to the site of work in agitator trucks of approved design. Unless otherwise permitted in writing by the engineer the agitator shall be a closed, water-tight, revolving drum. It shall be suitably mounted and shall be capable of transporting and discharging the concrete without segregation. The agitating speed of the drum shall be not less than 2 nor more than 6 revolutions per minute. Other types of units for transporting plant-mixed concrete shall not be used without written permission from the engineer. The volume of mixed concrete per-

mitted in the drum shall not exceed the manufacturer's rating nor exceed 80 percent of the gross volume of the drum.

The interval between introduction of water into the mixer drum and final discharge of the concrete from the agitator shall not exceed 1 hour. During this interval the mixture shall be agitated continuously.

2. *Truck mixing*.—Concrete may be mixed in a truck mixer of approved design. Truck mixing shall be in accordance with the following provisions:

Unless otherwise permitted in writing by the engineer the truck mixer shall be a closed, water-tight, revolving drum. It shall be suitably mounted and shall be fitted with blades capable of combining all ingredients into a thoroughly mixed and uniform mass, and of discharging the concrete without segregation.

The mixing speed of the drum shall be not less than 4 nor more than 15 revolutions per minute. The agitating speed of the drum shall be not less than 2 nor more than 6 revolutions per minute.

The volume of mixed concrete permitted in the drum of truck mixers shall not exceed the manufacturer's rating on the capacity plate nor 50 percent of the gross volume of the drum in the case of top-door-loading truck mixers nor $57\frac{1}{2}$ percent in the case of end-loading truck mixers.

Each truck mixer shall be equipped with an approved device for registering the number of revolutions made by the drum during the interval between introduction of water into the drum and discharge of concrete from the mixer. The drum shall revolve continuously during this interval.

When truck mixers are used a water-measuring device shall be provided to measure accurately the quantity of water for each batch. The device shall be mounted on the truck mixer or located at the point of taking on the water. The device shall permit of ready access and of ready determination of the amount of water used.

When wash water is used as a portion of the mixing water for the succeeding batch it shall be accurately measured and taken into account in determining the amount of additional mixing water required. When wash water is carried on the truck mixer, it shall be carried in a compartment separate from that used for carrying or measuring the mixing water.

Water Introduced at Plant.—When water, cement, and aggregates are introduced into a truck-mixer drum at the loading plant, the drum shall revolve without interruption until the concrete is discharged therefrom. Mixing shall commence immediately after the introduction of water and shall continue for at least 50 revolutions of the drum at mixing speed. Not more than 150 revolutions of the drum shall be at a speed

in excess of the drum's agitating speed. Any other revolutions shall be at agitating speed.

The interval between introduction of water into the drum and final discharge of concrete from a truck mixer shall not exceed 1 hour.

Water Introduced in Transit.—The interval between the charging of the mixer drum with cement and aggregates, and the introduction of water shall not exceed 1 hour.

Mixing shall commence immediately after the introduction of water and shall continue at mixing speed for at least 50 revolutions of the drum. The drum shall revolve without interruption until the concrete is discharged therefrom. Not more than 150 revolutions of the drum shall be at a speed in excess of the drum's agitating speed. Any other revolutions shall be at agitating speed.

The interval between introduction of water and final discharge of concrete from a truck mixer shall not exceed 1 hour.

Water Introduced at Site.—When water is to be introduced into a truck-mixer drum at the site of the concrete construction, the requirements above for "Water Introduced in Transit" shall govern.

3. Shrink mixing.—Concrete may be partially mixed by central plant mixing, for the purpose of shrinking the batch, and the mixing completed by truck mixing.

The central plant mixing shall be in accordance with the requirements in (a) above except that no mixing period shall be specified. The truck mixing shall be in accordance with (b) 2 above for (Water Introduced at Plant) save that the volume of mixed concrete allowed in the drum shall not exceed 66% percent of the gross volume of the drum.

(c) **Hand Mixing.**—Hand mixing will not be permitted, except in case of emergency and with written permission from the engineer. When permitted, it shall be performed only on watertight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. Shovels shall then be used to mix the dry sand and cement thoroughly. The dry mixture shall then be formed into a crater and enough water shall be added to produce mortar of the specified consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until it is of uniform consistency. The coarse aggregate shall then be wetted thoroughly and added to the mortar and the entire mass turned and re-turned at least six times and until all of the stone particles are covered thoroughly with mortar and the mixture is of a uniform color and general appearance. Hand-mixed batches shall not exceed one-half cubic yard in volume. Hand mixing will not be permitted for concrete that is to be placed under water.

206-3.7 PLACING CONCRETE.—All concrete shall be placed before it has taken its initial set and, in any case, within 30

minutes after mixing except as modified under 3.6 above. Concrete shall be placed in such manner as to avoid segregation of coarse or fine portions of the mixture, and shall be spread in horizontal layers when practicable. Comparatively wet mixes will be permitted initially in slabs and girders to facilitate the working of the concrete around nests of reinforcing steel so as to eliminate rock pockets or air bubbles. Enough puddlers and tampers shall be provided to compact each batch before the succeeding one is dumped and to prevent the formation of joints between batches. Extra tamping shall be done along all faces to obtain smooth surfaces. Care shall be taken to prevent mortar from spattering on forms and reinforcing steel and from drying ahead of the final covering with concrete. Where spattering occurs, the forms and steel shall be cleaned with wire brushes or with scrapers.

Troughs, pipes, or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete do not become separated. Where steep slopes are required, troughs and chutes shall be equipped with baffle boards or shall be in short lengths that reverse the direction of movement. When pipes are used, they shall be kept full of concrete and their lower ends shall be kept buried in fresh concrete as is required when a tremie is used. All chutes, troughs, and pipes shall be kept clean and free of coatings of hardened concrete by flushing thoroughly with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Troughs and chutes shall be of metal or shall be lined with metal and shall extend as nearly as possible to the point of deposit. When discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

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

The placing of concrete shall be so regulated that the pressures caused by wet concrete shall not exceed those used in the design of the forms.

Mechanical, high-frequency internal vibrators shall be used for compacting concrete in all structures containing more than 50 cubic yards of concrete and in both precast and cast-in-place piles. The vibrators shall be of a type approved by the engineer, with a minimum frequency of 5,000 cycles per minute and shall be capable of visibly affecting a properly designed mixture with a 1-inch slump for a distance of at least 18 inches from the vibrator. Sufficient vibrators shall be used to consolidate the incoming concrete within 15 minutes after placing. Vibrators shall not be held against forms or reinforcing steel nor shall they be used for flowing the concrete or spreading it into place. Vibrators shall be so manipulated as to produce concrete that

is free of voids, is of proper texture on exposed faces, and of maximum consolidation.

Concrete shall be placed continuously throughout each section of the structure or between indicated joints. If, in an emergency, it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the engineer may direct and the resulting joint shall be deemed a construction joint and treated as herein described under 3.9 below.

206-3.8 DEPOSITING CONCRETE UNDER WATER.—Concrete shall be deposited under water only under the immediate supervision of the engineer, and by the method described in the following paragraphs.

Only class S concrete shall be deposited under water. It shall be placed carefully to form a compacted mass in its final position by means of a tremie or a closed bottom-dump bucket, or by other approved means, and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used, it shall consist of a tube not less than 10 inches in diameter, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the seal and to permit its being lowered rapidly when necessary to choke off or retard the flow. The discharge end shall be completely sealed against inflow at all times and the tremie tube shall be kept full to the bottom of the hopper. The flow shall be regulated by raising or lowering the tremie.

When concrete is placed by means of a bottom-dump bucket, the bucket shall have a capacity of not less than one-half cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the prepared foundation or upon concrete already placed. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

206-3.9 FORMING CONSTRUCTION JOINTS.—The location of construction joints shall be subject to approval by the engineer. Construction joints shall be perpendicular to the principal lines of stress and in general shall be located at points of minimum shear.

At horizontal construction joints, gage strips $1\frac{1}{2}$ inches thick shall be placed inside the forms along all exposed faces to give the joints straight lines. Before placing fresh concrete, the surfaces of construction joints shall be worked over with

suitable tools to remove all laitance and loose and foreign material. The surfaces shall then be washed and scrubbed with wire broom, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, an old surface shall be coated thoroughly with a very thin coating of neat cement mortar. Concrete in substructures shall be placed in such manner that all horizontal construction joints will be truly horizontal and, if possible, in such locations as not to be exposed to view in the finished structure. Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Special care shall be taken to avoid construction joints through panelled wing walls or other large surfaces which are to be treated architecturally.

In order to bond successive courses, suitable keys shall be formed at each construction joint by the insertion and subsequent removal of thoroughly saturated strips of beveled wood. Rough stone or steel dowels may be used, at the discretion of the engineer, instead of keys.

206-3.10 INSTALLATION OF EXPANSION JOINTS.—Expansion joints shall be located and formed as required on the plans.

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

All metal expansion filler shall be placed in such manner as to be free of kinks. The resulting joints shall be water-tight and so formed and placed as to lead all drainage water to a point of discharge so located as to prevent the staining of exposed concrete surfaces. Sectional lengths of the prepared metal expansion filler shall be riveted together and soldered.

In sliding expansion joints the sliding contact surfaces shall be true planes parallel to the direction of movement. Where sliding joints are to be provided at the ends of slabs, girders, or beams, or between walls, etc., the surface of the supporting concrete shall be given a smooth finish and covered with two layers of three-ply roofing felt to separate it from the new concrete.

206-3.11 COLD WEATHER CONCRETING.—Unless authorized in writing by the engineer, the mixing and placing of concrete shall be discontinued when the atmospheric temperature is below 40° F. in the shade and is descending and shall not be resumed until the atmospheric temperature is as high as 35° F. in the shade and is ascending. If written authorization is granted for the mixing and placing of concrete under atmospheric conditions different from those specified above, the aggregates shall be heated either by steam or dry heat to a temperature between 70° F. and 150° F. The water shall be heated to a temperature between 130° F. and 150° F. The heating apparatus shall be capable of heating the mass uniformly and preventing the occurrence of spots of overheated material. The temperature of the mixed concrete shall be between 60° F. and 100° F. when it is placed in the forms. Neither salt nor other chemical shall be added to the concrete to prevent its freezing. The contractor shall furnish sufficient canvas and framework, or other type of housing, to enclose and protect the structure. Sufficient heating apparatus, such as stoves, salamanders, or steam equipment, and fuel to furnish all required heat, shall be supplied. The air surrounding the fresh concrete shall be kept at a temperature above 50° F. for a period of 5 days after the concrete has been placed.

Permission given to place concrete under the conditions mentioned above shall not relieve the contractor of responsibility for obtaining satisfactory results notwithstanding. Unsatisfactory concrete placed under such conditions shall be removed and replaced at the contractor's expense.

206-3.12 CURING CONCRETE.—(a) *Water Curing.*—Concrete shall be kept wet for 7 days after being placed. Concrete floors shall be covered with sand, earth, or other suitable material as soon as possible after being placed and shall be kept thoroughly moistened for 10 days. Covering material shall remain on the floor for at least 14 days. Bridge floors shall not be opened to traffic until 21 days after being placed when portland cement has been used, or 8 days when high-early-strength cement has been used.

Special attention shall be given by the contractor to the proper curing of concrete handrails and all surfaces requiring rubbed finishes.

In fast-drying weather the contractor shall cover roadway and sidewalk slabs with wetted burlap, cotton matting, or other suit-

able fabric immediately after the final finishing of the surface and shall keep the covering thereon until the concrete has hardened enough to allow further curing by methods outlined above.

206-3.13 REMOVAL OF FORMS AND FALSE WORK.—

(a) To facilitate finishing, forms used on ornamental work, railings, parapets, and exposed vertical surfaces shall be removed in not less than 12 or more than 48 hours, depending upon weather conditions. In order to determine the condition of concrete in columns, forms shall always be removed from them before the removal of shoring from beneath beams and girders.

(b) In warm weather, falsework and forms shall remain in place under slabs, beams, girders, and arches for 14 days after day of last pour, except as set forth in 1 and 2 below:

1. Forms for slabs having clear spans less than 10 feet may be removed after 7 days.

2. When high-early-strength cement is used, forms for all structures may be removed after 4 days.

(c) In cold weather, the length of time that forms and falsework are to remain in place shall be at the discretion of the engineer.

(d) False work and centering for spandrel-filled arches shall not be struck until fills back of abutments have been placed up to the spring line. False work supporting the deck of rigid frame structures shall not be removed until fills have been placed back of the vertical legs.

(e) Forms and false work shall not be removed without the consent of the engineer. The engineer's consent shall not relieve the contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the time the forms are removed and in no case shall any portion of the wood forms be left in the concrete. As soon as the forms are removed, all projecting wire or metal devices which have been used for holding the forms in place, and which pass through the body of the concrete, shall be removed or cut back at least one-fourth inch beneath the surface of the concrete. All holes, depressions, and small voids which show upon the removal of forms, shall be filled with cement mortar mixed in the same proportions as that which was used in the body of the work. Lips of mortar and all irregularities caused by form joints shall be removed.

(f) The presence of areas of excessive honeycomb may be considered sufficient cause for rejection of a structure. Upon written notice from the engineer that a given structure has been rejected, the contractor shall remove and rebuild the structure in part or wholly as specified, at his own expense. In patching holes or porous spots, all coarse or broken material shall be chipped away until a dense uniform surface of

concrete exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form faces perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with thick, dry mortar composed of 1 part of portland cement to 2 parts of sand, which shall be tamped into place thoroughly. The surface of this mortar shall be floated with a wooden float before initial set takes place and shall be neat and workmanlike in appearance. The patch shall be kept wet for a period of 5 days.

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

206-3.14 FINISHING CONCRETE.—All concrete surfaces exposed in the completed work shall comply with the requirements of (c) below "Ordinary finish" except where the plans indicate "Rubbed finish," "Special terrazzo finish," "Special tooled finish," "Special sand-blast finish," or "Special wire brush or scrubbed finish," and except as provided below for "Concrete floors," and "Curbs and sidewalk surfaces."

(a) *Concrete Floors.*—Immediately after being poured, concrete floors shall be struck off with templates to provide proper crowns and shall be hand finished to smooth, even surfaces by both longitudinal and transverse wooden floats, or by other suitable means. Final finish shall be slightly but uniformly roughened by brooming or other methods as directed by the engineer. A finished surface shall not vary more than one-eighth inch from a 10-foot straightedge placed parallel to the center line of the roadway. No variations that will prevent complete drainage on all parts of the deck will be permitted.

(b) *Curbs and Sidewalk Surfaces.*—Exposed faces of curbs and sidewalks shall be finished to true surfaces. Concrete shall be worked until coarse aggregate is forced down into the body of the concrete and a layer of mortar one-fourth inch thick is flushed to the top. The surface shall then be floated to a smooth but not slippery finish. The junction of a sidewalk with masonry parapets shall be finished with a fillet of $\frac{3}{4}$ -inch radius. Walk surfaces shall be laid out in blocks with grooving tools as shown on the plans or as directed by the engineer.

(c) *Ordinary Finish.*—An "Ordinary Finish" is defined as the finish left on a surface after the removal of the forms, the filling of all holes left by form ties, and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections. All surfaces which cannot be repaired to the satisfaction of the engineer shall be given a "Rubbed Finish." The concrete in bridge seats, caps, and tops of walls shall be struck off with a straightedge,

and floated to true grade. The use of mortar topping for concrete surfaces shall in no case be permitted.

(d) *Rubbed Finish.*—When forms can be removed while the concrete is still green, the surface shall be pointed and wetted and then rubbed with a wooden float until all irregularities and form marks are removed and the surface is covered with a lather composed of cement and water. If permitted by the engineer, a thin grout composed of one part cement and one part fine sand may be used in the rubbing. This lather shall be allowed to set for at least 5 days. The surface shall then be smoothed by being rubbed lightly with a fine carborundum stone. If the concrete has hardened before being rubbed, a mechanically operated carborundum stone shall be used to finish the surface. Such work must not be done until at least 4 days after placing and it must be done in the following manner: A thin grout composed of one part cement and one part fine sand shall be spread over a small area of the surface and rubbed immediately with the stone until all form marks and irregularities are removed and the surface is covered with a lather, after which the surface shall be finished as described above for green concrete. The surface shall be smooth in texture and uniform in appearance. The building up of depressions will not be permitted.

The character of the materials used and the care with which forms are constructed and concrete placed are factors in determining the amount of rubbing required. If, through the use of first-class form materials and the exercise of special care, concrete surfaces are obtained which are satisfactory to the engineer, the contractor may be relieved entirely or in part from the requirement for rubbing.

(e) *Special Terrazzo Finish.*—Special terrazzo finish shall be produced as follows: The surface, either dry or covered with water, shall be ground with a No. 16 carborundum stone or an abrasive of equal quality until it is smooth and the individual pebbles and aggregate particles are cut and polished. The surface shall then be thoroughly cleaned with water. Final rubbing shall be done with a No. 30 stone. The finished surface shall present the texture of polished marble and shall show the various aggregate particles in polished outline.

(f) *Special Tooled Finish.*—Special tooled finish shall be produced with a bush hammer, a pick, a crandall, or other tool approved for this purpose. Air tools, preferably, shall be used. No tooling shall be done until the concrete has set for at least 14 days and as much longer as may be necessary to prevent the aggregate particles from being "picked" out of the surface. The finished surface shall show a grouping of broken aggregate particles in a matrix of mortar, each aggregate particle being in slight relief.

(g) *Special Sand-blast Finish.*—Special sand-blast finish shall be similar to the tooled finish described above but shall be of

finer grained texture. Sand blasting must be done with approved equipment and in such manner as to produce even, fine-grained surfaces in which mortar has been cut away leaving the aggregate particles exposed.

(h) *Special Wire Brush or Scrubbed Finish*.—Special wire brush or scrubbed finish shall be produced by scrubbing a surface of green concrete with a solution of muriatic acid in the proportion of 1 part acid to 4 parts water. Stiff wire or fiber brushes shall be used in the scrubbing. As soon as forms are removed and while the concrete is yet comparatively green, the surface shall be thoroughly and evenly scrubbed as described above and until the cement film is completely removed and the aggregate particles are exposed leaving an even, pebbled texture presenting an appearance of fine granite or coarser conglomerate depending upon the aggregate used. As soon as scrubbing has progressed sufficiently to produce the texture desired, all traces of the acid shall be removed by washing the entire surface thoroughly with water to which a small amount of ammonia has been added.

206-3.15 DRAINAGE HOLES AND WEEP HOLES.—Drainage holes and weep holes shall be constructed in the manner and at the locations indicated on the plans or required by the engineer. Ports or vents for equalizing hydrostatic pressure shall be placed below low water.

Forms for weep holes through concrete may be clay pipe, concrete drain pipe, or wooden boxes. If wooden forms are used, they shall be removed after the concrete is placed.

206-3.16 PIPES, CONDUITS, AND DUCTS.—Pipes, conduits, and ducts that are to be encased in concrete, shall be installed by the contractor as the concrete is being placed. Unless otherwise indicated, pipes embedded in concrete shall be of standard, lightweight, cast-iron water pipe or of wrought iron. The pipe shall be held rigidly so that it will not be displaced during the placing of the concrete.

METHOD OF MEASUREMENT

206-4.1 The yardage to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the yardage of concrete for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No measurements or other allowances will be made for forms, false work, cofferdams, pumping, bracing, metal expansion joint filler, premoulded filler for expansion joints, copper flashing, or finishing of any description of concrete or concrete floors, etc. Any Class A concrete constructed where Class B concrete was ordered in writing shall be measured for payment as Class B concrete. No deductions in yardage will be made for the volumes of reinforcing steel, drainage holes, weep holes, timber bumpers, pipes and conduits, or pile heads imbedded in concrete.

The yardage shall not include any yardage of concrete contained in any other item when the said other item provides that its pay name be compensation for any concrete involved.

BASIS OF PAYMENT

206-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Concrete" of the class or classes called for in the bid schedule, which price and payment shall constitute full compensation for the concrete, for placing and finishing, for furnishing all materials, for furnishing and installation of all joints, joint fillers, weep holes, and timber bumpers, for forms and false work, and for all labor, equipment, tools, and incidentals necessary to complete the item, except that reinforcing steel shall be paid for at the contract unit price per pound under **REINFORCING STEEL**. Metal pipes and drains, metal conduits and ducts, and metal expansion angles shall be paid for as reinforcing steel or as structural steel as indicated on the plans.

No direct payment for the use of high-early-strength cement shall be made, but the cost of such cement shall be considered as included in the bid price paid for the various classes of concrete.

ITEM 206A.—CONCRETE

(Classes XA, XB, XC, XX, XY, and XS)

DESCRIPTION

206A-1.1 This item shall consist of concrete composed of portland cement, fine aggregate, coarse aggregate, and water, prepared and constructed in accordance with these specifications, at the locations, and of the form, dimensions, and class shown on the plans or ordered in writing by the engineer.

206A-1.2 QUALITY AND PROPORTIONING OF CONCRETE.—Concrete shall be considered as of satisfactory quality provided that it is made of job materials mixed in the proportions ordered in writing by the engineer and provided that it is made in complete accordance with all the requirements stated below under "construction methods." "Job materials" shall be materials furnished on the job for this item by the contractor, meeting specifications and accepted by the engineer.

206A-1.3 JOB MIXES.—The proportions of the "job materials"—portland cement, fine aggregate, coarse aggregate, and water—ordered in writing by the engineer shall be termed the "Job Mix." A job mix shall be determined by the engineer for each class of concrete involved in the contract. During the progress of construction, the job mix may be altered by the engineer under the terms of 1.5 or 1.6, whichever governs the case.

206A-1.4 ORIGINAL MIXES.—There shall be an "Original Mix" for each class of concrete involved in the contract. Where Mix Design B governs, the original mix for each class appears in the table under 1.6. Mix Design B shall govern in all cases except that when the special provisions contain a table of Original Mixes of Materials from Named Sources and the contractor furnishes materials under the terms of 1.5, the original mix shall be the mix appearing in the said table for the combination of materials furnished by the contractor.

206A-1.5 MIX DESIGN A—AGGREGATES FROM NAMED SOURCES.—(a) The table of original mixes for materials from named sources in the special provisions gives the original mixes for materials from sources named therein. Materials from any of these sources meeting specifications may be furnished as job materials. If any bidder desires to furnish aggregates from sources other than those named in the said table, and submits samples of such aggregates to the labora-

tory designated by the engineer not less than 18 days prior to the opening of bids and such aggregates meet all the specification requirements, tests will be made and an original mix for such materials will be duly determined and made public not less than 2 days prior to the opening of bids. Such requests must be accompanied by a request for an original mix and by the required deposit fixed in such cases. The original mix in each case shall give the proportions of cement, aggregates, and water, and will include in each case the grading and the fineness modulus of the fine aggregate, and the size limits of each size of coarse aggregate used in the test.

(b) Immediately upon notice of award, the contractor shall advise the engineer of the exact location of the source or sources of aggregates which he proposes to furnish and use for this item. If, for material from these sources, an original mix has been duly determined and made public as provided in (a) above, the engineer shall set the job mix in accordance with such original mix subject to the further requirements of this subsection (b).

This job mix will govern during construction so long as aggregates are furnished from the sources originally designated provided they continue to meet the specifications and provided that the fineness modulus of the fine aggregate does not vary more than 0.2 either way from the fineness modulus of the sample used in the determination of the original mix, and further provided that each size of coarse aggregate conforms to the requirements for grading for the respective size. Slight variations in the relative quantities of fine and coarse aggregate for the purpose of controlling workability and in the amount of water for the purpose of maintaining the required consistency will be permitted under direction of the engineer. However, the total quantity of aggregate per bag of cement required by the job mix shall not be changed and the amount of water shall not vary more than 5 percent from that specified in the job mix, except as provided below:

(1) If, during the progress of the work, it is found impossible to obtain concrete of the required workability with the proportions designated in the job mix, the engineer may make such changes in the job mix as may be necessary to secure the workability desired, provided that in no case shall the ratio of water to cement be greater than that specified in the original job mix, and provided further that the contractor shall be compensated for any additional cement required by reason of such changes in proportions according to the following rule:

The additional quantity of cement to be paid for will be calculated by deducting the theoretical cement factor (barrels of cement per cubic yard for the original mix) from the theoretical cement factor for the revised job mix and multiplying this by the number of cubic yards of concrete theoretically required in the section involved.

(2) If, during the progress of the work, the contractor wishes to use aggregates from sources other than those originally designated by him and if such aggregates are aggregates from a named source or sources for which an original mix has been duly determined and made public, and meet the specifications, the engineer shall set a new job mix in accordance with such original mix, subject to the requirements and conditions under (b).

(c) The proportions given in the table of named sources in the special provisions have been fixed by the engineer in accordance with determinations made in the laboratory using representative samples of aggregates from each individual source or combination of sources, and that portland cement of those acceptable cements commercially available found to produce concrete of the least strength. The same cement was used with each and every aggregate or combination of aggregates. The representative samples met the grading and other requirements of the specifications applicable to them.

The proportions fixed for each combination of materials from named sources are those proportions which for the given combination were found to produce laboratory specimens of concrete of the strength shown in table 1 for concrete of its class, using the slump indicated and not more than the maximum amount of water permitted, both as given below in table 1. The proportions stated are for aggregates in a saturated surface dry condition. Strength tests shall be made in accordance with A.A.S.H.O. Method T-22.

Original mixes determined prior to the opening of bids, as provided for in (a) above shall be determined on the same basis and using the same cement used in determining the original mixes given in the table of named sources in the special provisions.

TABLE 1.—Proportions for mix design A

Class of concrete	Designed compressive strength at 28 days— A.A.S.H.O. Method T-22	Maximum net water content per bag of cement	Slump
	<i>Lbs. per sq. in.</i>	<i>Gallons</i>	<i>Inches</i>
XA.....	4,000	6.0	3-5
XB.....	3,000	7.0	2-3
XC.....	2,000	8.5	2-3
XX.....	4,000	6.0	2-3
XY.....	4,000	6.0	3-5
XS.....	4,000	6.0	6-8

206A-1.6 MIX DESIGN B. CONSTANT CEMENT FACTOR.—(a) For contracts where the special provisions do not contain a table of original mixes for materials from named sources and for contracts where the special provisions do contain such a table but job materials furnished are not from any of the sources covered by the table or from sources covered by an original mix under the terms of Mix Design A, the original mix to govern shall be the mix for the particular class of concrete as given in table 2 below.

The weights given in table 2 are weights of saturated surface-dry aggregates and are for aggregates having bulk specific gravities of 2.65, as determined by A.A.S.H.O. Methods T-84 and T-85. Proportionate corrections shall be made when the job aggregates used have bulk specific gravities above 2.70 or below 2.60. In any such case the corrected amount shall be the product of the number of pounds shown in table 2 multiplied by the ratio of the bulk specific gravity of the job aggregate to 2.65.

TABLE 2.—Proportions for mix design B. Constant cement factor

Class of concrete	Amount of saturated surface-dry aggregate per bag (94-pounds) of cement		Maximum net water content per bag of cement	Slump
	Fine	Coarse		
	<i>Pounds</i>	<i>Pounds</i>	<i>Gallons</i>	<i>Inches</i>
XA.....	190	295	6.0	3-5
XB.....	230	435	7.0	2-3
XC.....	360	520	8.5	2-3
XX.....	210	330	6.0	2-3
XY.....	190	245	6.0	3-5
XS.....	165	265	6.0	6-8

(b) After the materials provided by the contractor have been accepted for the project, the engineer will set the job mix in accordance with table 2 and the further requirements in the following paragraphs under (b).

If during the progress of the work it is found impossible to obtain concrete of the desired plasticity and workability with the relative weights of fine and coarse aggregate designated in the job mix, the engineer will make such changes in the proportions as are deemed necessary to obtain the desired plasticity and workability and set a new job mix, provided that in no case shall the total weight of aggregates per bag of cement be changed except as provided in 1 and 2 below.

(1) If it is found impossible to prepare concrete of the required slump without exceeding the maximum net water con-

tent specified in table 2 the total weight of the aggregate set in the job mix shall be reduced as directed by the engineer so that the maximum water content will not be exceeded. However, the contractor shall not be compensated for any additional cement which may be required by reason of such adjustment.

(2) If during the progress of the work there is a change in the specific gravity of one or both of the job aggregates, the job mix shall be changed to conform to the new specific gravity in accordance with the procedure outlined above.

206A-1.7 CLASSIFICATION.—The concrete constructed under this item will be designated and classified as class XA, XB, XC, XX, XY, or XS. Each class of concrete shall be used in such structures or in such parts of designated structures as called for on the plans or directed in writing by the engineer. Where not otherwise shown on the plans, the requirements as to use will be as given in table 3.

TABLE 3.—Classes and uses of concrete

Class	Maximum size of coarse aggregate, square mesh	Use
	<i>Inches</i>	
XA.....	1	General use and concrete exposed to sea water.
XB.....	2	Massive sections or highly reinforced sections.
XC.....	2½	Massive unreinforced sections.
XX.....	2	Massive sections or highly reinforced sections.
XY.....	½	Thin reinforced sections or handrails.
XS.....	1	Concrete placed under water.

MATERIALS

206A-2.1 Materials shall comply with the requirements prescribed under subsections 2.1, 2.2, 2.3, 2.4, 2.5, and 2.6 of ITEM 206.—CONCRETE.

CONSTRUCTION METHODS

206A-3.1 Construction methods shall be as prescribed under subsections 3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, and 3.16 of ITEM 206.—CONCRETE and concrete mixture for class XS shall be placed as required by subsection 3.8 of the said item.

METHOD OF MEASUREMENT

206A-4.1 The yardage to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the yardage of concrete for payment, the dimensions used shall be those shown on the plans

or ordered in writing by the engineer. No measurements or other allowances will be made for forms, false work, cofferdams, pumping, bracing, metal expansion joint filler, premolded filler for expansion joints, copper flashing, or finishing of any description of concrete or concrete floors, etc. No deductions in yardage will be made for the volumes of reinforcing steel, drainage holes, weep holes, timber bumpers, pipes, and conduits, or pile heads imbedded in concrete.

The yardage shall not include any yardage of concrete contained in any other item when the said other item provides that its pay name be compensation for any concrete involved.

BASIS OF PAYMENT

206A-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Concrete" of the class or classes called for in the bid schedule, which price and payment shall constitute full compensation for the concrete, for placing and finishing, for furnishing all materials, for furnishing and installation of all joints, joint fillers, weep holes, and timber bumpers, for forms and false work, and for all labor, equipment, tools, and incidentals necessary to complete the item, except that reinforcing steel shall be paid for at the contract unit price per pound under REINFORCING STEEL, and except that when mix design A governs, the cost delivered of any additional cement shall be paid to the contractor, as stipulated under the terms of the procedure with mix design A in the manner prescribed in articles 9.4 or 9.5. Metal pipes and drains, metal conduits and ducts, and metal expansion angles shall be paid for as reinforcing steel or as structural steel as indicated on the plans.

No direct payment for the use of high-early-strength cement shall be made, but the cost of such cement shall be considered as included in the bid price for the various classes of concrete.

ITEM 207.—REINFORCING STEEL

DESCRIPTION

207-1.1 This item shall consist of furnishing and placing reinforcing steel of the quality, type, and size designated, in accordance with these specifications, and in conformity with the requirements shown on the plans. When deformed bars are specified, the form of the bars used must be approved by the engineer and shall be such as to provide a net section at all points equivalent to that of a plain square or round bar of equal nominal size. Cold-twisted bars shall not be used. Steel mesh and expanded metal shall be used only when specified and shall be of the type shown on the plans and approved by the engineer.

MATERIALS

207-2.1 BAR REINFORCEMENT.—Bar reinforcement shall conform to the following specifications:

(a) *Billet Steel.*—Billet steel shall conform to A.A.S.H.O. Specification M-31 with the following modifications:

1. The use of cold twisted bars will not be permitted.
2. Bars shall be of structural steel grade or intermediate grade.

(b) *Rail Steel.*—Rail steel shall conform to A.A.S.H.O. Specification M-42 with the following modifications:

1. The use of hot twisted bars will not be permitted.
2. Bars shall be shop bent.
3. Bars shall not be produced by the "piling" method.

(c) *Axle Steel.*—Axle steel shall conform to A.A.S.H.O. Specification M-53 with the following modification:

1. Bars shall be of structural steel grade or intermediate grade.

(d) *Tests.*—If purchased in small lots from a warehouse, reinforcement may be accepted, at the discretion of the engineer, and subject to the bending test.

207-2.2 FABRICATED BAR OR ROD REINFORCEMENT.—Steel bars and rods fabricated in mat form shall conform to A.A.S.H.O. Specification M-54.

207-2.3 WELDED WIRE FABRIC REINFORCEMENT.—Steel wires fabricated into sheets (mesh) shall conform to A.A.S.H.O. Specification M-55.

CONSTRUCTION METHODS

207-3.1 All reinforcement shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust when placed.

When bending is required, the reinforcement shall be bent accurately without the use of heat. Bars having cracks or splits at the bends shall be rejected. All reinforcement shall be placed in the exact positions shown on the plans, and shall be held so securely in position by wiring and blocking from the forms and by wiring together at intersections that it will not be displaced during the depositing and compacting of the concrete. Precast concrete blocks or metal chairs should be used where appropriate. The use of pebbles for blocking is prohibited.

The placing and fastening of reinforcement in each section of the work shall be approved by the engineer before any concrete is deposited in the section.

When bar-bending diagrams are not shown on the contract plans, detail plans showing the shapes to which reinforcing bars will be bent shall be submitted to the engineer for approval.

207-3.2 SPlicing REINFORCEMENT.—Main reinforcing bars carrying determinate stresses shall be spliced only where shown on the plans, unless approval for splicing is obtained from the engineer before the reinforcing steel is ordered.

METHOD OF MEASUREMENT

207-4.1 The poundage to be paid for shall be the calculated theoretical number of pounds (on the basis of 490 pounds per cubic foot) of the reinforcing steel placed as shown on the plans, complete in place and accepted. The unit weight used for deformed bars shall be the weight of plain square or round bars, as the case may be, of equal nominal size. Clips, ties, separators, or other material used for fastening the reinforcing steel in place and structural steel shall not be included in the poundage for payment under this item. If so indicated on the plans, the poundage to be paid for shall include the weight of metal pipes and drains, metal conduits and ducts, and metal expansion angles.

BASIS OF PAYMENT

207-5.1 The poundage, determined as provided above, shall be paid for at the contract unit price per pound for "Reinforcing Steel," which price and payment shall constitute full compensation for furnishing and placing all the material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 220.—STRUCTURAL STEEL

DESCRIPTION

220-1.1 This item shall consist of furnishing, fabricating, and erecting, or furnishing and fabricating, or erecting structural steel, whichever is called for in the bid schedule. This item shall include structural, eyebar, rivet, and special alloy steels, wrought iron, steel forgings, steel castings, iron castings, and the painting thereof, and shall also include any incidental metal construction not otherwise provided for, all in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or ordered in writing by the engineer.

Furnishing and fabricating shall include delivery of the fabricated shop-painted materials free of charge at the place designated in the special provisions.

Erecting shall include unloading of the fabricated material, payment of any demurrage charges, transporting to the bridge site and furnishing and applying field paint unless otherwise specified.

MATERIALS

220-2.1 METALS.—Metal materials, including structural, eyebar, and rivet steels; special alloy steel; steel forgings; and steel, wrought iron, gray iron, and malleable castings, shall comply with and meet the requirements of "Standard Specifications for Highway Bridges" (1935) of the A.A.S.H.O., division II, sections 7 to 13, inclusive.

Alloy steels shall be plainly marked at frequent intervals for identification. These marks shall be made during or immediately after rolling, shall be of such nature and spacing that they will be visible on practically all pieces cut during fabrication, and shall be visible after shop and field paints have been applied.

Railings and parapets for bridges, wing walls, retaining walls, etc., composed of rolled shapes or rolled shapes in combination with pipe or other metal sections shall meet the requirements of the above A.A.S.H.O. specifications, article 3.8.1.

220-2.2 SCHEDULE OF PAINT COATS FOR METALS.—Steel structures, including handrails, shall be painted with three coats of paint as described below. The particular "alternate" to be used shall be as shown on the plans.

(a) *Shop Coat.*—Red-lead paint.

(b) *First Field Coat.*—Red lead paint, tinted light brown with lampblack in an amount not more than one-fourth pound per gallon of linseed oil. Alternate: White-lead zinc-oxide paint, tinted light gray with lampblack.

(c) *Second Field Coat.*—Aluminum paint (to be used when first field coat is red lead). First alternate: White-lead zinc-oxide paint (to be used when first field coat is white lead), tinted with lampblack to light gray of a different shade from that of the first field coat. Second alternate: White-lead chrome-oxide green paint.

220-2.3 COMPOSITION OF PAINTS.—The composition of paints shall be in the following proportions. Paint shall be furnished in paste form unless the plans specifically permit dry pigment.

(a) *Red-lead Paint*

WHEN DRY PIGMENT IS USED

WHEN PASTE IS USED

100 pounds dry red-lead pigment.	100 pounds red-lead paste.
3 gallons raw linseed oil.	1 $\frac{3}{8}$ gallons raw linseed oil.
2 $\frac{1}{2}$ pints turpentine.	2 $\frac{1}{2}$ pints turpentine.
2 $\frac{1}{2}$ pints liquid drier.	2 $\frac{1}{2}$ pints liquid drier.

(b) *White-lead Zinc-oxide Paint*

WHEN TURPENTINE IS USED

WHEN MINERAL SPIRITS ARE USED

75 pounds white lead.	75 pounds white-lead paste.
25 pounds zinc-oxide paste.	25 pounds zinc-oxide paste.
3 to 4 gallons raw linseed oil.	3 to 4 gallons raw linseed oil.
$\frac{1}{2}$ to $\frac{3}{4}$ gallon turpentine.	$\frac{1}{2}$ to $\frac{3}{4}$ gallon mineral spirits.
2 to 3 pints drier.	2 to 3 pints drier.

(c) *White-lead Chrome-oxide Green Paint*

100 pounds white lead (soft paste).
 20 pounds chrome-oxide green (paste in oil).
 2 $\frac{3}{4}$ gallons raw linseed oil.¹
 1 gallon long oil spar varnish.
 2 pints drier.

(d) *Aluminum Paint.*—Aluminum paint shall be in the proportion of 2 pounds of aluminum powder or aluminum pigment paste to 1 gallon of varnish. When mixed in this proportion, the resulting paint shall give a free flowing, smooth,

¹ Instead of raw linseed oil, a mixture of one-third boiled linseed oil and two-thirds raw linseed oil may be used. If so used, the drier may be reduced 50 percent and an equal volume of turpentine substituted.

continuous coating free of breaks or sags. When applied to a smooth vertical steel surface, the paint shall have satisfactory leafing properties.

Aluminum paint shall be mixed on the day it is used, except that "ready-mixed" paint, composed of aluminum powder and varnish meeting the specifications, may be furnished upon the engineer's approval provided that it retains its "leafing" properties for, and is used within, a period of 2 weeks after mixing.

220-2.4 MATERIALS FOR PAINTS.—These materials shall conform to the requirements of Federal specifications, as follows:

- Red lead, dry or paste, TT-R-191a, Grade B.
- Basic carbonate white lead, dry or paste, TT-W-251a, Type A or Type B.
- Zinc oxide, dry or paste, TT-Z-301.
- Chrome-oxide green (paste in oil) TT-C-231, Type A.
- Aluminum powder, TT-A-476, Type A.
- Aluminum-pigment paste, TT-A-466, Type A.
- Lampblack, TT-L-71.
- Linseed oil, raw, JJJ-O-336.
- Linseed oil, boiled, JJJ-O-331.
- Turpentine, LLL-T-791a or LLL-T-792.
- Mineral spirits, TT-T-291.
- Drier, TT-D-651.
- Varnish, for aluminum paint, (powder and paste), TT-V-81a, Type I or Type II, as per plans.
- Varnish, long oil spar, TT-V-121a.

220-2.5 PACKING AND SHIPPING PAINT.—All paint furnished must be shipped in strong, substantial containers, plainly marked with the name, weight, and volume of the paint content, together with the color, formula, and the name and address of the manufacturer.

CONSTRUCTION METHODS

220-3.1 FABRICATION.—The preparation, handling, testing, inspection, and shop assembly of the material, and all the details of fabrication shall meet the requirements of the A.A.S.H.O. "Standard Specifications for Highway Bridges" (1935) division I, section 10, except articles 3.10.52, 3.10.53, 3.10.55, 3.10.65, 3.10.66, 3.10.67, and 3.10.69.

220-3.2 RAILING.—Metal railing shall meet the requirements of division IV, article 4.8.3 of the above A.A.S.H.O. specifications.

220-3.3 PAINTING METAL SURFACES.—Shop painting shall meet the requirements of division III, section 11, of the above A.A.S.H.O. specifications, with the following additional requirements:

(a) *Inaccessible Surfaces.*—On all surfaces which are inaccessible for paint brushes, the paint shall be applied by spraying or with sheepskin daubers to insure thorough covering.

Spraying.—Power spraying equipment shall apply the paint in a fine even spray without the addition of any thinner. In cool weather, the paint may be warmed to reduce the viscosity for use. Such warming shall be accomplished by heating the paint containers in water or by placing them on steam radiators.

Paint when applied with spray equipment shall be immediately followed by brushing when necessary to secure uniform coverage and to eliminate wrinkling, blistering, and air holes.

(b) *Painting Galvanized Surfaces.*—For the purpose of conditioning the surface of galvanized surfaces for painting, the painting shall be deferred as long as possible in order that the surface may weather.

Before painting galvanized surfaces they shall be treated as follows:

In 1 gallon of soft water dissolve 2 ounces each of copper chloride, copper nitrate, and sal ammoniac, then add 2 ounces of commercial muriatic acid. This should be done in an earthen or glass vessel, never in tin or other metal receptacle. Apply the solution with a wide flat brush to the galvanized surface. The surface will assume a dark, almost black, color, which on drying will become gray.

(c) *Cleaning of Surfaces.*—Surfaces of metal to be painted shall be thoroughly cleaned, removing rust, loose mill scale, dirt, oil or grease, and other foreign substances. Three methods of cleaning are provided herein. Unless otherwise specified on the plans method A shall be used.

Method A—Hand cleaning.—The removal of rust, scale, and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers, or other effective means. Oil and grease shall be removed by the use of gasoline or benzine. Bristle or wood fiber brushes shall be used for removing loose dust.

Method B—Sandblasting.—The metal to be cleaned by this method shall be sandblasted to remove all mill scale and other substances down to the bare metal. Special attention shall be given to cleaning of corners and re-entrant angles. Before painting, any sand adhering to the steel in corners and elsewhere shall be removed. The cleaning shall be approved by the engineer prior to any painting. The material shall be painted as soon as practicable after it is cleaned.

Method C—Flame cleaning.—The metal to be cleaned by this method shall be treated in accordance with the following operations:

1. Oil, grease, and similar adherent matter shall be removed by washing with a suitable solvent. Excess solvent shall be wiped from the metal before proceeding with subsequent operations.

2. The surfaces to be painted shall be cleaned and dehydrated (freed of occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least 1. The inner cones of these flames shall have a ratio of length to port diameter of at least 8 and shall be not more than 0.15 inches center to center. The oxyacetylene flames shall be traversed over the surfaces of the steel in such manner and at such speed that the surfaces are dehydrated; and dirt, rust, loose scale, scale in the form of blisters or scabs, and similar foreign matter are freed by the rapid, intense heating by the flames. The flames shall not be traversed so slowly that loose scale or other foreign matter is fused to the surface of the steel. The number, arrangement, and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated.

3. Promptly after the application of the flames, the surfaces of the steel shall be wire brushed, hand scraped wherever necessary, and then swept and dusted to remove all free material and foreign particles. Compressed air shall not be used for this operation.

4. Paint shall be applied promptly after the steel has been cleaned and while the temperature of the steel is still above that of the surrounding atmosphere so that there will be no recondensation of moisture on the cleaned surfaces.

5. The inside surfaces of boxed members and other surfaces, which will be inaccessible to the flame cleaning operation after the member is assembled, shall be cleaned as specified in paragraphs 1 and 2 above, and wire brushed but not painted before the member is boxed or assembled. After all fabrication of the member is completed, its inside surfaces shall be hand wire brushed or hand scraped wherever necessary in order to remove dirt and other foreign substances which may have accumulated after the surfaces were originally cleaned. The outside surfaces of the members shall then be cleaned and dehydrated, wire brushed, and hand scraped wherever necessary. All surfaces shall then be swept and dusted to remove free material and foreign particles and the member completely painted.

Field painting shall meet the requirements of the said section 11. In the application of aluminum paint by brushing, the finish strokes shall generally be made in the same direction. The use of spraying machines for applying aluminum paint will be permitted. For applying paints other than aluminum paint, the use of spraying machines will be permitted only on condition that the operator brush out the paint immediately after its application. The right is reserved to require the use of brushes should the engineer consider the work done by the spraying machine unsatisfactory.

Where timber decks are provided, the top flanges of all stringers and floor beams shall be protected by coverings com-

posed of a heavy layer of thick red-lead paste, tar, asphalt, or pitch, and one thickness of two-ply tar paper wide enough to project 3 inches beyond the edges of the members which shall be bent down at an angle of 45 degrees. This work shall be done before the final field painting.

METHOD OF MEASUREMENT

220-4.1 The poundage to be paid for shall be the number of pounds of structural steel in the completed and accepted structure. For the purpose of measurement for payment, castings, silicon steel, steel anchor and bearing plates, steel plates, and structural shapes for expansion joints and pier protection, shall be considered as structural steel. The weight of erection bolts, field paint, and all boxes and crates or other containers used for packing, together with sills, struts, and rods used for supporting members during transportation, bridge hardware connectors for joining timber members, nails, spikes, and bolts, except anchor bolts, shall be excluded.

Unless otherwise provided, the weights paid for shall be computed weights which shall be calculated on the basis of the following assumptions:

Steel shall be assumed at 0.2833 pounds per cubic inch and cast iron at 0.26 pounds per cubic inch. The weights of rolled shapes, and of plates up to and including 36 inches in width, shall be computed on the basis of their nominal weights and dimensions, as shown on the approved shop drawings, deducting for capes, cuts, and open holes.

To the nominal weights of plates more than 36 inches in width, there shall be added one half the percentage of overrun in weight otherwise allowable.

Castings shall be computed from the dimensions shown on the approved shop drawings, with an additional weight allowance of 10 percent for fillets and overrun.

The weight of heads of shop-driven rivets shall be included in the computed weight, assuming the weights to be as follows:

<i>Diameter of rivets (inches):</i>	<i>Weight per 100 heads (pounds)</i>
$\frac{1}{2}$ -----	5
$\frac{5}{8}$ -----	9.7
$\frac{3}{4}$ -----	16
$\frac{7}{8}$ -----	24
1 -----	35
$1\frac{1}{8}$ -----	49
$1\frac{1}{4}$ -----	78

To the total computed weight of metal may be added 0.4 of 1 percent as an allowance for shop paint.

BASIS OF PAYMENT

220-5.1 (a) The poundage, determined as provided above, shall be paid for at the contract unit price per pound for "Structural Steel—Furnished, Fabricated, and Erected," which price and payment shall constitute full compensation for furnishing, fabricating, delivering, erecting ready for use, and painting all the steel and other metal, and for all labor, equipment, tools, and incidentals necessary to complete the item.

(b) When a quantity and unit price for "Structural Steel—Furnished and Fabricated" are contained in the bid schedule, the poundage, determined as provided above, shall be paid for at the said contract unit price per pound, which price and payment shall constitute full compensation for furnishing, fabricating, shop painting, and delivering the structural steel and other metal free of charges at the place designated in the special provisions, and for all labor, equipment, tools, and incidentals necessary to complete the item, save erection.

(c) When a quantity and unit price for "Structural Steel, Erected" are contained in the bid schedule, the poundage determined as provided above, shall be paid for at the said contract unit price per pound, which price and payment shall constitute full compensation for unloading all the structural steel and other metal, payment of any demurrage charges, transporting to the bridge site, erection complete ready for use, including furnishing and applying the field paint, and for all labor, equipment, tools, and incidentals necessary to complete the item, save furnishing and fabrication.

220-5.2 For the purposes of 5.1 above, and unless otherwise shown on the plans, castings, forgings, special alloy steels, steel plates, wrought iron, structural shapes for expansion joints, and pier protection shall be considered as structural steel, save that when quantities and unit prices for certain alloy steels, forgings, castings, or other specific categories of metal are called for in the bid schedule, the weight of such selected material, determined as provided above, shall be paid for at the respective contract unit price per pound for "Structural Steel (alloy steel, forgings, castings, and/or other category), Furnished, Fabricated, and Erected" or "Structural Steel (), Furnished and Fabricated," as the case may be, and as named in the bid schedule.

ITEM 230.—TREATED AND UNTREATED TIMBER

DESCRIPTION

230-1.1 This item shall consist of structural timber of the stress-grades, sizes, and dimensions specified, treated or untreated as called for in the bid schedule, and furnished, prepared, erected, and painted; also, any required yard lumber of the sizes and grade specified and all hardware, all in accordance with these specifications and in conformity with the design and details shown on the plans or ordered by the engineer. Structural timber shall be of the stress-grade quality stipulated on the plans for the specific component members of the structure. Yard lumber shall be of the kinds and grade called for on the plans. Round poles and round posts shall be of the kinds indicated on the plans and of the quality hereinafter specified.

230-1.2 TREATED TIMBER.—Treated timber shall be interpreted to mean timber of the stress grade called for, treated by a pressure method to retain at least the minimum quantity per cubic foot of the preservative stipulated in table 1. The type of preservative used shall be that called for in the bid schedule. Where more than one type is required by the contract, each type shall be used as indicated on the plans.

TABLE 1.—Requirements for treated timber

Uses	Minimum absorption of preservative, pounds of preservative per cubic foot of wood					
	Creosote oil or creosote coal tar solution		50-50 creosote-petroleum oil blend	Zinc chloride or chromated zinc chloride	Zinc meta-arsenite	Wolman salts (Tanalith)
	Empty cell	Full cell	Empty cell			
General bridge construction except marine use.	8	-----	10	(1)	(1)	(1)
Poles-----	8	-----	10	(1)	0.3	0.3

¹ See special provisions.

MATERIALS

230-2.1 Timber and lumber shall meet all the respective requirements for those materials as given in section 20 of division II of the A.A.S.H.O. "Standard Specifications for Highway Bridges" (1935) except for the specific deletions and amendments stated in (a) and (b) below. No boxed heart pieces shall be allowed in stringers, floor beams, caps, posts, sills, or rail posts of Douglas fir or redwood. Boxed heart pieces are defined as timber so sawed that at any point in the length of a sawed piece the pith lies entirely inside the four faces.

(a) Article 2.20.3 Grading of yard lumber.—Delete the first sentence and substitute: "Yard lumber shall be graded in accordance with the American Lumber Standards."

(b) Article 2.20.5 General.—Delete this entire section.

230-2.2 STRESS GRADES AND STANDARD STRESS GRADES.—For all structural uses for which a stress grade is specified, the materials furnished shall meet the requirements of the said A.A.S.H.O. specification, section 20 of division II, for structural timber of the respective stress grades stipulated on the plans for the several members and uses.

230-2.3 PRESERVATIVES.—The preservative shall meet the requirements given below for the particular type used.

(a) *Creosote Oil and Creosote-coal-tar Solution.*—Creosote oil and creosote-coal-tar solution shall meet the requirements given in subsection 21.1 of division II of the A.A.S.H.O. "Standard Specifications for Highway Bridges" (1935).

(b) *50-50 Creosote-petroleum Oil Blend.*—A blend of 50 percent creosote and 50 percent petroleum oil of suitable character may be used, if approved in writing by the engineer, in cases where such considerations as delayed or reduced checking indicate its use to be advantageous. Petroleum oil so used shall have an asphalt base, a flash point of not less than 220° F. (Cleveland Cup), a viscosity (Furol) at 180° F. of 60 to 180 seconds, and at 100° F. of not more than 1,300 seconds, and shall not contain more than 1 percent of water. When mixed with an equal volume of creosote, the resulting mixture shall be free from sludge and shall have a viscosity (Furol) at 180° F. of not over 70 seconds.

(c) *Zinc Chloride.*—Zinc chloride shall be free of acid and shall contain not more than 0.1 percent iron. Fused or solid zinc chloride shall contain at least 94 percent chloride of zinc. Concentrated zinc chloride shall contain at least 50 percent chloride of zinc.

(d) *Chromated Zinc Chloride.*—Chromated zinc chloride shall contain not less than 81.5 percent of zinc chloride as defined

above, and not more than 18.5 percent sodium bichromate, which shall be commercial bichromate of sodium



Concentrated chromated zinc chloride shall contain not less than 50 percent of chromated zinc chloride.

(e) *Zinc Meta-arsenite.*—Zinc meta-arsenite shall be in aqueous solution. The strength, acidity, etc., of the solution shall be such as to insure the required penetration and absorption of the preservative in the quantity required.

The zinc meta-arsenite shall be used in approximately the following proportions:

Arsenious acid (As_2O_3)	120 parts.
Zinc oxide (ZnO)	80 parts.
Acetic acid	Sufficient to keep the zinc meta-arsenite in solution.

(f) *Wolman Salts.*—Wolman salts shall be Tanalith conforming approximately to the following requirements:

Tanalith (to resist decay and termites):	Minimum, percent
Sodium fluoride	23.12
Disodium hydrogen arsenate	23.13
Potassium dichromate	34.68
Dinitrophenol	11.57
Insolubles, in hot water	0.50

230-2.4 SAMPLING AND TESTING.—(a) *Creosote Oils.*—Preservative oils shall be sampled using A.A.S.H.O. Method T-60.

(b) *Zinc Chloride.*—Zinc chloride shall be tested using A.S.T.M. Standard D 199-27.

(c) *Chromated Zinc Chloride.*—Chromated zinc chloride shall be tested for determination of zinc as described above for zinc chloride. For the determination of sodium bichromate the method shall be as follows:

Solutions required:

- Standard N/10 sodium thiosulphate.
- 20% solution c.p. potassium iodide.
- Starch solution.
- Concentrated c.p. hydrochloric acid.

The starch solution is best prepared by mixing 1 gm. of soluble starch to a paste with a little distilled water and adding it to 200 cc. of boiling distilled water. In case of solid chromated zinc chloride a sample of approximately 6 gm., and in case of 50 percent chromated zinc chloride a sample of about 12 gm., should be taken. The sample should be weighed

accurately in a closed weighing bottle, dissolved in distilled water, the volume made up to 500 cc. in a standard flask and a little hydrochloric acid added to remove any turbidity, and a 25 cc. aliquot taken for titration. In case of treating solutions (2 to 6 percent) a sample of 5 to 10 grams is weighed and taken directly for titration. The precision of the method is highest with a titration of 10 cc. to 15 cc. of N/10 thiosulphate. The aliquot or sample taken for titration is diluted to approximately 300 cc. in a beaker or Erlenmeyer flask. Five cc. of concentrated hydrochloric acid are added and the solution cooled a little below room temperature. Ten cc. of the 20 percent potassium iodide solution are added and the sample allowed to stand 10 minutes. The liberated iodine is then titrated with the N/10 thiosulphate until the yellow color of iodine almost disappears. Two cc. of starch solution are added and titration continued until the blue color just disappears. The percentage of sodium bichromate in the original sample is calculated as follows:

$$\frac{\text{cc.'s of N/10 thiosulphate} \times 0.4966}{\text{weight of aliquot sample}} = \text{percentage Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$$

(d) *Wolman Salts—Procedure for Analysis.*

1. *For sodium fluoride.*—After removal of other ingredients by silver nitrate, followed by sodium chloride, the filtrate is exactly neutralized to litmus and the fluorine precipitated by calcium chloride, which, after vigorous boiling, is filtered through the asbestos mat of a Gooch crucible, dried, and weighed as calcium fluoride.

2. *For the disodium hydrogen arsenate.*—After being treated with sulphuric acid and potassium iodide, followed by continued boiling until all liberated iodine is driven off, the solution is neutralized with solid sodium bicarbonate, then, with addition of starch solution, titrated to N/10 iodine solution.

3. *For potassium dichromate.*—Precipitate as barium chromate by the addition of barium acetate. After filtering and washing, dissolve with warm hydrochloric acid, add potassium iodide, and titrate against N/10 sodium thiosulphate.

4. *For dinitrophenol.*—To the dry salts, or to the residue of a solution evaporated nearly to dryness, add a little water and then concentrated sulphuric acid. Place in a separatory funnel and extract the dinitrophenol with ether by drawing it off into a small weighed flask. About four extractions of each sample will suffice. Evaporate with care over waterbath, with very slow final drying in a desiccator. Weigh as dinitrophenol, with the tolerance appropriate for the exact method employed.

230-2.5 PAINT FOR RAILS AND RAIL POSTS.—White paint for priming and for second coats on rails and rail posts shall consist of 100 percent white lead, uniformly mixed with

pure linseed oil to the required consistency. The finish coat shall consist of 3 parts by weight of white lead to 1 part by weight of zinc oxide, uniformly combined and mixed with pure linseed oil to the required consistency. Turpentine and/or drier may be added to the paint but shall not exceed one-half pint per gallon of paint. The paint materials shall meet the requirements for these materials specified under **STRUCTURAL STEEL**, and shall be delivered separately on the project in the original containers before being opened and mixed with the linseed oil.

CONSTRUCTION METHODS

230-3.1 All construction involving timber or lumber shall be in accordance with the requirements given in "Construction Methods" under **TIMBER BRIDGES**.

230-3.2 SEASONING AND OTHER PREPARATION FOR ALL TIMBER TREATMENT.—Seasoning and other preparation for timber treatment shall be in accordance with the "Standard Specifications for Highway Bridges" (1935) of the A.A.S.H.O., division III, section 17, articles 3.17.2 and 3.17.3, except that in the last sentence of article 3.17.2 the requirement of one-tenth pound per cubic foot condensation per hour shall be changed to one-sixth pound per cubic foot per hour.

All Douglas fir and white oak shall be incised prior to treatment with creosote using a machine equipped with power-driven rolls, and in accordance with standard practice. The incising shall be accomplished in such a manner as to obtain a uniform depth of penetration of creosote with a minimum loss of structural strength.

After treatment and before shipment, timber which is to be painted shall be kiln-dried or air-seasoned for 30 days.

230-3.3 PLANT EQUIPMENT.—Treating plants shall be equipped as specified in article 3.17.4 of section 17 cited above.

230-3.4 PENETRATION OF TREATMENTS.—The depths of penetration of treatments and the methods of determining the same shall comply with the requirements of article 3.17.5 of section 17 cited above, except that any penetration exceeding 2 inches in depth shall be considered as full sapwood penetration. In the case of sawn timbers, the location of the test boring shall be selected at the point of maximum sapwood thickness. In gaging the depth penetrated by preservatives other than creosote oil the method used shall be such as will enable the engineer to determine, to his satisfaction, the actual depth penetrated.

230-3.5 METHODS FOR TIMBER TREATMENT.—(a) *Oil Treatments.*—Oil treatments of Southern pine shall comply with the requirements of article 3.17.7 (a), (b), and (c) of section 17 cited above.

Oil treatments of Douglas fir shall comply with the requirements of article 3.17.8 of section 17 cited above.

(b) *Zinc Chloride Treatments.*—Zinc chloride and chromated zinc chloride treatments of Southern pine shall comply with the requirements of article 3.17.7 (d) of section 17.

Zinc chloride and chromated zinc chloride treatments of Douglas fir shall comply with the requirements of article 3.17.7 (d) of section 17 cited above, except that green material shall be steam-seasoned at a pressure of not more than 20 pounds per square inch for a period not exceeding 6 hours at not more than 260° F., which pressure and temperature maxima shall not be reached in less than 2 hours.

(c) *Wolman Salts Treatments.*—Treatment with Wolman salts shall be by the full cell process; and the ranges of temperature, pressure, and time duration shall be controlled so as to result in maximum penetration by the quantity of preservative solution injected.

In general, the material to be treated shall have been seasoned by air drying, or kiln drying, or a combination of both until the moisture content in the treatable areas of the wood has been reduced to not more than 20 percent of the oven-dry weight of the wood. When it is necessary to treat lumber or timber having a greater moisture content than 20 percent, such material shall be artificially seasoned in the retort by alternate steam bath and vacuum of such intensity and duration and such number of cycles as will prepare the material for a minimum absorption of solution to provide the stipulated net dry salt retention. In no case shall the steam pressure be such as to exceed a maximum temperature in the retort of 240° F.; and for Douglas fir and other more sensitive woods, the maximum pressure shall be not more than 20 pounds per square inch and the steaming period shall not exceed 6 hours, which pressure and temperature maxima shall not be reached in less than 2 hours. The retort shall be relieved of condensate and wood extracts continuously during both the steaming and the vacuum periods. After the final vacuum, the treating solution shall not be admitted to the retort until all such condensate and wood extracts have been evacuated thoroughly.

The concentration of Wolman salts in the solution shall be so adjusted that the injected quantity of solution, after the carrier water has dried out, shall leave not less than 90 percent nor more than 110 percent of the stipulated dry salt retention, in any one charge.

Concentration of the treating solution shall be taken as the percentage of weight of dry salt relative to the total weight of the solution, the weight of water being taken as 62.30 pounds per cubic foot at a temperature of 60° F. When the quantity of impregnated solution is determined by volume, the corresponding weight of the solution shall be corrected by the proper factor for any temperature other than 60° F., at which the readings for volume may have been taken. The weight of

a solution shall be considered as the actual weight of the water plus five-sixths of the weight of the dissolved salts.

Before and after each charge the density of the treating solution shall be observed by means of a calibrated hydrometer, and the concentration of the salts in the solution shall be calculated.

Refractory woods such as Douglas fir, larch, tamarack, green timber, partly seasoned timber, or heartwood lumber, for which the heavier concentrations of treating solution are required, shall not be placed for treatment in the same charge with non-refractory woods. For either class of material the concentration of treating solution shall provide the net dry salt retention stipulated, with the largest amount of absorption practicable for the kind of material treated.

Impregnation.—The properly conditioned material, closed off in a tightly sealed retort, shall be subjected to an initial vacuum of not less than 27 inches for not less than 15 minutes after the maximum has been reached. Then, with the vacuum apparatus remaining in operation so that the vacuum is fully maintained until the material to be impregnated has been wholly submerged, the treating solution shall be admitted to the retort, continuing until the retort is completely filled. Thereafter additional solution shall be forced into the retort by a pressure pump as rapidly as it is absorbed by the wood, and in such volume as gradually to build up the pressure of the solution within the retort to a maximum of 150 pounds per square inch for southern pine, and to a maximum of 175 pounds per square inch for Douglas fir and other similar refractory kinds of wood.

The pumping may be discontinued at intervals to observe the rate of absorption. The pressure shall be raised finally to the maximum and maintained until the amount of preservative solution required to comply with the stipulated net retention has been injected, or until less than 5 percent of the total quantity required has been injected during the latter half of 1 hour throughout which the rate of absorption has steadily decreased while the pressure has been maintained at the maximum.

The temperature of the treating solution shall be not less than 120° F. nor more than 200° F. during the pressure period, except that when the wood is of resinous character and is to be painted, the temperature of the treating solution shall not be such as to result in interference with the painting, but it shall not be less than 100° F.

After the pressure period, the retort shall be emptied of preservative solution and the air pressure adjusted so that when the charge is removed it will be free from drip or further loss of impregnated solution. All drip in the retort or solution extracted by final vacuum shall be returned to the work tank

before the readings are taken to determine the amount of absorption of the preservative solution.

Readings of volume and temperature of the solution in the work tank shall be taken by means of suitable, accurate devices on the tank. Readings shall be taken before introduction of the solution into the charged retort, at the start of the pressure pumping, after the first return of solution from the retort, and after the final return. A record shall be made of the readings for use in calculation of the initial absorption, kick-back and total remaining solution that has been injected into the charge.

(d) *Zinc Meta-Arsenite Treatments*.—Only properly conditioned material shall be treated. Treatment with zinc meta-arsenite shall conform to the following requirements: No charge shall retain less than 90 percent of the quantity of preservative specified, but the average retention of preservative by the material treated under any contract or order shall be at least 100 percent of the quantity specified. The amount of preservative retained shall be calculated on the basis of preservative at 60° F. The net amount of preservative retained in the wood shall be the difference between the salt in the measuring or weighing tank at the start and at the end of the treatment, after the solution from the cylinder, including all drip from the wood at the conclusion of the final vacuum period, has been returned to the measuring or weighing tank. This net retention shall be determined from the initial and final readings on the measuring or weighing tank using suitable, accurate devices thereon and from an analysis of the solution in the tank at the start and at the end of the treatment.

The preservative solution shall have such a strength that the material to be treated shall have the required retention of preservative with the largest volumetric absorption practicable.

(e) *Full-Cell Process*.—The wood shall be subjected to a vacuum of sufficient intensity and duration to insure that the wood is as dry and free of air as practicable, and to permit a retention of the specified amount of preservative per cubic foot of wood.

The preservative shall be introduced at atmospheric temperatures of not less than 60° F. The cylinder shall be filled without breaking the vacuum. The pressure shall then be raised to and maintained at a minimum of 100 pounds per square inch or until the quantity of preservative required to insure the final retention stipulated is injected into the wood, or until the largest volumetric injection that is practicable has been obtained. The temperature of the preservative during the pressure period shall be not more than 110° F. After pressure is completed the cylinder shall be emptied speedily of preservative, and a vacuum of not less than 22 inches promptly created and maintained until the wood can be removed from the cylinder free of dripping preservative.

METHOD OF MEASUREMENT

230-4.1 The quantities to be paid for shall be the number of thousand feet board measure (M feet b. m.) of each variety of lumber and timber, complete in place and accepted. Measurements of lumber and timber will be computed from the nominal dimensions and actual lengths shown on the plans. The cross section dimensions on the plans shall be interpreted as standard sizes. The standard cross section dimensions shall be used in the computations even though the actual size be scant in the amount specified. The measurement of lumber and timber shall include only such material as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as false work, bracing, sheeting, etc., nor timber bumpers at the ends of concrete spans or steel spans with concrete decks.

No portion of any pile shall be included in the measurement for payment.

BASIS OF PAYMENT

230-5.1 The quantities, determined as provided above, shall be paid for at the contract unit prices per thousand feet board measure (M feet b. m.) for "Untreated Timber," "Treated Timber, Creosote Preservative," "Treated Timber, Zinc Chloride Salts Preservative," "Treated Timber, Wolman Salts Preservative," or "Treated Timber, ZMA Preservative," as the case may be, which prices and payments shall constitute full compensation for procuring, furnishing, and delivering all lumber and timber, for any preservative treatment required, for all hardware, and other metal parts used in the item, for preparing, framing, assembling, erecting, and painting, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Timber bumpers at the ends of concrete floor slabs shall be considered an incidental part of the work paid for under CONCRETE.

in writing by the engineer. No deductions will be made for weep holes, drain pipe, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

240-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Dry Rubble Masonry," which price and payment shall be full compensation for furnishing and placing all material, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 240.—DRY RUBBLE MASONRY

DESCRIPTION

240-1.1 This item shall consist of stone masonry laid without mortar and constructed on the prepared foundation bed in accordance with these specifications, and in conformity with the lines, grades, sections, and dimensions shown on the plans or ordered in writing by the engineer.

MATERIALS

240-2.1 STONE.—The stone shall be clean, hard, and of a kind known to be durable and shall be subject to the engineer's approval.

Stones, except those used in pinning and filling interstices in the heart of walls, shall have minimum thicknesses of 6 inches, minimum widths of 12 inches and minimum lengths of 15 inches. In the lower courses, stones shall have minimum volumes of 1 cubic foot.

CONSTRUCTION METHODS

240-3.1 Stones shall be roughly dressed and laid on their natural beds. They shall be well bonded, joints being broken by at least 6 inches. Headers shall form at least one-fifth of the exposed faces of walls, shall be uniformly distributed and shall extend at least 12 inches into the backing. For walls 18 inches or less in thickness, headers shall extend from front to back face. Walls shall have no appreciable open spaces and only sufficient spalls shall be used to wedge the larger stones.

Walls shall be provided with a top course of stones at least 2 feet long and of a width equal to the thickness of the wall. Stones in a top course shall be carefully laid on a solid bed.

No part of a wall shall be built materially in advance of another part and a uniform height shall be maintained throughout.

METHOD OF MEASUREMENT

240-4.1 The yardage to be paid for shall be the number of cubic yards of dry rubble masonry complete in place and accepted. Projections extending beyond the faces of walls shall not be included. In computing the yardage for payment, the dimensions used shall be those shown on the plans or ordered

ITEM 241.—FOUNDATION MASONRY**DESCRIPTION**

241-1.1 This item shall consist of cement-mortar stone masonry in footings, foundations, walls (where the top surfaces are not less than 2 feet below the finished ground lines), and at other places called for on the plans or ordered in writing by the engineer. The masonry shall be constructed on the prepared foundation bed in accordance with these specifications and in conformity with the lines, grades, and sections shown on the plans or ordered in writing by the engineer.

MATERIALS

241-2.1 STONE.—The stone shall be clean, hard, and of a kind known to be durable and shall be subject to the engineer's approval. It shall preferably be native to the vicinity of the work. (Vicinity of the work shall be understood to mean within a radius of approximately 10 miles.)

(a) *Sizes and Shapes.*—Each stone shall be of good shape and shall be free from depressions and projections that might weaken or prevent it from being properly bedded. Stone having a volume of at least $1\frac{1}{2}$ cubic feet each shall constitute at least 50 percent of those used.

In general stones shall have thicknesses of not less than 5 inches, widths of not less than $1\frac{1}{2}$ times their respective thicknesses, with minimum widths of 12 inches and lengths of not less than $1\frac{1}{2}$ times their respective widths.

(b) *Dressing.*—The trimming or shaping of stones will not be required except to remove thin or weak portions and to remove projections that might prevent the proper bedding of the stones. The bed surface of a face stone shall be approximately normal to the face of the stone for at least 3 inches and from this point it may depart from a normal plane not to exceed 2 inches in 12 inches.

(c) *Finish for Exposed Faces.*—Projections beyond the face line will not be objectionable.

241-2.2 QUARRY OPERATIONS.—Quarry operations and delivery of stone to the point of use shall be organized so as to insure keeping deliveries well ahead of masonry operations. A sufficiently large stock of stone of the kinds being used in the work shall be kept on the site at all times to permit adequate selection of stone by the masons.

241-2.3 MORTAR.—Cement, fine aggregate, and water shall conform to the respective requirements for these materials as specified under CONCRETE, except as to the grading of fine aggregate which shall all pass the No. 8 sieve, not less than 15 percent nor more than 40 percent shall pass the No. 50 sieve, and not more than 10 percent shall pass the No. 100 sieve. Masonry cement meeting Federal Specification SS-C-181b may be substituted for portland cement in mortar for masonry used in retaining walls of a height not exceeding 6 feet; for other construction, masonry cement may be used if and as shown on the plans.

The mortar for the masonry shall be composed of one part of cement and two parts of fine aggregate by volume and sufficient water to make the mortar of such consistency that it can be handled easily and spread with a trowel. Mortar shall be mixed only in those quantities required for immediate use. Unless an approved mortar mixing machine is used, the fine aggregate and cement shall be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains the proper consistency. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar will not be permitted.

CONSTRUCTION METHODS

241-3.1 SELECTION AND PLACING.—The prepared foundation bed for the work shall be firm, and normal to, or in steps normal to, the face of the wall, and shall have been approved by the engineer before any stone is placed.

All masonry shall be constructed by experienced workmen. Large flat stones shall be used in the bottom course, and large selected stones shall be used in the corners. In general, the stones shall decrease in size from the bottom to the top of the work. Unless otherwise shown on the plans, the stones in the top course shall be of random thicknesses with a minimum of 6 inches, shall be from $1\frac{1}{2}$ feet to 5 feet in length. Where a foundation wall is less than 18 inches in width, the stones in the top course shall be wide enough to cover the top of the footing, foundation, or wall.

All stones shall be cleaned thoroughly and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread. They shall be set in random bond so that all stones, including backing and hearting, are bonded thoroughly with each other so as to produce strong, substantial masonry. They shall be laid with their longest faces horizontal in full beds of mortar.

The stones shall be so handled as not to jar or displace the stones already set. Suitable equipment shall be provided for

setting stones larger than those that can be handled by two men. The rolling or turning of stones on the wall will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

241-3.2 BEDS AND JOINTS.—The mortar beds and joints may vary from $\frac{1}{2}$ inch to 3 inches in thickness and shall be filled flush with mortar to the faces of stone.

241-3.3 HEADERS.—Headers shall be distributed uniformly throughout the work so as to form at least one-fifth of the face areas. They shall be of such lengths as to extend from the front face of the work into the backing at least 12 inches. When a wall is 18 inches or less in thickness, the headers shall extend entirely through from front to back face.

241-3.4 BACKING.—The backing shall be built chiefly of large stones and in a workmanlike manner. The individual stones composing it shall be well bonded with the stones in the face of the work and with each other. All openings and interstices in the backing shall be filled completely with mortar or with spalls surrounded completely by mortar.

241-3.5 WEATHER LIMITATIONS.—No placing of stone shall be done in freezing weather, except by written permission from the engineer, and then only by the use of such methods as he may prescribe for preparing the materials and protecting the work after laying. Such permission and the use of the methods prescribed shall not, however, release the contractor from his obligation to build a satisfactory structure. All work damaged by cold weather shall be removed and replaced. In hot or dry weather the masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least 3 days after completion.

METHOD OF MEASUREMENT

241-4.1 The yardage to be paid for shall be the number of cubic yards of foundation masonry complete in place and accepted. Projections extending beyond the faces of walls shall not be included. In computing the yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No deductions will be made for weep holes, drain pipes, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

241-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Foundation Masonry," which price and payment shall be full compensation for furnishing and placing all materials, for mortar, for masonry, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 242.—CEMENT RUBBLE MASONRY

DESCRIPTION

242-1.1 This item shall consist of cement stone masonry in side walls and pier walls, of stone box culverts and multiple stone box culverts, in headwalls for pipe culverts, and at other places called for on the plans or ordered in writing by the engineer. The masonry shall be constructed on the prepared foundation bed or on foundation masonry in accordance with these specifications and in conformity with the lines, grades, sections, and dimensions shown on the plans or ordered in writing by the engineer.

Figure 1 appearing in this specification item is an illustration of the characteristics and appearance desired for the structure.

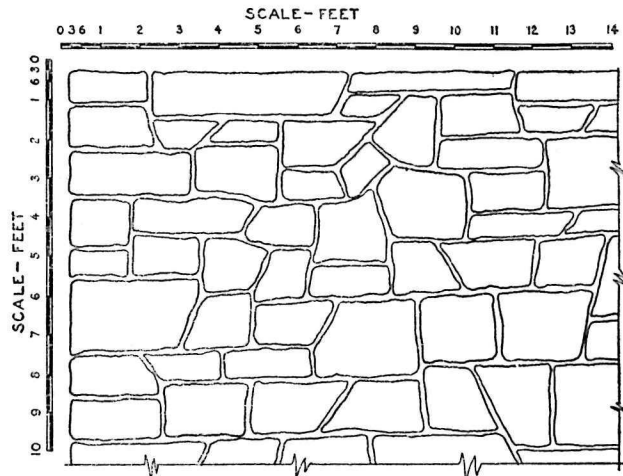


FIGURE 1.—Cement rubble masonry.

MATERIALS

242-2.1 STONE.—The stone shall be clean, hard, and of a kind known to be durable and shall be subject to the engineer's approval. It shall preferably be native to the vicinity of the work. (Vicinity of the work shall be understood to mean within a radius of approximately 10 miles.)

(a) *Sizes and Shapes.*—The individual face stones shall be furnished in the sizes indicated on the drawings.

Unless other sizes are shown on the drawings, stones shall conform to sizes shown in the figure appearing in this item, and, in general, shall have thicknesses of not less than 5 inches, widths of not less than $1\frac{1}{2}$ times their respective thicknesses, with minimum widths of 12 inches and lengths of not less than $1\frac{1}{2}$ times their respective widths. Each stone shall be of good shape and be free from depressions and projections that might weaken or prevent it from being properly bedded. At least 50 percent of the total volume of the masonry shall be of stones having a volume at least one cubic foot each. When a definite dimension of a stone is shown on the plans, the stone shall be of the size shown. There shall be a variety in the sizes of face stones and, as a general rule, not more than 10 percent shall be equal in size.

(b) *Dressing.*—The stone shall be hammer dressed to remove any thin or weak portions. Face stones shall be dressed to provide bed and joint lines that do not vary more than $1\frac{1}{2}$ inches from true lines and to insure the meeting of bed and joint lines without the rounding of the corners of the stones in excess of $1\frac{1}{2}$ inches in radius. Bed surfaces of face stones shall be approximately normal to the faces of the stones for about 2 inches and from this point may depart from a normal plane not to exceed 2 inches in 12 inches.

Stratification in arch ring stones shall be parallel to the radial joints, and in other stones shall be parallel to the bed joints.

(c) *Finish for Exposed Faces.*—The maximum and minimum projections of rock faces beyond the pitch lines shall not vary from each other by more than 2 inches.

242-2.2 QUARRY OPERATIONS.—Quarry operations and delivery of stone to the point of use shall be organized so as to insure keeping deliveries well ahead of masonry operations. A sufficiently large stock of stone of the kinds being used in the work shall be kept on the site at all times to permit adequate selection of stone by the masons.

242-2.3 MORTAR.—Cement, fine aggregate, and water shall conform to the respective requirements for these materials as specified under **CONCRETE**, except as to the grading of fine aggregate which shall all pass the No. 8 sieve, not less than 15 percent nor more than 40 percent shall pass the No. 50 sieve, and not more than 10 percent shall pass the No. 100 sieve. Masonry cement meeting Federal Specification SS C-181b may be substituted for portland cement in mortar for masonry used in retaining walls of a height not exceeding 6 feet; for other construction, masonry cement may be used if and as shown on the plans.

The mortar for the masonry shall be composed of 1 part of cement and 2 parts of fine aggregate by volume and sufficient

water to make the mortar of such consistency that it can be handled easily and spread with a trowel. Where so indicated on the plans, mortar shall contain 1 part cement to 3 parts fine aggregate. Mortar shall be mixed only in those quantities required for immediate use. Unless an approved mortar mixing machine is used, the fine aggregate and cement shall be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains the proper consistency. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar will not be permitted.

CONSTRUCTION METHODS

242-3.1 SELECTION AND PLACING.—When the masonry is to be placed on a prepared foundation bed, the bed shall be firm and normal to, or in steps normal to, the face of the wall, and shall have been approved by the engineer before any stone is placed. When it is to be placed on foundation masonry, the bearing surface of this masonry shall be cleaned thoroughly and wetted immediately before the mortar bed is spread.

All masonry shall be constructed by experienced workmen. Face stones shall be set in random bond so as to produce the effect shown on the drawings and approved by the engineer.

Care shall be taken to prevent the bunching of small stones or stones of the same size. When weathered or colored stones, or those of varying texture, are being used, care shall be exercised to distribute the various kinds of stones uniformly throughout the exposed faces of the work. Large stones shall be used for the bottom courses and large, selected stones shall be used in the corners. In general, the stones shall decrease in size from the bottom to the top of work.

All stones shall be cleaned thoroughly and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread. They shall be laid with their longest faces horizontal in full beds of mortar, and the joints shall be flushed with mortar.

The exposed faces of individual stones shall be parallel to the faces of the walls in which the stones are set.

The stones shall be so handled as not to jar or displace the stones already set. Suitable equipment shall be provided for setting stones larger than those that can be handled by two men. The rolling or turning of stones on the wall will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

242-3.2 BEDS AND JOINTS.—Beds for face stone may vary from $\frac{1}{2}$ to $2\frac{1}{2}$ inches in thickness. They shall not extend in an unbroken line through more than five stones. Joints may

vary from $\frac{1}{2}$ to $2\frac{1}{2}$ inches in thickness. They may be at angles with the vertical from 0 to 45 degrees. Face stone shall bond at least 6 inches longitudinally and 2 inches vertically. At no place shall corners of four stones be adjacent to each other.

Cross beds for vertical faced walls shall be level, and for battered walls may vary from level to normal to the batter line of the face of the wall.

242-3.3 HEADERS.—Headers shall be distributed uniformly throughout the walls of structures so as to form at least one-fifth of the exposed faces. They shall be of such lengths as to extend from the front face of the wall into the backing at least 12 inches. When a wall is 18 inches or less in thickness, the headers shall extend entirely through from front to back face.

242-3.4 BACKING.—The backing shall be built chiefly of large stones and in a workmanlike manner. The individual stones composing the backing and hearting shall be well bonded with the stones in the face wall and with each other. All openings and interstices in the backing shall be filled completely with mortar or with spalls surrounded completely by mortar.

242-3.5 POINTING.—Both bed and vertical joints shall be filled with mortar and struck off with a rounded wooden tool so as to leave a round depression in the mortar from one-half to three-fourths of an inch in width and from one-fourth to three-eighths of an inch in depth.

242-3.6 COPING.—Copings, if called for, shall be as shown on the plans. Where copings are not called for, the top of the wall shall be finished with stones wide enough to cover the top of the wall, from $1\frac{1}{2}$ to 5 feet in length, and of random heights, with a minimum height of 6 inches. Stone shall be laid in such a manner that the top course is an integral part of the wall.

242-3.7 WEEP HOLES.—All walls and abutments shall be provided with weep holes. Unless otherwise shown on the plans or directed by the engineer, the weep holes shall be placed at the lowest points where free outlets can be obtained and shall be spaced not more than 10 feet center to center.

242-3.8 CLEANING EXPOSED FACES.—Immediately after laying, and while the mortar is fresh, all face stone shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed. Before final acceptance and if ordered by the engineer, the surface of the masonry shall be cleaned using wire brushes and, if necessary, acid.

242-3.9 WEATHER LIMITATIONS.—No placing of stone shall be done in freezing weather except by written permission from the engineer and then only by the use of such methods as he may prescribe for preparing the materials and protecting the work after laying. Such permission and the use

of the methods prescribed shall not, however, release the contractor from his obligation to build a satisfactory structure. All work damaged by cold weather shall be removed and replaced. In hot or dry weather the masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

METHOD OF MEASUREMENT

242-4.1 The yardage to be paid for shall be the number of cubic yards of cement rubble masonry complete in place and accepted. Projections extending beyond the faces of the walls shall not be included. In computing the yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No deductions will be made for weep holes, drain pipe, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

242-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Cement Rubble Masonry," which price and payment shall be full compensation for furnishing and placing all materials, for mortar for masonry, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 243.—CLASS B STONE MASONRY

DESCRIPTION

243-1.1 This item shall consist of cement stone masonry in minor structures, in head walls for culverts, in retaining walls at the toes of slopes, and at other places called for on the plans or ordered in writing by the engineer. The masonry shall be constructed on the prepared foundation bed or on foundation masonry, in accordance with these specifications and in conformity with the lines, grades, sections, and dimensions shown on the plans or ordered in writing by the engineer.

Figure 2 appearing in this specification item is an illustration of the characteristics and appearance desired for the structure.

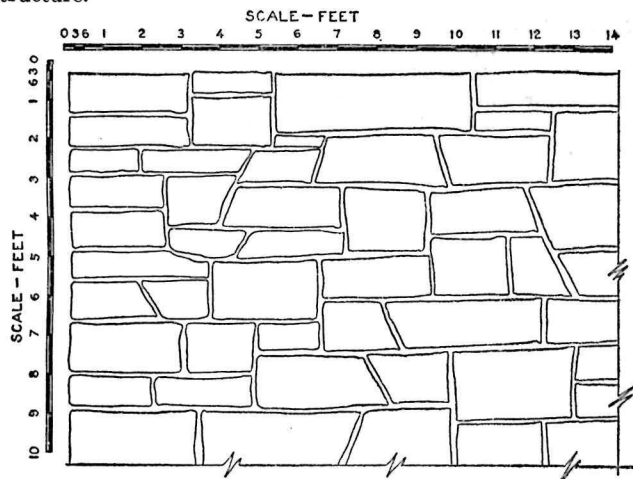


FIGURE 2.—Class B stone masonry.

MATERIALS

243-2.1 STONE.—The stone shall be clean, hard, and of a kind known to be durable and shall be subject to the engineer's approval. It shall preferably be native to the vicinity of the work. (Vicinity of the work shall be understood to mean within a radius of approximately 10 miles.)

(a) *Sizes and Shapes.*—The individual face stones shall be furnished in the sizes and of the face areas indicated on the drawings.

Unless other sizes are shown on the drawings, stones shall conform to sizes shown in the figure appearing in this item, and, in general, shall have thicknesses of not less than 5 inches, widths of not less than one and one-half times their respective thicknesses, with minimum widths of 12 inches and lengths of not less than one and one-half times their respective widths. Each stone shall be of good shape and be free of depressions and projections that might weaken or prevent it from being properly bedded. When a definite dimension of a stone is shown on the plans, the stone shall be of the size shown. There shall be a variety in the sizes of stones and, as a general rule, not more than 10 percent shall be equal in size.

(b) *Dressing.*—The stone shall be dressed to remove any thin or weak portions. Face stones shall be dressed to provide bed and joint lines that do not vary more than three-fourths of an inch from true lines and to insure the meeting of bed and joint lines without the rounding of the corners of the stones in excess of 1 inch in radius. Bed surfaces of face stones shall be approximately normal to the faces of the stones for about 3 inches and from this point may depart from a normal plane not to exceed 2 inches in 12 inches.

Stratification in arch ring stones shall be parallel to the radial joints, and in other stones shall be parallel to the bed joints.

(c) *Finish for Exposed Faces.*—Face stones shall be pitched to line along beds and joints. The maximum and minimum projections of rock faces beyond the pitch lines shall not vary from each other by more than 2 inches.

243-2.2 QUARRY OPERATIONS.—Quarry operations and delivery of stone to the point of use shall be organized so as to insure keeping deliveries well ahead of masonry operations. A sufficiently large stock of stone of the kinds being used in the work shall be kept on the site at all times to permit adequate selection of stone by the masons.

243-2.3 MORTAR.—Cement, fine aggregate, and water shall conform to the respective requirements for these materials as specified under CONCRETE, except as to the grading of fine aggregate which shall all pass the No. 8 sieve, not less than 15 nor more than 40 percent shall pass the No. 50 sieve, and not more than 10 percent shall pass the No. 100 sieve. Masonry cement meeting Federal Specification SS-C-181b may be substituted for portland cement in mortar for masonry used in retaining walls of a height not exceeding 6 feet; for other construction, masonry cement may be used if and as shown on the plans.

The mortar for the masonry shall be composed of one part of cement and two parts of fine aggregate by volume and sufficient water to make the mortar of such consistency that it can be handled easily and spread with a trowel. Mortar shall be mixed only in those quantities required for immediate use. Unless an approved mortar mixing machine is used, the fine aggregate and cement shall be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains the proper consistency. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar will not be permitted.

CONSTRUCTION METHODS

243-3.1 SAMPLE SECTION.—If required by the special provisions, the contractor shall build at a site designated by the engineer, an L-shaped sample section of wall not less than 5 feet high and 8 feet long, showing examples of face wall, end wall, top wall, method of turning corners and method of forming joints, which shall be subject to the engineer's approval, and no masonry other than the foundation masonry shall be laid prior to the approval of such sample.

243-3.2 SELECTION AND PLACING.—When the masonry is to be placed on a prepared foundation bed, the bed shall be firm and normal to, or in steps normal to, the face of the wall, and shall have been approved by the engineer before any stone is placed. When it is to be placed on foundation masonry, the bearing surface of this masonry shall be cleaned thoroughly and wetted immediately before the mortar bed is spread.

All masonry shall be constructed by experienced workmen. Face stones shall be set in random bond so as to produce the effect shown on the drawings and to correspond with the sample section approved by the engineer.

Care shall be taken to prevent the bunching of small stones or stones of the same size. When weathered or colored stones, or stones of varying texture, are being used, care shall be exercised to distribute the various kinds of stones uniformly throughout the exposed faces of the work. Large stones shall be used for the bottom courses and large, selected stones shall be used in the corners. In general, the stones shall decrease in size from the bottom to the top of work.

All stones shall be cleaned thoroughly and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread. They shall be laid with their longest faces horizontal in full beds of mortar, and the joints shall be flushed with mortar.

The exposed faces of individual stones shall be parallel to the faces of the walls in which the stones are set.

The stones shall be so handled as not to jar or displace the stones already set. Suitable equipment shall be provided for setting stones larger than those that can be handled by two men. The rolling or turning of stones on the walls will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

243-3.3 BEDS AND JOINTS.—Beds for face stones may vary from $\frac{1}{2}$ to 2 inches in thickness. They shall not extend in an unbroken line through more than 5 stones. Joints may vary from $\frac{1}{2}$ to 2 inches in thickness. They shall not extend in an unbroken line through more than 2 stones. They may be at angles with the vertical from 0° to 45° . Face stone shall bond at least 6 inches longitudinally and 2 inches vertically. At no place shall corners of four stones be adjacent to each other.

Cross beds for vertical faced walls shall be level, and for battered walls may vary from level to normal to the batter line of the face of the wall.

243-3.4 HEADERS.—Headers shall be distributed uniformly throughout the walls of structures so as to form at least one-fifth of the exposed faces. They shall be of such lengths as to extend from the front face of the wall into the backing at least 12 inches. When a wall is 18 inches or less in thickness, the headers shall extend entirely through from front to back face.

243-3.5 BACKING.—The backing shall be built chiefly of large stones and in a workmanlike manner. The individual stones composing the backing and hearting shall be well bonded with the stones in the face wall and with each other. All openings and interstices in the backing shall be filled completely with mortar or with spalls surrounded completely by mortar.

243-3.6 POINTING.—Both bed and vertical joints shall be finished as shown on the plans or directed by the engineer. The mortar in joints on top surfaces of masonry shall be crowned slightly at the center of the masonry to provide drainage.

When raked joints are called for, all mortar in the exposed face joints and beds shall be raked out squarely to the depth noted on the plans. Stone faces in the joints shall be cleaned free of mortar.

When weather joints are called for, the beds shall be weather struck. The joints shall be slightly raked to conform to the bed weather joint and in no case shall the mortar be flush with the faces of the stones.

243-3.7 COPING.—Copings, if called for, shall be as shown on the plans. Where copings are not called for, the top of the wall shall be finished with stones wide enough to cover the

top of the wall, from $1\frac{1}{2}$ to 5 feet in length, and of random heights, with a minimum height of 6 inches. Stone shall be laid in such a manner that the top course is an integral part of the wall. The tops of the top courses of stone shall be pitched to line in both vertical and horizontal planes.

243-3.8 WEEP HOLES.—All walls and abutments shall be provided with weep holes. Unless otherwise shown on the plans or directed by the engineer, the weep holes shall be placed at the lowest points where free outlets can be obtained and shall be spaced not more than 10 feet center to center.

243-3.9 CLEANING EXPOSED FACES.—Immediately after being laid, and while the mortar is fresh, all face stone shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed. Before final acceptance and if ordered by the engineer, the surface of the masonry shall be cleaned using wire brushes and, if necessary, acid.

243-3.10 WEATHER LIMITATIONS.—No placing of stone shall be done in freezing weather except by written permission from the engineer and then only by the use of such methods as he may prescribe for preparing the materials and protecting the work after it has been laid. Such permission and the use of the methods prescribed shall not, however, release the contractor from his obligation to build a satisfactory structure. All work damaged by cold weather shall be removed and replaced. In hot or dry weather the masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

METHOD OF MEASUREMENT

243-4.1 The yardage to be paid for shall be the number of cubic yards of class B stone masonry complete in place and accepted. Projections extending beyond the faces of the walls shall not be included. In computing the yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No deductions will be made for weep holes, drain pipe, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

243-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Class B Stone Masonry," which price and payment shall be full compensation for furnishing and placing all materials, including mortar for masonry, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 244.—CLASS A STONE MASONRY

DESCRIPTION

244-1.1 This item shall consist of cement stone masonry in major structures, in retaining walls at toes of cut slopes, and at other places called for on the plans or ordered in writing by the engineer. The masonry shall be constructed on the prepared foundation bed or on foundation masonry, in accordance with these specifications and in conformity with the lines, grades, sections, and dimensions shown on the plans or ordered in writing by the engineer.

Figure 3 appearing in this specification item is an illustration of the characteristics and appearance desired for the structure.

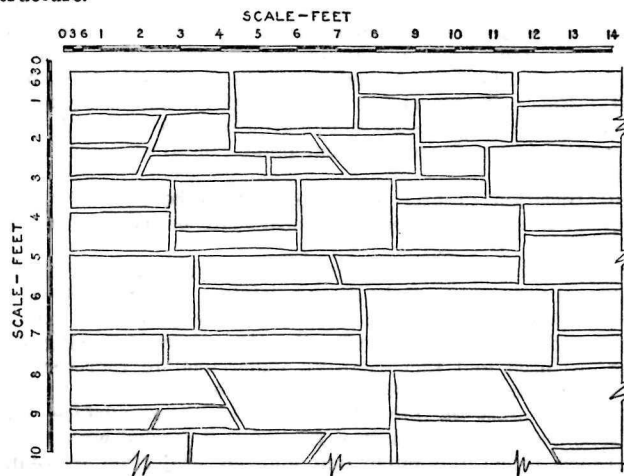


FIGURE 3.—Class A stone masonry.

MATERIALS

244-2.1 STONE.—The stone shall be clean, hard, and of a kind known to be durable and shall be subject to the engineer's approval. It shall preferably be native to the vicinity of the work. (Vicinity of the work shall be understood to mean within a radius of approximately 10 miles.)

(a) *Sizes and Shapes.*—The individual stones for the various parts of the structure shall be furnished in the sizes and of the face areas indicated on the drawings.

Unless other sizes are shown on the drawings stones shall conform to sizes shown in the figure appearing in this item, and, in general, shall have thicknesses of not less than 5 inches, widths of not less than one and one-half times their respective thicknesses, with minimum widths of 12 inches and lengths of not less than one and one-half times their respective widths. Each stone shall be of good shape and be free of depressions and projections that might weaken or prevent it from being properly bedded. When a definite dimension of a stone is shown on the plans, the stone shall be of the size shown. There shall be a variety in the sizes of stones and, as a general rule, not more than 10 percent shall be equal in size.

(b) *Dressing.*—The stone shall be dressed to remove any thin or weak portions. Face stones shall be dressed so that top and bottom beds are parallel to each other, and to provide bed and joint lines that do not vary more than one-fourth inch from true lines and to insure the meeting of bed and joint lines without the rounding of the corners of the stones. Bed surfaces of face stones shall be approximately normal to the faces of the stones for about 3 inches and from this point they may depart from a normal plane not to exceed 2 inches in 12 inches.

Stratification in arch ring stones shall be parallel to the radial joints, and in other stones shall be parallel to the bed joints.

(c) *Finish for Exposed Faces.*—Face stones shall be pitched to true lines along all beds and joints. The projections of faces beyond the pitch lines and the kind of finish for exposed faces of the work are shown on the plans. The following symbols are used and they shall be understood to represent the type of surface or dressing specified below.

1. *Split or seam face (S).*—In which the surface shall present a smooth appearance, free of tool marks, with no depressions below the pitch line and no projection exceeding three-fourths of an inch beyond the pitch line.

2. *Rock faced (R. F.).*—In which the face shall be an irregular projecting surface without indications of tool marks, with no concave surfaces below the pitch line and with projections beyond the pitch line, when measured in inches, not exceeding the number preceding the symbol shown on the plans, e. g., "1½ R. F." means projections beyond the pitch line not exceeding 1½ inches.

Drill holes or other marks of quarrying or handling will not be permitted on the exposed faces of stones.

244-2.2 QUARRY OPERATIONS.—Quarry operations and delivery of stone to the point of use shall be organized so as to insure keeping deliveries well ahead of masonry operations. A sufficiently large stock of stone of the kinds being used in the work shall be kept on the site at all times to permit adequate selection of stone by the masons.

244-2.3 MORTAR.—Cement, fine aggregate, and water shall conform to the respective requirements for these materials as specified under CONCRETE, except as to the grading of fine aggregate which shall all pass the No. 8 sieve, not less than 15 nor more than 40 percent shall pass the No. 50 sieve, and not more than 10 percent shall pass the No. 100 sieve. Masonry cement meeting Federal Specification SS-C-181b may be substituted for portland cement in mortar for masonry used in retaining walls of a height not exceeding 6 feet; for other construction masonry cement may be used if and as shown on the plans.

The mortar for the masonry shall be composed of one part of cement and two parts of fine aggregate by volume and sufficient water to make the mortar of such consistency that it can be handled easily and spread with a trowel. Mortar shall be mixed only in those quantities required for immediate use. Unless an approved mortar mixing machine is used, the fine aggregate and cement shall be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains the proper consistency. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar will not be permitted.

CONSTRUCTION METHODS

244-3.1 SAMPLE SECTION.—The contractor shall build at a site designated by the engineer, an L-shaped sample section of wall not less than 5 feet high and 8 feet long, showing examples of face wall, end wall, top wall, method of turning corners, and method of forming joints, which shall be subject to the engineer's approval, and no masonry other than the foundation masonry shall be laid prior to the approval of such sample.

244-3.2 SELECTION AND PLACING.—When the masonry is to be placed on a prepared foundation bed, the bed shall be firm and normal to, or in steps normal to, the face of the wall, and shall have been approved by the engineer before any stone is placed. When it is to be placed on foundation masonry, the bearing surface of this masonry shall be cleaned thoroughly and wetted immediately before the mortar bed is spread.

All masonry shall be constructed by experienced workmen. Face stones shall be set in random bond so as to produce the effect shown on the drawings and to correspond with the sample section approved by the engineer.

Care shall be taken to prevent the bunching of small stones or stones of the same size. When weathered or colored stones, or stones of varying texture are being used, care shall be exercised to distribute the various kinds of stones uniformly throughout the exposed faces of the work. Large stones shall be used for the bottom courses and large, selected stones shall be used in the corners. In general, the stones shall decrease in size from the bottom to the top of work.

All stones shall be thoroughly cleaned and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread. They shall be laid with their longest faces horizontal in full beds of mortar, and the joints shall be flushed with mortar.

The exposed faces of individual stones shall be parallel to the faces of the walls in which the stones are set.

The stones shall be so handled as not to jar or displace the stones already set. Suitable equipment shall be provided for setting stones larger than those that can be handled by two men. The rolling or turning of stones on the wall will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

244-3.3 BEDS AND JOINTS.—Beds for face stones may vary from $\frac{1}{2}$ to 1 inch in thickness. They shall not extend in an unbroken line through more than 5 stones. Joints may vary from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in thickness. They shall not extend in an unbroken line through more than 2 stones. They may be at angles with the vertical from 0° to 45° . Face stone shall bond at least 6 inches longitudinally and 2 inches vertically. At no place shall corners of four stones be adjacent to each other.

Cross beds for vertical faced walls shall be level, and for battered walls may vary from level to normal to the batter line of the face of the wall.

244-3.4 HEADERS.—Headers shall be distributed uniformly throughout the walls of structures so as to form at least one-fifth of the exposed faces. They shall be of such lengths as to extend from the front face of the wall into the backing at least 12 inches. When a wall is 18 inches or less in thickness, the headers shall extend entirely through from front to back face.

244-3.5 BACKING.—The backing shall be built chiefly of large stones and in a workmanlike manner. The individual stones composing the backing and hearting shall be well bonded with the stones in the face wall and with each other. All openings and interstices in the backing shall be filled completely with mortar or with spalls surrounded completely by mortar.

244-3.6 POINTING.—Both bed and vertical joints shall be finished as shown on the plans or directed by the engineer. The mortar in joints on top surfaces of masonry shall be crowned slightly at the center of the masonry to provide drainage.

When raked joints are called for, all mortar in the exposed face joints and beds shall be raked out squarely to the depth noted on the plans. Stone faces in the joints shall be cleaned free of mortar.

When weather joints are called for, the beds shall be weather struck. The joints shall be slightly raked to conform to the bed weather joint and in no case shall the mortar be flush with the faces of the stones.

244-3.7 COPING.—Copings, if called for, shall be as shown on the plans. Where copings are not called for, the top of the wall shall be finished with stones wide enough to cover the top of the wall, from $1\frac{1}{2}$ to 5 feet in length, and of random heights, with a minimum height of 6 inches. Stone shall be laid in such a manner that the top course is an integral part of the wall. The tops of the top courses of stone shall be pitched to line in both vertical and horizontal planes.

244-3.8 WEEP HOLES.—All walls and abutments shall be provided with weep holes. Unless otherwise shown on the plans or directed by the engineer, the weep holes shall be placed at the lowest points where free outlets can be obtained and shall be spaced not more than 10 feet center to center.

244-3.9 CLEANING EXPOSED FACES.—Immediately after being laid, and while the mortar is fresh, all face stone shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed. Before final acceptance and if ordered by the engineer, the surface of the masonry shall be cleaned using wire brushes and, if necessary, acid.

244-3.10 WEATHER LIMITATIONS.—No placing of stone shall be done in freezing weather except by written permission from the engineer and then only by the use of such methods as he may prescribe for preparing the materials and protecting the work after it has been laid. Such permission and the use of the methods prescribed shall not, however, release the contractor from his obligation to build a satisfactory structure. All work damaged by cold weather shall be removed and replaced. In hot or dry weather the masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least 3 days after completion.

METHOD OF MEASUREMENT

244-4.1 The yardage to be paid for shall be the number of cubic yards of class A stone masonry complete in place and accepted. Projections extending beyond the faces of the walls shall not be included. In computing the yardage for payment, the dimensions used shall be those shown on the plans or

ordered in writing by the engineer. No deductions will be made for weep holes, drain pipe, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

244-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Class A Stone Masonry," which price and payment shall be full compensation for furnishing and placing all materials, including mortar for masonry, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 245.—STONE MASONRY IN PARAPETS

DESCRIPTION

245-1.1 This item shall consist of either class A or class B stone masonry in parapets or in other walls which are 2 feet or less in thickness and both faces of which are exposed and required to be finished. The class of stone masonry to be used will be shown on the plans. The masonry shall be constructed on the prepared foundation bed or on foundation masonry, in accordance with the requirements for the class of masonry called for, in accordance with these specifications and in conformity with the lines, grades, sections, and dimensions shown on the plans or ordered in writing by the engineer.

MATERIALS

245-2.1 STONE.—Unless otherwise specified the stone shall conform to the requirements for stone under CLASS A STONE MASONRY OR CLASS B STONE MASONRY as the case may be.

245-2.2 MORTAR.—The mortar shall conform to the requirements for mortar under CLASS A STONE MASONRY OR CLASS B STONE MASONRY as the case may be.

CONSTRUCTION METHODS

245-3.1 SELECTION AND PLACING.—Selected stone, squared and pitched to line and with heads dressed, shall be used in ends of walls and in all exposed angles and corners. Headers shall occupy not less than one-fifth of the area of both faces. They shall be well interlocked and as many as possible shall extend entirely through the wall. Both the headers and stretchers in the two faces of the wall shall be well interlocked in the heart and shall comprise practically the whole volume of the wall. All interstices in the wall shall be completely filled with cement grout or spalls completely surrounded with mortar or grout.

245-3.2 COPINGS.—Copings, if called for, shall be as shown on the plans. Where copings are not called for, a parapet or other wall shall be finished with a top course of well shaped stones of random wall heights to form an integral part of the wall. Individual stones in the top course shall be as wide as the wall is thick, from $1\frac{1}{2}$ to 5 feet in length, and have their top edges pitched to true lines in both horizontal and vertical planes. Unless otherwise noted, projection of rock faces beyond the pitch line on the tops and edges of top stones shall not exceed $1\frac{1}{2}$ inches.

METHOD OF MEASUREMENT

245-4.1 The yardage to be paid for shall be the number of cubic yards of class A stone masonry or class B stone masonry in parapets complete in place and accepted. Projections extending beyond the faces of walls forming rock faces shall not be included. In computing the yardage for payment, the dimensions used shall be those shown on the plans for the actual pitch lines, or ordered in writing by the engineer. Mortar joints including those between other classes of masonry and masonry in parapets, will be included. No deductions will be made for weep holes, drain pipe, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

245-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Class A Stone Masonry in Parapets" or "Class B Stone Masonry in Parapets," which price and payment shall be full compensation for furnishing and placing all materials, including mortar for masonry, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavations.

ITEM 246.—STONE MASONRY FACING FOR CONCRETE**DESCRIPTION**

246-1.1 This item shall consist of either class A or class B stone masonry composing a facial wall one stone thick, to be backed with concrete. The class of stone masonry to be used will be shown on the plans. The masonry shall be constructed on the prepared foundation bed or on foundation masonry, in accordance with the requirements for the class of masonry called for, in accordance with these specifications, and in conformity with the lines, grades, sections, and dimensions shown on the plans or ordered in writing by the engineer.

MATERIALS

246-2.1 STONE.—Unless otherwise specified, the stone shall conform to the requirements for stone under CLASS A STONE MASONRY or CLASS B STONE MASONRY as the case may be.

Masonry facing shall be not more than one stone thick, and of the dimensions shown on the plans.

246-2.2 MORTAR.—The mortar shall conform to the requirements for mortar under CLASS A STONE MASONRY or CLASS B STONE MASONRY as the case may be.

CONSTRUCTION METHODS

246-3.1 SAMPLE SECTION.—If required under the specification for the class of masonry specified or by the special provisions, the contractor shall build, at a site designated by the engineer, an L-shaped sample section of wall not less than 5 feet high and 8 feet long, showing examples of face wall, end wall, top wall, method of turning corners, and methods of forming joints, which shall be subject to the engineer's approval.

246-3.2 SELECTION AND PLACING.—The stone shall be set in random bond in conformity to the requirements for the class of masonry being used and so as to produce the effect shown on the drawings or to conform to the sample wall, as may be directed.

246-3.3 STEEL ANCHORS.—Hooked steel anchors consisting of $\frac{1}{2}$ inch square bars each bent into an elongated letter S shall be spaced 2 feet apart both horizontally and vertically unless closer spacing is shown on the plans or ordered in writing by the engineer. Each anchor shall be rigidly embedded in

a horizontal joint of the masonry with one end 2 inches from the faces of the stones. The other end shall project approximately 10 inches into the concrete backing.

246-3.4 POINTING.—When weather joints are called for, the beds shall be weather struck and the joints shall be slightly raked to conform to the bed-weather joint, and in no case shall the mortar be flush with the faces of the stones.

When brushed joints are called for, all mortar in the exposed face joints and beds shall be broomed slightly, while the mortar is fresh, to the depth shown on the plans.

246-3.5 BRACING.—When, in the opinion of the engineer, the depositing of concrete against the stone facing might create pressure sufficient to force the stonework out of line, the contractor shall brace the wall in a manner satisfactory to the engineer, but failure of the engineer to order such bracing shall not release the contractor from his obligation to build a satisfactory structure.

246-3.6 PLACING CONCRETE BACKING.—When the stone facing has been laid and the mortar has attained sufficient strength, all surfaces against which concrete is to be placed shall be cleaned carefully and all dirt, loose material, and accumulations of mortar droppings removed. Picks, scrapers, and wire brooms shall be used for this purpose if necessary. If compressed air is available on the work, it shall be used to blow out the dust and dirt. Just before the concrete is placed, the surfaces shall be washed thoroughly. Water shall be dashed forcibly against the stones and into the joints. Use of a stream from a hose is preferable for this purpose. In depositing concrete, the top surface immediately adjacent to the stones shall be held slightly low and a neat cement grout of the consistency of cream shall be carried on top of the concrete and against the masonry at all times, so that the entire exposed areas of all the stones are coated with grout. All interstices of the masonry shall be filled and the concrete thoroughly spaded and worked until it is brought into intimate contact with every part of the back face of the masonry.

METHOD OF MEASUREMENT

246-4.1 The yardage to be paid for shall be the number of cubic yards of class A or class B stone masonry facing for concrete complete in place and accepted. In computing the yardage for payment, the stone facing shall be assumed to have a uniform average thickness of one foot, unless otherwise shown or noted on the plans, measured perpendicularly to the exposed face of the wall. Masonry paid for under any other item shall not be included. Mortar joints, including those between stone facing for concrete and other classes of masonry that may be adjacent thereto, will be included. No deductions will be made for weep holes, drain pipe, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

246-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Class A Stone Masonry Facing for Concrete" or "Class B Stone Masonry Facing for Concrete," which price and payment shall be full compensation for furnishing and placing all material, including mortar for masonry, false work and bracing and for all labor, equipment, tools, and incidentals necessary to complete the item, except concrete backing and steel anchors. Steel anchors shall be paid for at the contract unit price per pound for reinforcing steel under REINFORCING STEEL.

ITEM 247.—DIMENSIONED MASONRY

DESCRIPTION

247-1.1 This item shall consist of cement mortar stone masonry composed of stones for which two or more fixed dimensions are given on the plans. It shall include all arch ring, coping, belt course, corner quoins, skew back stones, and any other stones indicated on the plans. The masonry shall be constructed in accordance with these specifications and in conformity with the locations, lines, grades, sections, and dimensions shown on the plans or ordered in writing by the engineer.

MATERIALS

247-2.1 **STONE.**—The stone shall be of the kind called for in the special provisions. Stone shall be sound and durable, properly quarried, free of reeds, rifts, seams, laminations, and minerals which, by weathering, would cause discoloration or deterioration and shall be subject to the engineer's approval. The stones shall be properly protected at all times. Those damaged in transportation or handling will be rejected unless their use in each instance is permitted specifically by the engineer.

(a) *Dimensions.*—All dimensions shall conform to those shown on the plans unless changes are ordered in writing by the engineer. Where the width of bed is not shown, it shall be not less than one and one-fourth times the rise with a minimum width of 12 inches. Where headers are shown, their lengths shall be not less than the width of bed of the widest adjacent stretcher plus 12 inches.

(b) *Bed Faces.*—Unless otherwise shown or ordered, bed faces shall be horizontal. They shall be cut full and square for a distance of at least 3 inches from the exposed face, from which point they may depart from a plane normal to the face not to exceed 1 inch in 12 inches and shall be free of depressions and cupping which might impair the strength of the stone or hinder obtainment of full bearing on the mortar.

(c) *Joint Faces.*—Unless otherwise shown on the plans or ordered, joint faces shall be vertical and at right angles with the exposed faces of the stones. They shall be cut full and square for a distance of at least 2 inches from the exposed faces, from which point they may depart from a plane normal to the face not to exceed 1 inch in 12 inches.

(d) *Arch Stone Joint Faces.*—Voussoir joint faces shall be radial and at right angles to the front faces of the stones. They shall be "hard cut" for a distance of at least 3 inches from the front faces and the soffits, from which points they may depart from a plane normal to the face not to exceed three-fourths inch in 12 inches. The back or face in contact with the concrete of the arch barrel shall be parallel to the front face and shall be "fine pointed" for a distance of 6 inches from the intrados, from which point it shall be scabbed off as indicated on the plans. The top shall be cut perpendicular to the front face and shall be medium pointed for a distance of at least 3 inches from the front.

Stratification in arch ring stones shall be parallel to the radial joints, and in other stones shall be parallel to the bed joints.

(e) *Finish for Exposed Faces.*—The kind of finish for exposed faces of the work will be shown on the plans. The following symbols will be used and they shall be understood to represent the type of surface or dressing specified below:

1. *Fine pointed (F. P.).*—In which the point depressions shall be approximately three-eighths of an inch apart with surface variations not to exceed one-eighth inch from the pitch line.

2. *Medium pointed (M. P.).*—In which the point depression shall be approximately five-eighths of an inch apart with surface variations not to exceed one-fourth inch from the pitch line.

3. *Coarse pointed (C. P.).*—In which the point depressions shall be approximately 1 to 1¼ inches apart with surface variations not to exceed three-eighths of an inch from the pitch line.

4. *Split or seam face (S.).*—In which the surface shall present a smooth appearance, be free from tool marks, with no depressions below the pitch line and no projection exceeding three-fourths of an inch beyond the pitch line.

5. *Rock faced (R. F.).*—In which the face shall be an irregular projecting surface without indications of tool marks, with no concave surfaces below the pitch line, and with projections beyond the pitch line, when measured in inches, not exceeding the figure preceding the symbol as used on the plans, e. g., "1½ R. F." means projections beyond the pitch line not exceeding 1½ inches. Where a variable "rock face" is specified, stones of the same height of projection shall be well distributed.

247-2.2 **QUARRY OPERATIONS.**—Quarry operations and delivery of stone to the point of use shall be organized so as to insure keeping deliveries well ahead of masonry operations. A sufficiently large stock of stone of the kinds being used in the work shall be kept on the site at all times to permit adequate selection of stone by the masons.

247-2.3 MORTAR.—Cement, fine aggregate, and water shall conform to the respective requirements for these materials as specified under CONCRETE, except as to the grading of fine aggregate which shall all pass the No. 8 sieve, not less than 15 nor more than 40 percent shall pass the No. 50 sieve, and not more than 10 percent shall pass the No. 100 sieve. Masonry cement meeting Federal Specification SS-C-181b may be substituted for portland cement in mortar for masonry used in retaining walls of a height not exceeding 6 feet; for other construction, masonry cement may be used if and as shown on the plans.

The mortar for the masonry shall be composed of one part of cement and two parts of fine aggregate by volume and sufficient water to make the mortar of such consistency that it can be handled easily and spread with a trowel. Mortar shall be mixed only in those quantities required for immediate use. Unless an approved mortar mixing machine is used, the fine aggregate and cement shall be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains the proper consistency. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar will not be permitted.

CONSTRUCTION METHODS

247-3.1 PLACING.—All masonry shall be constructed by experienced workmen. The stones shall be set as shown on the plans. They shall be thoroughly cleaned and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread. The stones shall be so handled as not to jar or displace stones already set. The rolling or turning of stones on the wall will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar. Stone shall be handled with appliances which do not require tool marks on the faces and which do not mar the stone in any manner. They shall be set on full mortar beds and settled into place with suitable mauls before the mortar has set. Vertical joints shall be flushed with mortar. No hammering, except with light hammers and points, will be permitted.

Arch ring stone shall be carefully set to exact position and held in place with hardwood wedges until the joints are packed with mortar.

247-3.2 BEDS AND JOINTS.—The thickness of beds may vary from 1 inch to three-fourths of an inch, from the bottom to the top of the work, but in each course the beds shall be of uniform thickness throughout.

Arch ring stone joints on the faces and soffits shall be not less than $\frac{3}{4}$ inch nor more than 1 inch in thickness. All parts of the joints less than $2\frac{1}{2}$ inches in width shall be completely packed with mortar; grout shall be used if necessary completely to fill the joints. Portions of the joints wider than $2\frac{1}{2}$ inches shall be filled with concrete when the backing or arch barrel is concreted.

247-3.3 ANCHORS AND BONDING.—Arch ring stones shall be bonded to the concrete backing with one steel anchor in each voussoir joint for each foot of depth of ring stone measured radially. Unless otherwise shown on the plans, the steel anchor shall be made of a $\frac{5}{8}$ -inch round bar bent into an elongated letter S. It shall be embedded not less than 18 inches in the concrete backing and shall extend into the joint within 5 inches of the faces of the stone.

Steel anchors shall be used for other dimensioned masonry where called for on the plans or ordered by the engineer.

The bonding of various portions of the work shall be as shown on the plans. Alternate courses of quoins shall bond at inner corners at least 9 inches.

247-3.4 PLACING CONCRETE BACKING.—All surfaces against which concrete is to be placed shall be cleaned carefully and all dirt, loose material, and accumulations of waste mortar removed, using picks, scrapers, and wire brooms if necessary. Just before the concrete is placed, the surfaces shall be washed thoroughly. Water shall be dashed forcibly against the stones and into the joints. In depositing concrete, the top surface immediately adjacent to the stones shall be held slightly low and a neat cement grout of the consistency of cream shall be carried on top of the concrete and against the masonry at all times, so that the entire exposed areas of the stones are coated with grout. All interstices of the masonry shall be filled and the concrete thoroughly spaded and worked until it is brought into intimate contact with every part of the back face of the masonry.

247-3.5 FALSE WORK AND BRACING.—When, in the opinion of the engineer, false work and bracing are necessary to hold the stones in proper position, the contractor shall construct such false work and bracing in a manner satisfactory to the engineer, but failure of the engineer to order their construction shall not release the contractor from his obligation to build a satisfactory structure.

247-3.6 POINTING.—The pointing or finishing of all joints shall be as shown on the plans or as specified in the special provisions.

When raked joints are called for, all mortar in exposed face joints and beds shall be raked out squarely to the depth noted on the plans. Stone faces in the joints shall be cleaned free of mortar.

When weather joints are called for, the beds shall be weather struck. The joints shall be slightly raked to conform to the bed weather joint and in no case shall the mortar be flush with the faces of the stones.

The mortar in joints on top surfaces shall be crowned slightly at the center of the masonry to provide drainage.

247-3.7 CLEANING EXPOSED FACES.—Immediately after being laid, and while the mortar is fresh, all face stone shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed. Before final acceptance, the surface of the masonry shall be cleaned using wire brushes, and if necessary, acid.

247-3.8 WEATHER LIMITATIONS.—No placing of stone shall be done in freezing weather except by written permission from the engineer and then only by the use of such methods as he may prescribe for preparing the materials and protecting the work after it has been laid. Such permission and the use of the methods prescribed shall not, however, release the contractor from his obligation to build a satisfactory structure. All work damaged by cold weather shall be removed and replaced. In hot or dry weather the masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least 3 days after completion.

METHOD OF MEASUREMENT

247-4.1 The yardage to be paid for shall be the number of cubic yards of dimensioned masonry complete in place and accepted. The volume of mortar joints and beds between dimensioned masonry and other classes of masonry shall not be included in the measurement for dimensioned masonry for payment. In computing the yardage for payment the dimensions used shall be governed by the following provisions:

(a) *Payment Lines Shown on Plans.*—For all stones for which payment lines are shown on the plans, the dimensions used shall be those shown on the plans or ordered in writing by the engineer.

(b) *Payment Lines Not Shown on Plans.*—For all stones for which no payment lines are shown on the plans, the dimensions used shall be those of the stone measured in place in the completed work.

(c) *Concealed Dimensions.*—For stones some of the dimensions of which are concealed, thus preventing actual measurement, the dimensions shall be calculated on the following assumptions:

1. *Arch ring stones.*—Concealed dimensions shall be assumed to be the same as corresponding exposed dimensions.

2. *Stones with but one face each showing.*—Each end shall be assumed normal to the contiguous face of the stone and the width equal to $1\frac{1}{4}$ times the neat rise, that is, the rise exclusive of joints.

3. *Stones with two faces each showing.*—Each end shall be assumed normal to the contiguous face of the stone. The width of the stone on the median line of each end shall be taken as equal to $1\frac{1}{4}$ times the neat rise and the back face shall be taken as a vertical plane between the back edges of the ends thus established. In case of a conflict between the assumption of an end normal to one face of a stone and the assumption of width at the other end, the assumption of a right angle shall prevail.

4. *Stones with only a portion of a face each showing.*—Where only a portion of the face shows, as at a re-entrant angle, the length dimension to be used shall be the length of face showing plus 9 inches, to allow for bond.

BASIS OF PAYMENT

247-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Dimensioned Masonry," which price and payment shall be full compensation for furnishing and placing all materials, including the mortar, for false work and bracing, and for all labor, equipment, tools, and incidentals necessary to complete the item, except concrete backing and steel anchors. Steel anchors shall be paid for at the contract unit price per pound for reinforcing steel under REINFORCING STEEL.

ITEM 248.—BRICK MASONRY**DESCRIPTION**

248-1.1 This item shall consist of brick masonry composed of brick laid in cement mortar, prepared and constructed in accordance with these specifications at the locations and of the form and dimensions shown on the plans or ordered in writing by the engineer. The masonry shall be used for walls, piers, copings, facings, or other specified purposes and shall be constructed on the prepared foundation bed or on foundation masonry.

MATERIALS

248-2.1 BRICK.—Brick shall meet the requirements of "Standard Specifications for Highway Bridges" (1935) of A.A.S.H.O., article 2.16.2 save that the grade of brick shall be as shown on the plans.

248-2.2 MORTAR.—Mortar shall conform to the requirements under FOUNDATION MASONRY, subsection 2.3.

CONSTRUCTION METHODS

248-3.1 The construction methods shall be in accordance with the requirements of the above A.A.S.H.O. specification, article 3.9.3, and shall comply with the following additional requirements:

The tops of retaining walls, abutment wing walls, and similarly exposed brick work shall be provided, unless otherwise shown on the plans, with either a stone or concrete coping which shall project at least 1 inch beyond the face of the brick work and shall have a batter or drip bead permitting water to drip clear of the wall, but the coping on an abutment back-wall will have no projection beyond its bridge seat face. Any concrete required shall be of the class shown on the plans.

METHOD OF MEASUREMENT

248-4.1 The yardage to be paid for shall be the number of cubic yards of brick masonry complete in place and accepted. In computing the yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No deductions will be made for weep holes, drain pipes, or other openings of less than 2 square feet in area.

BASIS OF PAYMENT

248-5.1 The yardage of masonry, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Brick Masonry," which price and payment shall constitute full compensation for furnishing and placing all materials, including metal ties and mortar for the masonry, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 250.—REINFORCED CONCRETE CULVERT PIPE**DESCRIPTION**

250-1.1 This item shall consist of reinforced concrete culvert pipe of the classes, sizes, and dimensions required on the plans, furnished and installed at such places as are designated on the plans or by the engineer, in accordance with these specifications and in conformity with the lines and grades given.

This item shall include the furnishing and construction of such joints and such connections to other pipes, catch basins, end walls, etc., as may be required to complete the structure as shown on the plans.

Pipe shall be "Standard Reinforced Concrete Culvert Pipe" and/or "Extra Strength Reinforced Concrete Culvert Pipe," as called for in the bid schedule.

MATERIALS AND MANUFACTURE

250-2.1 The pipe shall meet the requirements of A.A.S.H.O. Specification M-41 for Reinforced-Concrete Culvert Pipe.

The engineer reserves the right to inspect and test the pipe after its delivery to the work. Injurious defects revealed subsequently to acceptance of pipe at the manufacturer's plant shall be cause for rejection.

CONSTRUCTION METHODS

250-3.1 BEDDING AND BACKFILL.—The formation of the bed for the pipe and the backfilling, after the pipe has been placed as prescribed below, shall be as provided under **BEDDING AND BACKFILL FOR PIPE CULVERTS**.

250-3.2 PLACING PIPE.—The pipe shall be laid carefully, hubs up, ends fully and closely jointed, and true to lines and grades as given. Proper facilities shall be provided for lowering the sections when they are to be placed in a trench. Each section shall be securely attached to the adjoining sections by the method contemplated for the type of joint used. All joints, unless otherwise specified, shall be filled with stiff mortar composed of one part of portland cement and one and one-half parts of sand. Cement, sand, and water shall conform to the requirements for these materials contained in the specifications given for **CONCRETE**. The mortar shall be placed so as to form a durable, watertight joint. After each section of pipe is laid and before the succeeding section is laid, the

lower portion of the hub shall be plastered thoroughly on the inside with mortar to such depth as to bring the inner surfaces of the abutting pipes flush and even. After the section is laid, the remainder of the joint shall be filled with mortar and sufficient additional mortar shall be used to form a bead around the outside of the joint. The inside of the joint shall then be wiped and finished smooth. After the initial set, the mortar on the outside shall be protected from the air and sun with a cover of thoroughly wetted earth or burlap. Any pipe which is not in true alinement or which shows any undue settlement after being laid, or is damaged, shall be taken up and relaid or replaced without extra compensation.

METHOD OF MEASUREMENT

250-4.1 The footages to be paid for shall be the actual number of linear feet of pipe of the several classes and sizes measured as installed in place, completed, and accepted.

BASIS OF PAYMENT

250-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Standard Strength Reinforced Concrete Culvert Pipe," or "Extra Strength Reinforced Concrete Culvert Pipe," of the several sizes, which prices and payments shall constitute full compensation for furnishing or manufacturing, hauling, and installing pipe, for jointing and joint materials, and for all materials, labor, equipment, tools, and incidentals necessary to complete the item, but shall not constitute payment for headwalls or for excavation.

ITEM 251.—VITRIFIED CLAY CULVERT PIPE**DESCRIPTION**

251-1.1 This item shall consist of vitrified clay culvert pipe (2,000 D) of the sizes and dimensions required on the plans, furnished and installed at such places as are designated on the plans or by the engineer, in accordance with these specifications and in conformity with the lines and grades given. This item shall include the furnishing and construction of such joints and connections to other pipes, catch basins, end walls, etc., as may be required to complete the structure as shown on the plans.

MATERIALS AND MANUFACTURE

251-2.1 Vitrified clay pipe shall meet the requirements of A.A.S.H.O. Specification M-65.

CONSTRUCTION METHODS

251-3.1 The formation of the bed for the pipe and the backfilling, after the pipe has been placed as prescribed below, shall be as provided under BEDDING AND BACKFILL FOR PIPE CULVERTS.

251-3.2 PLACING PIPE.—Proper facilities shall be provided for lowering the sections when they are to be placed in a trench. The pipe shall be laid carefully, bells up, ends fully and closely jointed, and true to lines and grades as given. Each section shall be attached securely to the adjoining sections by the method contemplated for the type of joint used. All joints, unless otherwise specified, shall be filled with stiff mortar composed of one part of portland cement and one and one-half parts of sand. Cement, sand, and water shall conform to the requirements for these materials contained in the specification given for CONCRETE. The mortar shall be placed so as to form a durable, watertight joint. After each section of pipe is laid and before the succeeding section is laid, the lower portion of the bell shall be plastered thoroughly on the inside with the mortar to such depth as to bring the inner surfaces of the abutting pipes flush and even. After the section is laid, the remainder of the joint shall be filled with mortar and sufficient additional mortar shall be used to form a bead around the outside of the joint. The inside of the joint shall then be wiped and finished smooth. After the initial set, the mortar on the outside shall be protected from the

air and sun with a cover of thoroughly wetted earth or burlap. Any pipe, which is not in true alinement or which shows any undue settlement after being laid, or is damaged, shall be taken up and relaid or replaced without extra compensation.

METHOD OF MEASUREMENT

251-4.1 The footages to be paid for shall be the actual number of linear feet of pipe of the several sizes, measured as installed in place, completed, and accepted.

BASIS OF PAYMENT

251-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Vitrified Clay Culvert Pipe" of the several sizes, which prices and payments shall constitute full compensation for furnishing, hauling, and installing the pipe, for jointing and jointing materials and for all materials, labor, equipment, tools, and incidentals necessary to complete the item, but shall not constitute compensation for head walls, or for excavation.

ITEM 252.—CAST IRON CULVERT PIPE**DESCRIPTION**

252-1.1 This item shall consist of cast iron pipe of the types, classes, sizes, and dimensions required on the plans, furnished and installed at such places as are designated on the plans or by the engineer, in accordance with these specifications and in conformity with the lines and grades given.

This item shall include the furnishing and installation of such specials, joints and connections to other pipes, catch basins, end walls, etc., as may be required to complete the structure as shown on the plans.

Pipe shall be of the type or types and the class or classes called for in the bid schedule. The types are identified as "Smooth," "Corrugated," and "Ribbed." The classes are identified as "Standard" (2,000 D), "Heavy" (3,000 D), and "Extra Heavy" (4,000 D). When the bid schedule or plans do not indicate the type, the contractor may furnish the type of his choice, except that for each class required only one type shall be furnished on a single job.

MATERIALS AND MANUFACTURE

252-2.1 The pipe shall meet the requirements of A.A.S.H.O. Specification M-64.

CONSTRUCTION METHODS

252-3.1 BEDDING AND BACKFILL.—The formation of the bed for the pipe and the backfilling, after the pipe has been placed as prescribed below, shall be as provided under **BEDDING AND BACKFILL FOR PIPE CULVERTS**.

252-3.2 PLACING PIPE.—Proper facilities shall be provided for lowering the sections when they are to be placed in a trench. The pipe shall be laid carefully, hubs up, ends fully and closely jointed, and true to lines and grades as given. Each section shall be attached securely to the adjoining sections by the method contemplated for the type of joint used. All joints, unless otherwise specified, shall be filled with stiff mortar composed of one part of portland cement and one and one-half parts of sand. Cement, sand, and water shall conform to the requirements for these materials contained in the specification given for **CONCRETE**. The mortar shall be placed so as to form a durable, water-tight joint. After each section of pipe is laid and before the succeeding section is laid, the

lower portion of the hub shall be plastered thoroughly on the inside with mortar to such depth as to bring the inner surfaces of the abutting pipes flush and even. After the section is laid, the remainder of the joint shall be filled with mortar and sufficient additional mortar shall be used to form a bead around the outside of the joint. The inside of the joint shall then be wiped and finished smooth. After the initial set, the mortar on the outside shall be protected from the air and sun with a cover of thoroughly wetted earth or burlap. Any pipe which is not in true alinement or which shows any undue settlement after being laid, or is damaged, shall be taken up and relaid or replaced without extra compensation.

METHOD OF MEASUREMENT

252-4.1 The footages to be paid for shall be the actual number of linear feet of pipe of the several types, classes, and sizes measured as installed in place, completed, and accepted.

BASIS OF PAYMENT

252-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Cast Iron Culvert Pipe" of the several types, classes, and sizes, which prices and payments shall constitute full compensation for furnishing, hauling, and installing the pipe, for jointing and joint materials, and for all materials, labor, equipment, tools, and incidentals necessary to complete the item, but shall not constitute payment for headwalls, nor for excavation.

ITEM 253.—CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE

DESCRIPTION

253-1.1 This item shall consist of corrugated galvanized sheet metal pipe of the sizes, gages, and dimensions required on the plans, furnished and installed at such places as are designated on the plans or by the engineer, in accordance with these specifications and in conformity with the lines and grades given.

This item shall include the furnishing and construction of such joints and connections to other pipes, catch basins, end walls, etc., as may be required to complete the structure as shown on the plans.

Pipe shall be of the full circle, riveted type, with lap-joint construction unless otherwise specified.

MATERIALS AND MANUFACTURE

253-2.1 BASE METAL.—Corrugated metal pipe culverts shall be fabricated from corrugated galvanized sheets the base metal of which shall be made by either the open hearth process or a process that produces genuine wrought iron. The base metal shall conform to one of the chemical requirements of table 1.

TABLE 1.—Requirements for metal for galvanized pipe

Elements	Chemical composition by ladle analysis (position of base metals does not indicate preference)						Tolerance by check analysis of finished sheets
	Kind of base metal						
	Pure iron	Copper-bearing pure iron	Copper iron	Copper molybdenum iron	Copper steel	Genuine wrought iron	
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Carbon, max.....						0.05	0.01
Manganese, max.....						.06	.01
Phosphorus, max.....	0.015	0.015	0.015	0.015		.12	
Sulphur, max.....	.040	.040	.040	.040	0.050	.04	.01
Silicon, max.....						.15	
Copper, min.....		.20	.20	.40	.20		.02
Molybdenum, min.....				.05			
Sum of first 5 elements, max.....		.10	.25	.25	.70	.42	.04
Sum of first 6 elements, max.....	.10						.04

253-2.2 RIVETS.—All rivets shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized.

253-2.3 SPELTER COATING.—The base metal sheets shall be galvanized on both sides by the hot-dip process, after which these sheets may be sheared to proper sizes. A coating of prime western spelter or its equal shall be applied at the rate of not less than 2 ounces per square foot of double exposed surface. If the average spelter coating as determined from the required samples is less than 2 ounces of spelter per square foot, or if any one specimen has less than 1.8 ounces of spelter per square foot of double exposed surface, the lot sampled shall be rejected. The finished sheets shall be of first class commercial quality, free of injurious defects, such as blisters, flux, and uncoated spots.

253-2.4 DESIGN.—The lengths of sheets, widths of laps, standard gages and computed weights per linear foot of the finished culverts, shall be as specified in table 2. The dimensions given in that table for diameter of pipe are nominal. The average weight per linear foot of a finished culvert, exclusive of end finish, shall not underrun the computed weight specified by more than 5 percent.

TABLE 2.—Requirements for corrugated metal culverts

Nominal diameter	Length of sheet before forming	Minimum width of lap	Galvanized sheet gage	Computed weight per linear foot of finished culvert exclusive of end finish	Connecting bands galvanized sheet gage (or heavier)
Inches	Inches	Inches	Number	Pounds	Number
8	28½	1½	16	7.3	16
10	35	1½	16	9.0	16
12	41	1½	16	10.5	16
15	50½	1½	16	12.9	16
18	60	1½	16	15.3	16
21	69½	1½	16	17.7	16
24	80	2	14	25.2	16
30	98	2	14	30.9	16
36	117	2	12	51.0	14
42	137	3	12	59.5	14
48	156	3	12	68.0	14
54	1-80 1-98	3	12	77.8	14
60	2-98		10	108.9	12

In fabricating 42- and 48-inch sizes, two sheets may be used by allowing sufficient total sheet lengths to provide for an additional standard lap.

The gages of the sheets shall be increased if so indicated on the plans for culverts under high fills. In such case any connecting bands shall be of a gage not more than 2 numbers higher than that of the sheets connected, and in any case shall not be thinner than 16-gage.

253-2.5 GAGE DETERMINATIONS AND TOLERANCES.—

The gage of the culvert metal shall be determined from the weights of the galvanized sheets. The theoretical weights per square foot, together with permissible tolerances, on the flat galvanized sheets, shall be as indicated in table 3.

TABLE 3.—*Theoretical weights of galvanized sheets and permissible tolerances*

Galvan- ized sheet	Theoretical weight of galvanized sheet	Permissible tolerances in weights of sheets, plus or minus in per- centage of theoretical weight ¹		
		All of one gage and size in shipment ²	Single pack- ages	Single sheets
<i>Gage</i>	<i>Oz. per sq. ft.</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
8	112.5	5	7	10
10	92.5	5	7	10
12	72.5	5	7	10
14	52.5	5	7	10
16	42.5	5	7	10

¹ References are to gross weights of bundled material and to net weights of crated and boxed material. If the minimum or maximum only be ordered, double tolerance is to be taken on permissible side.

² Applies only to lots of 6,000 pounds or more.

253-2.6 CORRUGATIONS.—Corrugations shall be not less than $2\frac{1}{4}$ inches nor more than $2\frac{3}{4}$ inches center to center. The corrugations shall be not less than one-half inch in depth.

253-2.7 PERFORATED PIPE.—Perforations shall be approximately one-fourth inch in diameter after the pipe has been galvanized. They shall be punched on centers spaced $1\frac{1}{2}$ inches lengthwise of the sheet so as to be in inside ridges of all but the end corrugations of each culvert section. The number of longitudinal rows of perforations shall conform to the requirements of the following table:

Diameter of pipe, inches.....	8	10	12	15	18	21	24	30
Number of rows of holes.....	8	8	10	10	15	15	20	20

253-2.8 RIVETS AND RIVETING.—Rivets shall be of the following diameters for the gage numbers specified:

<i>Gage number</i>	<i>Diameter, inch</i>	<i>Gage number</i>	<i>Diameter, inch</i>
16	$\frac{5}{16}$	10	$\frac{3}{8}$
14	$\frac{5}{16}$	8	$\frac{3}{8}$
12	$\frac{3}{8}$		

All rivets shall be driven cold in such a manner that the plates are drawn tightly together throughout the entire lap. No rivet center shall be closer to the edge of the metal than

twice the rivet diameter. All rivets shall have neat, workmanlike, and full hemispherical heads of a form acceptable to the engineer, shall be driven without bending, and shall completely fill the holes. Longitudinal laps shall be riveted with one rivet in the valley of each corrugation. The longitudinal laps in all pipe 42 inches or more in diameter shall be double riveted. Circumferential, shop-riveted laps shall have a maximum rivet spacing of 6 inches, except that 6 rivets will be sufficient in 12-inch pipe.

253-2.9 NET LENGTH OF PIPE.—The length of pipe shall be the net length of the finished pipe which shall not include any material used to obtain an end finish on the pipe. If the average deficiency in length of any shipment of pipe is greater than 1 percent, the shipment shall be rejected.

253-2.10 END FINISH.—The inlets and outlets of all culverts fabricated of 16- or 14-gage sheets shall be reinforced in a manner approved by the engineer, when so specified.

253-2.11 COUPLING BANDS.—Field joints shall be made with bands of the same base metal as the culverts. The bands shall be not less than 7 inches wide for culverts with diameters of 8 to 30 inches, inclusive, and not less than 12 inches wide for culverts with diameters of 36 to 60 inches, inclusive. Such bands shall be so constructed as to lap on an equal portion of each of the culvert sections to be connected, and preferably shall be connected at the ends by galvanized angles having minimum dimensions of 2 by 2 by $\frac{1}{8}$ inches. The 7-inch band shall have at least two galvanized bolts of not less than $\frac{1}{2}$ -inch diameter. The 12-inch band shall have three bolts of $\frac{1}{2}$ -inch diameter. Other equally effective methods of connecting the coupling bands may be used if approved by the engineer.

253-2.12 WORKMANSHIP.—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 following defects are specified as constituting poor workmanship, and the presence of any or all of them, or other defects, in any individual culvert pipe or in general in any shipment shall constitute sufficient cause for rejection: Uneven laps; elliptical shapes; variation from a straight center line; ragged or diagonal-sheared edges; loose, unevenly lined or spaced rivets; poorly formed rivet heads; unfinished ends; illegible brands; lack of rigidity; bruised, scaled, or broken spelter coating; dents or bends in the metal itself.

253-2.13 MILL AND FACTORY INSPECTION.—If the engineer so elects, he may have the material inspected and sampled in the rolling mill or in the shop where fabricated. He may require the mill to furnish the chemical analysis of any heat used. The inspection, either in the mill or in the shop, shall be under the direction of the engineer. The engineer or his representative shall have free access to the mill or shop

for inspection, and every facility shall be extended to him for this purpose. Inclusion in any lot of any material or pipe previously rejected at the mill or shop, will be considered sufficient cause for the rejection of the entire lot.

253-2.14 FIELD INSPECTION.—The contractor shall furnish an itemized statement of the sizes and lengths of culvert pipe in each shipment. Field inspection shall include an examination of the culvert pipe for deficiency in lengths of sheets used, nominal specified diameter and net length of finished culvert pipe, and any evidence of poor workmanship as outlined above. The inspection may include the taking of samples for chemical analysis, and determination of weight of spelter coating. The pipe making up the shipment shall meet the requirements of these specifications fully, and if 25 percent of the pipe in any shipment fails to meet these requirements, the entire shipment may be rejected.

253-2.15 IDENTIFICATION.—No culverts will be accepted unless the metal is identified by a stamp on each section showing:

First.—Name of sheet manufacturer.

Second.—Name of brand and kind of base metal.

Third.—Gage number.

Fourth.—Weight of spelter coating.

Fifth.—Identification symbols showing $\left\{ \begin{array}{l} \text{heat No.} \\ \text{pot No.} \end{array} \right.$

Provided, however, that identification symbols showing heat numbers will not be required for wrought iron, but identification by pot number will be required.

The identification brands shall be placed on the sheets by the manufacturers of the sheets in such a way that when rolled into culverts the identification will appear on the outside of each section of each pipe. Pipes having any sections not so stamped shall be rejected. The kind of base metal shall be designated independently of the brand or trade mark so as to identify clearly the base metal furnished as being one of the kinds listed in the headings of table 1. The designation of the "kind of base metal" may be indicated by placing on each sheet the initials of the exact name of the base metal used therein as the name appears in the table, as follows: PI for pure iron, CBPI for copper-bearing pure iron, CI for copper iron, CMI for copper molybdenum iron, CS for copper steel, and GWI for genuine wrought iron.

253-2.16 ACCEPTED BRANDS OF METALS.—No metal will be accepted until after the sheet manufacturer's certified analysis and manufacturer's guarantee have been passed upon by the engineer and accepted. Misbranding or other misrepresentation, and nonuniformity of product will each be considered

a sufficient reason to discontinue the acceptance, under this specification, of any brand found unsatisfactory in any of these respects. Notice sent to the sheet manufacturer of the discontinuance of acceptance of his brand will be considered to be notice to all culvert companies handling that particular brand. The kind of base metal that he proposes to furnish shall be designated by the bidder in his bid. One brand, and one brand only, shall be approved for each kind of base metal furnished by each of the actual manufacturers of the sheets.

253-2.17 SHEET MANUFACTURER'S CERTIFIED ANALYSIS.—The manufacturer of each brand shall file with the engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the respective percentages of carbon, manganese, phosphorus, sulphur, silicon, and copper; also of molybdenum when it is to be a constituent of the particular kind of base metal to be used. The certificate shall be sworn to for the manufacturer by a person having legal authority to bind the company.

253-2.18 SHEET MANUFACTURER'S GUARANTEE.—The manufacturer of the sheets shall submit with the certified analysis a guarantee providing that all metal furnished shall conform to the certified analysis filed, that it shall bear a suitable identification brand or mark, and that it shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gage, or spelter coating. The guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material of the brand guaranteed.

253-2.19 SAMPLING.—Chemical analysis of the base metal of the finished sheets, when required, may be made using samples taken for testing for weight of spelter coating. For testing the coating of sheets before the culverts are fabricated, a sample strip about 3 inches wide shall be cut crosswise or diagonally across the full width of one sheet of each lot bearing the same identification symbol. From this strip and along the newly sheared edge, samples $2\frac{1}{4}$ inches square, or of equivalent area, shall be cut from the middle and near each end. For testing coating of fabricated culverts, at least one sample $2\frac{1}{4}$ inches square, or a sample of equivalent area, shall be selected from each 20 culverts of a shipment, provided that not less than 3 samples, each from a different section, shall represent any one shipment.

253-2.20 ANALYSIS OF FINISHED SHEET.—When not otherwise specified, chemical analysis, when required, shall be made according to A.S.T.M. Designation E 30-36-T.

253-2.21 TESTS FOR SPELTER COATING.—The tests for weight of spelter coating shall be made according to A.A.S.H.O. Method T-65.

CONSTRUCTION METHODS

253-3.1 BEDDING AND BACKFILL.—The formation of the bed for the pipe and the backfilling, after the pipe has been placed as prescribed below, shall be as provided under **BEDDING AND BACKFILL FOR PIPE CULVERTS**.

253-3.2 PLACING PIPE.—Every culvert under the highway shall be so laid that the minimum distance from the finished surface of the roadbed to the top of the pipe shall be not less than one-half the diameter of the pipe with a minimum of one foot.

The pipe shall be laid with the separate sections joined firmly together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in the joints which is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

Proper facilities shall be provided for lowering the pipe when it is to be placed in a trench. The pipe shall be laid carefully and true to lines and grades as given. Any pipe which is not in true alinement or which shows any undue settlement after being laid, or is damaged, shall be taken up and relaid or replaced without extra compensation.

Pipes of 42-inch or larger diameter shall be strutted as shown on the plans. The struts shall be placed before the embankment is made and shall be removed when removal is ordered by the engineer.

METHOD OF MEASUREMENT

253-4.1 The footages to be paid for shall be the actual number of linear feet of pipe of the several sizes and gages, measured as installed in place, completed and accepted. The measurement shall be from end to end of each culvert in place, as terminated by the end finish.

BASIS OF PAYMENT

253-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Corrugated Galvanized Sheet Metal Culvert Pipe" of the several sizes and gages, which prices and payments shall constitute full compensation for furnishing, hauling, and installing the pipe, for joints and jointing, and for all materials, labor, equipment, tools, and incidentals necessary to complete the item, but shall not constitute compensation for headwalls nor for excavation.

ITEM 254.—BITUMINOUS COATED CORRUGATED SHEET METAL CULVERT PIPE, TYPE 1

DESCRIPTION

254-1.1 This item shall consist of bituminous coated sheet metal culvert pipe with asphalt or metal pavement, of the sizes, gages, and dimensions required on the plans, furnished and installed at such places as are designated on the plans or by the engineer, in accordance with these specifications and in conformity with the lines and grades given.

This item shall include the furnishing and construction of such joints and such connections to other pipes, catch basins, end walls, etc., as may be required to complete the structure as shown on the plans.

MATERIALS AND MANUFACTURE

254-2.1 The bituminous coated pipe shall conform to all the requirements given under **CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE** and, in addition, shall be completely coated inside and out with an asphalt cement which will meet the performance requirements set forth herein.

(a) *Types of Pavement.*—This specification covers pipe in which the pavement consists wholly of asphalt cement (hereinafter called asphalt pavement) and pipe with a pavement of asphalt cement suitably reinforced with metal (hereinafter called reinforced asphalt pavement).

In pipe with asphalt pavement the pavement shall cover the inside of the pipe over the bottom one-fourth of its circumference and shall be composed of asphalt.

In pipe with reinforced asphalt pavement the inside of the pipe over the bottom one-fourth of its circumference shall be covered with a metal reinforcement. This reinforcement may be a flat steel plate curved to fit the bottom of the pipe or it may be a suitable form of steel mesh reinforcement. The steel plate reinforcement, when used, shall be of metal approved for culvert pipe, shall have the same weight of zinc coating as the pipe, and shall be not lighter than No. 22 galvanized sheet gage. The plate or mesh reinforcement shall be securely fastened to the pipe so that it becomes an essential and fixed part of the pipe.

(b) *Thickness of Asphalt for Pavement and Coating.*—The inside of the pipe shall be coated uniformly for three-fourths of the circumference (top of pipe when installed) to a minimum

thickness of 0.04 inch. The thickness shall be measured on the crests of the corrugations.

In pipe with asphalt pavement the remaining one-fourth of the circumference (bottom of pipe when installed) shall be coated to a minimum thickness of 0.37 inch, measured on the crests of the corrugations and to such thickness that it will withstand the erosion test hereinafter specified.

In pipe with reinforced asphalt pavement, the lower one-fourth of the circumference (bottom of pipe when installed) shall be coated to such thickness that it will withstand the erosion test hereinafter specified. The openings between the reinforcement and the corrugations of the pipe shall be closed at the edges of the pavement in such manner that the pavement coating and the coating on the sidewalls of the pipe will be continuous.

(c) *Erosion Test.*—In addition to having the coating thicknesses specified above, the pipe shall pass an erosion test, which shall be performed as follows:

The sample used in the test shall consist of a representative 2-foot length of coated pipe. The erosive charge shall consist of 50 pounds of grade MW building brick, conforming to the requirements of the Specifications for Building Brick of the A.S.T.M., Designation C62, broken into cubical pieces 2 to 3 inches in size, and 3 gallons of water. Each end of the sample shall be closed with a metal cap having the form of a truncated cone with the side sloping at approximately 15° with the axis and of a depth such that the cone will be able to receive the entire erosive charge.

The closed sample containing the erosive charge shall be revolved end over end in such a manner that the erosive charge will roll alternately along the inner surfaces of the opposite sides of the pipe (inside top and bottom, as when installed in service). The speed of rotation shall be 3.7 ± 0.1 revolutions per minute and the rotation shall be continued until a total of 1,110 revolutions have been made. This period (approximately 5 hours) is called a test period. During the test period at least 75 percent of the sample shall be immersed, as it revolves, in a bath of water maintained at a temperature of 50–55° F.

To pass the test the top three-fourths of the internal surface of the sample shall not show areas of bare metal totaling more than 2 inches in length per corrugation on any four of the eight central corrugations after one test period. The bottom one-fourth of the internal surface of pipe with asphalt pavement shall not show areas of bare metal totaling more than 2 inches in length per corrugation on any four of the eight central corrugations after a total of ten test periods, in which a new erosive charge is used for each test period. Pipe with reinforced asphalt pavement shall show no areas of bare metal in the pavement, within the central 15 inches of its length, after a total of ten test periods, in which a new erosive charge is used for each test period.

(d) *Asphalt.*—The asphalt cement shall be not less than 99.5 percent soluble in carbon disulphide. The asphalt cement shall adhere to the metal tenaciously; shall not chip off in handling; and shall protect the pipe from deterioration, as evidenced by meeting the following tests successfully:

1. *Stability test.*—The asphalt cement shall not lose its stability when subjected to the highest summer temperature, as indicated by passing the test performed as follows: Parallel lines shall be drawn along the valleys of the corrugations of a representative sample of coated pipe and the specimen placed on end in a constant temperature oven, with the parallel lines in a horizontal position. The temperature of the specimen shall be maintained within 2° F. of 150° F. for a period of 4 hours. At the end of this time, no part of any line shall have dropped more than one-fourth inch.

2. *Imperviousness test.*—The asphalt cement shall be impervious to liquids as indicated by passing the test performed as follows: A 25-percent solution of sulphuric acid, or a 25-percent solution of sodium hydroxide, or a saturated salt solution (such as sodium chloride) shall be held in the valley of a corrugation for a period of 48 hours, during which time no loosening or separation of the bituminous material from the galvanizing shall have taken place.

254-2.2 LICENSE AGREEMENT.—The holders of patents No. 1,652,703 and No. 1,984,125, which include claims relating to the type of culvert pipe described in this specification and to the methods of making culverts, agree to grant a license to any company which desires to make application therefor, on nominal payment of \$1 per annum, permitting culverts to be manufactured to meet the requirements of this specification.

A copy of the license agreement is attached and is made a part of this specification.

AGREEMENT

THIS AGREEMENT, made and entered into by and between The American Rolling Mill Company, a corporation of Ohio, with a principal place of business at Middletown, Ohio, Licensor, and

-----, a corporation of -----, with a principal place of business at -----, Licensee.

WHEREAS, the Licensor, is the owner of United States Letters Patent No. 1,652,703, issued December 13, 1927, covering CORRUGATED METAL CULVERTS, with an interior flooring and coating, and No. 1,984,125 issued December 11, 1934, covering METHODS OF MAKING CULVERTS, and

WHEREAS, the Licensee is desirous of obtaining a license under said Letters Patent.

NOW, THEREFORE, in consideration of One Dollar (\$1.00) each to the other paid, receipt whereof is hereby acknowledged, and the mutual covenants herein contained, it is agreed as follows:

1. The Licensor hereby grants to the Licensee a nonexclusive, nonassignable license under the said Letters Patent Nos. 1,652,703 and 1,984,125 to manufacture a particular product set forth in Article 2 hereof, and to use and sell said product only in the State of _____ and for use on Federal Aid projects only.

2. The license herein granted and conveyed shall extend only to the manufacture, use, and sale of a product described as follows: A circumferentially corrugated culvert having the interior thereof at least coated with an adhesive, resilient substance, covering at least a substantial portion of the lower half of the culvert, but so applied along the base of the culvert as to be substantially thicker than as applied to the side walls. It is understood that the product to be manufactured and sold under this license will not have one or more substantially smooth and/or level floors substantially filling the valleys of the corrugations in the bottom of the invert.

3. For and in consideration of the license grant herein contained, Licensee shall pay to the Licensor a royalty of One Dollar (\$1.00) per year.

4. The Licensee agrees to keep the Licensor informed at all times of the character and specifications of culverts made under this license and will, at all reasonable business hours, permit Licensor to inspect the culverts on hand, as well as in the course of manufacture and the apparatus for making the same, wherever said culvert shall be manufactured or stored by or for Licensee.

5. Licensor reserves the right to cancel this contract forthwith if at any time it ascertains that Licensee is manufacturing and/or selling coated corrugated culverts not made in accordance with Article 2 hereof.

6. This license, unless sooner terminated in accordance with the provisions of Paragraph 5 hereof, shall extend for the life of United States Letters Patent Nos. 1,652,703 and 1,984,125 excepting that Licensor reserves the right to cancel this contract for nonuse extending for a period of two years.

7. This license shall be personal to Licensee and shall not be assignable, except upon the written consent of the Licensor thereto first obtained.

IN WITNESS WHEREOF, the parties hereto have set their hands and seals this _____ day of _____, 19____,
Attest:

THE AMERICAN ROLLING MILL CO.

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	President
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	Secretary
Attest:	
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	President
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	Secretary

CONSTRUCTION METHODS

254-3.1 BEDDING AND BACKFILL.—The formation of the bed for the pipe and the backfilling, after the pipe has been placed as prescribed below, shall be as provided under **BEDDING AND BACKFILL FOR PIPE CULVERTS.**

254-3.2 PLACING PIPE.—Every culvert under the highway shall be so laid that the minimum distance from the finished surface of the roadbed to the top of the pipe shall be not less than one-half the diameter of the pipe with a minimum of 1 foot.

The pipe shall be laid with the separate sections joined firmly together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in the joints which is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

Proper facilities shall be provided for lowering the pipe when it is to be placed in a trench. The pipe shall be laid carefully and true to lines and grades as given. Any pipe which is not in true alinement or which shows any undue settlement after being laid, or is damaged, shall be taken up and relaid or replaced without extra compensation.

During installation, the asphalt protected pipe shall be handled without damaging the asphalt coating. The pipe shall be placed so that the element of the cylindrical pipe constituting the center line of the thickened portion of the asphalt protection shall coincide with the flow line of the culvert.

Pipes of 42-inch or larger diameter shall be strutted as shown on the plans. The struts shall be placed before the embankment is made and shall be removed when removal is ordered by the engineer.

METHOD OF MEASUREMENT

254-4.1 The footages to be paid for shall be the actual number of linear feet of pipe of the several sizes and gages, measured as installed in place, completed, and accepted. The measurement shall be from end to end of each culvert in place, as terminated by the end finish.

BASIS OF PAYMENT

254-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 1" of the several sizes and gages, which prices and payments shall constitute full compensation for furnishing, hauling, and installing the pipe, for joints and jointing, and for all materials, labor, equipment, tools, and incidentals necessary to complete the item, but shall not constitute compensation for headwalls nor for excavation.

**ITEM 255.—BITUMINOUS COATED CORRUGATED SHEET
METAL CULVERT PIPE, TYPE 2**
DESCRIPTION

255-1.1 This item shall consist of bituminous coated sheet metal culvert pipe of the sizes and dimensions required on the plans, furnished and installed at such places as are designated on the plans or by the engineer, in accordance with these specifications and in conformity with the lines and grades given.

This item shall include the furnishing and construction of such joints and connections to other pipes, catch basins, end walls, etc., as may be required to complete the structure as shown on the plans.

MATERIALS AND MANUFACTURE

255-2.1 The pipe shall conform to all the requirements of the specification for CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE, and in addition shall be completely coated inside and out with an asphalt cement that will meet the requirements set forth herein.

(a) *Thickness of Asphalt Coating.*—The pipe shall be coated uniformly to a minimum thickness of 0.04 inch. The thickness shall be measured on the crests of the corrugations.

(b) *Asphalt.*—The asphalt for coating shall be 99.5 percent soluble in carbon disulphide, it shall adhere to the metal tenaciously, shall not chip off in handling, and shall protect the pipe from deterioration, as evidenced by passing the tests described below:

1. *Stability test.*—The asphalt shall not lose its stability when subjected to the highest summer temperature, as indicated by passing the test performed as follows: Parallel lines shall be drawn along the valleys of the corrugations of a representative sample of coated pipe and the specimen placed on end in a constant temperature oven, with the parallel lines in a horizontal position. The temperature of the specimen shall be maintained within 2° F. of 150° F. for a period of 4 hours. At the end of this time, no part of any line shall have dropped more than one-fourth inch.

2. *Imperviousness test.*—The asphalt shall be impervious to liquids as indicated by passing the test performed as follows: A 25-percent solution of sulphuric acid, or a 25-percent solution of sodium hydroxide, or a saturated salt solution (such as sodium

chloride) shall be held in the valley of a corrugation for a period of 48 hours, during which time no loosening or separation of the bituminous material from the galvanizing shall have taken place.

3. Erosion test.—In addition to having the coating thickness specified above, the pipe shall pass an erosion test, which shall be performed as follows:

The sample used in the test shall consist of a representative 2-foot length of fully coated pipe. The erosive charge shall consist of 50 pounds of grade MW building brick, conforming to the requirements of the Specifications for Building Brick of the A.S.T.M., Designation C62, broken into cubical pieces 2 to 3 inches in size, and 3 gallons of water. Each end of the sample shall be closed with a metal cap having the form of a truncated cone with the side sloping at approximately 15° with the axis and of a depth such that the cone will be able to receive the entire erosive charge.

The closed sample containing the erosive charge shall be revolved end over end in such a manner that the erosive charge will roll alternately along the inner surfaces of the opposite sides of the pipe. The speed of rotation shall be 3.7 ± 0.1 revolutions per minute and the rotation shall be continued until a total of 1,110 revolutions has been made. This period (approximately 5 hours) is called a test period. During the test period at least 75 percent of the sample shall be immersed, as it revolves, in a bath of water maintained at a temperature of 50-55° F.

To pass the test, the internal surface of the sample shall not show along either element tested, areas of bare metal totaling more than 2 inches in length per corrugation on any four of the eight central corrugations after one test period.

CONSTRUCTION METHODS

255-3.1 BEDDING AND BACKFILL.—The formation of the bed for the pipe and the backfilling, after the pipe has been placed as prescribed below, shall be as provided under **BEDDING AND BACKFILL FOR PIPE CULVERTS**.

255-3.2 PLACING PIPE.—Every culvert under the highway shall be so laid that the minimum distance from the finished surface of the roadbed to the top of the pipe shall be not less than one-half the diameter of the pipe with a minimum of 1 foot.

The pipe shall be laid with the separate sections joined firmly together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in the joints which is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

Proper facilities shall be provided for lowering the pipe when it is to be placed in a trench. The pipe shall be laid carefully and true to lines and grades as given. Any pipe which is

not in true alinement or which shows any undue settlement after being laid, or is damaged, shall be taken up and relaid or replaced without extra compensation.

During installation, the asphalt protected pipe shall be handled without damaging the asphalt coating.

Pipes of 42-inch or larger diameter shall be strutted as shown on the plans. The struts shall be placed before the embankment is made and shall be removed when removal is ordered by the engineer.

METHOD OF MEASUREMENT

255-4.1 The footages to be paid for shall be the actual number of linear feet of pipe of the several sizes, measured as installed in place, completed, and accepted. The measurement shall be from end to end of each culvert in place, as terminated by the end finish.

BASIS OF PAYMENT

255-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 2" of the several sizes, which prices and payments shall constitute full compensation for furnishing, hauling, and installing the pipe, for joints and jointing, and for all materials, labor, equipment, tools, and incidentals necessary to complete the item, but shall not constitute compensation for headwalls nor for excavation.

ITEM 256.—REMOVING, CLEANING, AND STOCKPILING OR RELAYING SALVAGED CULVERT PIPE

DESCRIPTION

256-1.1 This item shall consist of removing, cleaning, and stockpiling, or relaying culvert pipe as indicated on the plans.

CONSTRUCTION METHODS

256-3.1 The pipe shall be carefully removed and thoroughly cleaned, and shall then be relaid where designated, in accordance with the appropriate specification item for the type of pipe involved, or it shall be stockpiled where and as ordered by the engineer. Any cutting of the pipe that may be required to obtain the necessary lengths for relaying shall be done by the contractor as ordered by the engineer.

METHOD OF MEASUREMENT

256-4.1 The footages to be paid for shall be the number of linear feet of culvert pipe, irrespective of type or size, removed and cleaned, measured as stockpiled, or relaid, completed, and accepted.

BASIS OF PAYMENT

256-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Removing, Cleaning, and Stockpiling Salvaged Culvert Pipe" or "Removing, Cleaning, and Relaying Salvaged Culvert Pipe," which prices and payments shall constitute full compensation for all necessary excavation for removing pipe, for removing, hauling, cleaning, and stockpiling or relaying culvert pipe, for any necessary cutting of pipe, for furnishing new coupling bands required, and for all labor, tools, equipment, and incidentals necessary to complete the item, except excavation.

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INCIDENTAL CONSTRUCTION

ITEM 300.—PILING

DESCRIPTION

300-1.1 This item shall consist of piling furnished and placed in accordance with these specifications and in conformity with the plans and driven at the location and to the penetration ordered by the engineer. Foundation, trestle, and sheet piles shall be untreated timber, treated timber, concrete, or structural steel, all as shown on the plans and called for in the bid schedule. No alternate types or kinds of piling, save such as are shown on the plans, shall be used.

300-1.2 TEST PILES.—For his information the contractor may drive such test piles as he may believe necessary. In all cases he shall furnish the piles and necessary equipment. The location and manner of driving of test piles shall be at the discretion of the contractor, save that the contractor shall cooperate with the engineer in facilitating the keeping of accurate records of driving and complete field data and, after he has finished with any individual test pile, shall drive such test pile to any deeper penetration that the engineer may order, and save that when so indicated on the plans, the location and manner of driving of test piles shall be as ordered by the engineer. Unless otherwise indicated on the plans, the test piles furnished shall be of sufficient length to permit driving to practical refusal and shall be of the same section and size required for piles in the structure.

300-1.3 LOAD TESTS.—When called for in the bid schedule, the contractor shall make actual loading tests, as directed. Unless otherwise shown on the plans, these tests shall consist of the application of test loads placed upon a suitable platform supported by the pile or by other methods approved by the engineer. Suitable apparatus for determining accurately the superimposed weight and the settlement of the pile under each increment of load shall be supplied by the contractor. The safe allowable load shall be considered as 50 percent of that load which, after 48 hours' application, has caused not more than one-fourth inch of permanent settlement, measured at the top of the pile. When loading tests are required, at least 1 pile for each group of 100 piles shall be thus tested. Unless otherwise stated on the plans, the test load on timber piles shall be 40 tons, and the test load on concrete and steel piles shall be

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twice the design load as shown on the plans, but not less than 60 tons.

300-1.4 TIMBER PILE BEARING VALUES BY FORMULA.—In the absence of tests as described above, the safe bearing power of each timber pile shall be determined by whichever of the following formulas is applicable:

$$\text{For gravity hammers, } P = \frac{2WH}{S+1},$$

$$\text{For single-acting steam hammers, } P = \frac{2WH}{S+0.1},$$

$$\text{For double-acting steam hammers, } P = \frac{2H(W+Ap)}{S+0.1},$$

in which P =safe load per pile in pounds; W =weight of falling hammer in pounds; H =height of fall in feet; A =area of piston in square inches; p =steam pressure in pounds per square inch at hammer; S =average penetration per blow in inches for the last 5 blows of a gravity hammer or the last 20 blows of a steam hammer.

The formulas above are applicable only when—

1. The hammer has a free fall.
2. The head of the pile is free from broomed or crushed wood fiber or other serious impairment.
3. The penetration is at a reasonably quick and uniform rate.
4. There is no appreciable bounce after the blow.
5. The weight of pile is not more than the weight of the hammer used, if the hammer used is of the gravity type.

The bearing power as determined by the appropriate formula in the foregoing list shall be considered effective only when it is less than the crushing strength of the pile.

In all cases when bearing power is determined by a formula, timber piles shall be driven if possible until the safe bearing power of each is not less than 20 tons.

300-1.5 CONCRETE AND STEEL PILE BEARING VALUES.—The formulas specified above for timber piling may be used in determining a rough approximation for the bearing power of precast and cast-in-place concrete and of structural steel piles.

In all cases when the bearing power of concrete and steel piles is determined by formula the piles shall be driven, if possible, until the safe bearing power of each is not less than 30 tons.

300-1.6 SAFE LOADS.—When the safe bearing power of any pile is found by test, or computation, to be less than the design load, longer piles or additional piles shall be driven as ordered in writing by the engineer.

300-1.7 JETTED PILES.—The safe bearing power of jetted piles shall be determined by actual tests or by the appropriate method and formula given above. No jet shall be used during the test blows.

MATERIALS

300-2.1 UNTREATED TIMBER PILES.—The kind of timber used shall be as shown on the plans.

In general, untreated timber piles shall be used only below permanent ground-water level and shall not be used in water that is infested by marine borers.

The diameter of the heartwood of an untreated pile shall be not less than four-fifths of the corresponding required cross-sectional dimension of the pile, where so required on the plans.

Quality.—All timber piling shall be cut from sound and live trees, preferably during the winter season. It shall contain no unsound knots. Sound knots will be permitted, provided the diameter of a knot does not exceed 4 inches, or one-third of the diameter of the stick at the point where it occurs. Any defect or combination of defects that will impair the strength of the pile more than the maximum allowable knot would impair it shall not be permitted. The butts shall be sawed square and the tips shall be sawed square or tapered to a point not less than 4 inches in diameter as directed by the engineer. Sawn piles shall meet equivalent requirements.

Unless otherwise specified, all piles shall be peeled by removing all of the rough bark and at least 80 percent of the inner bark. No strip of inner bark remaining on the stick shall be over three-fourths of an inch wide or over 8 inches long, and there shall be at least 1 inch of clean wood surface between any two such strips. Not less than 80 percent of the surface on any circumference shall be clean wood.

Round piles shall be cut above the ground swell and shall taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside of the cross-sectional center of a pile at any point more than 1 percent of the length of the pile. In short bends, the distance from the cross-sectional center of a pile to a line stretched from the cross-sectional center above the bend to the cross-sectional center below the bend shall not exceed 4 percent of the length of the bend or a maximum of 2½ inches. All knots shall be trimmed close to the body of a pile.

Dimensions.—Round piles shall have minimum diameters at the tips measured under the bark, as follows:

Length of pile	Tip diameter	
	Douglas fir	All other species
	<i>Inches</i>	<i>Inches</i>
Less than 40 feet.....	9	8
40 to 60 feet.....	9	7
Over 60 feet.....	8	6

The minimum diameter of a pile at a section 4 feet from the butt, measured under the bark, shall be as shown in table 1. The diameter of a pile at the butt shall not exceed 20 inches. Squared piles shall have the dimensions shown on the plans. Sheet piles shall be drift sharpened at their lower ends so as to wedge the adjacent piles tightly together.

TABLE 1.—Required diameters of piles at a section 4 feet from butt

Length of pile	Douglas fir	Southern pine, Southern cypress	All other species
	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
Less than 20 feet.....	13	12	12
20 to 30 feet.....	13	13	13
30 to 40 feet.....	14	13	14
Over 40 feet.....	15	14	15

300-2.2 TREATED TIMBER PILES.—Treated foundation piles, treated trestle piles, and treated foundation piles for trestle bents shall be of the kinds of timber called for on the plans and shall conform to the corresponding requirements for untreated timber piling. In addition, they shall be treated by pressure methods with preservative as prescribed in TREATED AND UNTREATED TIMBER. All piles shall retain preservative in at least the amounts given in table 2. All round piles except Douglas fir shall be so treated as to obtain penetration of all sapwood. Douglas fir piles shall be so treated as to obtain at least three-fourths of an inch penetration in piles for general use and at least seven-eighths of an inch penetration in piles for marine use. For all sawn piles the penetration obtained shall meet the requirements stipulated under TREATED AND UNTREATED TIMBER.

TABLE 2.—Minimum retention of preservative per cubic foot of wood

Piling	Creosote oil or creosote coal tar solution		50-50 creosote petroleum blend
	Empty cell	Full cell	Empty cell
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
General use.....	8		10
Marine use:			
Southern pine.....		16	
Douglas fir.....		14	

300-2.3 CONCRETE PILES.—Concrete for piles shall meet all the requirements for the specified class as provided under CONCRETE, except that the maximum size of aggregate shall be not over 1 inch in any case. The concrete shall be class A unless otherwise stated on the plans.

Reinforcement shall conform to the requirements for REINFORCING STEEL and the weight and dimensions shall be as shown on the plans.

300-2.4 PRECAST CONCRETE PILES.—Precast piles shall be made in accordance with the plans, and reinforcement shall be placed accurately and secured rigidly in such manner as to insure its proper location in the completed pile in accordance with the plans. Centers of main reinforcing bars shall be not closer to the surface of the concrete than 2½ inches. Concrete shall be placed carefully, tamped, and spaded, or vibrated, care being taken to fill every part of the form and to work the concrete around and under the reinforcement without displacing it. The piles shall be cast separately, or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until 4 days after the adjacent piles have been poured. Piles cast in tiers shall be separated by tar paper carefully placed. The concrete in each pile shall be placed continuously. The completed piles shall be free from stone pockets, porous spots or other defects, and shall be straight and true to the form specified. The forms shall be true to line and built of dressed lumber. A 1-inch chamfer strip shall be used in all corners. Forms shall be watertight and shall not be removed within 24 hours after the concrete is placed. Every exposed surface of a pile shall be given a rubbed finish. Piles shall be cured at least 40 days at a temperature of not less than 40° F., or 30 days at a temperature of not less than 60° F. except that if high-early-strength cement is used the curing time may be reduced to 7 days. Piles shall not be driven until this curing is completed. When concrete piles are lifted or moved, they shall be supported at the quarter points.

300-2.5 CAST-IN-PLACE CONCRETE PILES.—The piles shall be of the design or designs shown on the plans.

The metal shell shall meet the requirements of the design approved for the particular type. Any broken, improperly driven, or otherwise defective shell shall be removed and replaced. The class of concrete to be used for cast-in-place concrete piles shall be as specified. Reinforcement shall be secured in such a manner as to insure its proper placement in the finished pile. Accumulations of water in the shells shall be removed before concrete is placed.

No driving shall be done within 20 feet of concrete less than 7 days old.

300-2.6 EXTENSIONS, SPLICES, AND BUILD-UPS.—Extensions or build-ups on precast concrete piles shall be avoided, preferably, but when necessary they shall be made as follows:

After the driving is completed the concrete at the end of the pile shall be cut away, leaving the reinforcing steel exposed for a length of 40 diameters. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the pile shall be fastened securely to the projecting steel and the necessary form work shall be placed, care being taken to prevent leakage along the pile. The concrete shall be of the same quality as that used in the pile. Just prior to placing concrete, the top of the pile shall be wetted thoroughly and covered with a thin coating of neat cement, rettempered mortar, or other suitable bonding material. The forms shall remain in place not less than 7 days and then shall be removed carefully and the entire exposed surface of the pile finished as above specified.

300-2.7 STRUCTURAL STEEL PILES.—Structural steel piles shall be rolled steel sections of the weight and shape called for on the plans. They shall be structural steel meeting the requirements for "Steel for Bridges," A.S.T.M. Designation A 7-39, provided, that, where the bid schedule calls for copper bearing structural steel, the steel shall contain not less than 0.20 percent nor more than 0.35 percent of copper. Steel piles, when placed in the leads, shall conform to the camber and sweep permitted by allowable mill tolerance. Piles bent or otherwise injured will be rejected.

300-2.8 SHEET PILES.—Sheet piles shall meet all the requirements prescribed above for the particular material and conforming to the detail design of cross section and shape shown on the plans.

300-2.9 PILE SHOES.—Pile shoes shall be of approved design, as called for on the plans.

CONSTRUCTION METHODS

300-3.1 Piles shall be used only in places where a minimum penetration of 10 feet in firm material, or 20 feet in soft material, can be obtained. Where a soft upper stratum overlies a

hard stratum, the piles shall penetrate the hard material a sufficient distance to fix the ends rigidly. For foundations of arch, continuous span, or movable bridges or high abutments, the piles shall be embedded completely in firm material that will afford good lateral support. When this is impracticable, the soft material shall be excavated and replaced with foundation fill as indicated on the plans or ordered in writing by the engineer.

All excavation of the foundations in which piles are to be driven shall be complete before driving is commenced. After driving is completed, all loose and displaced materials shall be removed from around the piles, leaving clean solid surfaces to receive the concrete.

300-3.2 DRIVING PILES.—All piles shall be driven, as shown on the plans or ordered in writing. They shall be driven within an allowed variation as to direction of pile of not more than one-fourth inch per foot of pile length. When water jets are used, the number of jets and the nozzle volume and pressure shall be sufficient to erode the material adjacent to the piling freely. The plant shall have sufficient capacity to deliver at all times a pressure of at least 100 pounds per square inch at two $\frac{3}{4}$ -inch jet nozzles. Before the desired penetration is reached the jets shall be shut off and the piles driven by hammer to final penetration.

Every timber pile shall be provided with a metal collar except when the head is fitted into a steel head block. When the nature of the driving is such that piles are unduly injured, the heads of all piles shall be protected by caps of approved design, preferably having a rope or other suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block.

Metal shoes of the design shown on the plans shall be used as indicated on the plans or ordered in writing.

Piles shall be driven with steam hammers, or a combination of water jets and steam hammers, except that with written permission from the engineer, gravity hammers may be used for driving timber piles. The plant and equipment furnished shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The boiler shall be equipped with an accurate pressure gage and another gage shall be supplied at the hammer intake to determine the drop in pressure between the boiler and the hammer.

Any gravity hammer permitted shall weigh not less than 3,000 pounds. The fall shall be regulated so as to avoid injury to the pile and in no case shall exceed 20 feet.

Steam hammers used for driving concrete piles shall develop an energy per blow at each full stroke of piston of not less than 3,500 foot-pounds per cubic yard of concrete in the pile being driven. The total energy developed by the hammer shall be not less than 6,000 foot-pounds per blow.

Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or steel braces to insure support to the pile during driving. Except where piles are driven through water, the leads, in general, shall be of sufficient length to make the use of a follower unnecessary, and shall be so designed as to permit proper placing of batter piles. The driving of piling with followers shall be avoided if practicable and shall be done only under written permission from the engineer.

300-3.3 DEFECTIVE PILES.—All broken piles or piles driven out of their proper locations shall be removed or, at the option of the engineer, a second pile may be driven adjacent to the unsatisfactory pile. Broken piles or piles driven out of location shall be at the expense of the contractor.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again, if required by the engineer.

300-3.4 UTILIZING TEST PILES AND LOADED TEST PILES.—After the completion of loading tests, the load used shall be removed as directed and the piles utilized in the structure if found satisfactory for such use or disposed of in any other manner ordered by the engineer. Test piles not loaded shall be utilized similarly. Any test pile, after it has served its purpose as a test pile shall be removed if so ordered by the engineer or shall be cut off below the ground line and footing.

300-3.5 CUTTING OFF AND CAPPING PILES.—Tops of foundation piles shall be embedded in the concrete footing at least 1 foot and, where seals of concrete deposited in water are used, piles shall project at least 6 inches above the top of the seal concrete. Timber piles shall be cut off level at the elevation indicated on the plans. The length of pile above cut-off shall be sufficient to permit the removal of all injured material. The distance from the side of any pile to the nearest edge of the footing shall be not less than 9 inches. Timber sheet piling shall be braced with waling strips, properly lapped, and joined at all splices and corners, as shown on the plans.

300-3.6 PROTECTING UNTREATED TIMBER TRESTLE PILES.—The heads of untreated piles shall be given one of the following treatments, as may be directed in writing by the engineer:

(a) The sawed surface shall be thoroughly brush-coated with two applications of hot creosote oil or other approved preservative.

(b) The sawed surface shall be heavily coated with red lead paint, after which it shall be covered with cotton duck, of at least 8-ounce weight, which shall be folded down over the sides of the pile and firmly secured thereto with large-headed roofing nails. The edges of the duck shall be trimmed to give a work-

manlike appearance. The duck shall then be waterproofed by being thoroughly saturated and coated with one or more applications of red lead paint.

300-3.7 PROTECTING TREATED TIMBER TRESTLE PILES.—All cuts in treated piles and all abrasions, after having been carefully trimmed, shall be coated with at least three applications of hot creosote oil and covered with hot roofing pitch. Before bolts are driven, all holes shall be impregnated with hot creosote oil by means of an approved bolt-hole treater. All unfilled holes after being treated shall be plugged with creosoted plugs.

After being cut to receive the cap, the head of each treated pile shall be given three coats of hot creosote oil. It shall then be covered with hot tar-pitch, over which shall be placed a sheet of three-ply roofing felt or galvanized iron, or a covering of alternate layers of hot tar-pitch and loose-woven fabric as specified for membrane waterproofing, using four layers of pitch and three of the fabric. The cover shall measure at least 6 inches more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large-headed nails or secured by being bound with galvanized wire.

Treated piles shall be handled carefully. They shall not be dropped suddenly, outer fibers shall not be broken, and the surface shall not be bruised nor penetrated by tools. Cant dogs, hooks, or pike poles shall not be used.

300-3.8 Sheet piles prescribed by the plans shall be of the degree of watertightness, when installed in place, stipulated on the plans.

METHOD OF MEASUREMENT

300-4.1 The footage of piles to be paid for shall be the actual number of linear feet of piles left in place in the completed and accepted work with no allowance for cut-offs except as specified in 4.2 below. The footage and number of piles ordered shall be the responsibility of the contractor. No allowance shall be made for any piles that are not driven in accordance with the specifications. No allowance will be made for broken piles, for piles ordered and not used, or for defective shells for cast-in-place piles.

Test piles, whether or not utilized as service piles in the structure, shall not be included in the above footage.

The footage of test piles to be paid for shall be the number of linear feet of test piles driven as ordered. The number of test piles driven at any structure shall not exceed the number of test piles authorized on the plans for that structure. The footage to be paid for shall be the entire footage placed in the leads, whether or not used in the completed structure and whether or not cut-off.

The number of load tests to be paid for shall be the number of load tests made, completed, and accepted.

The number of pile shoes to be paid for shall be the number of shoes of approved design ordered and used on accepted piles.

300-4.2 If the length of piles is shown on the plans or ordered in writing by the engineer, an allowance for cut-offs shall be made as follows:

(a) *Timber and Steel Piles.*—If the cut-off is 3 feet or less, no allowance for cut-off will be made. If the cut-off for a pile is in excess of 3 feet, the allowance for that pile shall be the actual cost, delivered at the structure site, of the portion of pile cut off.

(b) *Concrete Piles.*—No allowance will be made for cast-in-place piles. For precast concrete piles, an allowance of one-half the contract price per linear foot will be made, except that no allowance will be made for the footage of piles damaged during driving.

In case "build-ups" of concrete piles are necessary, the "build-up" length will be paid for at the contract price per linear foot for piles in place.

BASIS OF PAYMENT

300-5.1 The footage of piles, determined as provided above, shall be paid for at the contract unit prices per linear foot for "Untreated Timber Piling," "Treated Timber Piling," "Concrete Piling," "Structural Steel Piling," "Copper Bearing Structural Steel Piling," "Timber Sheet Piling," "Concrete Sheet Piling," or "Steel Sheet Piling," as the case may be, complete in place, which prices and payments shall constitute full compensation for all materials, for concrete, structural steel, reinforcement, for timber and timber preservative, and all labor, equipment, tools, and incidentals necessary to complete the item.

The footage of test piles, determined as provided above, shall be paid for at the contract unit price per foot for "Test Piles."

The number of loading tests, determined as provided above, shall be paid for at the contract unit price each for "Loading Tests of Piles," which price and payment shall constitute full payment for building the load platform, procuring and placing the loading material, and removing and disposing of the platform and material, or for furnishing necessary equipment for other approved methods of testing, for making the test and for removing the equipment.

The number of pile shoes, determined as provided above, shall be paid for at the contract unit price each for "Pile Shoes," which price and payment shall constitute full compensation both for furnishing the shoes and for utilizing the same on piles as ordered.

Foundation fill for lateral support in soft material, when ordered in writing, shall be paid for as provided under FOUNDATION FILL.

ITEM 310.—LOOSE RIPRAP

DESCRIPTION

310-1.1 This item shall consist of stone riprap for bank protection furnished and constructed at the locations indicated, in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

310-2.1 The stones for the riprap shall be hard, angular, quarry stones of such a quality that they will not disintegrate on exposure to water or weathering. Stones shall vary in weight from 20 to 400 pounds each. Not less than 25 percent of the individual stones shall weigh from 200 to 400 pounds each.

CONSTRUCTION METHODS

310-3.1 Foundation trenches and other necessary excavations shall be excavated by the contractor and approved by the engineer before the placing of riprap is begun. The stones shall be handled or dumped into place so as to form the cross sections shown on the plans. Unless changes are ordered by the engineer, the riprap shall extend from 2 feet below the bed of a stream to the mean high water line. Stones above a low water line shall form a uniform surface free from humps or depressions and with no excessively large cavities below, or individual stones projecting above the general surface.

METHOD OF MEASUREMENT

310-4.1 The yardage to be paid for shall be the number of cubic yards of riprap measured in place, completed, and accepted.

BASIS OF PAYMENT

310-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Loose Riprap," which price and payment shall constitute full compensation for furnishing and placing all materials, backfilling, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

BASIS OF PAYMENT

311-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Derrick-placed Rock Retaining Wall," which price and payment shall constitute full compensation for furnishing, selecting, transporting, and placing stones, for filling voids and backfilling, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 311.—DERRICK-PLACED ROCK RETAINING WALL**DESCRIPTION**

311-1.1 This item shall consist of retaining walls of selected large stones for supporting and retaining embankments constructed at the locations indicated, in accordance with these specifications, and of the forms, lines, and dimensions shown on the plans or required by the engineer.

MATERIALS

311-2.1 Stones used for this work shall be sound and durable and at least 75 percent of the volume of the completed wall shall consist of stones that individually are not less than 8 cubic feet in volume. Stones may be obtained from excavations performed under this contract, but it shall be the contractor's responsibility to save suitable stone from the excavations or to obtain it at his own expense from sources approved by the engineer.

CONSTRUCTION METHODS

311-3.1 A foundation bed shall be excavated approximately as indicated on the plans, but in all cases shall be of sufficient depth to form the stable and secure base for a rock wall that is satisfactory to the engineer. Spoil from the foundation excavation shall be used to fill the larger voids in the wall or shall be placed in nearby roadway embankment.

The rock wall shall be constructed to the lines and dimensions staked by the engineer. Stones shall be securely bedded and partially bonded. In general, they shall be placed with their longest dimensions at right angles to the outside face of the wall. Otherwise, no special care in placing individual stones will be required nor is an especially smooth or even appearance in the outside slope or face of the wall intended or desired. Spalls, spoil from foundation excavation, or other approved material shall be used for filling the larger voids in the wall.

METHOD OF MEASUREMENT

311-4.1 The yardage to be paid for shall be the number of cubic yards of derrick-placed rock retaining wall measured in place, completed, and accepted.

ITEM 312.—HAND-LAID ROCK EMBANKMENT

DESCRIPTION

312-1.1 This item shall consist of hand-laid rock embankment constructed at the locations indicated, in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

312-2.1 The stones used for this embankment shall be sound and durable. No stone shall be less than one-half cubic foot in volume and 75 percent of the stones shall each be at least 1 cubic foot in volume. Stones obtained from excavation performed under this contract may be used in the embankments. Additional stones required shall be obtained from sources approved by the engineer.

CONSTRUCTION METHODS

312-3.1 Sufficient excavation shall be made to expose a foundation bed that is satisfactory to the engineer. The stones shall be founded on this bed and laid up to the lines and dimensions required. The stones shall be bonded to some extent and securely bedded. Spalls shall be used to fill voids. Any spaces back of the hand-laid rock embankment shall be filled entirely with compacted material.

METHOD OF MEASUREMENT

312-4.1 The yardage to be paid for shall be the number of cubic yards of hand-laid rock embankment measured in place, completed, and accepted.

BASIS OF PAYMENT

312-5.1 The yardage determined as provided above shall be paid for at the contract unit price per cubic yard for "Hand-laid Rock Embankment," which price and payment shall constitute full compensation for furnishing, selecting, and transporting stones, for placing stones by hand, for backfilling, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 313.—CONCRETE CRIBBING

DESCRIPTION

313-1.1 This item shall consist of cribbing, composed of concrete crib members, furnished and constructed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

313-2.1 CRIB MEMBERS.—Concrete for crib members shall meet all the requirements for the specified class as provided under CONCRETE, except that the maximum size of aggregate shall be not over 1 inch in any case. The concrete shall be class A unless otherwise stated on the plans.

The details of the crib members and their arrangement shall be as shown on the plans, except that the contractor may be permitted to purchase concrete crib members from manufacturers. Such members may be of other equivalent design provided the design is approved in writing by the engineer. In such case the contractor shall submit detailed specifications and plans for the approval of the engineer, and such plans must be approved before delivery of the material is begun.

All members shall be free of depressions, and of spalled, patched or plastered surfaces or edges, or any other defect that may impair their strength or durability. Cracked or otherwise defective members will be rejected.

313-2.2 DRIFTBOLTS AND CASINGS.—Driftbolts shall be of wrought iron or galvanized steel not less than 1 inch in diameter and of the required length.

Casings for driftbolts shall be of galvanized steel or iron pipe not less than 1¼ inches in diameter.

CONSTRUCTION METHODS

313-3.1 PLACING CRIB MEMBERS.—The prepared foundation bed for the cribbing shall be firm and normal to the surface of the cribbing, and shall have been approved by the engineer before any of the crib work is placed.

The crib members shall be erected as shown on the plans. In general, concrete sill members transverse to the crib face shall be used to support the lower cribbing course. All members shall be secured together by means of drift-bolts passing through galvanized casings or by other effective locking de-

vices. The crib members shall be handled carefully and any members that become cracked or otherwise damaged shall be completely removed and new members substituted at the contractor's expense.

313-3.2 FILLING CRIB INTERIOR.—The filling of the interior of the crib shall progress simultaneously with the erection of the cribbing, and shall be of approved material placed in layers not exceeding 6 inches each in thickness and shall be tamped or consolidated to the satisfaction of the engineer. A layer of hand-placed rock, 8 inches in least dimension, shall be laid against the front members of the cribbing to prevent loss of fill material through the openings. All vegetable matter and adobe soil shall be excluded from the backfill. The puddling method of backfilling shall not be used.

METHOD OF MEASUREMENT

313-4.1 The footage to be paid for shall be the number of square feet in the outside face of the structure complete in place and accepted, measured between lines of intersection of outside surfaces.

BASIS OF PAYMENT

313-5.1 The footage, determined as provided above, shall be paid for at the contract unit price per square foot for "Concrete Cribbing," which price and payment shall constitute full compensation for the furnishing, making, handling, and installing of the concrete crib members, for the concrete contained therein, for furnishing and placing the interior filling materials, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 314.—METAL CRIBBING

DESCRIPTION

314-1.1 This item shall consist of metal cribbing furnished and constructed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

314-2.1 CRIB MEMBERS.—The crib members shall consist of metallic headers and stretchers with the appurtenances necessary for complete assembly in the field. Each header and stretcher shall be fabricated completely in the plant prior to shipment to the site. If indicated on the plans, fillers for placing between the stretchers on the face of the wall, and end caps for the outside ends of the headers shall be furnished.

The sheets from which all headers and stretchers are manufactured shall be made of material meeting the requirements for chemical composition and spelter coating specified under CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE.

The various members of the crib shall be constructed of metal of not less than 16 gage.

The details of the crib members shall be as shown on the plans, except that the contractor may be permitted to furnish metal crib members of other equivalent designs approved in writing by the engineer. In such case, he shall submit detailed specifications and plans for approval by the engineer and such plans must be approved before delivery of the material is begun.

The headers and stretchers, upon assembly, shall interlock by means of flexible bolt connections.

CONSTRUCTION METHODS

314-3.1 PLACING CRIB MEMBERS.—The prepared foundation bed for the cribbing shall be firm and normal to the face of the cribbing, and shall have been approved by the engineer before any of the crib work is placed.

The crib members shall be erected as shown on the plans. The members shall be handled carefully and any members that are damaged shall be removed and new members substituted at the contractor's expense.

314-3.2 FILLING CRIB INTERIOR.—The filling of the interior of the crib shall progress simultaneously with the erection

of the cribbing, and shall be of approved material placed in layers not exceeding 6 inches each in thickness and shall be tamped or consolidated to the satisfaction of the engineer. Where the open type is used, a layer of rock, 8 inches in least dimension, shall be laid against the front members of the cribbing to prevent loss of fill material through the openings. All vegetable matter and adobe soil shall be excluded from the backfill. The puddling method of backfilling shall not be used.

METHOD OF MEASUREMENT

314-4.1 The footage to be paid for shall be the number of square feet in the outside face of the structure complete in place and accepted, measured between lines of intersection of outside surfaces.

BASIS OF PAYMENT

314-5.1 The footage, determined as provided above, shall be paid for at the contract unit price per square foot for "Metal Cribbing," which price and payment shall constitute full compensation for the furnishing, handling, and installing of the metal crib members including all materials, bolts, and hardware, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 315.—TIMBER AND LOG CRIBBING

DESCRIPTION

315-1.1 This item shall consist of cribbing, composed of timber or log members as called for in the bid schedule, furnished, prepared, and constructed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

315-2.1 CRIB MEMBERS.—Sawn timber for crib members shall be of the type and grade indicated on the plans and shall conform to the requirements under TREATED AND UNTREATED TIMBER. It shall be treated or untreated as called for in the bid schedule.

Logs for crib members shall conform to the requirements specified for logs under LOG BRIDGES.

The dimensions of crib members shall be as shown on the plans.

Any necessary accessory lumber, hardware, etc., shall conform to the requirements given under TIMBER BRIDGES.

CONSTRUCTION METHODS

315-3.1 PREPARATION AND PLACING.—All framed surfaces and cuts, except in cedar, cypress, and redwood, shall receive a thorough coating with approved preservative immediately before being assembled. When timbers or logs are to be treated, all framing indicated on the plans shall be completed before it is treated.

The prepared foundation bed for the cribbing shall be firm and normal to the face of the cribbing, and shall have been approved by the engineer before any of the crib work is placed.

All timber and log framing shall be done in a workmanlike manner, true to line and angle. Care shall be exercised in the erection of all cribs to produce true faces as shown on the plans and all timbers or logs in faces shall be horizontal. The cribbing shall be supported on mud sills with flattened lower surfaces, placed as shown on the plans.

The minimum lengths and sizes of timbers and logs shall be as shown on the plans. Each course shall break joints with the adjacent courses. The timbers or logs in the base tier of

the face of cribbing and in alternate tiers of the face above the base shall be as long as practicable and preferably shall extend the full length of the face. In intermediate tiers they shall have a length of not less than 8 feet and shall be arranged to break joints. Crib faces shall be laid solid or with spaces as indicated on the plans.

315-3.2 FACE AND TIE LOGS.—The face and tie logs are to be notched together, and hewn, if necessary, so that the face logs will be in contact with each other throughout their entire length, except that when a satisfactory rock backing is placed against the face logs, the engineer may permit open spaces not exceeding 4 inches in width between the face logs. When permission to use such spaces is given, rock backfill shall be placed carefully, using the larger rocks adjacent to the logs and backing up with the smaller rocks in such manner that no material can escape or be washed out.

315-3.3 TIES.—The length of the ties required for the proper support and anchorage of the cribbing shall be as determined by the engineer. The length of ties shall be sufficient to develop the required anchorage against overturning, and in no case shall the length of tie extending into the fill be less than two-thirds of the height of fill above the tie in question. Ties shall be anchored to the face walls by framing, either dovetailed or by sufficient projection beyond the face of the crib to form the proper anchorage. Ties at the fill ends shall be anchored to cross pieces fastened to them at right angles by driftbolts or other suitable means. Ties shall be spaced not more than 8 feet center to center in any horizontal tier and shall be staggered with the next tier of ties. Tiers of ties shall be not more than 3 feet apart vertically.

315-3.4 FASTENING.—All logs including face logs, tie logs, mud sills, and anchor logs shall be notched together properly as shown on the plans, and in all cases, shall be driftbolted together except where stipulated to the contrary on the plans.

In the case of sawn timbers, each successive tier of timbers shall be fastened to the tier upon which it rests by driftbolts not less than three-fourths of an inch in diameter and of sufficient length to extend through two tiers and not less than 4 inches into the third tier.

Driftbolts shall be staggered and spaced not more than 8 feet center to center in each tier. All end joints and splices shall be half-lapped for 10 inches and drifted at the center.

315-3.5 FILLING CRIB INTERIOR.—The filling of the interior of the crib shall progress simultaneously with the erection of the cribbing, and shall be of approved material placed in even, horizontal layers and tamped and consolidated to the satisfaction of the engineer.

METHOD OF MEASUREMENT

315-4.1 The footage to be paid for shall be the number of square feet in the outside face of the structure complete in place and accepted, measured between lines of intersection of outside surfaces.

BASIS OF PAYMENT

315-5.1 The footage, determined as provided above, shall be paid for at the contract unit price per square foot for "Untreated Timber Cribbing," "Treated Timber Cribbing," or "Log Cribbing," as the case may be, which price and payment shall constitute full compensation for furnishing and placing all timber, logs, mud sills, tie timbers or logs, anchor timbers or logs, driftbolts, and hardware, and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation.

ITEM 320.—UNDERDRAINS

DESCRIPTION

320-1.1 This item shall consist of underdrains, constructed in accordance with these specifications and in conformity with the lines, grades, dimensions, and designs shown on the plans or required by the engineer.

MATERIALS

320-2.1 PIPE.—Pipe for underdrains shall be concrete, clay, perforated corrugated galvanized sheet metal, or bituminous coated perforated galvanized sheet metal, whichever is shown on the plans and called for in the bid schedule, and shall be of the size called for.

(a) *Concrete Pipe.*—Concrete pipe for underdrains shall conform to the requirements for nonreinforced concrete pipe as given in Federal Specification SS-P-371, except that the absorption test will not be required and provided that the strength in pounds per linear foot shall not be less than 2,000 *D*. *D* is the symbol for the nominal inside diameter of the pipe in feet.

Concrete pipe of porous, perforated, or other designs will be accepted provided the pipe meets the strength requirement given above and provided further that, in the opinion of the engineer, the design is such as to assure performance at least equal to that of the pipe above specified.

(b) *Clay Pipe.*—Clay pipe for underdrains shall conform to the requirements of Federal Specification SS-P-361, except that the absorption test will not be required and provided that the strength in pounds per linear foot shall not be less than 2,000 *D*. *D* is the symbol for the nominal inside diameter of the pipe in feet.

Clay pipe of porous, perforated, or other designs will be accepted provided the pipe meets the strength requirement given above and provided further that, in the opinion of the engineer, the design is such as to assure performance at least equal to that of the pipe above specified.

(c) *Perforated Corrugated Galvanized Sheet Metal Pipe.*—This pipe shall conform to the requirements of CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE; provided, however, that where 6- or 8-inch diameter pipe is called for, the pipe shall meet the said requirements in all respects or shall meet those requirements with the following modifications:

1. *Shape and seams.*—Pipe shall be of the corrugated full circle type having securely locked or welded seams. Locked seams shall be turned under and pressed down smoothly so as not to affect the shape and nominal diameter of the pipe.

2. *Corrugations.*—Corrugations shall be not less than 1½ inches nor more than 1⅞ inches center to center, measured at right angles to the direction of the corrugations. The depth of the corrugations shall be not less than one-quarter inch.

3. *Gage and weight.*—The metal shall be 18 gage or heavier and the average weight per linear foot of finished pipe shall be 3.7 pounds or heavier for 6-inch, 5 pounds or heavier for 8-inch pipe. Underruns not exceeding 5 percent will be permitted.

4. *Perforations.*—The perforations shall be at least one-quarter of an inch in diameter as measured on the finished pipe, and shall be placed in the inside crests of all corrugations. The rows of perforations shall be spaced on approximately 1-inch centers, measured circumferentially.

5. *Connecting bands.*—Connecting bands shall have corrugations that mesh with the corrugations in the pipe, and shall be fastened with galvanized bolts. Other equally effective methods for connecting the sections may be used if approved by the engineer.

(d) *Bituminous Coated Perforated Corrugated Galvanized Sheet Metal Pipe.*—This pipe shall meet the requirements given under (c) above and in addition shall be coated with asphalt in accordance with the requirements given under BITUMINOUS COATED CORRUGATED SHEET METAL CULVERT PIPE, TYPE 2. The perforations as measured on the finished pipe shall be at least one-quarter inch in diameter.

CONSTRUCTION METHODS

320-3.1 TRENCH AND BEDDING.—The trench shall be excavated to the width, line, and grade given by the engineer, the depth of trench to vary from 2½ to 4½ feet below the finished surface at the top of the trench where the construction is under the gutter or ditch or under the roadway, and to depths required for proper drainage at other locations, provided, however, that wherever the plans show the required depth, such depth shall govern the construction. A 2-inch bed (unless otherwise shown on the plans, in which case the dimension on the plan shall govern) of stone or gravel, all passing a 1-inch sieve and retained on the No. 4 sieve, shall be spread in the bottom of the trench throughout its entire length and brought to a uniform grade.

320-3.2 PLACING AND BACKFILL.—Pipe of the kind and size required shall be embedded firmly in the bottom course of stone. Bell and spigot pipe shall be laid with the bell ends upgrade and the spigot ends fully entered in the adjacent

bells but not mortared or otherwise closed to the desired infiltration of water. The joints shall be covered with two-ply tar paper strips not less than 6 inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of stone on either side of the pipe for a distance of 3 inches.

Perforated pipe shall be laid with the perforated side of the pipe down and separate sections shall be firmly joined together.

After the pipe has been laid and has been inspected and approved by the engineer, clean gravel, or broken stone filling, all passing a 3-inch sieve and retained on a $\frac{3}{4}$ -inch sieve (unless otherwise shown on the plans, in which case the plans shall govern) shall be placed carefully, so as not to displace the pipe or joint covering around and over the pipe, to within 12 inches of the finished ground surface unless otherwise shown on the plans, in which case the plans shall govern. The upper 12 inches of the trench shall then be filled with suitable material of either the porous or impervious type as shown on the plans or as ordered by the engineer. All filling shall be tamped firmly.

320-3.3 MORTAR SEAL.—Where shown on the plans, the top surface of the gravel backfill shall be shaped as shown and sealed with a course of mortar approximately 1 inch in thickness. The mortar shall consist of portland cement and sand mixed with water in the proportions of one part of cement to five parts of sand. The materials for the mortar shall be subject to approval by the engineer before being used.

320-3.4 BLIND DRAIN.—Where blind drains are called for, they shall be dug to the cross section shown on the plans and to the depth staked by the engineer. The trench thus prepared shall be filled with stones, broken stone, or gravel of the approximate sizes shown on the plans, or required by the engineer, to within 12 inches of the finished ground surface. The upper 12 inches of the trench shall then be filled with suitable material of either the porous or impervious type as shown on the plans or required by the engineer. Both stone and surface filling shall be firmly tamped.

METHOD OF MEASUREMENT

320-4.1 The footages to be paid for shall be the number of linear feet of underdrain with the several kinds and sizes of pipe or of blind drain measured separately in place, completed, and accepted.

BASIS OF PAYMENT

320-5.1 The footages, determined as provided above, shall be paid for at the contract unit price per linear foot for "Concrete Pipe Underdrain," "Clay Pipe Underdrain," "Perforated Corrugated Galvanized Sheet Metal Pipe Underdrain," and

"Bituminous Coated Perforated Corrugated Galvanized Sheet Metal Pipe Underdrain," of the several sizes, or "Blind Drain," as the case may be, which prices and payments shall be full compensation for furnishing and installing all pipe, for furnishing gravel or stone bedding and backfill and mortar seal, for backfilling the trench as required, and for all labor, equipment, tools, and incidentals necessary to complete the item, except trench excavation.

CONSTRUCTION METHODS

ITEM 321.—DROP INLETS AND CATCH BASINS

DESCRIPTION

321-1.1 This item shall consist of drop inlets or catch basins, as the case may be, with cast iron frames and gratings or reinforced concrete slab covers, as required, constructed in accordance with this specification and other specification items involved and in conformity with the dimensions, elevations, and design shown on the plans or required by the engineer.

MATERIALS

321-2.1 The materials entering into the construction, and their combination, construction, and/or fabrication, shall conform to the requirements of this and other specification items involved.

321-2.2 CAST-IRON FRAMES AND GRATINGS.—Cast-iron frames and gratings shall conform to the requirements of Federal Specification QQ-I-652. They shall be free of pouring faults, blow holes, cracks, and other imperfections. The castings shall be sound, true to form and thickness, clean, and neatly finished, and shall be coated with coal tar pitch varnish. Gratings which are to rest on frames shall bear on them evenly. They shall be assembled before shipment and so marked that the same pieces may be reassembled readily in the same position when installed. Inaccuracy of bearing shall be corrected by machining, if necessary. A frame and the grating to be used with it shall constitute one pair.

321-2.3 REINFORCED CONCRETE SLAB COVERS.—Reinforced concrete slab covers shall be constructed of concrete of the class and with the type of reinforcement shown on the plans. When so required by the plans, the concrete shall be colored by the addition of sufficient emulsified carbon black (meeting the requirements given under CONCRETE SIDEWALKS) to approach the natural color of the rock found on the project. To determine the quantity of carbon black required, the contractor will be required to cast, at his own expense, sample blocks of concrete 6 by 6 by 4 inches, adding varying quantities as directed until the required shade is acquired to the satisfaction of the engineer. The finished slab shall present a neat and smooth appearance and shall have a uniform color. The steel handles shall be coated with coal tar pitch varnish. Handles shall be omitted when the engineer so orders.

321-3.1 Inlets or catch basins constructed shall be of the type indicated on the plans or ordered by the engineer, and shall conform to the requirements shown on the plans.

Excavation shall be made to the required depth and the base upon which the inlet or basin is to be constructed shall be compacted to a firm, even surface.

For concrete inlets or basins, forms shall be used conforming to the requirements specified under CONCRETE. The concrete shall be tamped or spaded into place thoroughly. It shall be covered with suitable material and kept moist for 3 days or longer, if necessary, and shall be protected in a satisfactory manner until thoroughly hardened.

Cast-iron or other metal frames shall be set on full mortar beds composed of one part of portland cement and two parts of fine aggregate.

Concrete slabs shall be separated from the remainder of the structure by four-ply roofing paper separators at all points of contact.

Sections of connection pipe shall be incorporated into the construction and placed at the elevation, direction, and grade required. The inner ends of the pipe shall be flush with the inner faces of the walls, unless otherwise ordered.

METHOD OF MEASUREMENT

321-4.1 The number of drop inlets or catch basins, as the case may be, to be paid for shall be the number complete in place and accepted. They will not be considered complete until the covers or frames and gratings intended are installed and accepted. The number of reinforced concrete covers or of pairs of frames and gratings to be paid for shall be the number complete in place and accepted.

BASIS OF PAYMENT

321-5.1 The number of drop inlets and the number of catch basins, determined as provided above, shall be paid for at the contract unit prices for "Drop Inlets" of the sizes called for in the bid schedule and for "Catch Basins," as the case may be, which prices and payments, shall constitute full compensation for furnishing and placing all materials, for installing the covers or frames and gratings, for disposal of surplus material, and for all labor, equipment, tools, and incidentals necessary to complete the item, except the furnishing of the covers or the frames and gratings, and except foundation excavation.

The number of pairs of cast iron frames and gratings determined as provided above shall be paid for at the contract unit price for "Cast Iron Frames and Gratings," which price and payment shall constitute full compensation for procuring and delivering the frames and gratings at the site.

The number of reinforced concrete covers, determined as provided above, shall be paid for at the contract unit price for "Reinforced Concrete Inlet Cover" which price and payment shall constitute full compensation for procuring or making the cover, for the concrete and other materials contained therein.

ITEM 322.—EMBANKMENT SPILLWAYS

DESCRIPTION

322-1.1 This item shall consist of furnishing and installing embankment spillway inlet assemblies and outlet pipes in accordance with these specifications and at the locations shown on the plans or ordered by the engineer.

MATERIALS AND MANUFACTURE

322-2.1 Embankment spillway inlet assemblies shall be of the type shown on the plans, and shall be constructed of 16 gage corrugated galvanized sheet metal conforming to the requirements of CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE. The dimensions and proportions of inlet assemblies shall be in substantial agreement with those of the design shown on the plans, but minor variations may be accepted at the discretion of the engineer to permit the use of manufacturers' standard jigs and templates in the fabrication. Bulkheads and outlet pipe shall be fillet welded or riveted to the inlet chamber to form watertight connections. Anchors, lips, and skirts shall be securely riveted or welded.

Outlet pipes shall be of the size shown on the plans and shall conform to the requirements of CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE, except that all coupling bands shall be not less than 12 inches wide, and except that pipe shall be coated with an asphalt pipe dip as provided below.

All spillway inlet assemblies, coupling bands, and outlet pipes shall be coated with an asphalt pipe dip at the plant and before being shipped. The quality and character of the dip and the method of application shall be such that the coating on the pipe will be tough and pliable and will adhere firmly to the spelter.

CONSTRUCTION METHODS

322-3.1 Spillway inlets shall be placed in the position shown on the plans and the earth backfill shall be tamped thoroughly.

Connecting outlet pipes shall be installed in accordance with the requirements under CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE.

Care shall be used to prevent displacement of the asphalt coating during hauling and placing. All spots on the pipe or inlet assemblies where the coating has been damaged shall be painted with two coats of an approved asphaltic paint.

METHOD OF MEASUREMENT

322-4.1 The number of embankment spillway inlet assemblies to be paid for shall be the number installed and accepted.

BASIS OF PAYMENT

322-5.1 The number of spillway inlets, determined as provided above, shall be paid for at the contract unit price for "Embankment Spillway Inlet Assemblies," of the type called for in the bid schedule, which price and payment shall be full compensation for furnishing and installing the inlet assemblies and for all labor, equipment, tools, and incidentals necessary to complete the item, except foundation excavation, and except connecting outlet pipes and including elbows, which shall be paid for under CORRUGATED GALVANIZED SHEET METAL CULVERT PIPE.

ITEM 323.—GROUTED RUBBLE GUTTER

DESCRIPTION

323-1.1 This item shall consist of grouted rubble gutter, constructed on a prepared bed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

323-2.1 RUBBLE STONE.—The gutter stones shall be approved, sound, durable, rubble stones, not less than 6 inches and not more than 8 inches in thickness, with approximately flat top surfaces, with widths of not less than 2 inches and lengths of not less than 6 inches. All gutter stones shall be inspected before and after being laid, and all rejected material shall be removed immediately from the work.

323-2.2 FILLER AGGREGATE.—Aggregate for filling the spaces between gutter stones shall consist of approved, clean slag, gravel, sand, or crushed stone of such size that it will all pass a sieve having $\frac{3}{8}$ -inch square openings.

323-2.3 GROUT.—The cement grout for filling the spaces between the gutter stones shall be composed of one part portland cement and two parts of fine aggregate. The portland cement, fine aggregate, and water shall meet the requirements for these materials given under CONCRETE.

CONSTRUCTION METHODS

323-3.1 BED.—The bed shall be formed at the required depth below and parallel with the finished surface of the gutter. All soft and yielding or other unsuitable material shall be removed and suitable material substituted. The bed shall be compacted thoroughly and finished to a smooth, firm surface.

When indicated on the plans, a layer of cinders or of clean sand and gravel or of other approved porous material having the compacted thickness required by the plans shall be placed to form a bed for the grouted rubble gutter.

323-3.2 PLACING.—The gutter stones shall be bedded in the foundation in straight rows with each stone perpendicular to the finished surface. The stones shall be set in close contact, their flat surfaces up and their longest dimensions at right angles to the center line of the gutter. They shall break joints satisfactorily and there shall be no interstices exceeding 1 inch in width.

The stones shall be rammed thoroughly until the surface is firm and conforms to the finished surface in grade, alinement, and cross section. Any gutter having an irregular or uneven surface shall be taken up and relaid satisfactorily.

323-3.3 FILLING AND GROUTING.—After the stones have been rammed into place and the surface is satisfactory, the spaces or voids between and around the stones shall be filled with slag, gravel, sand, or crushed stone to within 4 inches of the surface, after which cement grout shall be poured and broomed into the spaces between the stones, this operation being continued until the grout remains about 1 inch below the tops of the stones. The grout shall be of such consistency that it will flow readily into the spaces between the stones, but it must not be so wet that the solid matter separates from the water.

METHOD OF MEASUREMENT

323-4.1 The yardage to be paid for shall be the number of square yards (widths and lengths measured horizontally) of grouted rubble gutter complete in place and accepted.

BASIS OF PAYMENT

323-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Grouted Rubble Gutter," which price and payment shall constitute full compensation for furnishing and placing all materials, for excavating and refilling below the finished grade of the gutter, for all tamping, for disposing of surplus material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 324.—CONCRETE CURB AND COMBINATION CONCRETE CURB AND GUTTER

DESCRIPTION

324-1.1 This item shall consist of curb or combination curb and gutter, made of concrete and constructed in accordance with these specifications at the locations and of the form, dimensions, and designs shown on the plans or required by the engineer.

MATERIALS

324-2.1 Concrete shall be of the class indicated on the plans and shall conform to the requirements for that particular class given under CONCRETE.

CONSTRUCTION METHODS

324-3.1 BEDDING.—Excavation shall be made to the required depth and the base upon which the curb or combination curb and gutter is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material.

A layer of cinders or of clean sand and gravel, or of other approved porous material having the compacted thickness required by the plans shall be placed to form a bed for the combination curb and gutter.

324-3.2 PLACING.—Forms to hold the concrete shall be built and set in place as described under CONCRETE. Mixing, placing, finishing, and curing of concrete shall be as provided under CONCRETE and in accordance with the requirements given below.

The concrete shall be placed in the forms in layers of 4 or 5 inches each, and to the depth required. It shall be tamped and spaded until mortar entirely covers the top and form surfaces. The top of the curb or curb and gutter shall be floated smooth and the edges rounded to the radii shown on the plans. Before the concrete is given the final finishing, the surface of the gutter shall be tested with a 10-foot straightedge and any irregularities of more than one-fourth inch in 10 feet shall be eliminated.

The curb or curb and gutter shall be constructed in uniform sections 10 feet in length except where shorter sections are necessary for closures, but no section shall be less than 4 feet long. The sections shall be separated by sheet templates set perpendicular to the face and top of the curbing. The tem-

plates shall be one-eighth inch in thickness, of the same width as that of the curb or curb and gutter, and not less than 2 inches deeper than the depth of the curb or curb and gutter. Templates shall be set carefully and held firmly during the placing of the concrete and shall be allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

Expansion joints shall be formed in the curbs at intervals of 40 feet, using premolded filler one-half inch in thickness and conforming to the requirements for this material as given under CONCRETE. When a curb is placed next to a concrete pavement, expansion joints in the curb shall be located opposite expansion joints in the pavement.

The forms shall be removed within 24 hours after concrete has been placed. Minor defects shall be repaired with mortar containing one part of portland cement and two parts of fine aggregate. Plastering shall not be permitted on the face of a curb or curb and gutter and all rejected curb or curb and gutter shall be removed and replaced without additional compensation. The exposed surfaces of a combination curb and gutter, the top of a curb, and the face from the top to the batter point of a curb shall be finished, while the concrete is still green, by wetting a soft brick or a wood block and rubbing the surfaces until they are smooth.

Where a curb is constructed in advance of the construction of the surfacing course, the face of the curb shall be finished from the top to a point 2 inches below the batter point. The face shall be wet thoroughly, either by dipping the brick or block in water, or by throwing water on the curb or curb and gutter with a brush. After the concrete has been rubbed smooth with water, it shall be rubbed with a thin grout containing one part of portland cement and one part of fine aggregate. Rubbing with grout shall continue until a uniform color is produced.

When completed, the curb or combination curb and gutter shall be covered with suitable material and kept moist for a period of 3 days, or longer if necessary, and shall be suitably protected from the weather until thoroughly hardened.

After the concrete has set sufficiently, the spaces in front and back of the curb or combination curb and gutter shall be refilled to the required elevation with suitable material, which shall be tamped in layers of not more than 6 inches each until firm and solid.

METHOD OF MEASUREMENT

324-4.1 The footages to be paid for shall be the number of linear feet of concrete curb of the several depths, and of combination concrete curb and gutter, measured in place, completed, and accepted. No deduction will be made for the flattening of curbs for entrances.

BASIS OF PAYMENT

324-5.1 The footages, measured as provided above, shall be paid for at the contract unit prices per linear foot for "Concrete Curb" of the several depths and for "Combination Concrete Curb and Gutter," as the case may be, which prices and payments shall constitute full compensation for furnishing and placing all materials, for concrete, for reinforcing steel and expansion joint material, forms, drainage openings, excavation for curb and combination curb and gutter, subbase for combination curb and gutter, refilling, tamping, and disposal of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 325.—BITUMINOUS GUTTER**DESCRIPTION**

325-1.1 This item shall consist of a gutter surfacing composed of a mixture of aggregate and bituminous material, constructed on a prepared bed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

325-2.1 The bituminous mixture shall be of the grading called for in the bid schedule and shall conform to the requirements for type F-1 plant mixture as given under CLASS F, TYPE F-1, DENSE GRADED PLANT-MIX SURFACE COURSE with the following modifications:

When the bid schedule calls for grading F, mineral aggregate shall be furnished and 100 percent of the aggregate shall pass a sieve with 1-inch square openings, from 40 to 60 percent shall pass a sieve with $\frac{1}{2}$ -inch square openings, and from 25 to 35 percent shall pass a No. 4 sieve.

The bituminous material shall be rapid-curing cut-back asphalt and the grade shall be RC-2 or RC-3, whichever is designated by the engineer. The amount of bituminous material to be used in the mixture shall be as designated by the engineer and shall be from 5 to 7 percent of the weight of the dry aggregate.

The mixture may be prepared as provided under CLASS F, TYPE F-1, DENSE GRADED PLANT-MIX SURFACE COURSE or by other methods satisfactory to the engineer. The method and manner of preparation and mixing shall be such as to coat the aggregate uniformly and completely.

CONSTRUCTION METHODS

325-3.1 BED.—The bed shall be formed at the required depth below and parallel with the finished surface of the gutter. All soft and yielding or other unsuitable material shall be removed and suitable material substituted. The bed shall be compacted thoroughly and finished to a smooth, firm surface.

When indicated on the plans, a layer of cinders or of clean sand or gravel, or of other approved porous material having the compacted thickness required by the plans shall be placed to form a bed for the bituminous gutter.

325-3.2 FORMS.—If shown on the plans, forms of a type satisfactory to the engineer shall be staked securely into position at the correct line and elevation.

325-3.3 PLACING MIXTURE.—The mixture shall be placed on the prepared bed only when, in the opinion of the engineer, the bed is sufficiently dry and weather conditions are suitable. The mixture shall be screeded and tamped into place. After compaction, it shall be of the thickness shown on the plans and shall have a dense, uniform surface.

METHOD OF MEASUREMENT

325-4.1 The yardage to be paid for shall be the number of square yards (widths and lengths measured horizontally) of bituminous gutter complete in place and accepted.

BASIS OF PAYMENT

325-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Bituminous Gutter, Grading ()" which price and payment shall constitute full compensation for furnishing all materials, for excavating and refilling below the finished grade of the gutter, for forms, for all tamping, for disposing of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 330.—CONCRETE SIDEWALK**DESCRIPTION**

330-1.1 This item shall consist of a concrete sidewalk made of portland cement concrete with or without a mortar topping, constructed on a prepared bed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans. Mortar topping shall be used only when so indicated on the plans.

MATERIALS

330-2.1 CONCRETE.—Portland cement concrete shall be of the class shown on the plans and shall conform to the requirements given in the item covering that particular class of concrete.

330-2.2 MORTAR.—Sand and cement for mortar topping shall conform to the requirements therefor as given under CONCRETE.

330-2.3 PREMOLDED EXPANSION JOINT FILLER.—Premolded expansion joint filler shall conform to the requirements as given under CONCRETE.

330-2.4 EMULSIFIED CARBON BLACK.—Emulsified carbon black shall be a uniform colloidal dispersion of standard carbon gas black in a liquid medium. At least 25 percent by weight shall be carbon black. The product shall be free of lamp black, mineral black, silicas, asbestine, talc, bone-black, or other fillers. It shall be free of substances deleterious to the strength, durability, or appearance of concrete. Emulsified carbon black shall be so finely processed and dispersed that when 1 part of the product is stirred into 10 parts of water and the mixture is left standing without agitation for 72 hours, the resulting liquid will remain uniformly colored from top to bottom. The emulsified carbon black shall be delivered on the job in sealed containers plainly marked with the manufacturer's name and address, together with the trade name of the product.

CONSTRUCTION METHODS

330-3.1 PREPARATION OF BED.—Excavation shall be made to the required depth, and the foundation shall be shaped to conform to the section shown on the plans and shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material.

Where indicated on the plans, a bed of cinders or of clean sand and gravel or of other approved porous material shall be placed and compacted to the thickness shown on the plans.

330-3.2 FORMS AND EXPANSION JOINTS.—Forms of a type satisfactory to the engineer shall be staked securely in position at the correct line and elevation.

Premolded expansion joint filler of the dimensions shown on the plans shall be set in the positions shown on the plans before the placing of concrete is started.

330-3.3 PLACING.—The mixing, placing, finishing, and curing of concrete shall be as provided under CONCRETE and, where mortar topping is called for, in accordance with the following requirements: Where the plans indicate a mortar topping, the concrete shall be struck off 1 inch below the intended surface of the sidewalk. In such case, the remainder of the sidewalk shall consist of mortar containing 1 part portland cement and 1½ parts sand. Where indicated on the plans, carbon black in the amount indicated shall be mixed in the mortar. When changing from concrete mixing to mortar mixing, the mixer shall be washed out thoroughly before the mortar mixing is started. The mortar layer shall be placed within 30 minutes after the underlying concrete layer has been placed.

At a proper time during the setting period, the surface of the mortar course shall be troweled until it is of uniform smoothness and is true to the lines, elevations, and surface required. The mortar course shall be cut through with a trowel, where required, in straight lines normal to the edge of the sidewalk. The surface shall then be brushed. The edges of the sidewalk and the transverse cuts shall be shaped with a suitable tool so formed as to round the edges to a one-half inch radius. The mortar-topped sidewalk shall be cured by covering with wet burlap kept wet continuously for at least 72 hours.

METHOD OF MEASUREMENT

330-4.1 The yardage to be paid for shall be the number of square yards of concrete sidewalk complete in place and accepted.

BASIS OF PAYMENT

330-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Concrete Sidewalk," which price and payment shall constitute full compensation for furnishing and placing all materials, for concrete, expansion joint material and mortar topping, for excavating and compacting the foundation bed, for furnishing and placing any cinder, gravel, or other porous base material, for forms, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 331.—BRICK SIDEWALK**DESCRIPTION**

331-1.1 This item shall consist of a brick sidewalk, constructed on a prepared gravel foundation in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans.

MATERIALS

331-2.1 GRAVEL.—The gravel for the foundation course shall consist of hard, durable particles or fragments of stone with a filler of sand or other finely divided mineral matter. The composite material shall be free from vegetable matter and lumps or balls of clay and, when tested according to A.A.S.H.O. Methods T-11 and T-27, shall meet the following grading requirements: 100 percent shall pass a sieve having 1-inch square openings, 40 to 75 percent shall pass a No. 4 sieve, and not more than 12 percent shall pass a No. 200 sieve.

331-2.2 SAND.—Sand for bedding and filling joints shall consist of hard, durable grains free from vegetable matter and other deleterious substances, shall be well graded from coarse to fine, and shall show not more than 5 percent loss in the elutriation test. Sand for bedding shall all pass a sieve having three-eighths of an inch square openings and from 95 to 100 percent shall pass a No. 4 sieve. Sand for filling joints shall all pass a No. 16 sieve.

331-2.3 BRICK.—Brick shall be of uniform color and have a fine-grained, uniform, and dense structure. They shall be free of lumps of lime, laminations, cracks, checks, or other defects which may in any way impair their strength, durability, appearance, or usefulness for the purpose intended. The brick shall emit a clear metallic ring when struck with a hammer and shall meet the requirement for grade **M** brick as given in Federal Specification SS-B-656.

CONSTRUCTION METHODS

331-3.1 PREPARATION OF BED.—Excavation shall be made to the required depth. The subgrade upon which the gravel foundation is to be placed shall be compacted to a firm, even surface.

The gravel for the foundation course shall be spread on the prepared subgrade to such a depth that when compacted the

foundation course will have the thickness shown on the plans. Side forms shall be used to control the depth and alinement of the finished work. The gravel for the foundation course shall be compacted thoroughly by rolling with a power roller or by tamping with square-faced metal hand tampers. Any irregularities or depressions that develop during rolling or hand tamping shall be corrected by loosening the surface and adding or removing material and recompact the surface until it is smooth and regular.

After the foundation course has been prepared as specified, the sand for the bedding shall be spread. The sand for bedding shall be dry when spread and shall be uniformly "struck off" with a template to a loose depth slightly in excess of the depth indicated on the plans.

331-3.2 PLACING AND FILLING BRICK.—The brick shall be laid upon the sand bedding in accordance with the patterns indicated on the plans. The brick shall be laid with the best faces up, and in close contact so that the joints between the brick will be as thin as possible. Only whole brick shall be used, excepting half brick for starting the alternate courses and pieces of brick for the closures. While laying brick, the workmen shall not walk or stand on the sand bedding. After being laid, the brick shall be inspected, culled, and approved before being tamped.

After being approved the surface shall be swept free of spalls and thoroughly rammed or tamped so as to settle all of the brick into the sand bedding and form a level surface. The force of the tamping shall be transmitted to the brick through planks of suitable length and width. Instead of ramming and tamping the brick into final position as specified, the contractor may use a hand roller not less than 24 inches in diameter, not less than 24 inches in width, and weighing not less than 240 pounds for rolling the brick and settling them into the bedding.

After the brick have been rammed, tamped, or rolled, the surface shall be tested for uniformity. Any variation from the general surface in excess of one-fourth inch in 10 feet shall be corrected and the affected area again compacted.

The surface of the walk shall then be covered with a light application of dry sand to fill the joints between the brick. The sand shall be swept over the brick with push brooms until the joints between the brick are completely filled.

The side forms shall be carefully removed so as not to disturb or displace the brick set along the edges of the walks, and the area adjacent to the walks shall be refilled to the required elevation with suitable material, which shall be thoroughly compacted in layers of not more than 4 inches each until firm and solid.

331. BRICK SIDEWALK

METHOD OF MEASUREMENT

331-4.1 The yardage to be paid for shall be the number of square yards of brick sidewalk complete in place and accepted.

BASIS OF PAYMENT

331-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Brick Sidewalk," which price and payment shall constitute full compensation for furnishing and placing the brick, sand, and gravel foundation material, for excavating and compacting the foundation bed, for forms, for refilling and compacting areas adjacent to walks, for disposal of surplus material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 332.—BITUMINOUS SIDEWALK

DESCRIPTION

332-1.1 This item shall consist of a sidewalk surfacing composed of a mixture of aggregate and bituminous material, constructed on a prepared bed in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans.

MATERIALS

332-2.1 The bituminous mixture shall be type F-1 or type H-1, whichever is called for in the bid schedule.

(a) *Type F-1 Mixture.*—Type F-1 mixture shall be of the grading called for in the bid schedule and shall conform to the requirements for plant mixture as given under CLASS F, TYPE F-1, DENSE GRADED PLANT-MIX SURFACE COURSE with the modifications given below.

The bituminous material shall be rapid-curing cut-back asphalt and the grade shall be RC-2 or RC-3, whichever is designated by the engineer. The amount of bituminous material to be used in the mixture shall be as designated by the engineer and shall be from 4 to 6 percent of the weight of the dry aggregate.

The mixture may be prepared as provided under CLASS F, TYPE F-1, DENSE GRADED PLANT-MIX SURFACE COURSE or by other methods satisfactory to the engineer. The method and manner of preparation and mixing shall be such as to coat the aggregate uniformly and completely.

(b) *Type H-1 Mixture.*—Type H-1 mixture shall conform to all the requirements for cold asphaltic concrete seal coat mixture as given under CLASS E-1, MACADAM PAVEMENT, PLANT-MIX SEAL COAT.

CONSTRUCTION METHODS

332-3.1 **PREPARATION OF BED.**—The existing subgrade, base, or surface shall be shaped to conform to the section shown on the plans and shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material. When indicated on the plans, a bed of cinders, or of clean sand and gravel, or of other approved porous material shall be placed and compacted to the thickness shown on the plans.

332-3.2 FORMS.—If shown on the plans, forms of a type satisfactory to the engineer shall be staked securely in position at the correct line and elevation. If forms are not indicated on the plans and there are no abutting curbs, shoulders shall be formed of the subgrade or base material in such manner as to keep the surfacing to true lines.

332-3.3 PLACING MIXTURE.—The mixture shall be placed on the prepared bed only when, in the opinion of the engineer, the bed is sufficiently dry and weather conditions are suitable. The mixture shall be placed in one or more courses of uniform thickness as shown on the plans. Each course shall be smoothed by raking or screeding and shall be thoroughly compacted by rolling with a hand-operated roller weighing not less than 300 pounds or with a small power roller of a type satisfactory to the engineer. After compaction, the surfacing shall be of the thickness and section shown on the plans, shall be smooth and even and of a dense and uniform texture. Forms, if used, shall be removed and the shoulders shaped and compacted to the required section.

METHOD OF MEASUREMENT

332-4.1 The yardage to be paid for shall be the number of square yards of bituminous sidewalk complete in place and accepted.

BASIS OF PAYMENT

332-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Type F-1 Bituminous Sidewalk, Grading ()" or "Type H-1 Bituminous Sidewalk," as the case may be, which price and payment shall constitute full compensation for furnishing all materials, preparation of the bed and shoulders, for forms, for placing and compacting, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 340.—WATERPROOFING

DESCRIPTION

340-1.1 This item shall consist of the waterproofing of concrete surfaces in accordance with these specifications, by the method designated in the bid schedule, and at the locations shown on the plans or ordered by the engineer.

MATERIALS

340-2.1 BITUMINOUS MATERIAL.—The bituminous material for prime and mop coats shall be either asphalt or tar, whichever is called for in the bid schedule.

For prime coats, asphalt shall conform to the requirements of Federal Specification SS-A-701 and tar shall conform to the requirements for grade TW-1-X in subsection 341-2.1 under DAMP-PROOFING.

For mop coats, asphalt shall conform to the requirements of Federal Specification SS-A-666, Type III, and tar shall conform to the requirements of Federal Specification R-P-381, Type I.

340-2.2 WATERPROOFING FABRIC.—Waterproofing fabric for use with asphalt shall conform to the requirements of Federal Specification HH-C-581a, and for use with tar to Federal Specification HH-C-591.

The fabric shall be stored in a dry, protected place. Rolls shall not be stored on end.

340-2.3 MORTAR.—Mortar shall be composed of one part of portland cement and three parts of sand by volume, and water. Cement, sand, and water shall conform to the requirements for these materials under CONCRETE. Unless an approved mortar mixing machine is used, the sand and cement shall be mixed in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains such a consistency that it can be handled and spread easily with a trowel.

340-2.4 ASPHALT PLANK.—Asphalt plank shall be composed of asphalt and fiber material. It shall be furnished in preformed, dense, and homogeneous slabs, 1¼ inches in thickness and of the cross section designated as shiplap. Planks may be from 6 to 8 inches in width but all pieces for one structure shall be of the same width except for such "closers" as may be necessary. The lengths shall be such as to permit the laying of the planks to the best advantage on the surface to be covered but shall not be less than 3

nor more than 8 feet. Individual planks shall be straight, uniform in cross section and dimension, free of cracks, fissures and other defects, and with ends cut square and true. Tolerances not to exceed one-sixteenth inch over or under nominal thickness and one-eighth inch over or under nominal width will be permitted.

CONSTRUCTION METHODS

340-3.1 MEMBRANE WATERPROOFING.—Membrane waterproofing shall be a firmly bonded membrane composed of two layers of asphalt treated fabric and three moppings of asphalt or two layers of tar treated fabric and three moppings of tar, together with a coating of primer, all applied as follows:

All concrete surfaces which are to be waterproofed shall be smooth, and free of projections or holes that might cause puncture of the membrane. The surface shall be dry and thoroughly cleaned of dust and loose materials immediately before the application of the waterproofing. Waterproofing shall not be done in wet or freezing weather without written authorization from the engineer.

Asphalt shall be applied at a temperature between 300° and 350° F., and tar between 200° and 250° F.

A coating of primer shall be applied and allowed to dry before any mop coat is applied.

The fabric shall be so laid that drainage will be over, and not against or along, the laps. It shall be "shingled" so that there will be two thicknesses at all points. Edge laps shall be at least 4 inches and end laps at least 12 inches. One ply of fabric shall not touch another or the concrete surface since there must be three unbroken moppings.

Beginning at the low point of the surface to be waterproofed, a section about 20 inches wide shall be mopped with the hot asphalt or tar. A strip of fabric of half the width of the roll shall be rolled immediately on the hot asphalt or tar and pressed carefully into place so as to expel all entrapped air and obtain close conformity with the surface. This strip and an adjacent area of concrete surface, slightly more than one-half the width of a roll, shall then be mopped with hot asphalt or tar and a full width strip of fabric shall be rolled and pressed into place as before, so as to cover completely the first strip. This second strip and an adjacent area of the concrete surface shall then be mopped with hot asphalt or tar and the third strip of fabric shingled on so as to lap the first strip by not less than 4 inches. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least 4 inches over the last strip but one. The entire surface shall then be mopped with hot asphalt or tar. The work shall be so regulated that at the close of the day's work the final mopping shall have been

applied to all the fabric in place. Special care shall be taken to see that all laps are thoroughly sealed down.

All corners and angles shall be waterproofed without cutting or slitting the fabric. Flashing shall be done carefully around all openings and obstructions in a manner meeting the approval of the engineer. At curbs, spandrel walls, etc., the flashing shall be done with separate sheets lapping the main membrane not less than 12 inches. All expansion joints and cracks in the concrete surfaces shall be covered with especially designed flashing. Joints which are essentially open but which are not designed to provide for expansion shall first be caulked with oakum and leadwool and then filled with hot joint filler.

340-3.2 MEMBRANE WATERPROOFING WITH MORTAR PROTECTION.—The waterproofing membrane shall be constructed in all particulars in accordance with the specifications for the materials and methods of construction given above in 3.1.

Every part of the membrane, except on undercut surfaces, shall then be covered with a course of reinforced mortar. This course shall be 1½ inches thick, and shall be reinforced with wire netting, 2-inch mesh, No. 18 gage, placed so as to lie midway between the top and bottom surfaces of the mortar. The top surface of the mortar course shall be trowelled to a smooth, hard finish. On undercut surfaces (the under side of parts of the structure the surface of which makes an angle of less than 90° with a horizontal plane) the membrane shall be protected with a layer of three-ply roofing felt laid in hot asphalt or tar instead of the mortar covering. The bituminous material used for this purpose shall be the same as that used in building up the membrane. The protective mortar course shall be cured by burlap held in close surface contact and kept wet for 72 hours.

340-3.3 MEMBRANE WATERPROOFING WITH ASPHALT PLANK PROTECTION.—The waterproofing membrane shall be constructed in all particulars in accordance with the specifications for the materials and methods of construction given above in 3.1.

Every part of the membrane shall then be covered with asphalt plank. The plank shall be laid in regular straight courses as indicated on the plans. Whole planks shall be used in all cases except as otherwise required for closures and for trim around openings and obstructions. Closing and trimming pieces shall be cut to size carefully. Before the planks are laid, all surplus talc or other powder shall be removed from them with a stiff brush or broom. Each piece shall be laid in a mopping of hot asphalt or tar and the edges and ends of pieces in place shall be coated with the hot asphalt or tar before another piece is placed. Each individual piece shall be crowded tightly

against the piece next to it and the completed work shall have a uniform, smooth surface without open cracks or spaces.

340-3.4 DEFECTIVE WORK.—Any waterproofing that is found to leak at any time prior to the final acceptance of the contract shall be repaired and remedied to the satisfaction of the engineer and at the sole expense of the contractor.

METHOD OF MEASUREMENT

340-4.1 The yardage to be paid for shall be the number of square yards of waterproofing of the several kinds, completed and accepted.

BASIS OF PAYMENT

340-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Membrane Waterproofing (—)," "Membrane Waterproofing (—) with Mortar Protection," or "Membrane Waterproofing (—) with Asphalt Plank Protection," as the case may be, which price and payment shall constitute full compensation for furnishing all the materials, for the mesh reinforcing for mortar protection, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 341.—DAMP-PROOFING

DESCRIPTION

341-1.1 This item shall consist of damp-proofing concrete surfaces with tar in accordance with these specifications and at the locations shown on the plans or ordered by the engineer.

MATERIALS

341-2.1 Tar for absorptive treatment shall meet the requirements given in table 1 for TW-1-X and shall be crude water-gas tar, which may be treated for the removal of excess water if necessary to meet the detailed requirements of this specification.

Tar for application as a seal shall meet the requirements given in table 1 for TR-1 and shall be prepared from the refined gas-house coke-oven and/or water-gas tars fluxed with suitable distillates. It shall be homogeneous.

TABLE 1.—Requirements for tar for damp-proofing

	A.A.S.H.O. test method	TW-1-X		TR-1	
		Min.	Max.	Min.	Max.
Sp. gr.-----	T-43-----	1.03	1.10	1.09	1.19
Sp. vis., Engler, 104° F.-----	T-54-----		3	35	60
Sol. in CS ₂ , percent by wt.-----	T-44-----	98		80	
Water, percent by vol.-----	T-55-----		3		2
Total distillate to—					
338° F., percent by wt.-----	T-52-----	{		2	8
455° F., percent by wt.-----				8	20
518° F., percent by wt.-----				16	28
572° F., percent by wt.-----			50		36
Soft. pt. of residue, ° F.-----	T-53-----				149
Application temp. ° F.-----				75	100

CONSTRUCTION METHODS

341-3.1 After the concrete is cured in conformity with the requirements given under CONCRETE, the surfaces to be damp-proofed shall be allowed to dry at least 10 days. They shall then be coated thoroughly with four coats of tar TW-1-X applied cold with a brush or spray gun and each coat shall be absorbed before the succeeding one is applied. After absorption of the final coat, a seal coat of tar TR-1, shall be

applied at a temperature of about 80° F. and brushed thoroughly into all surfaces. The seal coat shall harden before any water or earth is allowed to come against it. No coat shall be applied when the concrete or the preceding coat is damp, or at any time when in the opinion of the engineer the weather is unsuitable.

METHOD OF MEASUREMENT

341-4.1 The yardage to be paid for shall be the actual number of square yards of surface damp-proofed, completed, and accepted.

BASIS OF PAYMENT

341-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Damp-proofing," which price and payment shall constitute full compensation for furnishing and placing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 342.—CONDITIONING OF SUBFLOOR

(For bituminous wearing course)

DESCRIPTION

342-1.1 This item shall consist of the conditioning of an existing wood or concrete floor so that a bituminous wearing course may be placed upon it, in accordance with these specifications and as ordered by the engineer.

CONSTRUCTION METHODS

342-3.1 **CONDITIONING OF WOOD SUBFLOOR.**—Before the wearing surface is placed, all parts of the subfloor shall be fastened securely to prevent vibration and, unless otherwise specified, all sharp corners, projections, or irregularities in the surface shall be removed. Wood that is worn or that 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 sealed completely by being caulked with oakum, or by other suitable means. All dust, dirt, debris, or foreign material shall be removed by sweeping the subfloor with stiff brooms and, if necessary, by flushing it with water. If water is used, the subfloor shall be allowed to become thoroughly dry and then swept with stiff brooms.

342-3.2 **CONDITIONING OF CONCRETE SUBFLOOR.**—The requirements as to cleanliness, specified above for wood subfloors, shall also apply to concrete subfloors when being conditioned. Irregularities in the surface such as might project into or injure the bituminous carpet shall be removed.

METHOD OF MEASUREMENT

342-4.1 Conditioning of subfloor shall not be measured for direct payment.

BASIS OF PAYMENT

342-5.1 Performance of this item, under the contract, is not payable directly, but shall be considered as a subsidiary obligation of the contractor covered under the contract price paid for the contemplated wearing course.

ITEM 343.—MINERAL-SURFACED ASPHALT PLANK**DESCRIPTION**

343-1.1 This item shall consist of a bridge floor wearing surface composed of a mineral-surfaced asphalt and fiber material furnished in planks, constructed in one course on a prepared concrete or wood bridge subfloor, in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the plans or required by the engineer.

MATERIALS

343-2.1 The mineral-surfaced asphalt plank shall meet the requirements of A.A.S.H.O. Specification M-46. Asphalt primer and asphalt cement shall be of an approved quality.

CONSTRUCTION METHODS

343-3.1 SUBFLOOR.—The subfloor shall be an approved subfloor conditioned as provided under **CONDITIONING OF SUBFLOOR.**

343-3.2 APPLICATION ON CONCRETE SUBFLOOR.—Asphalt primer shall be brushed thoroughly over the subfloor at the rate of approximately one gallon per 100 square feet of subfloor. After the primer has dried, asphalt cement shall be mopped over the surface at the rate of approximately 50 pounds per 100 square feet. The cement shall be hot when applied and the asphalt planks shall be embedded therein before it has cooled appreciably. Before the planks are placed, surplus talc or other powder shall be removed from them with stiff brushes or brooms. The planks shall be embedded in the hot asphalt cement in a neat, workmanlike manner, with broken joints, and the edges and ends of plank in place shall be coated with hot asphalt before another plank is placed. Each plank shall be crowded snugly against adjacent planks so that all joints are filled completely with asphalt cement.

343-3.3 APPLICATION ON WOOD SUBFLOOR.—Asphalt primer shall be applied as required for concrete subfloor. Asphalt plank shall be laid in a neat, workmanlike manner, breaking joints, and each individual plank crowded tightly against adjacent planks. Wedges, jacks, or bars may be used for this purpose. Open joints remaining in the finished floor and the joints between the planks and the retaining strips on each side of the driveway shall be filled with hot asphalt cement.

Each end of a plank shall be secured by at least 2 nails, one in each corner. Nails in the edges of the planks shall be spaced not over 12 inches apart and the adjacent lines of nails shall be staggered. Nails shall not be driven closer than 1¼ inches from any end or edge and shall be driven until their heads are one-eighth inch below the top surfaces of the planks.

Nails.—Either wire or cut nails or spikes may be used. All nails and spikes shall be galvanized. The size of nail used for any given thickness shall not be less than that indicated in the following table:

<i>Thickness of asphalt plank, inches</i>	<i>Nail size</i>
¾	12d
1	16d
1¼	20d
1½	30d
2	40d

METHOD OF MEASUREMENT

343-4.1 The yardage to be paid for shall be the number of square yards of mineral-surfaced asphalt plank of the required thickness, in place, completed, and accepted.

BASIS OF PAYMENT

343-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per square yard for "Mineral-Surfaced Asphalt Plank" of the thickness called for, which price and payment shall constitute full compensation for the conditioning of the subfloor, for furnishing and placing all materials, for nails, asphalt for priming, for mopping, for joints, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 344.—BRONZE BEARING PLATES

DESCRIPTION

344-1.1 This item shall consist of bronze bearing plates furnished and placed in accordance with these specifications and in conformity with the sizes, dimensions, design, and locations shown on the plans.

MATERIALS

344-2.1 Bronze bearing plates shall conform to the requirements of A.S.T.M. Designation B22-38-T, Classes B, C, or D material. The designation and class for the material to be furnished shall be as shown on the plans. Bronze castings shall be free of foreign material, casting faults, injurious blow holes, or other defects rendering the castings unsuitable for the service intended.

CONSTRUCTION METHODS

344-3.1 Bearing plates shall be set accurately in correct position as provided under STEEL BRIDGES and as shown on the plans and shall have uniform bearing over the total specified area. They shall be anchored securely to the concrete by ribs or bolts of the sizes shown on the plans, and set in the concrete as shown on the plans. Surfaces having sliding contact shall be planed parallel to the direction of movement and shall be smooth and level, and just before being placed shall be coated thoroughly with graphite and grease. Special care shall be taken to avoid placing concrete in such a manner as to interfere with the free action of sliding surfaces.

METHOD OF MEASUREMENT

344-4.1 The weight to be paid for shall be the actual scale weight in pounds of the bronze plates furnished, placed, and accepted.

BASIS OF PAYMENT

344-5.1 The weight, determined as provided above, shall be paid for at the contract unit price per pound for "Bronze Bearing Plates" which price and payment shall constitute full compensation for furnishing and placing all materials, for bolts or set screws, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 345.—COPPER FLASHING

DESCRIPTION

345-1.1 This item shall consist of sheet copper flashing furnished and placed in expansion and construction joints in accordance with these specifications and at the locations shown on the plans or ordered by the engineer.

MATERIALS

345-2.1 Copper for flashing shall be uniform in quality and temper. It shall be clean, sound, smooth, commercially flat, and free of foreign material, pipes, slivers, laps, cracks, twists, seams, scale, damaged ends or edges, buckles, or other injurious defects. The sheets shall be rolled from virgin metals or from virgin metals and scrap of known and approved composition, and shall contain not less than 99.88 percent copper, silver being counted as copper. Unless otherwise shown, the thickness of the sheets shall be No. 22 U. S. Standard gage.

CONSTRUCTION METHODS

345-3.1 Sheets for flashing shall be of the width, and shall be bent to the shapes shown or ordered. The flashing in each joint shall be continuous, separate pieces being connected by thoroughly workmanlike soldered joints to form a complete watertight unit. The flashing shall be placed in such manner as to insure its embedment in the concrete on each side of the joints in the exact positions shown on the plans.

METHOD OF MEASUREMENT

345-4.1 Copper flashing shall not be measured for direct payment.

BASIS OF PAYMENT

345-5.1 Performance of this item, under the contract, is not payable directly, but shall be considered as a subsidiary obligation of the contractor covered under the contract price paid for various classes of concrete.

ITEM 346.—BLAST PLATES**DESCRIPTION**

346-1.1 This item shall consist of blast plates for the protection of the superstructure of overhead crossings against the blasts of locomotives passing beneath, made of wrought iron or asbestos board, and furnished and placed in accordance with these specifications and at the locations and in the manner shown on the plans.

MATERIALS

346-2.1 WROUGHT IRON.—Wrought iron for blast plates shall conform to the requirements of A.S.T.M. Designation A42-37-T for Refined Wrought Iron Bars.

346-2.2 ASBESTOS BOARD.—Asbestos blast board material shall be fireproof and composed of asbestos fiber and portland cement united under pressure into dense rigid sheets which meet the engineer's approval.

346-2.3 SPECIAL CEMENT.—Special cement for covering rivet and bolt heads shall be a special asbestos product resistant to fire and locomotive blasts and fumes, waterproof and durable under extremes of temperature. It shall not set up to a brittle, hard texture, but shall retain permanently a slight degree of plasticity or pliability.

346-2.4 HARDWARE.—All bolts and nuts for connections shall be chromium plated. Washers for bolts shall be of the dimensions and shape shown on the plans or required by the engineer.

CONSTRUCTION METHODS

346-3.1 The method of attachment and installation of the blast plates shall be as shown on the plans. Upon the completion of the placing of the blast plates, every rivet and bolt head that is exposed on the under surface shall be covered with a hemisphere of special cement. This cement shall be mixed to such a plasticity that it can be pressed over the metal parts to be covered, concentrically with the bolts. Special wooden or metal hand molds shall be used and the special cement shall be placed in such manner as to adhere firmly to the washers and other metal parts after removal of the molds.

METHOD OF MEASUREMENT

346-4.1 The footage or pounds to be paid for shall be the number of square feet or pounds of blast plates complete in place and accepted, whichever is called for in the bid schedule. When the bid schedule calls for payment in pounds, weights shall be determined by weighing the blast plates on scales.

BASIS OF PAYMENT

346-5.1 The quantity of blast plates, determined as provided above, shall be paid for at the contract unit price per square foot or per pound, as the case may be, for "Asbestos Board Blast Plates," or "Wrought Iron Blast Plates," which price and payment shall constitute full compensation for furnishing and placing of all materials, for special cement and hardware, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 360.—RIGHT-OF-WAY MONUMENTS

DESCRIPTION

360-1.1 This item shall consist of concrete right-of-way monuments furnished and placed, in accordance with these specifications at the locations and in conformity with the design and dimensions shown on the plans or required by the engineer. Type A monuments shall be used in all cases except that type B monuments may be used where solid rock is encountered if the contractor so elects.

MATERIALS

360-2.1 Monuments shall be constructed of concrete of the class specified on the plans. Reinforcing steel and copper plugs shall be placed as shown on the plans.

CONSTRUCTION METHODS

360-3.1 Each monument shall be set accurately at the required location and elevation and in such a manner as to insure its being held firmly in place.

METHOD OF MEASUREMENT

360-4.1 The number to be paid for shall be the actual number of right-of-way monuments furnished, installed, and accepted.

BASIS OF PAYMENT

360-5.1 The number of right-of-way monuments, determined as provided for above, shall be paid for at the contract unit prices for "Right-of-Way Monuments Type A" or "Right-of-Way Monuments Type B," as the case may be, which prices and payments shall constitute full compensation for furnishing all materials, for installing the monuments complete in place, for the concrete contained therein, for excavating and backfilling, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 361.—CONCRETE MAINTENANCE MARKER POSTS

DESCRIPTION

361-1.1 This item shall consist of numbered concrete maintenance marker posts furnished and placed, in accordance with the specifications, at the locations and in conformity with the dimensions and design shown on the plans or required by the engineer.

MATERIALS

361-2.1 The posts shall be constructed of concrete of the class specified on the plans. An approved brand of white portland cement shall be used.

The numerals shall be of die-cast metal, of the size shown on the plans, and shall be anchored in the concrete. The metal shall be nonrusting and dark in color.

CONSTRUCTION METHODS

361-3.1 Each post shall be set at the required location and elevation and in such manner as to insure its being held in place.

METHOD OF MEASUREMENT

361-4.1 The number to be paid for shall be the actual number of posts furnished, placed, and accepted.

BASIS OF PAYMENT

361-5.1 The number of posts, determined as provided for above, shall be paid for at the contract unit price for "Concrete Maintenance Marker Posts," which price and payment shall constitute full compensation for furnishing and installing the numbered posts complete in place, for the concrete contained therein, for excavating and backfilling, for all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 362.—TIMBER CULVERT MARKERS

DESCRIPTION

362-1.1 This item shall consist of timber culvert markers furnished and installed in accordance with these specifications, at the locations shown on the plans or ordered by the engineer, and in conformity with the detail plans for culvert markers.

MATERIALS

362-2.1 Timber culvert markers shall be of the dimensions, species and grade shown on the plans. The painting details shall be as shown on the plans.

CONSTRUCTION METHODS

362-3.1 Culvert markers shall be firmly embedded in the ground to the depths shown on the plans. The locations of the markers with respect to headwalls or drop inlets and the shoulders of the road shall be as shown on the plans, or ordered by the engineer.

METHOD OF MEASUREMENT

362-4.1 The number to be paid for shall be the number of timber culvert markers installed and accepted.

BASIS OF PAYMENT

362-5.1 The number, determined as provided above, shall be paid for at the contract unit price for "Timber Culvert Markers," which price and payment shall be full compensation for furnishing all material, for painting and installing the culvert markers, for excavating and backfilling the holes, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 363.—CATTLE GUARDS

DESCRIPTION

363-1.1 This item shall consist of cattle guards and connecting fences and gates constructed, in accordance with these specifications, at the locations and in conformity with the lines and grades shown on the plans or ordered by the engineer.

MATERIALS

363-2.1 The materials shall conform to the kind, grade, type, and size specified on the plans.

CONSTRUCTION METHODS

363-3.1 The cattle guards and connecting fences and gates shall be assembled and placed as shown on the plans and to the satisfaction of the engineer.

METHOD OF MEASUREMENT

363-4.1 The quantity to be paid for shall be the actual number of cattle guards installed and accepted.

BASIS OF PAYMENT

363-5.1 The number of cattle guards, determined as provided for above, shall be paid for at the contract unit price for "Cattle Guards," which price and payments shall constitute full compensation for furnishing and constructing the cattle guards, for excavating and backfilling, for furnishing and constructing connecting fences and gates, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 364.—BARBED WIRE FENCE

DESCRIPTION

364-1.1 This item shall consist of barbed wire fence of the type shown on the plans, constructed in accordance with these specifications at the locations and in conformity with the lines and grades shown on the plans or required by the engineer.

MATERIALS

364-2.1 The materials used shall be of the kind and type specified on the plans.

CONSTRUCTION METHODS

364-3.1 All old fencing that is to be replaced by new fencing or that the plans show is to be removed shall be dismantled, removed, and disposed of as directed by the engineer.

Posts shall be set vertically to the depth shown on the plans and maintained in accurate alinement while the post holes are backfilled with suitable material thoroughly tamped in layers, or shall be set by other approved methods of installing posts. After the posts are set properly, the wires shall be fastened to the posts with approved fasteners. Wire stays shall then be placed as called for on the plans.

METHOD OF MEASUREMENT

364-4.1 The footage to be paid for shall be the actual number of linear feet of barbed wire fence in place, completed, and accepted.

BASIS OF PAYMENT

364-5.1 The footage, determined as provided for above, shall be paid for at the contract unit price per linear foot for "Barbed Wire Fence," which price and payment shall constitute full compensation for dismantling, removing, and disposing of the old fence, for excavating and backfilling, for furnishing and placing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 365.—GATES

DESCRIPTION

365-1.1 This item shall consist of gates and fittings of the sizes and types shown on the plans, constructed in accordance with these specifications at the locations and in conformity with the designs and dimensions shown on the plans or ordered by the engineer.

MATERIALS

365-2.1 The materials shall conform to the kinds, grades, and sizes specified on the plans, and shall include the necessary fittings and posts.

CONSTRUCTION METHODS

365-3.1 The posts shall be of the size indicated and of the same types as those in the existing fences, and shall be set in the class of concrete called for on the plans and to the depth shown on the plans.

METHOD OF MEASUREMENT

365-4.1 The quantity to be paid for shall be the actual number of gates installed and accepted.

BASIS OF PAYMENT

365-5.1 The number of gates, determined as provided for above, shall be paid for at the contract unit price for "Gates" which price and payment shall constitute full compensation for the furnishing and placing of all materials, including all excavation and backfill, fittings and posts, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 380.—TRAFFIC STRIPE

DESCRIPTION

380-1.1 This item shall consist of furnishing and applying, on a completed surface, a traffic stripe of the width shown on the plans, in accordance with these specifications and at the locations shown on the plans or ordered by the engineer.

MATERIALS

380-2.1 The paint shall meet the requirements of A.A.S.H.O. Specification M-34 if the surface is bituminous, or M-35 if the surface is of brick or concrete.

CONSTRUCTION METHODS

380-3.1 All work is to be performed in a neat and workman-like manner. The stripe may be placed on the road either by hand methods or by means of an approved striping machine.

METHOD OF MEASUREMENT

380-4.1 The mileage to be paid for shall be the number of miles of traffic stripe, measured along the center line of the stripe, completed and accepted.

BASIS OF PAYMENT

380-5.1 The mileage, determined as provided above, shall be paid for at the contract unit price per mile for "Traffic Stripe," which price and payment shall constitute full compensation for furnishing and applying the paint, and for all labor, equipment, tools, and incidentals necessary to complete the item.

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ITEM 381.—TIMBER GUIDE POSTS

DESCRIPTION

381-1.1 This item shall consist of timber guide posts furnished and installed at the locations shown on the plans or selected by the engineer, in accordance with these specifications and in conformity with the detail plans for the guide posts. Timber guide posts shall be fitted with warning reflectors where shown on the plans and called for in the bid schedule.

MATERIALS

381-2.1 Timber guide posts shall be of the dimensions, of timber, and grade of timber specified on the plans. The posts shall be painted or unpainted as indicated on the plans. Painting, if called for, shall be in accordance with the details shown on the plans. The details of warning reflectors shall be as shown on the plans.

CONSTRUCTION METHODS

381-3.1 Guide posts shall be firmly embedded in the ground to the depth shown on the plans.

METHOD OF MEASUREMENT

381-4.1 The quantity to be paid for shall be the number of timber guide posts installed and accepted.

BASIS OF PAYMENT

381-5.1 The number of guide posts, determined as provided for above, shall be paid for at the contract unit price for "Timber Guide Posts" or "Timber Guide Posts with Warning Reflectors," as the case may be, which price and payment shall be full compensation for furnishing all material, for painting and installing the guide posts, for excavating and backfilling the holes, for furnishing and installing the warning reflectors, and for all labor, equipment, tools, and incidentals necessary to complete the item.

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ITEM 382.—HUB-HIGH WOOD GUARDRAIL**DESCRIPTION**

382-1.1 This item shall consist of hub-high wood guardrail of either rustic, or surfaced and painted timber, treated or untreated as called for in the bid schedule, constructed in accordance with these specifications, at the locations, and in conformity with the designs and dimensions shown on the plans or ordered by the engineer.

MATERIALS

382-2.1 The posts and railing shall be of the species of timber specified on the plans, or, if not specified thereon, as required by the engineer.

382-2.2 RUSTIC POSTS AND RAILS.—Rustic posts and rails shall be straight, sound, and free of injurious defects and shall have been cut from live trees not less than 30 days but not more than 1 year before use. They shall have been seasoned with the bark on. Immediately before the logs are used in the work, all bark shall be peeled and all knots and projections trimmed smooth. Slight curvature or “wind” to give a pleasing appearance to the structure will be permitted. Logs of only one species shall be used in the construction of any one continuous length of guardrail.

382-2.3 SAWED POSTS AND RAILS.—Sawed posts and rails shall conform to the requirements given under **TREATED AND UNTREATED TIMBER**, and shall be of the grade specified on the plans. Railing shall be of sufficient length to span two panels. Sawed posts and railings shall be surfaced on four sides and shall be “treated” or “untreated” as called for in the bid schedule; if treated, the preservative to be used shall be as called for in the bid schedule.

382-2.4 STAIN AND PAINT.—The stain for the visible portion of rustic posts shall be Cabot’s Creosote Stain No. 247 or a material equivalent to it.

White paint for posts and rails other than rustic shall meet the requirements for white paint given under **TREATED AND UNTREATED TIMBER**.

Black paint shall consist of lampblack ground in oil and mixed to the required consistency with pure raw linseed oil.

CONSTRUCTION METHODS

382-3.1 ERECTION.—The posts shall be set vertically to the depth shown on the plans. They shall be maintained in accurate alinement while the post holes are backfilled with

suitable material and the fill thoroughly tamped in layers. After backfilling, the tops of posts shall be sawed off to exact grade and sloped or beveled as called for on the plans. Posts and railings shall be shaped or notched as called for on the plans and so that satisfactory contact surfaces are obtained where rails are secured to the posts.

Holes for bolts shall be bored with bits of the same diameters as the bolts. Except for rustic guardrail, all bolts shall be given two coats of red-lead shop paint as specified for structural steel.

382-3.2 PAINTING.—Unless otherwise specified, sawed and surfaced guardrail shall be painted with three coats of white paint to within 8 inches of the ground line. All timber to be painted must be seasoned. Painting shall be done only when the timber is free of frost and the surface is dry and clean. No painting shall be done in wet or freezing weather. All paint coats shall be thoroughly dry before succeeding coats are applied. Paint shall be applied in heavy coats, completely covering every part of the surface and shall be worked well into the joints and open spaces; it shall be so thoroughly and evenly spread that no excess paint collects at any point. The first 8 inches of posts (except rustic posts) above the ground line shall be painted with two coats of the black paint.

382-3.3 STAINING.—Rustic guardrail, after erection has been completed, shall be stained with two applications of the approved stain, covering the rails and the exposed portions of the posts. The wood shall be dry when being stained. The first coat shall be thoroughly dry when the second is applied. Stain shall not be applied in damp weather.

METHOD OF MEASUREMENT

382-4.1 The footage to be paid for shall be the actual number of linear feet of wood guardrail in place, completed, and accepted, measured from outside to outside of end posts. The measurement shall not include handrail erected on timber bridges.

BASIS OF PAYMENT

382-5.1 The footage, determined as provided above, shall be paid for at the contract unit price per linear foot for “Hub-High Rustic Guardrail,” “Hub-High Untreated Wood Guardrail,” or “Hub-High Treated Wood Guardrail, ()” treated with the particular preservative required, which prices and payments shall constitute full compensation for furnishing and placing all posts and rails, for all materials, for nails, bolts, driftbolts, and other hardware, for paint, preservative, and stain, for all excavating and backfilling, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 400.—FURNISHING AND PLACING LOAMY TOPSOIL

DESCRIPTION

400-1.1 This item shall consist of loamy topsoil furnished, deposited and spread, all in accordance with these specifications, at the locations shown on the plans or designated by the engineer.

MATERIALS

400-2.1 The material shall consist of loamy topsoil defined as follows: A natural, workable loamy topsoil without admixture of subsoil, refuse, or any foreign materials and reasonably free of stumps, roots, hard dirt, stiff clay, stones larger than 1 inch in diameter, noxious weeds, brush, or other litter. Acceptable loamy topsoil shall be such a mixture of sand, silt, and clay particles as to exhibit sandy and clayey properties in about equal proportions. Such loamy topsoil shall contain not less than 5 percent nor more than 20 percent of organic matter as determined by loss on ignition of oven-dried samples.

Ignition test.—The ignition test shall be performed on samples of soil according to the method described in U. S. Department of Agriculture Circular 139 on pages 6 and 7.

CONSTRUCTION METHODS

400-3.1 Acceptable loamy topsoil shall, prior to stripping, have demonstrated by the occurrence upon it of healthy crops, grass, or other vegetable growths, that it has been reasonably well drained and that it does not contain toxic amounts of either acid or alkaline elements. After inspection and approval by the engineer and prior to stripping, the contractor shall remove any grass, briars, stumps, or roots by mowing, grubbing, or other satisfactory means.

The loamy topsoil shall be deposited and spread to the depth ordered by the engineer.

The contractor shall take all reasonable precautions to avoid injury to existing or planted growths, and to structures or surfacing on the roadway.

During hauling operations the roadway surfacing shall be kept clean and any topsoil or other dirt which may be brought upon the surfacing shall be removed promptly and thoroughly lest it become compacted by traffic. If necessary, the wheels of all vehicles shall be kept clean to avoid bringing any dirt upon the surfacing.

After the spreading of loamy topsoil, any large stones, stiff clods, hard lumps, brush, roots, stumps, litter, or other foreign material shall be raked up and removed from the topsoil area. Spreading shall be completed in such a manner that seeding, sodding, or planting, if and as called for on the plans, can proceed after completion of this work without additional soil preparation.

METHOD OF MEASUREMENT

400-4.1 The yardage to be paid for shall be the number of cubic yards of loamy topsoil, measured in the vehicle at point of delivery, complete in place and accepted.

BASIS OF PAYMENT

400-5.1 The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Furnishing and Placing Loamy Topsoil," which price and payment shall constitute full compensation for furnishing, excavating, loading, hauling, depositing, and spreading the topsoil, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 401.—CUTTING, LIFTING, AND PLACING SOD**DESCRIPTION**

401-1.1 This item shall consist of living sod, removed from areas indicated on the plans or designated by the engineer, placed and installed, all in accordance with these specifications, at the locations shown on the plans or designated by the engineer. If found necessary, the sod shall be temporarily stored for later placing and installing.

MATERIALS

401-2.1 Loamy topsoil and seed shall meet the respective requirements specified for these materials under the items FURNISHING AND PLACING LOAMY TOPSOIL AND SEEDING.

CONSTRUCTION METHODS

401-3.1 The sod shall be cut into rectangular sections, which may vary in length but shall be of equal width, to a depth equal to the growth of the roots, but in no case less than 2 inches. Sections or strips shall be of a size that will permit them to be lifted without breaking. Longer sections, as a rule, will be permitted in clay topsoils and shorter sections will be required in soils containing a high percentage of sand. Sections shall be cut away below the root line with acceptable sod cutters or sharp, flat spades and shall be rolled in tight rolls or laid flat on boards or planks and lifted and transported to storage piles or carried to the point of installation without breaking. In all cases sod must be lifted and loaded or unloaded by hand. Dumping from vehicles will not be permitted.

401-3.2 While in temporary storage, sod shall remain in tight rolls or shall be placed grass to grass or roots to roots. The stacked rolls or piled layers shall be sprinkled with water and covered with moist burlap, straw, or other acceptable material when and as directed by the engineer. Any sod permitted by the contractor to dry out shall be rejected whenever, in the judgment of the engineer, its survival after placing has been rendered doubtful.

In no case shall temporary storage be permitted for more than 5 days, and sod broken in transit or stored beyond this time limit may be rejected by the engineer.

401-3.3 Before sod is placed, soil preparation or topsoiling as required shall have been completed. The ground upon which

sod is to be placed shall be brought to an even surface satisfactory to the engineer.

401-3.4 In setting sod, no gaps shall be left between the sections. Any openings shall be plugged with sod and, after the sections are set in place, acceptable loamy topsoil shall be used to fill the joints and to cover the sod in place to a depth of about one-quarter inch. The entire surface sodded shall be seeded with an approved grass seed mixture applied to the topsoil surface dressing at the rate of one-half pound per 1,000 square feet of sod in place. The seed shall be mixed with clean, dry sand or dry, sandy loam before being applied. Following this seeding, the sod sections shall be tamped or rolled in place as directed by the engineer.

401-3.5 Sod placed on slopes that are steeper than 2 to 1, and in ditch areas, shall be staked in place, the stakes being driven flush with the surface after tamping or rolling has been completed. Stakes shall be at least 8 inches in length, shall have a cross-sectional area not greater than 1 square inch, and shall be spaced as indicated on the plans or as directed by the engineer.

METHOD OF MEASUREMENT

401-4.1 The area to be paid for shall be the number of square feet of sod complete in place and accepted.

BASIS OF PAYMENT

401-5.1 The area, determined as provided above, shall be paid for at the contract unit price per square foot for "Cutting, Lifting, and Placing Sod," which price and payment shall constitute full compensation for cutting, lifting, hauling, or moving to final position, for any temporary storage, for conditioning of surfaces to be sodded, for placing top dressing, for seeding, tamping, rolling, staking, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 402.—SEEDING

DESCRIPTION

402-1.1 This item shall consist of furnishing and placing seed, all in accordance with these specifications, at the locations shown on the plans or designated by the engineer.

MATERIALS

402-2.1 SEED.—The varieties of seed and the proportions to be used shall be as shown on the plans for both grass seed and seed of other than the true grasses such as clovers, vetches, rye, and lespedeza, and shall be furnished and delivered in separate standard bags. The seed shall be mixed after delivery as directed by the engineer.

All seed shall comply with applicable State and Federal seed laws, shall meet the requirements for minimum percentage of purity and germination and maximum allowable weed seed content shown on the plans, and shall be reasonably free of noxious weed seed. One-pint samples of seed shall be furnished by the contractor for testing if required by the engineer.

402-2.2 MANURES AND FERTILIZERS.—Barnyard or stable manures shall consist of animal droppings mixed with not more than 25 percent by volume of straw or other bedding materials and shall be free of materials toxic to plant growth. Manures shall be well rotted. Samples 1 cubic yard in volume shall be furnished by the contractor for approval prior to delivery.

Where acceptable barnyard or stable manure is difficult to procure, dried blood, tankage, fish scrap, or such organic fertilizers (or equivalent materials) mixed with each other or with commercial chemical fertilizers, shall be considered as equivalent to manure, provided that such mixed organic or organic and chemical fertilizers shall contain the minimum percentages of available nitrogen, phosphorous, and potassium called for as shown on the plans.

CONSTRUCTION METHODS

402-3.1 Seeding operations shall be performed as indicated on the plans, and at the times and seeding periods therein stated.

The contractor shall notify the engineer at least 48 hours in advance of the time he intends to begin sowing seed and shall not proceed with such work until permission to do so has been granted in writing by the engineer.

402-3.2 ADVANCE PREPARATION OF SEEDBED.—Prior to the sowing of seed, the topsoil, and manure (or equivalent material) shall be distributed and spread over the seedbed in the amount or rate indicated on the plans. The surface of the seedbed shall be plowed, harrowed, and raked until it has become loosened and pulverized and until added materials have become incorporated to a depth of not less than 5 inches. The seedbed shall be brought to the lines or grades indicated on the plans or designated by the engineer, all sticks, litter, stones larger than one inch in diameter, and other foreign materials being removed.

402-3.3 SOWING.—Grass or other seeds, separately or in mixture, shall be sown in the required amount, preferably by rotary or other mechanical seeders. No seeding shall be done during windy weather or when the ground is frozen, wet, or is otherwise nontillable. Seeding shall be done in two directions at right angles to each other. The rates of seeding shall be as indicated on the plans.

Leguminous seeds such as clover or vetch shall be suitably inoculated before being sown unless otherwise specified on the plans.

Grass seed mixtures shall be raked in lightly to a depth of approximately one-fourth inch. When mixed seeds other than those of true grasses are specified, such heavy seeds may be sown separately and raked in after sowing to an approximate depth of one-half inch.

As soon as the seed is raked in, the seedbed shall be rolled with a light roller of a weight permitted by the engineer. On clay soils, rolling shall be done with extreme care. Rolling shall be omitted where, in the engineer's judgment, compaction of clay soils will tend to prevent seed germination.

402-3.4 The contractor shall water, mow, and otherwise properly maintain to the engineer's satisfaction, all seeded areas until the acceptance of the contract.

METHOD OF MEASUREMENT

402-4.1 The area of seeding to be paid for shall be the number of seeding units seeded as ordered in accordance with these specifications and accepted. A unit shall consist of 1,000 square feet measured horizontally.

BASIS OF PAYMENT

402-5.1 The number of seeding units, determined as provided above, shall be paid for at the contract unit price per unit for "Seeding," which price and payment shall constitute full compensation for furnishing seed in the kinds and amounts specified together with required manure or equivalent material, the preparation of the seedbed, the sowing, raking and rolling of seed, all watering, mowing and maintenance of the seeded area, and for all labor, equipment, tools, and incidentals necessary to complete the item, except furnishing and placing topsoil.

ITEM 403.—FURNISHING SEED

DESCRIPTION

403-1.1 This item shall consist of seed, of the varieties called for in the bid schedule, furnished, furnished and delivered, or furnished and stored, whichever is called for in the bid schedule, all in accordance with these specifications.

MATERIALS

403-2.1 **SEED.**—Each variety of seed, both grass seed and seed of other than the true grasses such as clovers, vetches, rye, and lespedeza, shall be furnished and delivered in separate standard bags.

The seed furnished shall meet the requirements for seed under SEEDING.

CONSTRUCTION METHODS

403-3.1 The seed shall be delivered at the place called for and when storing is required shall be stored at the places provided by the Government, and in the manner designated by the engineer.

METHOD OF MEASUREMENT

403-4.1 The quantities to be paid for shall be the number of pounds of seed (net weight) of the several varieties, in standard bags, furnished, furnished and delivered, or furnished and stored, whichever is called for in the bid schedule, and accepted.

BASIS OF PAYMENT

403-5.1 The pounds of seed, determined as provided above, shall be paid for at the contract unit prices per pound for "Furnishing Seed," "Furnishing and Delivering Seed," or "Furnishing and Storing Seed," of the several varieties, which prices and payments shall constitute full compensation for furnishing, furnishing and delivering, or furnishing and storing, as the case may be, the seed in an acceptable manner.

ITEM 404.—FURNISHING PLANTS AND PLANTING

DESCRIPTION

404-1.1 This item shall consist of live trees, shrubs, vines, and other woody or herbaceous plants of the type, class, species, and size specified and called for in the bid schedule, furnished and planted all in accordance with these specifications, at the locations shown on the plans or designated by the engineer.

The planting shall include the preparation of the ground and the fertilizing thereof, shall include the furnishing of the specified miscellaneous materials, any necessary storing of plants in heeling grounds or temporary nurseries, and shall include all mulching, watering, staking, guying, pruning, and wrapping of plants, and the clean-up of planting areas.

MATERIALS

404-2.1 **QUALITY OF PLANT MATERIALS.**—All plant material shall be true to its type and name in accordance with the "Standardized Plant Names."

All plants shall have a well-branched vigorous and balanced root and top growth and shall be of standard No. 1 grade or equal in accordance with the "Horticultural Standards."

All plants shall be free of mechanical injury or injury from sun or frost and shall show no evidence of insect attack or disease. Any plant material arriving at the point of delivery or at the site of planting with dried-out or otherwise damaged top or root systems or with mildewed tops, and any thin, weak plants of poor form or abnormal leaf color shall be rejected.

All plants shall be nursery-grown except where otherwise specified on the plans.

404-2.2 **NURSERY-GROWN MATERIALS.**—Nursery-grown material shall be transplanted one or more times in accordance with the A.A.N. "Horticultural Standards." The last transplanting or root-pruning shall have been completed at least one growing season prior to delivery. Budded or grafted stock will not be accepted except when so stipulated on the plans. Digging shall precede shipment by not more than 48 hours.

404-2.3 **COLLECTED MATERIALS.**—Collected plant material shall be plants that have not been transplanted or otherwise disturbed in the ground prior to digging for delivery, except for such root-pruning as is required on the plans. Any such root-pruning shall have been completed at least one growing season prior to delivery.

Collected plant material shall be plants of native or "naturalized" species, growing in loam, sand or clay soils that are favorable to digging without damage to root systems. These plants must be dug with a root system sufficient to insure healthy, rapid growth after planting. Digging shall precede loading for delivery as ordered by the engineer by not more than 24 hours. The plants must be watered or puddled and protected during delivery by a root covering of wet straw, burlap, tarpaulin, or otherwise as required by the engineer.

404-2.4 MISCELLANEOUS MATERIALS.—Fertilizer shall be barnyard or stable manures or organic or inorganic fertilizers, furnished separately or in mixtures, as required on the plans. Cord, rope, wire, stakes, turnbuckles, mulch materials, and tree guards shall meet the requirements of the plans.

404-2.5 BALLED AND BURLAPPED PLANTS.—Plants designated "B & B" shall be balled and burlapped. All such plants shall be dug from soil that will hold a firm ball. Burlap shall be held in place by cord, rope, or wire wrapping. Any B & B material arriving with a broken or loose root ball or one of "manufactured" earth shall be rejected.

404-2.6 PREPARATION FOR SHIPMENT.—All plant material shall be dug with care by experienced workmen. Digging shall be done in such manner as to retain the essential root systems and avoid damage to root systems by mechanical agencies or frost. Each species or variety shall be handled or packed in an approved manner and as required by soil and climatic conditions at the time of digging and with due regard to conditions of shipment and time to be consumed in transit and delivery. All stock shall be legibly tagged with the name and size of the material according to A.A.N. standards of practice.

404-2.7 SHIPMENT.—All plants shall be packed for shipment in cars or trucks and in a manner to protect them during transit. Material shall be tied in bundles as outlined in the "Horticultural Standards." Dry-rooted or bare-rooted plants shall be packed in moist straw, moss or other accepted material. Box cars shall be ventilated adequately to prevent "sweating" during transit.

404-2.8 INSPECTION.—All plant material shall be available for inspection in the growing nurseries or collecting fields before it is dug. The contractor shall notify the engineer not less than 48 hours in advance of the digging or shipping of any plant material from the growing nursery or collecting source. Final inspection will be made at the planting site.

All plant material shall comply with State and Federal laws regarding inspection for plant diseases and infestation. Inspection certificates, as required by law, shall accompany each invoice or consignment of stock and upon arrival at the point of delivery shall be given to the engineer.

CONSTRUCTION METHODS

404-3.1 TEMPORARY STORAGE AND HEELING-IN.

Where temporary storage or heeling-in is required the contractor shall provide and prepare a suitable heeling ground or heeling-in nursery conveniently located near the planting site prior to the shipment of plant material from the growing nursery or other source.

Plant material unloaded and accepted by the engineer shall be immediately heeled-in or transported direct to the planting site and planted. Material left out of the ground over night or left with roots bare to the sun or otherwise unprotected during transit, unloading, heeling-in, or planting shall be rejected by the engineer if, in his judgment, such lack of protection has resulted in drying out of roots or other injury to plants. Before being heeled-in, the roots of plants shall be puddled in a mud bath. Materials shall be arranged in the storage space as directed by the engineer.

404-3.2 PREPARATION OF PLANTING SITE.—Holes for the plants shall be dug of sufficient size to permit not less than 6 inches of loose friable loam backfill beneath and around the outer periphery of the root system or root ball. Holes for the larger plants shall be dug before the removal of such plants from the heeling grounds. For large shade trees, flowering trees, evergreen trees or large shrubs wherever the soil is sterile or wherever existing conditions in the judgment of the engineer are unfavorable to plant growth the holes shall be of sufficient size to permit the placing of 12 inches of topsoil around and under the root ball.

404-3.3 PLANT BACKFILL.—In advance of the removal of plants from the heeling ground (or from the source when not heeled-in) topsoil for filling under and around the plant shall be provided at each planting hole. Such topsoil for plant backfill shall meet the requirements for loamy topsoil given under FURNISHING AND PLACING LOAMY TOPSOIL or an equivalent material made from the natural soil at the location, mixed with muck, peat, manure or commercial fertilizer as required by the engineer.

404-3.4 PLANTING ORDER.—The order of planting shall be as follows:

- (a) Large trees.
- (b) Small trees, large shrubs.
- (c) Small shrubs.
- (d) Vines and ground cover.
- (e) Perennials, herbaceous plants, grass, and other seeding.

404-3.5 PLANTING.—The contractor shall notify the engineer of planting operations not less than 48 hours prior to removal from the heeling ground.

Plants shall be placed in the planting holes with the roots spread out and spaced in a natural manner while the specified backfill is tamped or puddled around them. In general, plants shall be planted at the same depth at which they originally grew in the nursery or collecting field. The formation of air pockets should be avoided in performing the tamping or puddling. For trees, evergreen shrubs, and larger deciduous shrubs where water is readily available, planting shall be by puddling. Sticks or clods should be picked out or removed.

404-3.6 PRUNING.—All deciduous plants shall be pruned at the time of planting or immediately afterwards as directed by the engineer. Collected plants, except the white and gray birch group and similar trees not benefited by heavy pruning, shall be thinned to the extent of one-half or more of their respective leaf surfaces. Nursery-grown plants shall have not less than one-third of their leaf surfaces removed. Pruning shall be done with due regard to the natural form and growth characteristics.

404-3.7 STAKING AND GUYING.—All trees and shrubs exceeding 4 feet in height after pruning, if planted in exposed positions, shall be staked or guyed in accordance with the methods shown on the plans. The staking or guying shall be done immediately after planting. Trees or shrubs blown down or otherwise damaged through lack of proper support shall be replaced and reset as required by the engineer.

404-3.8 MULCHING AND WRAPPING.—After being planted, all plants shall be mulched and watered as required on the plans. Manure or other fertilizing material shall not be used for mulching purposes unless so ordered. Wrapping where required shall be as prescribed on the plans.

404-3.9 RAIN BASINS.—Around each planted tree, shrub, or vine a shallow basin, or rain cup, shall be formed in the ground, having a diameter equal to that of the planting hole. These basins or rain cups shall be maintained in shape during the life of the contract.

404-3.10 CLEAN-UP AFTER PLANTING.—After the planting has been completed the ground at planting sites shall be cleaned up. Subsoil, rock, and other spoils material shall be removed and disposed of as directed by the engineer.

404-3.11 MAINTENANCE DURING CONTRACT PERIOD.—After planting, all plants shall be watered thoroughly at weekly intervals, if required. Only a heavy rainfall will be considered as equivalent to thorough watering. After watering or heavy rainfall a dust mulch shall be formed around the plants by mulching or cultivation. The contractor shall maintain all plant material held in storage grounds or planted as directed by the engineer. Such maintenance shall continue until final inspection and acceptance.

METHOD OF MEASUREMENT

404-4.1 The quantities of plants to be paid for shall be the number of living trees, shrubs, vines, or herbaceous plants furnished and planted and accepted. Each tree, shrub, vine, or herbaceous plant shall be inspected, and, if found true to name in accordance with the official "Standardized Plant Names," shall be measured for caliper or height as outlined in the "Horticultural Standards." Measurements of plants such as palms, cacti, or other succulents or desert plants not covered by these "Horticultural Standards" shall be as shown on the plans. Plants will be checked for number, type, class, species, and size at time of delivery but final check will be made when planting is completed. Only living plants in a healthy condition at the time of final inspection will be accepted, in accordance with article 9.6.

BASIS OF PAYMENT

404-5.1 The quantities of plants, determined as provided above, shall be paid for at the contract unit prices each for "Furnishing Plants and Planting" of the types, classes, species, and sizes called for in the bid schedule, which prices and payments shall constitute full compensation for furnishing, digging, loading, delivering, storing and planting, for mulching, fertilizing, watering, staking, guying, pruning and wrapping, and for the formation of rain basins, the clean-up of planting areas, and for all labor, equipment, tools, and incidentals necessary to complete the item, except that topsoil shall be furnished and paid for under REPLACING TOPSOIL OR FURNISHING AND PLACING LOAMY TOPSOIL.

ITEM 405.—FURNISHING PLANTS

DESCRIPTION

405-1.1 This item shall consist of live trees, shrubs, vines, and other woody or herbaceous plants of the type, class, species, and size specified and called for in the bid schedule, furnished, furnished and delivered, or furnished and stored, whichever is called for in the bid schedule, all in accordance with these specifications.

MATERIALS

405-2.1 **PLANTS.**—The plants furnished shall meet all the requirements in subsections 2.1 to 2.8 inclusive under **FURNISHING PLANTS AND PLANTING.**

CONSTRUCTION METHODS

405-3.1 The plants shall be delivered at the place called for and when storing is required the plants shall be stored at the places provided by the Government, and in the manner designated by the engineer.

METHOD OF MEASUREMENT

405-4.1 The quantities of plants to be paid for shall be the number of living trees, shrubs, vines, or herbaceous plants furnished, furnished and delivered, or furnished and stored, and accepted. Each tree, shrub, vine or herbaceous plant shall be inspected, and, if found true to name in accordance with the official "Standardized Plant Names," shall be measured for caliper or height as outlined in the "Horticultural Standards." Measurements of plants such as palms, cacti, or other succulents or desert plants not covered by these "Horticultural Standards" shall be as shown on the plans. When furnishing and storing are called for, plants will be checked for number, type, class, species and size at the time of delivery, but final check will be made when storage is completed. Only living plants in a healthy condition at the time of final inspection will be accepted.

BASIS OF PAYMENT

405-5.1 The quantities of plants, determined as provided above, shall be paid for at the contract unit prices each for "Furnishing Plants," "Furnishing and Delivering Plants," or "Furnishing and Storing Plants" of the types, classes, species, and sizes called for in the bid schedule, which prices and payments shall constitute full compensation for furnishing, furnishing and delivering, or furnishing and storing, as the case may be, and for all labor, equipment, tools and incidentals necessary to complete the item.

DIVISION III.—DESIGN DETAILS

(Not included in this book)

DIVISION IV.—CONTRACT FORMS

The standard Government forms referred to in these general specifications or in other contractual documents are not included in this book, but may be obtained upon application.

The form of bid schedule given below is for convenience of reference only, and is not to be filled in as the actual bid for submission.

BID SCHEDULE

(Bidders Please Note: Before Preparing the Proposal Read Carefully "Invitation for Bids" and "Instruction to Bidders.")

The bidder shall insert a bid price in the bid schedule opposite each pay name for which a quantity appears in the bid schedule as prepared by the engineer, provided however, that when any individual price is set in the bid schedule in lieu of requesting a bid price such set price shall govern whether or not a quantity appears opposite the individual price so set. A bid price is not to be entered nor tendered for any pay name for which no quantity appears in the bid schedule.

Only one item in each group of alternate items as indicated hereafter is to be supplied or constructed under the contract. The bidder is to insert his bid price in the prepared bid schedule opposite that item of those called for in each group for which he is willing to bid the lowest price.

Items numbered ----- are major items.

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
1		Maintenance of Special Detours, shown on plans as authorized in article 4.4 (a), to be paid for as earned. Estimated cost set by the district engineer. (12)	Contingent sum	
2		Maintenance as authorized in articles 4.4 (b), and 7.11, to be paid for as earned. Estimated cost set by the district engineer (12, 27)	Contingent sum	
3		Extra and miscellaneous force account work as authorized in article 9.4 (b) 2, to be paid for as earned. Estimated cost set by district engineer. (43)	Contingent sum	
20(1)		Acres Clearing and Grubbing, at ----- per acre. (48)		
21(1)		Units Random Clearing, at ----- per clearing unit. (52)		
21(2)		Units Heavy Random Clearing, at ----- per clearing unit. (52)		
21A(1)		Units Random Grubbing, at ----- per grubbing unit. (55)		
21A(2)		Units Heavy Random Grubbing, at ----- per grubbing unit. (55)		
22(1)		Sq. ft. Selective Removal of Trees and Snags, at ----- per sq. ft. (57)		
22(2)		Selective Removal of Trees and Snags, 6-inch size, at ----- each. (57)		
22(3)		Selective Removal of Trees and Snags, 10-inch size, at ----- each. (57)		
22(4)		Selective Removal of Trees and Snags, 18-inch size, at ----- each. (57)		
22(5)		Selective Removal of Trees and Snags, 30-inch size, at ----- each. (57)		
22(6)		Selective Removal of Trees and Snags, 48-inch size, at ----- each. (57)		
22(7)		Selective Removal of Trees and Snags, 60-inch size, at ----- each. (57)		
23(1)		Cu. yds. Stripping and Storing Topsoil, at ----- per cu. yd. (58)		

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Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
24(1)		Cu. yds. Unclassified Excavation, at ----- per cu. yd. (62)		
24(2)		Cu. yds. Unclassified Excavation, Unit (), at ----- per cu. yd. (62)		
24(3)		Cu. yds. Solid Rock Excavation, at ----- per cu. yd. (62)		
24(4)		Cu. yds. Common Excavation, at ----- per cu. yd. (62)		
25(1)		Cu. yds. Unclassified Excavation for Structures, at ----- per cu. yd. (67)		
26(1)		Cu. yds. Unclassified Excavation for Borrow, Case 1, at ----- per cu. yd. (70)		
26(2)		Cu. yds. Unclassified Excavation for Borrow, Case 2, at ----- per cu. yd. (70)		
27(1)		Station-yards Overhaul (500 feet free haul), at ----- per station-yard. (73)		
27(2)		Station-yards Overhaul (1,000 feet free haul), at ----- per station-yard. (73)		
28(1)		Cu. yd.-miles Special Overhaul of Borrow (500 feet free haul), at ----- per cu. yd.-mile. (74)		
28(2)		Cu. yd.-miles Special Overhaul of Borrow (1,000 feet free haul), at ----- per cu. yd.-mile. (74)		
29(1)		Cu. yds. Extra Compaction of Embankment (Case 3), at ----- per cu. yd. (79)		
29(2)		Cu. yds. Test-Controlled Compaction of Embankment (Case 4), at ----- per cu. yd. (79)		
30(1)		Cu. yds. Foundation Fill, at ----- per cu. yd. (80)		
31(1)		Cu. yds. Stone or Gravel Sheathing, at ----- per cu. yd. (82)		
35(1)		Cu. yds. Replacing Topsoil, at ----- per cu. yd. (90)		
36(1)		Cu. yds. Porous Material for Tree Root Protection, at ----- per cu. yd. (92)		
37(1)		Lin. ft. Furrow Ditches, at ----- per lin. ft. (93)		

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Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
38(1)		Units Obliteration of Old Roadways, at..... .....per unit..... (95)		
38(2)		Obliteration of Old Roadways to be paid for as earned..... (95)	Contingent sum	
39(1)		Acres Roadside Clean-up, at..... .....per acre..... (98)		
39(2)		Units Roadside Clean-up, at..... .....per unit..... (98)		
40(1)		Cu. yds. Spot Subgrade Reinforcement, at..... .....per cu. yd..... (100)		
42(1)		Miles Finishing Earth Graded Roads, at..... .....per mile..... (103)		
43(1)		Miles Fine Grading Subgrade and Shoulders, at..... .....per mile..... (106)		
45(1)		Units Watering of Embankment, Item 29, at..... .....per 1,000 gal. unit..... (109)		
45(2)		Units Watering of Subgrade, Item (), at..... .....per 1,000 gal. unit..... (109)		
45(3)		Units Watering of Base Course, Item (), at..... .....per 1,000 gal. unit..... (109)		
45(4)		Units Watering of Surface Course, Item (), at..... .....per 1,000 gal. unit..... (109)		
45(5)		Providing and Maintaining Water Plant or Plants..... (109)	Lump sum	
()		Acres Pit-clearing (Article 6.1) for Item (), at..... .....per acre (18)		
()		Cu. yds. Pit-stripping (Article 6.1) for Item (), at..... .....per cu. yd. (18)		
()		Pit-moves (Article 6.1) for Item (), at..... .....each (18)		
()		Cu. yd.-miles Additional Haul (Article 6.1) for Item (), at..... .....per cu. yd.-mile (18)		
()		Ton-miles Additional Haul (Article 6.1) for Item (), at..... .....per ton-mile (18)		
50(1)		Cu. yds. Selected Borrow Base Course, at..... .....per cu. yd..... (112)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
51(1)		Cu. yds. New Material for Stabilized Soil Base Course, Type (), Grading (), at..... .....per cu. yd..... (116)		
51(2)		Tons New Material for Stabilized Soil Base Course, Type (), Grading (), at..... .....per ton..... (116)		
51(3)		Miles Mixing Stabilized Soil Base Course, Case (), at..... .....per mile..... (116)		
51(4)		Sq. yds. Mixing Stabilized Soil Base Course, Case (), at..... .....per sq. yd..... (116)		
52(1)		Cu. yds. Gravel Base Course, Class (), Grading (), at..... .....per cu. yd..... (120)		
52(2)		Tons Gravel Base Course, Class (), Grading (), at..... .....per ton..... (120)		
52A(1)		Cu. yds. Crushed Gravel or Crushed Stone Base Course, Class (), Grading (), at..... .....per cu. yd..... (125)		
52A(2)		Tons Crushed Gravel or Crushed Stone Base Course, Class (), Grading (), at..... .....per ton..... (125)		
53(1)		Sq. yds. Telford Base Course, at..... .....per sq. yd..... (128)		
53(2)		Tons Telford Base Course, at..... .....per ton..... (128)		
54(1)		Sq. yds. Sledged Stone Base Course, at..... .....per sq. yd..... (130)		
54(2)		Tons Sledged Stone Base Course, at..... .....per ton..... (130)		
55(1)		Cu. yds. Dry Choked Stone or Slag Base Course, at..... .....per cu. yd..... (133)		
55(2)		Tons Dry Choked Stone or Slag Base Course, at..... .....per ton..... (133)		
56(1)		Tons Waterbound Macadam Base Course, at..... .....per ton..... (139)		
57(1)		Sq. yds. Reconstructed Base Course, at..... .....per sq. yd..... (142)		
57(2)		Cu. yds. Reconstructed Base Course, Additional Gravel Material, at.....per cu. yd..... (142)		

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Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
57(3)		Tons Reconstructed Base Course, Additional Gravel Material, at..... .....per ton.. (142)		
57(4)		Cu. yds. Reconstructed Base Course, Additional Crushed Stone Material, at..... .....per cu. yd.. (142)		
57(5)		Tons Reconstructed Base Course, Additional Crushed Stone Material, at..... .....per ton.. (142)		
58(1)		Miles Reconditioning of Used Roadbed, at..... .....per mile.. (144)		
59(1)		Tons Bituminous Macadam Base Course Aggregate, at..... .....per ton.. (150)		
59(2)		Gals. Asphalt, Grade (), for Bituminous Macadam Base Course, at..... .....per gal.. (150)		
59(3)		Tons Asphalt, Grade (), for Bituminous Macadam Base Course, at..... .....per ton.. (150)		
59(4)		Gals. Tar, Grade (), for Bituminous Macadam Base Course, at..... .....per gal.. (150)		
59(5)		Tons Tar, Grade (), for Bituminous Macadam Base Course, at..... .....per ton.. (150)		
60(1)		Tons Hot Asphalt Concrete Base Course, Stone Aggregate, at..... .....per ton.. (162)		
60(2)		Tons Hot Asphalt Concrete Base Course, Slag Aggregate, at..... .....per ton.. (162)		
100(1)		Cu. yds. Selected Borrow Surface Course, at..... .....per cu. yd.. (165)		
101(1)		Cu. yds. Gravel Surface Course, Class (), Grading (), at..... .....per cu. yd.. (169)		
101(2)		Tons Gravel Surface Course, Class (), Grading (), at..... .....per ton.. (169)		
101(3)		Cu. yds. Gravel Surface Course, Class 3, at.....per cu. yd.. (169)		
101(4)		Tons Gravel Surface Course, Class 3, at.....per ton.. (169)		

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Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
102(1)		Cu. yds. Crushed Gravel or Crushed Stone Surface Course, Class (), Grading (), at..... .....per cu. yd.. (174)		
102(2)		Tons Crushed Gravel or Crushed Stone Surface Course, Class (), Grading (), at..... .....per ton.. (174)		
102(3)		Cu. yds. Crushed Gravel or Crushed Stone Surface Course, Class 3, at..... .....per cu. yd.. (174)		
102(4)		Tons Crushed Gravel or Crushed Stone Surface Course, Class 3, at..... .....per ton.. (174)		
110(1)		Gals. Slow-Curing Liquid Asphaltic Material, Grade (), for Prime Coat, at..... .....per gal.. (178)		
110(2)		Tons Slow-Curing Liquid Asphaltic Material, Grade (), for Prime Coat, at..... .....per ton.. (178)		
110(3)		Gals. Medium-Curing Cut-back Asphalt, Grade (), for Prime Coat, at..... .....per gal.. (178)		
110(4)		Tons Medium-Curing Cut-back Asphalt, Grade (), for Prime Coat, at..... .....per ton.. (178)		
110(5)		Gals. Tar, Grade (), for Prime Coat, at..... .....per gal.. (178)		
110(6)		Tons Tar, Grade (), for Prime Coat, at..... .....per ton.. (178)		
111(1)		Gals. Rapid-Curing Cut-back Asphalt, Grade (), for Tack Coat, at..... .....per gal.. (180)		
111(2)		Tons Rapid-Curing Cut-back Asphalt, Grade (), for Tack Coat, at..... .....per ton.. (180)		
111(3)		Gals. Emulsified Asphalt for Tack Coat, at..... .....per gal.. (180)		
111(4)		Tons Emulsified Asphalt for Tack Coat, at..... .....per ton.. (180)		
111(5)		Gals. Asphalt, Grade (150-200), for Tack Coat, at..... .....per gal.. (180)		
111(6)		Tons Asphalt, Grade (150-200), for Tack Coat, at..... .....per ton.. (180)		
111(7)		Gals. Tar, Grade (), for Tack Coat, at..... .....per gal.. (180)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
111(8)		Tons Tar, Grade (), for Tack Coat, at..... .....per ton.. (180)		
112(1)		Miles Windrowing and Spreading Type 1 Blotter Material for Bituminous Preservative Treatment, at..... .....per mile.. (187)		
112(2)		Cu. yds. Type 2 Blotter Material for Bituminous Preservative Treatment, at..... .....per cu. yd.. (187)		
112(3)		Tons Type 2 Blotter Material for Bituminous Preservative Treatment, at..... .....per ton.. (187)		
112(4)		Cu. yds. Type 3 Blotter Material for Bituminous Preservative Treatment, at..... .....per cu. yd.. (187)		
112(5)		Tons Type 3 Blotter Material for Bituminous Preservative Treatment, at..... .....per ton.. (187)		
112(6)		Cu. yds. Type 4 Blotter Material for Bituminous Preservative Treatment, at..... .....per cu. yd.. (187)		
112(7)		Tons Type 4 Blotter Material for Bituminous Preservative Treatment, at..... .....per ton.. (187)		
112(8)		Cu. yds. Bituminous Treated Stockpiled Blotter Material, at..... .....per cu. yd.. (187)		
112(9)		Tons Bituminous Treated Stockpiled Blotter Material, at..... .....per ton.. (187)		
112(10)		Gals. Slow-Curing Liquid Asphaltic Material, Grade (), for Bituminous Preservative Treatment, at..... .....per gal.. (187)		
112(11)		Tons Slow-Curing Liquid Asphaltic Material, Grade (), for Bituminous Preservative Treatment, at..... .....per ton.. (187)		
112(12)		Gals. Medium-Curing Cut-back Asphalt, Grade (), for Bituminous Preservative Treatment, at..... .....per gal.. (187)		
112(13)		Tons Medium-Curing Cut-back Asphalt, Grade (), for Base Preservative, at..... .....per ton.. (187)		
112(14)		Gals. Tar, Grade (), for Bituminous Preservative Treatment, at.....per gal.. (187)		

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Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
112(15)		Tons Tar, Grade (), for Bituminous Preservative Treatment, at..... .....per ton.. (187)		
113(1)		Cu. yds. Cover Aggregate for Type 2 Seal Coat, at..... .....per cu. yd.. (195)		
113(2)		Tons Cover Aggregate for Type 2 Seal Coat, at..... .....per ton.. (195)		
113(3)		Cu. yds. Cover Aggregate for Type 3 Seal Coat, Grading (), at..... .....per cu. yd.. (195)		
113(4)		Tons Cover Aggregate for Type 3 Seal Coat, Grading (), at..... .....per ton.. (195)		
113(5)		Cu. yds. Base Choker and Cover Aggregate for Type 4 Seal Coat, at..... .....per cu. yd.. (195)		
113(6)		Tons Base Choker and Cover Aggregate for Type 4 Seal Coat, at..... .....per ton.. (195)		
113(7)		Gals. Rapid-Curing Cut-back Asphalt, Grade (), for Seal Coat, at..... .....per gal.. (195)		
113(8)		Tons Rapid-Curing Cut-back Asphalt, Grade (), for Seal Coat, at..... .....per ton.. (195)		
113(9)		Gals. Emulsified Asphalt for Seal Coat, at..... .....per gal.. (195)		
113(10)		Tons Emulsified Asphalt for Seal Coat, at..... .....per ton.. (195)		
113(11)		Gals. 90+ Asphaltic Material for Seal Coat, at..... .....per gal.. (195)		
113(12)		Tons 90+ Asphaltic Material for Seal Coat, at..... .....per ton.. (195)		
113(13)		Gals. Asphalt, Grade (150-200), for Seal Coat, at..... .....per gal.. (195)		
113(14)		Tons Asphalt, Grade (150-200), for Seal Coat, at..... .....per ton.. (195)		
113(15)		Gals. Tar, (Grade (), for Seal Coat, at..... .....per gal.. (195)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
113(16)		Tons Tar, Grade (), for Seal Coat, at..... .....per ton.. (195)		
114(1)		Cu. yds. (Class A Pavement) Aggregate for Designation (AT-) Surface Treatment, at..... .....per cu. yd.. (201)		
114(2)		Tons (Class A Pavement) Aggregate for Designation (AT-) Surface Treatment, at..... .....per ton.. (201)		
114(3)		Cu. yds. (Class A Pavement) Aggregate for Designation (E-) Surface Treatment, at..... .....per cu. yd.. (201)		
114(4)		Tons (Class A Pavement) Aggregate for Designation (E-) Surface Treatment, at..... .....per ton.. (201)		
114(5)		Tons Rapid-Curing Cut-back Asphalt, Grade (), for Class A Surface Treatment, at..... .....per ton.. (201)		
114(6)		Gals. Rapid-Curing Cut-back Asphalt, Grade (), for Class A Surface Treatment, at..... .....per gal.. (201)		
114(7)		Tons 90+ Asphaltic Material for Class A Surface Treatment, at..... .....per ton.. (201)		
114(8)		Gals. 90+ Asphaltic Material for Class A Surface Treatment, at..... .....per gal.. (201)		
114(9)		Tons Asphalt, Grade (150-200), for Class A Surface Treatment, at..... .....per ton.. (201)		
114(10)		Gals. Asphalt, Grade (150-200), for Class A Surface Treatment, at..... .....per gal.. (201)		
114(11)		Tons Emulsified Asphalt for Class A Surface Treatment, at..... .....per ton.. (201)		
114(12)		Gals. Emulsified Asphalt for Class A Surface Treatment, at..... .....per gal.. (201)		
114(13)		Tons Tar, Grade (), for Class A Surface Treatment, at..... .....per ton.. (201)		
114(14)		Gals. Tar, Grade (), for Class A Surface Treatment, at..... .....per gal.. (201)		
120(1)		Miles (Class B-1 Pavement) Road-Mix Surfacing Laid, Case (), at..... .....per mile.. (210)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
120(2)		Sq. yds. (Class B-1 Pavement) Road-Mix Surfacing Laid, Case (), at..... .....per sq. yd.. (210)		
120(3)		Cu. yds. (Class B-1 Pavement) New Road-Mix Aggregate, Grading (), at..... .....per cu. yd.. (210)		
120(4)		Tons (Class B-1 Pavement) New Road-Mix Aggregate, Grading (), at..... .....per ton.. (210)		
120(5)		Gals. Slow-Curing Liquid Asphaltic Material, Grade (), for Class B-1, at..... .....per gal.. (210)		
120(6)		Tons Slow-Curing Liquid Asphaltic Material, Grade (), for Class B-1, at..... .....per ton.. (210)		
121(1)		Tons (Class B-2 Pavement) Plant Mixture, Grading (), at..... .....per ton.. (217)		
121(2)		Gals. Slow-Curing Liquid Asphaltic Material, Grade (), for Class B-2, at..... .....per gal.. (217)		
121(3)		Tons Slow-Curing Liquid Asphaltic Material, Grade (), for Class B-2, at..... .....per ton.. (217)		
122(1)		Miles (Class C-1 Pavement) Road-Mix Surfacing Laid, Case (), at..... .....per mile.. (225)		
122(2)		Sq. yds. (Class C-1 Pavement) Road-Mix Surfacing Laid, Case (), at..... .....per sq. yd.. (225)		
122(3)		Cu. yds. (Class C-1 Pavement) New Road-Mix Aggregate, Grading (), at..... .....per cu. yd.. (225)		
122(4)		Tons (Class C-1 Pavement) New Road-Mix Aggregate, Grading (), at..... .....per ton.. (225)		
122(5)		Gals. Medium-Curing Cut-back Asphalt, Grade (), for Class C-1, at..... .....per gal.. (225)		
122(6)		Tons Medium-Curing Cut-back Asphalt, Grade (), for Class C-1, at..... .....per ton.. (225)		
123(1)		Cu. yds. (Class C-2 Pavement) Road-Mix Primary Course Aggregate, Designation (), at..... .....per cu. yd.. (233)		
123(2)		Tons (Class C-2 Pavement) Road-Mix Primary Course Aggregate, Designation (), at..... .....per ton.. (233)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
123(3)		Cu. yds. (Class C-2 Pavement) Choker Aggregate, at..... per cu. yd.. (233)		
123(4)		Tons (Class C-2 Pavement) Choker Aggregate, at..... per ton.. (233)		
123(5)		Cu. yds. (Class C-2 Pavement) Cover Aggregate, at..... per cu. yd.. (233)		
123(6)		Tons (Class C-2 Pavement) Cover Aggregate, at..... per ton.. (233)		
123(7)		Gals. Rapid-Curing Cut-back Asphalt, Grade (), for Class C-2, at..... per gal.. (233)		
123(8)		Tons Rapid-Curing Cut-back Asphalt, Grade (), for Class C-2, at..... per ton.. (233)		
123(9)		Gals. Emulsified Asphalt, for Class C-2, at..... per gal.. (233)		
123(10)		Tons Emulsified Asphalt, for Class C-2, at..... per ton.. (233)		
123(11)		Gals. Tar, Grade (), for Class C-2, at..... per gal.. (233)		
123(12)		Tons Tar, Grade (), for Class C-2, at..... per ton.. (233)		
130(1)		Tons (Class D Pavement, Type D-1) "Extra Hard" Macadam Aggregate, at..... per ton.. (239)		
130(2)		Tons (Class D Pavement, Type D-1) "Hard" Macadam Aggregate, at..... per ton.. (239)		
130(3)		Gals. Asphalt, Grade (), for Type D-1, at..... per gal.. (239)		
130(4)		Tons Asphalt, Grade (), for Type D-1, at..... per ton.. (239)		
130(5)		Gals. Tar, Grade (), for Type D-1, at..... per gal.. (239)		
130(6)		Tons Tar, Grade (), for Type D-1, at..... per ton.. (239)		
131(1)		Tons (Class D Pavement, Type D-2) Macadam Aggregate, at..... per ton.. (245)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
131(2)		Gals. Asphalt, Grade (), for Type D-2, at..... per gal.. (245)		
131(3)		Tons Asphalt, Grade (), for Type D-2, at..... per ton.. (245)		
131(4)		Gals. Tar, Grade (), for Type D-2, at..... per gal.. (245)		
131(5)		Tons Tar, Grade (), for Type D-2, at..... per ton.. (245)		
132(1)		Tons (Class E-1 Pavement) Macadam Aggregate, at..... per ton.. (260)		
132(2)		Gals. Asphalt, Grade (), for Class E-1 Macadam, at..... per gal.. (260)		
132(3)		Tons Asphalt, Grade (), for Class E-1 Macadam, at..... per ton.. (260)		
132(4)		Gals. Tar, Grade (), for Class E-1 Macadam, at..... per gal.. (260)		
132(5)		Tons Tar, Grade (), for Class E-1 Macadam, at..... per ton.. (260)		
132(6)		Tons Hot Asphaltic Concrete (Stone Aggregate) Seal Coat for Class E-1, at..... per ton.. (260)		
132(7)		Tons Hot Asphaltic Concrete (Slag Aggregate) Seal Coat for Class E-1, at..... per ton.. (260)		
132(8)		Tons Cold Asphaltic Concrete (Stone Aggregate) Seal Coat for Class E-1, at..... per ton.. (260)		
132(9)		Tons Cold Asphaltic Concrete (Slag Aggregate) Seal Coat for Class E-1, at..... per ton.. (260)		
133(1)		Tons (Class E-2 Pavement, Type EM) Macadam Aggregate, at..... per ton.. (266)		
133(2)		Gals. Emulsified Asphalt for Type EM, at..... per gal.. (266)		
133(3)		Tons Emulsified Asphalt for Type EM, at..... per ton.. (266)		
140(1)		Tons (Class F Pavement, Type F-1) Plant Mixture, Grading (), at..... per ton.. (274)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
140(2)		Gals. Medium-Curing Cut-back Asphalt, Grade (), for Type F-1, at.....per gal.. (274)		
140(3)		Tons Medium-Curing Cut-back Asphalt, Grade (), for Type F-1, at.....per ton.. (274)		
140(4)		Gals. Rapid-Curing Cut-back Asphalt, Grade (), for Type F-1, at.....per gal.. (274)		
140(5)		Tons Rapid-Curing Cut-back Asphalt, Grade (), for Type F-1, at.....per ton.. (274)		
140(6)		Gals. 90+ Asphaltic Material for Type F-1, at.....per gal.. (274)		
140(7)		Tons 90+ Asphaltic Material for Type F-1, at.....per ton.. (274)		
140(8)		Gals. Asphalt, Grade (), for Type F-1, at.....per gal.. (274)		
140(9)		Tons Asphalt, Grade for Type F-1, at.....per ton.. (274)		
141(1)		Tons (Class F Pavement, Type F-2) Plant Mixture, Designation (), at.....per ton.. (282)		
141(2)		Tons (Class F Pavement, Type F-2) Choker Aggregate, at.....per ton.. (282)		
141(3)		Tons (Class F Pavement, Type F-2) Cover Aggregate, at.....per ton.. (282)		
141(4)		Gals. Rapid-Curing Cut-back Asphalt, Grade (), for Type F-2, at.....per gal.. (282)		
141(5)		Tons Rapid-Curing Cut-back Asphalt, Grade (), for Type F-2, at.....per ton.. (282)		
141(6)		Gals. 90+ Asphaltic Material for Type F-2, at.....per gal.. (282)		
141(7)		Tons 90+ Asphaltic Material for Type F-2, at.....per ton.. (282)		
141(8)		Gals. Asphalt, Grade (150-200), for Type F-2, at.....per gal.. (282)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
141(9)		Tons Asphalt, Grade (150-200), for Type F-2, at.....per ton.. (282)		
141(10)		Gals. Emulsified Asphalt for Type F-2, at.....per gal.. (282)		
141(11)		Tons Emulsified Asphalt for Type F-2, at.....per ton.. (282)		
141(12)		Gals. Tar, Grade (), for Type F-2, at.....per gal.. (282)		
141(13)		Tons Tar, Grade (), for Type F-2, at.....per ton.. (282)		
203(1)		Log Trestle Spans Complete () Length, at.....each.. (297)		
203(2)		Log Trestle Spans Complete () Length, at.....each.. (297)		
203(3)		Lin. ft. Logs in Log Bents, at.....per lin. ft.. (297)		
204(1)		Lin. ft. Log Culverts () Size, at.....per lin. ft.. (298)		
204(2)		Lin. ft. Log Culverts () Size, at.....per lin. ft.. (298)		
206(1)		Cu. yds. Concrete Class A, at.....per cu. yd.. (323)		
206(2)		Cu. yds. Concrete Class B, at.....per cu. yd.. (323)		
206(3)		Cu. yds. Concrete Class D, at.....per cu. yd.. (323)		
206(4)		Cu. yds. Concrete Class S, at.....per cu. yd.. (323)		
206A(1)		Cu. yds. Concrete Class XA, at.....per cu. yd.. (329)		
206A(2)		Cu. yds. Concrete Class XB, at.....per cu. yd.. (329)		
206A(3)		Cu. yds. Concrete Class XC, at.....per cu. yd.. (329)		
206A(4)		Cu. yds. Concrete Class XX, at.....per cu. yd.. (329)		
206A(5)		Cu. yds. Concrete Class XY, at.....per cu. yd.. (329)		
206A(6)		Cu. yds. Concrete Class XS, at.....per cu. yd.. (329)		
207(1)		Lbs. Reinforcing Steel, at.....per lb.. (331)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
220(1)		Lbs. Structural Steel—Furnished, Fabricated and Erected, at _____ per lb. (338)		
220(2)		Lbs. Structural Steel (), Furnished, Fabricated and Erected, at _____ per lb. (338)		
220(3)		Lbs. Structural Steel—Furnished and Fabricated, at _____ per lb. (338)		
220(4)		Lbs. Structural Steel (), Furnished and Fabricated, at _____ per lb. (338)		
220(5)		Lbs. Structural Steel, Erected, at _____ per lb. (338)		
230(1)		M feet b. m. Untreated Timber, at _____ per M feet b. m. (347)		
230(2)		M feet b. m. Treated Timber, Creosote Preservative, at _____ per M feet b. m. (347)		
230(3)		M feet b. m. Treated Timber, Zinc Chloride Salts Preservative, at _____ per M feet b. m. (347)		
230(4)		M feet b. m. Treated Timber, Wolman Salts Preservative, at _____ per M feet b. m. (347)		
230(5)		M feet b. m. Treated Timber, ZMA Preservative, at _____ per M feet b. m. (347)		
240(1)		Cu. yds. Dry Rubble Masonry, at _____ per cu. yd. (349)		
241(1)		Cu. yds. Foundation Masonry, at _____ per cu. yd. (352)		
242(1)		Cu. yds. Cement Rubble Masonry, at _____ per cu. yd. (357)		
243(1)		Cu. yds. Class B Stone Masonry, at _____ per cu. yd. (362)		
244(1)		Cu. yds. Class A Stone Masonry, at _____ per cu. yd. (368)		
245(1)		Cu. yds. Class A Stone Masonry in Parapets, at _____ per cu. yd. (370)		
245(2)		Cu. yds. Class B Stone Masonry in Parapets, at _____ per cu. yd. (370)		
246(1)		Cu. yds. Class A Stone Masonry Facing for Concrete, at _____ per cu. yd. (373)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
246(2)		Cu. yds. Class B Stone Masonry Facing for Concrete, at _____ per cu. yd. (373)		
247(1)		Cu. yds. Dimensioned Masonry, at _____ per cu. yd. (379)		
248(1)		Cu. yds. Brick Masonry, at _____ per cu. yd. (381)		
250(1)		Lin. ft. () inch Standard Strength Reinforced Concrete Culvert Pipe, at _____ per lin. ft. (383)		
250(2)		Lin. ft. () inch Standard Strength Reinforced Concrete Culvert Pipe, at _____ per lin. ft. (383)		
250(3)		Lin. ft. () inch Extra Strength Reinforced Concrete Culvert Pipe, at _____ per lin. ft. (383)		
250(4)		Lin. ft. () inch Extra Strength Reinforced Concrete Culvert Pipe, at _____ per lin. ft. (383)		
251(1)		Lin. ft. () inch Vitrified Clay Culvert Pipe, at _____ per lin. ft. (385)		
251(2)		Lin. ft. () inch Vitrified Clay Culvert Pipe, at _____ per lin. ft. (385)		
252(1)		Lin. ft. () inch Cast Iron Culvert Pipe, Standard, Type () at _____ per lin. ft. (387)		
252(2)		Lin. ft. () inch Cast Iron Culvert Pipe, Standard, Type () at _____ per lin. ft. (387)		
252(3)		Lin. ft. () inch Cast Iron Culvert Pipe, Heavy, Type () at _____ per lin. ft. (387)		
252(4)		Lin. ft. () inch Cast Iron Culvert Pipe, Heavy, Type () at _____ per lin. ft. (387)		
252(5)		Lin. ft. () inch Cast Iron Culvert Pipe, Extra Heavy, Type () at _____ per lin. ft. (387)		
252(6)		Lin. ft. () inch Cast Iron Culvert Pipe, Extra Heavy, Type () at _____ per lin. ft. (387)		
253(1)		Lin. ft. () inch Corrugated Galvanized Sheet Metal Culvert Pipe, at _____ per lin. ft. (394)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
253(2)		Lin. ft. () inch Corrugated Galvanized Sheet Metal Culvert Pipe, at..... .....per lin. ft.. (394)		
253(3)		Lin. ft. () inch Corrugated Galvanized Sheet Metal Culvert Pipe, at..... .....per lin. ft.. (394)		
254(1)		Lin. ft. () inch Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 1, at..... .....per lin. ft.. (400)		
254(2)		Lin. ft. () inch Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 1, at..... .....per lin. ft.. (400)		
254(3)		Lin. ft. () inch Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 1, at..... .....per lin. ft.. (400)		
255(1)		Lin. ft. () inch Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 2, at..... .....per lin. ft.. (403)		
255(2)		Lin. ft. () inch Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 2, at..... .....per lin. ft.. (403)		
255(3)		Lin. ft. () inch Bituminous Coated Corrugated Sheet Metal Culvert Pipe, Type 2, at..... .....per lin. ft.. (403)		
256(1)		Lin. ft. Remove, Clean and Stockpile Salvaged Culvert Pipe, at..... .....per lin. ft.. (404)		
256(2)		Lin. ft. Remove, Clean and Relay Salvaged Culvert Pipe, at..... .....per lin. ft.. (404)		
300(1)		Lin. ft. Untreated Timber Piling, at..... .....per lin. ft.. (414)		
300(2)		Lin. ft. Treated Timber Piling, at..... .....per lin. ft.. (414)		
300(3)		Lin. ft. Concrete Piling, at..... .....per lin. ft.. (414)		
300(4)		Lin. ft. Structural Steel Piling, at..... .....per lin. ft.. (414)		
300(5)		Lin. ft. Copper Bearing Structural Steel Piling, at..... .....per lin. ft.. (414)		
300(6)		Lin. ft. Timber Sheet Piling, at..... .....per lin. ft.. (414)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
300(7)		Lin. ft. Concrete Sheet Piling, at..... .....per lin. ft.. (414)		
300(8)		Lin. ft. Steel Sheet Piling, at..... .....per lin. ft.. (414)		
300(9)		Lin. ft. Test Piles, at..... .....per lin. ft.. (414)		
300(10)		Loading Tests of Piles, at..... .....each.. (414)		
300(11)		Pile Shoes, at..... .....each.. (414)		
310(1)		Cu. yds. Loose Riprap, at..... .....per cu. yd.. (415)		
311(1)		Cu. yds. Derrick-Placed Rock Retaining Wall, at..... .....per cu. yd.. (417)		
312(1)		Cu. yds. Hand Laid Rock Embankment, at..... .....per cu. yd.. (418)		
313(1)		Sq. ft. Concrete Cribbing, at..... .....per sq. ft.. (420)		
314(1)		Sq. ft. Metal Cribbing, at..... .....per sq. ft.. (422)		
315(1)		Sq. ft. Untreated Timber Cribbing, at..... .....per sq. ft.. (425)		
315(2)		Sq. ft. Treated Timber Cribbing, at..... .....per sq. ft.. (425)		
315(3)		Sq. ft. Log Cribbing, at..... .....per sq. ft.. (425)		
320(1)		Lin. ft. () inch Concrete Pipe Underdrain, at..... .....per lin. ft.. (428)		
320(2)		Lin. ft. () inch Concrete Pipe Underdrain, at..... .....per lin. ft.. (428)		
320(3)		Lin. ft. () inch Clay Pipe Underdrain, at..... .....per lin. ft.. (428)		
320(4)		Lin. ft. () inch Clay Pipe Underdrain, at..... .....per lin. ft.. (428)		
320(5)		Lin. ft. () inch Perforated Corrugated Galvanized Sheet Metal Pipe Underdrain, at..... .....per lin. ft.. (428)		
320(6)		Lin. ft. () inch Perforated Corrugated Galvanized Sheet Metal Pipe Underdrain, at..... .....per lin. ft.. (428)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
320(7)		Lin. ft. () inch Bituminous Coated Perforated Corrugated Galvanized Sheet Metal Pipe Underdrain, at..... per lin. ft. (428)		
320(8)		Lin. ft. () inch Bituminous Coated Perforated Corrugated Galvanized Sheet Metal Pipe Underdrain, at..... per lin. ft. (428)		
320(9)		Lin. ft. Blind Drain, at..... per lin. ft. (428)		
321(1)		Drop Inlets, () inch size, at..... each (431)		
321(2)		Drop Inlets, () inch size, at..... each (431)		
321(3)		Catch Basins, at..... each (431)		
321(4)		Reinforced Concrete Inlet Covers, at..... each (431)		
321(5)		Cast Iron Frames and Gratings, at..... per pair (431)		
322(1)		Embankment Spillway Inlet Assemblies, at..... each (434)		
323(1)		Sq. yds. Grouted Rubble Gutter, at..... per sq. yd. (436)		
324(1)		Lin. ft. Concrete Curb, () inch depth, at..... per lin. ft. (439)		
324(2)		Lin. ft. Concrete Curb, () inch depth, at..... per lin. ft. (439)		
324(3)		Lin. ft. Combination Concrete Curb and Gutter, at..... per lin. ft. (439)		
325(1)		Sq. yds. Bituminous Gutter, Grading (), at..... per sq. yd. (441)		
330(1)		Sq. yds. Concrete Sidewalk, at..... per sq. yd. (443)		
331(1)		Sq. yds. Brick Sidewalk, at..... per sq. yd. (446)		
332(1)		Sq. yds. Type F-1 Bituminous Sidewalk, Grading (), at..... per sq. yd. (448)		
332(2)		Sq. yds. Type H-1 Bituminous Sidewalk, at..... per sq. yd. (448)		

(Not to be filled in as actual bid for submission)

Item	Estimated quantity	Pay names, with unit bid price written in words (pay name defined on page shown in parenthesis)	Unit bid price	Amount bid
340(1)		Sq. yds. Membrane Waterproofing (), at..... per sq. yd. (452)		
340(2)		Sq. yds. Membrane Waterproofing () with Mortar Protection, at..... per sq. yd. (452)		
340(3)		Sq. yds. Membrane Waterproofing () with Asphalt Plank Protection, at..... per sq. yd. (452)		
341(1)		Sq. yds. Damp-proofing, at..... per sq. yd. (454)		
343(1)		Sq. yds. Mineral Surfaced Asphalt Plank, () inch thickness, at..... per sq. yd. (457)		
343(2)		Sq. yds. Mineral-Surfaced Asphalt Plank, () inch thickness, at..... per sq. yd. (457)		
344(1)		Lbs. Bronze Bearing Plates, at..... per lb. (458)		
346(1)		Sq. ft. Asbestos Board Blast Plates, at..... per sq. ft. (461)		
346(2)		Lbs. Asbestos Board Blast Plates, at..... per lb. (461)		
346(3)		Sq. ft. Wrought Iron Blast Plates, at..... per sq. ft. (461)		
346(4)		Lbs. Wrought Iron Blast Plates, at..... per lb. (461)		
360(1)		Right-of-Way Monuments, Type A, at..... each (462)		
360(2)		Right-of-Way Monuments, Type B, at..... each (462)		
361(1)		Concrete Maintenance Marker Posts, at..... each (463)		
362(1)		Timber Culvert Markers, at..... each (464)		
363(1)		Cattle Guards, at..... each (465)		
364(1)		Lin. ft. Barbed Wire Fence, at..... per lin. ft. (466)		
365(1)		Gates, at..... each (467)		
380(1)		Miles Traffic Stripe, at..... per mile (468)		
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