

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS

STANDARD
SPECIFICATIONS



Adopted October 20, 1937

GEO. H. BARN

In writing new specifications use something similar to following!

In making adjustments in contract prices the only overhead charges to

STATE OF NEVADA

DEPARTMENT OF HIGHWAYS

be considered shall be that assigned to and directly on job.

STANDARD SPECIFICATIONS



Adopted October 20, 1937

No. 15

CARSON CITY, NEVADA

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STATE OF NEVADA
DEPARTMENT OF HIGHWAYS

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PART I GENERAL REQUIREMENTS AND COVENANTS

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SECTION 1—DEFINITION OF TERMS

Whenever in these specifications, or in any documents or instruments in construction operations where these specifications govern, the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

- 1.33 ✓ **1.1 State.** The State of Nevada.
- 1.13 ✓ **1.2 Department.** The Department of Highways of the State of Nevada.
- 1.14 ✓ **1.3 Directors.** The Directors of the State Highway Department of Nevada as established by law, acting directly or through their authorized representatives.
- 1.15 ✓ **1.4 Engineer.** The State Highway Engineer of the State of Nevada, who is the executive officer of the Department of Highways, or an assistant or other representative duly authorized by the State Highway Engineer to act for him, such assistant or representative acting within the scope of the particular duties assigned him or of the authority given him.
- 1.19 ✓ **1.5 Inspector.** An authorized representative of the engineer assigned to make any or all inspections of the work performed and materials furnished by the contractor.
- 1.14 ✓ **1.6 Bidder.** Any qualified individual, firm or corporation submitting a proposal for the work contemplated, acting directly or through a duly authorized representative.
- 1.11 ✓ **1.7 Contractor.** The individual, firm or corporation undertaking the execution of the work under the terms of the contract, and acting directly or through a duly authorized representative.
- 1.36 ✓ **1.8 Superintendent.** The executive representative of the contractor, present on the work at all times during progress, authorized to receive and fulfill instructions from the

engineer and to accept orders for changed and extra work.

1.12 ✓ **1.9 Notice to Contractors.** The official notice included in the proposal inviting bids for the proposed work.

1.2 ✓ **1.10 Advertisement.** The official notice inviting bids for all proposed work included in any one letting.

1.25 ✓ **1.11 Proposal.** The approved prepared form on which the bidder has submitted in detail a statement of his offer to perform the work.

1.26 ✓ **1.12 Proposal Guaranty.** The required security submitted with the bid to insure the execution of contract and bond for the performance of the work if the bid is accepted.

1.9 ✓ **1.13 Contract.** The written agreement by the department and the contractor covering the performance of the work and the furnishing of labor and materials in the construction thereof. The contract shall include the notice to contractors, proposal, plans, specifications, special provisions, if any, performance bond, and supplemental documents, as hereinafter defined, *amending or extending the work contemplated.*

1.19 ✓ **1.14 Contract Amount.** The estimated contract cost computed on the basis of the proposal quantities and contract unit prices.

1.21 ✓ **1.15 Major Item.** Any contract item, the total cost of which is more than five percent of the contract amount.

1.23 ✓ **1.16 Performance Bond.** *approved* The security furnished by the contractor to guarantee the completion of the work in accordance with the terms of the contract.

1.39 ✓ **1.17 Surety.** The individual, firm, or corporation signing, as guarantor, the performance bond furnished by the contractor.

1.24 ✓ **1.18 Plans.** The approved official drawings of any and every kind, or reproductions thereof, that show the work to be done.

1.32 ✓ **1.19 Specifications.** The directions, provisions, and requirements contained herein, supplemented by any special provisions pertaining to the method and manner of performing the work, to quantities and qualities of materials to be furnished under the contract, and method of measurement and payment.
as provided herein kinds

✓ **1.20 Special Provisions.** Specifications and requirements pertaining to work proposed but not covered in these specifications.

1.18 ✓ **1.21 Change Order.** A written order by the engineer to the contractor making changes in the plans or specifications which do not involve ^{any} change in contract unit prices. If the change involves items for which there is no contract unit price, the order shall so state and stipulate that they shall be performed as extra work.

1.16 ✓ **1.22 Extra Work.** Work or material, the performance or furnishing of which is found necessary for the proper completion of the improvement, but which is not covered by any item of the bid schedule and for which no means of payment, direct or indirect, has been provided in the contract.

1.38 ✓ **1.23 Supplemental Agreement.** Written agreements executed by both parties to the contract to modify the contract to cover changes or changed conditions.

1.40 ✓ **1.24 The Work.** All the work specified and prescribed by the specifications, special provisions, plans, and contract.

1.17 ✓ **1.25 Highway.** The whole right of way which is reserved for use in constructing the roadway and its appurtenances.

1.28 ✓ **1.26 Roadway.** That portion of the highway included between the outside lines of gutters or side ditches, including also the structures and all slopes, ditches, channels, and waterways, appertaining to and necessary for proper drainage and protection.

✓ **1.27 Roadbed.** That portion of the roadway between the outside shoulder lines.

1.17 ✓ **1.28 Centerline.** The center of the roadway as laid out and staked by the engineer.

1.34 ✓ **1.29 Subgrade.** That portion of the roadbed upon which base course or wearing course is to be placed.

✓ **1.30 Shoulder.** That portion of the roadway between the edges of the wearing course and top edges of embankments or inside ditch slopes.

1.15 ✓ **1.31 Bridges.** Single or multiple span structures whose total span, is greater than 20 feet measured in a horizontal

plane along the center line of roadway between inside faces of end supports under the bridge seat or copings, *is greater than 20 feet*

1.35 ✓ **1.32 Substructure.** All of that part of the structure below the bridge seats or below the spring line of arches. Parapets and backwalls or abutments, and wing walls shall be considered as parts of the substructure.

1.37 ✓ **1.33 Superstructure.** All of that part of the structure above the bridge seats or above the spring line of arches.

~~**1.34 Bridge Complete.** The entire structure, including both substructure and superstructure.~~

1.37 ✓ **1.35 Culvert.** Structures of spans less than the minimum spans defined for bridges.

1.38 ✓ **1.36 Laboratory.** The laboratory of the department or other laboratory designated by the engineer.

1.36 ✓ **1.37 Calendar Day.** Any day shown on the calendar.

1.41 ✓ **1.38 Working Day.** Any calendar day, except as noted below, on which weather or ground conditions do not prevent utilization of at least 50 percent of the usual daily man-hours during regular working hours. Sundays and holidays shall be considered as working days only when the contractor performs work other than is necessary for the protection of the work and traffic.

1.41 ✓ **1.39 Holiday.** In the State of Nevada, these occur on:

January 1—New Year's Day

February 12—Lincoln's Birthday

February 22—Washington's Birthday

May 30—Memorial Day

July 4—Independence Day

First Monday of September—Labor Day

October 12—Columbus Day

October 31—Admission Day

November 11—Armistice Day

Last Thursday in November—Thanksgiving Day

December 25—Christmas Day

Or on a day on which the primary election is held throughout the State; or on a day on which a general or special State election is held; or on any day that may be appointed by the President of the United States or by

the Governor of Nevada for public fast, thanksgiving, or holiday.

If any holiday listed above falls upon a Sunday, the following Monday shall be considered a holiday.

- 1.3 ✓ ~~1.40~~ **A. S. T. M.** American Society for Testing Materials.
1.1 ✓ ~~1.41~~ **A. A. S. H. O.** American Association of State Highway Officials.

SECTION 2—PROPOSAL REQUIREMENTS AND CONDITIONS

2.1 Plans and Proposal Forms. Qualified prospective bidders will be furnished with proposal forms which will give the location and description of the work contemplated, state the time within which the work shall be completed, the amount of the proposal guaranty, the date, time and place of opening proposals, and contain the schedule of items for which unit bid prices are asked, including the estimated quantities of work to be performed and materials to be furnished. All special provisions will be grouped together and attached to the proposal forms. All documents attached to the proposal shall be considered a part thereof and shall not be detached or altered.

Plans and proposal form (including special provisions) for individual projects may be obtained by qualified bidders. Request for plans and proposal form shall be made on the form furnished by the department and shall be accompanied by a deposit of \$10. A refund of \$5 will be made if the plans are returned in good condition within 15 days after opening of bids.

Plans and special provisions for individual projects may be obtained for inspection purposes by interested nonbidding concerns upon receipt of \$5. Requests for such plans need not be made on the standard form. Plans and specifications obtained on this basis are nonreturnable and no refund will be made.

2.2 Interpretation of Estimate. The quantities listed in the proposal are to be considered as approximate and as prepared are for the comparison of bids. Payment to the contractor shall be made for actual quantities of work performed or materials furnished in accordance with the contract, and it is understood that the quantities of work to be done and materials to be furnished may each be increased or decreased as hereinafter stipulated.

2.3 Examination of Plans, Specifications, Special Provisions and Site of work. The bidder shall examine carefully the site of, and the proposal, plans, specifications, and contract forms for the work contemplated. It will be assumed that the bidder has investigated and is satisfied

as to the conditions to be encountered; as to the character, quality, and quantities of work to be performed and materials to be furnished; and as to the requirements of these specifications, special provisions, and contract. It is mutually agreed that submission of a proposal shall be considered prima-facie evidence that the bidder has made such examination.

Information pertaining to exploration, borings, test pits, and other preliminary investigation may appear on the plans or in the special provisions. While such data will have been collected with reasonable care, there is no expressed or implied guaranty that conditions so indicated are exact or entirely representative of those actually existing. The bidder shall put his own interpretation on results of such investigations and satisfy himself as to the conditions to be encountered.

2.4 Preparation of Proposal. The bidder's proposal shall be submitted on the proposal form furnished by the department. The blank spaces in the proposal shall be filled in correctly, where indicated, for each and every item for which a quantity is given, and the bidder shall state the prices, written in ink, both in words and numerals for which it is proposed to do each item of the work contemplated. The bidder shall sign the proposal correctly. In case of discrepancy between the prices shown in words and in numerals, the price shown in words shall prevail.

2.5 Rejection of Proposals Containing Alterations or Irregularities. Proposals may be rejected if they contain alterations, additions not called for, conditional or alternate bids unless called for, incomplete bids, or irregularities of any kind. Proposals in which the prices obviously are unbalanced may be rejected.

2.6 Proposal Guaranty. No proposal shall be considered unless accompanied by cash or by a certified check or cashier's check, made payable to the department, in an amount equal to not less than five percent of the total amount of the bid.

2.7 Delivery of Proposals. Each proposal shall be placed, together with the proposal guaranty, in a sealed envelope so marked as to indicate the identity of the project and the name and address of the bidder. Proposals

must be received prior to the hour and date set for the opening thereof, and shall be by that time in the hands of the official indicated in the notice to contractors.

2.8 Withdrawal of Proposals. A bidder may withdraw his proposal, provided the request in writing is in the hands of the official indicated in the notice to contractors by the time set for opening proposals. When such proposal is reached, it shall be returned to the bidder unopened.

2.9 Public Opening of Proposals. Proposals shall be opened and read publicly at the time and place indicated in the notice to contractors. Bidders or their authorized agents are invited to be present.

2.10 Disqualification of Bidders. More than one proposal from an individual, a firm or partnership, a corporation or an association under the same or different names will not be considered. Reasonable ground for believing that any bidder is interested in more than one proposal for the work contemplated shall cause the rejection of all proposals in which such bidder is interested. If there is reason for believing that collusion exists among the bidders, bids of all of the participants in such collusion shall be rejected, and such participants may be disqualified from bidding on future work.

2.11 Competency of Bidders. All bidders shall be pre-qualified as required by law. Plans and proposal shall be issued only to prospective bidders on the qualified list. To be qualified, a prospective bidder shall submit, under oath, on the standard form furnished by the department, a statement of his financial ability and experience in performing public work. Financial statements shall be prepared and certified by a certified public accountant. After verifying the information contained in the statement, the department shall notify the submitter of the maximum contract amount and class of work upon which he will be eligible to bid.

Statements of financial ability and experience shall be submitted as of the date upon which the fiscal year of the prospective bidder ends. In order to remain on the qualified list, a prospective bidder shall submit a new statement at the close of his fiscal year. A prospective bidder, not

already qualified, shall submit his statement of financial ability and experience at least five full days prior to the date set for opening of bids in which he is interested in order to have it considered, but qualification shall not be granted until such statement has been verified. Statements shall preferably be submitted at least 30 days prior to bid opening.

Nothing contained in this section shall be construed as depriving the department of its discretion in the matter of determining the lowest responsible bidder.

2.12 Material Guaranty. Before any contract is awarded, the bidder may be required to furnish a complete statement of the origin, composition and manufacture of any or all materials to be used in the construction of the work, together with samples, which samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

2.13 Qualification of Bids. A bidder who desires to bid upon more than one project at a single letting, but who desires to protect himself against receiving the award of more projects than he is equipped to handle, may bid upon any number of projects, securing the protection desired by making the following written statement signed by the bidder and attached to the proposal form for each of the projects:

"This bid is conditioned upon my (or our) receiving the award of contract for only one of the projects for which I (or we) have submitted bids at this letting. If the contract for any other project is awarded to me (or us), then this bid shall be considered withdrawn."

In case a bidder who has conditioned his bids, as above provided, is low bidder on more than one project, it shall be optional with the department as to which one of the projects is awarded him.

SECTION 3—AWARD AND EXECUTION OF CONTRACT

3.1 Consideration of Proposals. After the proposals are opened and read, the total amount of each shall be obtained from unit bid prices and approximate quantities, and these totals shall be immediately made public. Until the final award of the contract, however, the right is reserved to reject any and all proposals and to waive technical errors, as may be deemed best for the interests of the State.

3.2 Award of Contract. The award of the contract, if it be awarded, shall be to the lowest responsible bidder whose proposal complies with all the requirements prescribed. The award, if made, shall be made within 30 days after the opening of the proposals.

3.3 Return of Proposal Guaranties. All proposal guaranties shall be returned immediately following the determination of the bid amounts, except those of the two lowest bidders. These guaranties shall be returned immediately after a satisfactory performance bond has been furnished and the contract has been executed.

3.4 Requirement of Performance Bond. The bidder to whom the contract is awarded shall file, as a guaranty that he will complete the work in accordance with the terms of the contract, a good and sufficient bond in an amount not less than the contract amount. Such bond shall also provide and secure payment for all materials, labor, provender and supplies, teams, trucks, and other means of transportation, used in, or upon, or about, or for the performance of the work contracted to be done, and for any work or labor done thereupon or incidental thereto. This bond shall be on the form provided by the department and shall be written by a surety approved by the Insurance Commissioner of the State of Nevada. A power of attorney for an attorney in fact who executes bonds shall be registered with, and approved by, the Insurance Commissioner of the State of Nevada. The power of attorney shall show the limiting amount authorized for issuance of bonds. Written appointment of agent of bonding company in and for the State of Nevada shall also be registered with, and approved by, the insurance commissioner.

3.5 Execution of Contract. The contract shall be signed by the successful bidder and returned, together with the performance bond, within 15 calendar days after the bidder has received notice that the contract has been awarded. No proposal shall be considered binding upon the department until the execution of the contract.

3.6 Failure to Execute Contract. Failure to execute a contract and file an acceptable bond, as provided herein, within 15 calendar days from date of receipt of notice of award shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty to the department; not as a penalty, but as liquidated damages. Award may then be made to the next lowest responsible bidder, or the work may be readvertised and constructed under contract, or it may be performed otherwise as the engineer may decide.

SECTION 4—SCOPE OF WORK

4.1 Intent of Plans and Specifications. The intent is to prescribe a complete work of improvement which the contractor undertakes to do, in full compliance with the plans, these specifications, the special provisions, proposal, and contract. The contractor shall perform all items of work covered and stipulated in the proposal and perform changed and extra work, all in accordance with the lines, grades, typical cross sections, and dimensions shown on the plans, and shall furnish, unless otherwise provided in the special provisions or in the contract, all materials, implements, machinery, equipment, tools, supplies, transportation, and labor necessary to the prosecution and completion of the work.

4.2 Special Work. Proposed construction or requirements not covered by these specifications shall be covered by special provisions, and such construction or requirements shall be performed or complied with by the contractor as herein provided.

4.3 Changed Conditions. Should the contractor encounter, during the progress of the work, latent conditions of an unusual nature, differing materially from those indicated on the plans or in the specifications, or latent conditions differing materially from those ordinarily encountered and generally recognized as inhering in work of the character provided for in the plans and specifications, the contractor shall immediately notify the engineer thereof in writing. The engineer shall thereupon promptly investigate, and if he finds they do so materially differ, an equitable adjustment of the contract shall be made by means of a supplemental agreement. Claim for adjustment shall not be valid unless made in writing within 10 days after such latent conditions are encountered.

4.4 Changes in Plans and Specifications. The engineer reserves the right to make, by written order and without notice to surety, changes in the plans and specifications within the general scope of the contract.

The work as changed shall be performed by the contractor at contract unit prices, except when a change involves:

(a) work materially different from the original; (b) an increase or decrease of more than 25 percent of the contract amount; (c) an increase or decrease of more than 25 percent in the quantity of any major item, except items of overhaul, structure excavation, piling, concrete seal courses, water, and such other items as may be specifically excluded in the special provisions, or an increase or decrease in any minor item not excluded above of more than one and one-quarter percent of the contract amount.

Changes as indicated above under (a), (b), and (c) shall be made by means of a supplemental agreement, and if justified, both contract unit prices and contract time of performance may be adjusted. Adjustment of contract unit prices, if made, shall be based upon estimated change in unit cost of performance. Work shall not be started until the supplemental agreement has been signed by both parties.

Changes not requiring negotiated agreements, except as to extra work involved, shall be ordered by means of a change order, and acceptance by the contractor, as evidenced by his signature, shall constitute agreement that the change does not involve any adjustment of contract unit prices. Should the nature of the change order be such that the adjustment of contract time for completion as provided in Article 8.6 for increased quantities of work is not equitable, the engineer shall determine the additional time to be allowed, and such time shall be stated on the order. Work shall not be started on any such change until the change order has been delivered to the contractor and accepted by him.

In case the contractor refuses to accept a change order because he considers the change to involve an adjustment of prices, or agreement cannot be reached in regard to price adjustment for a supplemental agreement, the engineer may order the work to proceed and defer settlement of the disputed points.

4.5 Changes in Limits of Work. Changes in the limits of the work may be made, without notice to surety, provided the aggregate of such changes is not more than 25 percent of the contract amount. A supplemental agreement shall be prepared to cover such changes, and the work

shall not be started until the supplemental agreement has been signed by both parties to the contract.

4.6 Increased or Decreased Quantities of Work. In order to meet conditions encountered at the site, the engineer shall make minor adjustments of alignment, grade, earthwork slopes, and structure layouts, and such adjustments shall not be considered as changes in the plans as contemplated under Article 4.4. For this and other reasons, including unpredictable variations in earthwork shrinkage and slides, the exact final quantities cannot be determined at the time of advertising the work and, within the limits specified below, overruns and underruns from the quantities in the proposal shall be considered as normal and expected. The contractor shall perform such increased or decreased quantities without any adjustment of contract unit prices.

A supplemental agreement shall be required under the following conditions:

(a) If the actual quantities of all items show an overrun or underrun resulting in a change of 25 percent or more in the total cost of the work as compared with the contract amount.

(b) If the actual final quantity of any major item, except overhaul, foundation excavation, piling, water, and such other items as may be specifically excluded in the special provisions, overruns or underruns more than 25 percent.

When justifiable, an adjustment shall be made in the contract unit prices when a supplemental agreement is required as prescribed in (a) and (b), provided that such adjustment shall be based upon estimated increased or decreased unit cost of performance.

4.7 Extra Work. Extra work shall be performed by the contractor, upon receipt of a written order to perform such work, in accordance with the specifications and as directed. Such order shall be on the standard extra work order form and shall state the work to be done, the method of payment, and the estimated total cost. The method of payment may be agreed unit prices, force account, or a combination of the two. Agreed unit prices together with the estimated quantities of each unit shall be shown.

Orders involving force account work shall be detailed as required in Article 4.8.

Should the nature of the extra work be such that the adjustment of contract time for completion as provided in Article 8.6 for increased quantities of work is not equitable, the engineer shall determine the additional time to be allowed, and such time shall be stated on the order.

If it is found necessary during the progress of the work to exceed the total estimated cost by more than 15 percent, or to use equipment, materials, or items not listed in the order, a supplemental order shall be issued before such additional cost is incurred or such additional equipment or materials are used.

Acceptance of the order by the contractor, as evidenced by his signature, shall constitute his agreement to unit prices or rental rates indicated on the order as agreed prices or rates.

4.8 Force Account Work. When the proposal includes an item or items to be done by force account, or when a supplemental agreement or change order provides for doing certain work by force account, such work shall be performed upon receipt of a written order issued by the engineer. The order shall include the following details:

- (a) Statement of work to be done.
- (b) Estimated number of hours and estimated hourly wage for each class of labor.
- (c) Estimated number of hours and agreed rental rate for all equipment and teams.
- (d) Amount and estimated cost of all materials.
- (e) Estimated total cost.

In case rental rates cannot be agreed upon, the engineer may so indicate on the order and use for estimate purposes what he considers a fair price, deferring for future settlement the final rates to be used.

If it is found necessary during the progress of the work to exceed the total estimated cost by more than 15 percent, or to use equipment, materials, or items not listed in the order, a supplemental order shall be issued before such additional cost is incurred or such additional equipment or materials are used.

Acceptance of the order by the contractor, as evidenced by his signature, shall constitute his agreement to unit prices or rental rates indicated on the order as agreed prices or rates.

The plan of work to be followed, the equipment to be used, and the amount and class of labor to be employed shall be determined by the engineer.

4.9 Accommodations for Public Traffic. Unless otherwise provided in the special provisions, all expense of construction and maintenance for the accommodation of traffic shall be the obligation of the contractor without direct compensation. The road undergoing improvement shall be kept continuously open to public traffic and the United States mails. All trails, roads, and highways intersecting it shall be kept open and passable; temporary approaches and crossings shall be provided and maintained in safe condition. In lieu of maintaining traffic along the improvement, the contractor may, subject to the approval of the engineer, by-pass the traffic over detours constructed and maintained at his own expense.

When required by the special provisions, the contractor shall construct and maintain special detours, as located by the engineer, including any temporary bridges and accessory structures. The construction and maintenance of such detours shall be paid for as shown in the special provisions.

4.10 Rights in and Use of Materials Found in the Work. The contractor, with the approval of the engineer, may use on the proposed construction suitable stone, gravel, or sand found in the excavation, and will be paid for the excavation of such materials at the corresponding contract unit price therefor, but he shall replace at his own expense with other acceptable material all that portion of the materials so removed and used as was contemplated for use in the embankments, backfills, approaches, or otherwise. 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 material from within the highway right of way which is not within the excavation as indicated by the slope and grade lines, without written authorization from the engineer.

4.11. Final Cleaning Up. Before final acceptance, the contractor shall remove or obliterate, insofar as feasible, all objects or disturbances of the ground which mar the landscape and were caused by his operations, but which are not part of the improvement. This shall be required on all areas used or occupied by the contractor, regardless of right of way limits.

Rubbish, excess material, temporary structures, and discarded equipment shall be collected and burned, buried, or otherwise disposed of as directed by the engineer. Pits or trenches for equipment set-ups or camp sites shall be filled and the ground restored, insofar as feasible, to its original condition. Temporary haul roads shall be scarified and bladed to blend with surroundings. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground. Waste shall be removed from the tops of banks and placed in the bottom of the pit. Except on steep sidehills, the banks of pits shall be cut to not steeper than one on one slopes and trimmed reasonably smooth. On steep sidehills the banks shall be sloped to blend with the natural contours. Bottoms of pits shall be reasonably smooth and level. All other disturbances shall be removed or corrected as directed by the engineer.

SECTION 5—CONTROL OF THE WORK

5.1 Authority of Engineer. The engineer shall decide any and all questions which may arise as to the quality or acceptability of materials furnished and work performed; as to the manner of performance and rate of progress of the work; as to the interpretation of the plans and specifications; as to the acceptable fulfillment of the contract on the part of the contractor; as to compensation; and as to mutual rights between contractors. In case the contractor fails or refuses to carry out orders of the engineer within a reasonable time after receipt of such orders, the engineer shall have the right to perform such work as may be necessary to correct unsatisfactory conditions, and to deduct the cost of such work from sums due or to become due under the contract. Decisions of the engineer shall be subject to appeal to the board of directors, whose decisions shall be final and conclusive. Such appeal shall be in writing and shall be made within 10 days, but in the meantime the contractor shall diligently proceed with the work.

5.2 Plans and Working Drawings. The approved plans shall be supplemented by such working drawings as are necessary to adequately control the work. All authorized alterations affecting the requirements and information given on the approved plans shall be in writing. No changes shall be made of any plan or drawing after it has been approved by the engineer, except by direction of the engineer.

Working drawings for any structure shall consist of such detailed plans as may be required for the prosecution of the work and are not included in the plans furnished by the engineer. They shall include shop details, erection plans, masonry layout diagrams, and bending diagrams for reinforcing steel, approval of which by the engineer shall be obtained before any work involving these plans is performed. Plans for cribs, cofferdams, falsework, centering, form work and other items may also be required, and shall likewise be subject to approval by the engineer. Approval of working drawings of any kind by the engineer shall not operate to relieve the contractor of any of his

responsibility under the contract for the successful completion of the improvement, nor for the accuracy of dimensions, details and quantities, or agreement of dimensions and details.

The contract price shall include the cost of furnishing all working drawings.

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

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

Should it appear that the work to be done, or any of the matters relative thereto, is not sufficiently detailed or explained on the plans or in the specifications or special provisions, the contractor shall make written application to the engineer for such further explanations as may be necessary, and shall conform to the explanations given as part of the contract.

5.5 Cooperation of Contractor. The contractor shall be supplied with copies of the plans, specifications, and special provisions, and shall have available on the work at all times at least one copy each of these plans, specifications, and special provisions. He shall give the work the constant attention necessary to facilitate the progress thereof,

and shall cooperate with the engineer and with other contractors in every way possible. In case of a dispute arising between two or more contractors engaged on the same work, as to the respective rights of each under these specifications, the engineer shall determine the matters at issue and shall define the respective rights of the various interests involved, and his decision shall not in any way be a cause for claims for extra compensation by any of the parties.

The contractor shall at all times have a competent superintendent satisfactory to the engineer as his agent on the work. The superintendent shall have full authority to execute orders or directions of the engineer without delay, and to promptly supply such materials, tools, plant equipment and labor as may be required. Such superintendent shall be furnished irrespective of the amount of work sublet.

5.6 Construction Stakes. The engineer shall furnish and set construction stakes establishing lines and grades in road work, roadway and waterway center lines, and bench marks for bridge work, and shall furnish the contractor with all necessary information relating to lines and grades. In case of bridges, if requested by the contractor, the engineer shall furnish stakes determining the center lines of all piers, pedestals or abutments, together with stakes determining the angles of the wings or retaining walls. The contractor shall furnish, free of charge, all additional stakes, all templets, and other materials necessary for marking and maintaining points and lines given. The contractor shall construct the work in accordance with the engineer's stakes and marks, making use of them before they are disturbed, and shall be charged with full responsibility for conformity and agreement of the work with such stakes and marks. The contractor shall be held responsible for the preservation of all stakes and marks and if, in the opinion of the engineer, any of the stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing them shall be charged against, and shall be deducted from, the payment for the work.

5.7 Authority and Duties of Inspectors. Inspectors, employed by the department, shall be authorized to inspect

all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector shall not be authorized to revoke, alter, or waive any requirement of the specifications. He shall be authorized to call the attention of the contractor to any failure of the work or materials to conform to the specifications and contract, and shall have the authority to reject materials or suspend the work until any questions at issue can be referred to and decided by the engineer.

5.8 Inspection. The contractor shall furnish the engineer with every reasonable facility for ascertaining at any time whether or not the work performed and materials used are in accordance with the requirements and intent of the plans, specifications, and contract. If the engineer so requests, the contractor shall, at any time before final acceptance of the work, remove or uncover such portions of the finished work as may be directed. After examination, the contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed shall be paid for as extra work, but should the work so exposed or examined prove unacceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed shall be at the contractor's expense. No work shall be done nor materials used without suitable inspection by the engineer or his representative. Any work done or materials used without suitable inspection may, at the option of the engineer, be ordered removed and replaced at the contractor's expense. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, or obligate the department to make final acceptance.

5.9 Removal of Defective and Unauthorized Work. All work which has been rejected shall be remedied, or removed and replaced, in an acceptable manner by the contractor, at his own expense, and no compensation shall be allowed him for such removal or replacement. Any work done beyond the lines and grades shown on the plans or as given,

except as herein provided, or any extra work done without written authority, shall be considered as unauthorized and at the expense of the contractor, and shall not be measured or paid for. Work so done may be ordered removed at the contractor's expense. Upon failure on the part of the contractor to comply forthwith with any order of the engineer made under the provisions of this article, the engineer shall have authority to cause defective work to be remedied, or removed and replaced, and unauthorized work to be removed, and to deduct the costs from any moneys due or to become due the contractor.

5.10 Final Inspection. Whenever the work provided and contemplated by the contract shall have been satisfactorily completed, the engineer shall, within 10 days after receiving notice of completion, unless otherwise provided, make the final inspection.

If the work is not acceptable to the engineer at the time of such inspection, he shall advise the contractor in writing as to the particular defects to be remedied before final acceptance.

If within a period of 10 calendar days after such notice of nonacceptability has been given, the contractor has not taken steps to complete the work speedily as outlined by the engineer, the engineer may without further notice and without in any way impairing the contract, make such other arrangements as he may deem necessary to have the work completed in a satisfactory manner. The cost of so completing the work shall be deducted from any moneys due or which may become due the contractor under the contract.

SECTION 6—CONTROL OF MATERIAL

6.1 Source of Supply and Quality of Materials. The source of supply of each of the materials shall be approved by the engineer before delivery is started. Representative preliminary samples of the character and quantity prescribed shall be submitted by the contractor or producer for examination and tested in accordance with the methods referred to under Article 6.3. Only materials conforming to the requirements of these specifications and approved by the engineer shall be used in the work. If, after trial, it is found that sources of supply which have been approved do not furnish a uniform product, or if the product from any source proves unacceptable at any time, the contractor shall furnish approved material from other approved sources. No material which, after approval, has in any way become unfit for use shall be used in the work.

6.2 Local Materials. Possible sources of local materials may be designated in the special provisions and the grading analyses of samples shown. The quality of material in such deposits will be acceptable, but the contractor shall determine for himself the amount of equipment and work required to secure a finished product meeting the specifications, and whether blending with other local materials will be necessary. It shall be understood that it is not feasible to ascertain from samples an average grading analysis for the entire deposit, and that wide variations from the grading shown shall be considered as usual and to be expected.

The contractor shall furnish rights of way for hauling and shall pay all royalties necessary to acquire the material. When material deposits are not designated in the special provisions, the contractor shall provide sources of material acceptable to the engineer.

In case a designated deposit fails to contain the quantity of acceptable material indicated in the special provisions, the contractor shall immediately notify the engineer in writing. The engineer shall thereupon investigate, and if his investigation shows that there is not a sufficient quantity of acceptable material, he shall designate an alternate deposit from which to obtain the deficit. In such case an

adjustment of compensation shall be made as provided in Article 9.6. If, however, the contractor elects to use a deposit other than the alternate designated, the adjustment shall be made as if the alternate deposit was used.

The contractor may obtain material from deposits other than those designated, provided such material conforms to the specifications, will not result in any increase in the cost of the work or future work, and will not impair the appearance of the roadside more than if material were taken from the designated deposit. Generally, deposits located within 500 feet of the center line will not be approved. The engineer assumes no responsibility for the quantity of acceptable material in such deposits.

6.3 Samples and Tests. The engineer may require any or all materials to be subject to tests by means of samples or otherwise, as he may determine. The contractor shall afford such facilities as the engineer may require for collecting and forwarding samples and shall not make use of, or incorporate in the work, any material represented by the samples until all required tests have been made and the material accepted. The contractor in all cases shall furnish the required samples without charge. In the case of bituminous concrete pavement of any kind, the contractor shall furnish for tests, when required, samples cut from the completed work. The areas of pavement so removed shall be replaced with new mixture and refinished. No additional compensation shall be allowed for furnishing test samples and replacing the areas with new pavement.

Tests of materials shall be made by the engineer in accordance with commonly recognized standards of national organizations and such special methods and tests as are in use in the department laboratory. Wherever reference is made in these specifications to standard tests or requirements of the laboratory of the Department of Highways, the American Association of State Highway Officials, or the American Society for Testing Materials, the reference shall be construed to mean the standards that are in effect at the date of these specifications with subsequent amendments, changes, or additions as adopted by the organizations to the date of the contract.

6.4 Storage of Materials. Materials shall be stored so

as to insure the preservation of their quality and fitness for the work. Stored materials shall be located so as to facilitate prompt inspection. That portion of the right of way not required for public travel may be used for storage purposes, and for the placing of the contractor's plant and equipment, only to the extent that vegetation will not be destroyed nor the landscape marred. Any additional space required shall be provided by the contractor at his expense. Materials shall not be stored upon the highway except and as permitted by the engineer.

6.5 Defective Materials. All materials not conforming to these specifications shall be considered defective, and all such materials, whether in place or not, shall be rejected and shall be removed immediately from the work by the contractor at his expense, unless otherwise ordered by the engineer. 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 under the provisions of this article, the engineer shall have authority to remove and replace the defective material and to deduct the cost of removal and replacement from any moneys due or to become due the contractor.

SECTION 7—LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

7.1 Laws To Be Observed. The contractor shall keep himself fully informed of, and at all times shall observe and comply with, all Federal and State laws and local by-laws, workmen's compensation laws, ordinances, and regulations in any manner affecting the conduct of the work, and shall indemnify and save harmless the State and its representatives against any claim arising from the violations of any such law, bylaw, ordinance, or regulation, whether by the contractor himself or the contractor's employees.

7.2 Permits and Licenses. The contractor shall procure at his own expense all permits, licenses, insurance policies, etc., as may be necessary to comply with Federal, State, or local laws in the performance of the work. The contractor shall be required to procure private carrier licenses from the Public Service Commission of Nevada for all supply trucks operated on the public highways of the State outside the confines of this contract. All vehicles operated by the contractor, or his subcontractor or employees, in connection with the contract shall be registered in accordance with the Nevada registration act.

7.3 Patented Devices, Materials and Processes. It is mutually understood and agreed that, without exception, contract prices are to include all royalties and costs arising from patents, trade marks, and copyrights in any way involved in the work. It is the intent that whenever the contractor is required or desires to use any design, device, material, or process covered by letters patent or copyright, the right for such use shall be provided for by suitable legal agreement with the patentee or owner, and a copy of this agreement shall be filed with the engineer; however, whether or not such agreement is made or filed, the contractor and the surety in all cases shall indemnify and save the department harmless from any and all claims for infringement by reason of the use of any such patented design, device, material, or process, and shall indemnify the department for any costs, expenses, and damages which

it may be obliged to pay, by reason of any such infringement, at any time during the prosecution or after the completion of the work.

7.4 Federal Participation. The attention of the contractor is directed to the provisions of the Federal Highway Act of November 9, 1921 (42 U. S. Statutes at Large, page 212), as modified and extended, under which the United States shall aid the States in the construction of highways. When the United States Government is to pay any portion of the cost of the improvement, the above Act of Congress provides that the construction work and labor in each State shall be done in accordance with its laws and under the direct supervision of the department, subject to the inspection and approval of the Secretary of Agriculture in accordance with the rules and regulations made pursuant thereto. The construction work, therefore, will be subject to such inspection by the United States Secretary of Agriculture or his agents as may be necessary to meet the above requirements, but such inspection will in no sense make the Federal Government a party to this contract, and will in no way interfere with the rights of either party hereunder, nor will it subject the contractor to compliance with the Federal laws relative to labor, etc., on Government contracts, except where and as set out in the special provisions.

7.5 Restoration of Surfaces Opened by Permit. Upon the presentation of a duly authorized and satisfactory permit which provides that all necessary repair work will be paid for by the party to whom such permit is issued, the engineer may authorize the contractor to allow parties bearing such permits to make openings in the highway.

The contractor shall, when ordered by the engineer in writing, make in an acceptable manner all necessary repairs due to such openings, and such necessary work ordered by the engineer shall be paid for as extra work.

7.6 Sanitary Provisions. The contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the Nevada State Department of Health or of other authorities having jurisdiction.

7.7 Public Convenience and Safety. The contractor shall be responsible for safely maintaining traffic over, through, or around the work included in his contract with the maximum practicable convenience to such traffic, whether or not work has ceased temporarily. If the contractor constructs temporary bridges or provides temporary stream crossings, his responsibility for accidents shall include the roadway approaches as well as the structures of such crossings. The work shall be planned and carried on so as to reduce obstruction to the traveling public to the minimum. No road shall be closed to the public by the contractor except by express permission of the engineer. When the road under construction is being used by the traveling public, especial attention shall be paid to keeping the traveled way in such condition that the public can travel over it in comfort and safety. When so provided in the special provisions, structures, base courses, or pavements shall be constructed part at a time, with such lane or lanes maintained open to the public as required by the special provisions. The contractor shall at all times during the progress of the work, or temporary suspension of the work, provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals, and signs, provide a sufficient number of flagmen, and take all necessary precautions for the protection of the work and safety of the public, and those engaged on the work. Highways closed to traffic shall be protected by effective barricades. Signs and barricades shall conform to the standards shown on the plans or approved by the engineer. All barricades and obstructions shall be illuminated at night with reflector signs and lights, and all lights for this purpose shall be kept burning from sunset to sunrise.

When traffic lanes are in any way restricted and it becomes necessary in the interest of safety to either the traveling public or the work to materially restrict the rate of speed of traffic, the contractor shall provide sufficient flagmen to slow down or bring to a stop all traffic prior to entering the danger zone. A pilot car and driver, in addition to flagmen, shall be provided by the contractor to conduct traffic through the danger zone when operations restrict traffic to movement in one direction at a time.

The contractor's responsibility for the maintenance of barricades, lights, and signs on the work or on individual sections of the work shall cease only upon final acceptance of the contract or upon acceptance of individual sections as provided in Article 7.11.

No direct payment shall be made for this work unless otherwise provided in the special provisions.

7.8 Use of Explosives. When the use of explosives is necessary for the prosecution of the work, the contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner, in compliance with local laws and ordinances, and all such storage places shall be marked clearly "Dangerous—Explosives."

7.9 Preservation and Restoration of Property and Landscape. The contractor shall be responsible for the preservation of all public and private property, trees, vegetation, monuments, etc., along and adjacent to the roadway; shall use every precaution necessary to prevent damage or injury thereto; shall use suitable precaution necessary to prevent damage to pipes, conduits, and other underground structures and shall protect carefully from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location, and shall not remove them until directed. The contractor shall not injure or destroy trees or shrubs nor remove or cut them without proper authority. Insofar as feasible, the contractor shall confine his travel and other operations to the area within the limits of construction and not disturb the ground outside construction stakes. 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 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 an acceptable manner. If the contractor fails to carry out the provisions of this article the engineer shall have the right to have them carried out

and deduct the cost from any moneys due or to become due the contractor.

7.10 Responsibility for Claims. The contractor and surety shall save harmless the department 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 contractor or his agents.

The contractor guarantees the payment of all just claims for material, supplies, labor, and other just claims against him, or any subcontractor, in connection with this contract.

The contractor, under these specifications, shall carry liability insurance to indemnify the public for injuries sustained by reason of the carrying on of his work.

7.11 Acceptance of Section of Highway for Maintenance.

At the option of the engineer, certain sections of the work may be accepted for maintenance. In such cases, the sections shall be inspected, completed work tentatively accepted in writing at the discretion of the engineer, the maintenance of barriers, signs, and lights on the section discontinued, and the road opened to traffic and turned over to the department for maintenance. Such action shall not in any way be construed as a final acceptance of the road.

The contractor shall not be held responsible for damages to portions of the road which have been approved by the engineer and accepted for maintenance prior to final approval and acceptance of the road, provided such damages are due to actions of the elements or to the ordinary action of traffic. The contractor shall be responsible for any damages occasioned by defective work, his own operations, or because of noncompliance with the plans, specifications, and contract.

7.12 Contractor's Responsibility for Work. Except as provided above, 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

necessary precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from faulty materials or work or from the execution or 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 its completion and acceptance, and shall bear the expense thereof, except damage 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 the public enemy, acts of the State or Federal Government, slides found by the engineer to have been unavoidable, and ordinary wear and tear on any section of the road accepted for maintenance.

An act of God is construed to mean an earthquake, flood, cloudburst, cyclone, or other cataclysmic phenomenon of nature beyond the power of the contractor to foresee or to make preparation in defense of. A rain, windstorm, or other natural phenomenon of normal intensity for the particular locality and for the particular season of the year in which the work is being prosecuted shall not be construed as an "act of God" and no reparation to the contractor shall be made for damages to the work resulting therefrom. The engineer shall be the sole judge as to whether a particular natural phenomenon shall be classed as an "act of God" or as a normal occurrence.

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 temporary structures where necessary.

7.13 Personal Liability of Public Officials. In carrying out any of the above provisions or in exercising any power or authority granted to him by this contract, there shall be no liability upon the engineer or his authorized assistants, either personally or as officials of the State, it being understood that in such matters they act as the agents and representatives of the State.

7.14 No Waiver of Legal Rights. The department 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, or from showing that any such measurement, estimate, or certificate is untrue or incorrectly made, or that the work or materials do not conform in fact to the contract. The department shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the contractor and his surety such damages as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the department, or any representative of the department; nor any payment for the whole or any part of the work; nor any extension of time; nor any possession taken by the department shall operate as a waiver of any portion of the contract, or of any power herein reserved or any right to damages herein provided. A waiver of any breach of the contract shall not be a waiver of any other or subsequent breach.

SECTION 8—PROSECUTION AND PROGRESS

8.1 Subletting or Assigning of Contract. The contractor shall not sublet, sell, or assign any portion of his contract or the work provided for therein without the written consent of the engineer, and such permission shall not relieve the contractor of any responsibility for the fulfillment of the contract. Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing and accompanied by a showing that the organization which will perform the work is particularly experienced and equipped for such work. In case approval of the engineer is given to subcontract a portion of the work, the contractor shall file with the engineer copies of all subcontracts before this portion of the work is started.

8.2 Prosecution of the Work. The contractor shall begin the work to be performed under the contract, unless otherwise provided in the special provisions, not later than 20 calendar days after award of contract. At the beginning of construction, or at any subsequent suspension and resumption of work, the contractor shall notify the engineer at least 48 hours before beginning actual operations. He shall start the work at the part of the road designated by the engineer and shall prosecute the work at as many different points as the engineer shall direct.

The work shall be prosecuted diligently at such rate, with such materials, equipment, labor, and supervision as the engineer may consider necessary to insure its completion within the time set forth in the special provisions. When so ordered by the engineer, the contractor shall immediately provide such additional equipment, supplies, and labor as may be deemed necessary to complete the work within the required time.

On bridge contracts, within 15 days after award of contract, the contractor shall furnish the engineer with a working schedule, prepared in the form required by the department, showing in detail the date of completion of the various parts of the structure.

8.3 Limitation of Operations. The contractor shall at all times conduct the work in such manner and in such sequence as will insure the least practicable interference

with traffic; and he shall, when directed by the engineer, make use of convenient detours. He 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 arrange his work and dispose of his material so as not to interfere with the operations of other contractors engaged upon adjacent work, and shall join his work to that of others in a proper manner and in accordance with the spirit of the plans and specifications, and shall perform his work in the proper sequence in relation to that of other contractors, all as may be directed by the engineer. Each contractor shall be held responsible for any damage done by him or his agents to the work performed by another contractor. Each contractor shall so conduct his operations and maintain the work in such condition that adequate drainage shall be in effect at all times.

8.4 Character of Supervision, Workmen and Equipment.

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

Any superintendent, foreman, or workman employed by the contractor or by a subcontractor who, in the opinion of the engineer or his authorized representative, does not perform his work in a proper and skillful manner or is disrespectful, intemperate, disorderly, or otherwise objectionable, shall at the written request of the engineer be forthwith discharged by the contractor or subcontractor employing such superintendent, foreman, or workman, and shall not be employed again on any portion of the work without the written consent of the engineer. Should the contractor fail to remove such person or persons or fail to furnish suitable and sufficient machinery, equipment, or

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.

8.5 Temporary Suspension of Work. The engineer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work; or for such time as he may deem necessary due to the failure on the part of the contractor to carry out orders given or to perform any provision of the contract. The contractor shall immediately respect the written order of the engineer to suspend the work wholly or in part. The contractor shall not suspend the work without permission of the engineer. The work shall be resumed when conditions are favorable and deficiencies have been corrected, as ordered or approved in writing by the engineer. No allowance of any kind will be made for suspension of work by order of the engineer, except as provided in Article 8.6.

8.6 Determination and Extension of Contract Time for Completion. The contractor shall perform the work in an acceptable manner within the time stated in the contract, except that the contract time for completion shall be adjusted as follows:

(a) If satisfactory completion of the contract shall require performance of work in greater quantities than those set forth in the proposal, the time allowed for performance shall be increased in the same ratio as the final estimate bears to the contract amount, and by such amounts as may be allowed under supplemental agreements and change orders as provided by Articles 4.3, 4.4, 4.5, and 4.6, or by extra work orders as provided in Article 4.7.

(b) In case of suspension of major items of work by order of the engineer and through no fault of the contractor, the time for completion shall be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(c) When delays occur due to unforeseen causes beyond the control and without the fault or negligence of the contractor, including, but not restricted to, acts of God, acts

of the public enemy, acts of the Government, fires, floods, epidemics, strikes, and freight embargoes, the time for completion shall be extended an amount determined by the engineer to be equivalent to the delays; provided, however, written request for such extension of time is made by the contractor within 10 calendar days after the beginning of such delay. No allowance shall be made for delay or suspension of the work due to fault of the contractor.

8.7 Failure to Complete the Work on Time. If the contractor refuses or fails to complete the work within the time specified, including authorized extensions, there shall be deducted from the moneys due the contractor, not as a penalty but as liquidated damages, the sum named in the contract for each working day until the work is completed and accepted.

8.8 Annulment of Contract. Upon substantial evidence that the work does not conform to the plans and specifications, or of deliberate failure on the part of the contractor to comply with the terms of the contract, the engineer may proceed to annul the contract as follows:

The engineer shall advise the contractor in writing of his findings and require that the conditions complained of be corrected within a stated period of time.

If the contractor fails to correct the conditions cited within the period named, the department may annul this contract without further delay and take over the work and complete it by contract or otherwise, as the department may determine.

Neither by the taking over of the work nor by the annulment of this contract shall the department forfeit the right to recover damages from the contractor for failure to complete his contract. Should the cost of completing the work be in excess of the original contract price, the contractor and his surety shall be held responsible for such excess cost. Should the cost of completing the work be less than the original contract price, the amount so saved shall be paid to the contractor.

8.9 Termination of Contractor's Responsibility. This contract shall be considered complete when all work has

been completed, the final inspection made, the work accepted by the engineer, and the final estimate paid. The contractor shall then be released from further obligation except as provided in Article 7.14.

Should the cost of completing the work be in excess of the contract price stated on the basis of final quantities and contract unit prices

Contract price shall be as above

SECTION 9—MEASUREMENT AND PAYMENT

9.1 Measurement of Quantities. After the work is complete and before final payment is made, the engineer shall make final measurement to determine the quantities of various items of work performed, as the basis for final settlement.

The contractor, in all cases, shall be paid for the actual amount of authorized work satisfactorily performed in accordance with the contract, as shown by the final measurements.

All work completed under the contract shall be measured by the engineer according to the United States standard measures.

All longitudinal measurements for area of subgrade, base courses, surface courses, pavement, and shoulders shall be made horizontally, and not along the actual surface of the roadway, and no deduction shall be made for fixtures in the roadway having an area of nine square feet or less. For all transverse measurements for area of subgrade, base courses, surface courses, pavements, and shoulders, the dimension to be used in calculating the pay area shall be the neat dimension shown on plans or ordered in writing by the engineer.

All materials which are specified for measurement by the ton shall be weighed on platform scales furnished by and at the expense of the contractor, except as noted below, and located at a suitable point as determined by the engineer. Such scales shall be satisfactory to the engineer, shall be of sufficient size and capacity to weigh in one operation the entire loaded hauling vehicle, and they shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. Unless otherwise specified, car weights of material shipped by rail may be accepted, provided that only actual weight of acceptable material shall be paid for and not minimum car weights used for assessing freight tariff.

Approved vehicles for hauling may be of any type or size satisfactory to the engineer. Unless all approved vehicles on a job are of uniform capacity, each approved vehicle shall bear a plainly legible identification mark indicating

the specific approved capacity. The inspector may reject all loads not hauled in such approved vehicles.

9.2 Scope of Payment. The contractor shall accept the compensation, as herein provided, in full payment for furnishing all materials, labor, tools, and equipment necessary to the completed work, and for performing all work contemplated and embraced under the contract; for loss or damage arising from the nature of the work or from the action of the elements, except as hereinbefore provided; for any unforeseen difficulties which may be encountered during the prosecution of the work, except as specifically exempted in Article 4.3, until the final acceptance by the engineer; for all risks of every description connected with the prosecution of the work; for all expenses incurred in consequence of the suspension or discontinuance of the work as herein specified; for any infringement of patent, trade mark, or copyright; for all expense of maintaining completed portions of the work until final acceptance, except as provided in Article 7.11; and for completing the work according to the plans and specifications. Neither the payment of any estimate or of any retained percentage shall relieve the contractor of any obligation to make good any defective work or material.

9.3 Payment and Compensation for Changes in Plans or Quantities. When alterations in plans or quantities of work not requiring supplemental agreements are ordered and performed, the contractor shall accept payment in full at the contract unit price for the actual quantities of work done. Changes involving supplemental agreements shall be paid for as stipulated in such agreement.

9.4 Extra Work. Extra work shall be paid for in accordance with the accepted extra work order. Work specified in the order to be performed at agreed unit prices shall be paid for in the same manner as proposal items. Work specified and performed on a force account basis shall be paid for as specified in Article 9.5.

9.5 Force Account Work. Work specified and performed on a force account basis shall be paid for as follows:

(a) For all labor and foremen in direct charge of the specific operations, the contractor shall receive the same

wage rates paid to these men, as evidenced by certified copies of the pay rolls, for the time they are actually engaged upon such work. Men employed on force account work shall receive the same rate of pay as they received when employed on contract items, or if the men have not previously been employed by the contractor, the rate shall be the same as for other similar labor. The contractor shall also receive reimbursement for workmen's compensation insurance and social security taxes paid on the labor employed. In addition to reimbursement for labor pay rolls, workmen's compensation insurance and social security taxes, the contractor shall receive an amount equal to 15 percent of the labor pay roll cost.

The wages of any foreman or timekeeper who is employed partly on force account work and partly on other work, shall be prorated between the two classes of work according to the number of men employed on each class of work as shown by the pay rolls.

(b) For all materials entering into the work the contractor shall receive the actual cost of such material delivered to the work, including freight and hauling charges as shown by original receipted bills, to which cost shall be added a sum equal to 15 percent thereof.

(c) For teams and equipment, the contractor shall receive the agreed rental rate shown on the order for the time such teams and equipment are used on the work. In case rental rates have not been agreed upon in advance of performing the work, as shown by the accepted extra work order, the rate to be paid shall be the average cost of owning and operating equipment similar to that used.

The compensation as above provided in (a), (b), and (c) shall be received by the contractor as payment in full for work done on a force account basis, including superintendence, overhead, use of small tools, profit and incidentals.

The contractor and engineer, or authorized representative, shall compare records of pay rolls for labor furnished on force account basis at the end of each day; claims for work done on force account basis shall be submitted to the engineer by the contractor upon certified quadruplicate statements, to which shall be attached original receipted

bills and invoices covering materials and freight and haulage charges on materials entering into such work. Such statements shall be filed not later than the twentieth day of the month following that in which the work was actually performed.

9.6 Adjustment of Haul on Local Materials. In case a designated material deposit is found to contain an insufficient quantity of satisfactory material as provided in Article 6.2, the contractor shall receive the following adjustment of compensation:

(a) Costs of moving the plant from the deposit which has failed to an alternate deposit and setting up the plant at the alternate deposit shall be paid for as extra work, except that no such payment shall be made when the alternate deposit is also a deposit designated in the special provisions.

(b) Increase in the average haul over the entire contract caused by a change in designated deposits shall be paid for at the rate of seven cents per ton mile or 10 cents per yard mile.

9.7 Omitted Items. The department shall have the right to cancel the portions of the contract relating to the construction of any item therein by the payment to the contractor of a fair and equitable amount covering all items of cost incurred prior to the date of cancellation or suspension of the work by order of the engineer.

9.8 Partial Payment. If satisfactory progress is being made, the contractor shall receive monthly estimates based on the amount of work completed during the preceding month. Progress estimates shall be based upon materials in place and labor expended thereon; but not more than 90 percent of the contract price of any work shall be paid in advance of full completion and acceptance; provided, however, that the engineer, at any time after 50 percent of the work has been completed, if he finds that satisfactory progress is being made, may make any of the remaining partial payments in full. Should any defective work or material be discovered previous to the final acceptance, or should a reasonable doubt arise previous to the final acceptance as to the integrity of any part of the completed

work, the estimate and payment for such defective or questioned work shall not be allowed until the defect has been remedied and causes for doubt removed. The monthly payments shall be approximate only, and all partial estimates and payments shall be subject to correction in the final estimate and payment.

9.9 Acceptance and Final Payment. The department shall make written final acceptance of the contract promptly after all work has been fully completed and final inspection made. As soon as practicable after final acceptance, the engineer shall furnish the contractor with the final estimate of quantities of work performed under the contract. The contractor shall examine such estimate and notify the engineer in writing of his agreement or file a specific claim covering disputed items. Failure on the part of the contractor to so notify the engineer or file a claim within a period of 30 days after receipt of the estimate shall be construed to signify the contractor's agreement to the quantities as set forth, and he shall have no further claim against the department, except as indicated in the final estimate of quantities. Final payment shall be due and payable at the expiration of not less than 30 calendar days nor more than 60 calendar days from the date of final acceptance.

PART II

CONSTRUCTION DETAILS

SECTION 10—CLEARING

10.1 Description. This item shall consist of clearing the areas designated of all trees, brush, logs, stumps, vegetation, and rubbish. It also includes grubbing and disposal of all materials resulting from clearing operations.

10.2 Areas To Be Cleared. The entire area to be occupied by the roadway shall be cleared to neat construction lines as staked by the engineer. Where rounding of the intersection of cut or fill slopes and the natural ground is required, clearing shall extend to the outer edge of the rounding. Where no rounding is required and cut slopes are steeper than two on one, clearing shall extend one foot outside neat roadway lines. Material deposits, ditches, and channels shall be cleared within neat excavation limits.

10.3 Construction Methods. Trees shall be felled within the area to be cleared in such manner as to avoid damage to vegetation outside this area. When the special provisions so require, merchantable logs shall be limbed, cut into commercial lengths, and placed in compact piles at points indicated on the plans or directed by the engineer. Likewise, firewood shall be limbed, cut into eight-foot lengths, split into convenient sizes for handling, and placed in compact piles at points indicated on the plans or directed by the engineer.

Stumps, roots, brush, and other embedded wood, shall be grubbed or blasted from the ground. Grass and weeds shall be cut flush with the ground surface.

Branches of trees overhanging the area to be occupied by the roadbed shall be cut where necessary to obtain a clearance of 14 feet above the finished surface, or where the engineer considers them likely to become a hazard to traffic.

Except as provided above, all vegetable matter resulting from the clearing operations and encountered within the

area cleared, including leaves and duff, shall be piled and burned within the area cleared. In National Forest areas, burning shall be done in conformity with the regulations of the United States Forest Service, and in all cases the methods shall be such that there will be no damage to vegetation outside the area to be cleared. Rubbish which cannot be burned shall be removed and buried or otherwise disposed of as directed by the engineer.

Before starting excavation the roadway area shall be completely cleared and grubbed, except that in cuts over three feet deep the grubbing may be done simultaneously with the excavation, provided satisfactory precautions are taken to insure that all roots and stumps are removed as the excavation proceeds, and do not become embedded in embankments or subgrade.

10.4 Method of Measurement. When the proposal includes an item for clearing, the quantity for which payment shall be made shall be the area in acres, computed on the basis of units 100 feet in length multiplied by the average width of each unit within the lines between which clearing has been required. Any such unit on which there is no clearing shall not be measured for payment. The measurement shall include the areas cleared as required for designated deposits from which borrow is obtained, but no measurement shall be made for necessary clearing of other material deposits.

If the proposal contains a separate estimate of quantities, individual trees more than six inches in diameter, measured three feet above the ground, shall be measured for payment as units, and all other clearing shall be considered as incidental to the various classes of earthwork.

10.5 Basis of Payment. When the proposal does not include an item for clearing, compensation for this work shall be considered as included in the contract unit prices for other items.

When the proposal includes a separate estimate of quantities, this item, measured as provided above, shall be paid for at the contract unit price per acre for "Clearing," which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

When the proposal includes a separate estimate of quantities, trees ordered removed and measured as provided above shall be paid for at the contract unit price each for "Remove Trees," which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work. This item shall not apply on any section on which the item "Clearing" is included.

SECTION 11—REMOVING STRUCTURES AND OBSTRUCTIONS

11.1 Description. This item shall consist of the removal and satisfactory disposal of all fences, buildings, structures, or other encumbrances as indicated on the plans or directed by the engineer.

11.2 Construction Methods. Fences, structures, and other obstructions which interfere with construction, or are shown on the plans, shall be carefully removed and any materials which, in the opinion of the engineer, may be satisfactory for use elsewhere, shall be salvaged and neatly stacked at accessible points as directed, and shall become the property of the department. Materials removed shall not be used on, or incorporated in, the work, unless otherwise specified, without written permission from the engineer. Unsalvageable material shall be disposed of by burning or depositing at points where it will not impair the appearance of the roadway.

Buildings shall be moved to new locations or demolished as indicated on the plans or ordered by the engineer. Buildings moved to new locations shall be placed on carefully graded sites and set upon foundations similar to the foundations on which the buildings rested. The contractor shall exercise every precaution in moving buildings to prevent them from being damaged and shall repair any damage which his operations may have caused. All power lines, water lines, sewers, and other appurtenances to the buildings shall also be moved and reconnected. When moved, buildings shall be in as good or better condition than before moving.

Existing structures, such as drainage pipes, bridges, culverts, and minor irrigation structures, or parts of such structures, shall be removed as noted on the plans or directed by the engineer. Pipe culvert headwalls shall be demolished in such manner that the ends of the pipe are not injured. Portions of structures ordered removed shall be removed in such manner that the part remaining is uninjured and may be utilized in the construction of a new structure. Unless otherwise shown on the plans, bridge and culvert substructures shall be removed to a

level at least one foot below the ground surface, except that if the remaining portion will interfere with the new work, the entire substructure shall be removed.

Removal of public utilities will ordinarily be performed by the company owning the property, but should the company involved fail to remove obstructions, such obstructions shall be removed or altered as directed by the engineer.

11.3 Method of Measurement and Basis of Payment.

Payment for removal of structures and obstructions shall be made as follows:

If the proposal contains an item for removing fences, including gates, it shall be paid for at the contract unit price per lineal foot for "Remove Fence." If there is no proposal item, removal of short sections of fence not exceeding 150 feet in length shall be considered as included in compensation for other items of the work; if any such section exceeds 150 feet in length, the removal of that section shall be paid for as extra work.

Demolishing of buildings shall be paid for at the contract unit price each or the contract lump sum price, as shown by the unit in the proposal, for "Remove Buildings." Moving of buildings shall be paid for at the contract unit price each or the contract lump sum price, as shown by the unit in the proposal, for "Move Buildings." In case there is no proposal item for demolishing or removing buildings, the work shall be paid for as extra work.

Removal of roadway and irrigation structures or other obstructions, or portions of such structures or obstructions, shall be paid for at the contract unit price each, the contract unit price per lineal foot, the contract unit price per cubic yard, the contract lump sum price, or the contract unit price per square yard, as indicated by the unit for the particular type of structure or obstruction in the proposal.

Removal or alteration of public utility properties, underground pipes and conduits when ordered, and no item is provided in the proposal, shall be paid for as extra work.

Removal of minor roadway and irrigation structures or embedded timbers or masonry for which there is no item in the proposal shall be considered as incidental to roadway excavation, and compensation for such removal shall be included in the contract unit price for that item.

The compensation provided above shall be full payment for removing the obstruction, salvaging reusable materials, disposing of unsalvageable materials, and for all labor, materials, tools, equipment, supplies, and incidentals necessary to complete the work, including necessary excavation and haul.

SECTION 12—DISPOSAL OF EXISTING SURFACE

12.1 Description. This item shall consist of the removal and satisfactory disposal of existing roadway surfaces, at points indicated on the plans or ordered by the engineer.

12.2 Construction Methods. Portland cement concrete, asphaltic concrete, and other similar pavements not suitable for reuse shall be broken up and disposed of by incorporating in embankments, or placing as directed by the engineer at points where the material will not impair the appearance of the roadside.

Gravel, roadmix, or plantmix surfaces suitable for re-use shall be removed to the depth required, and surfacing so removed shall be carefully salvaged and placed in compact stock piles at locations designated by the engineer. Care shall be exercised to prevent admixture of earth or other foreign materials, and sites of stock piles shall be leveled to avoid undue loss of material. These surfaces where not deemed by the engineer to be suitable for reuse shall be scarified and incorporated in embankments or subgrade.

12.3 Basis of Payment. Removal of Portland cement concrete, asphaltic concrete, and similar types of surfacing shall be paid for at the contract unit price per square yard for "Remove (type) Surface," for the actual number of square yards removed and disposed of satisfactorily.

Gravel, roadmix, or plantmix surfacing removed and placed in stock pile shall be paid for at the contract unit price per square yard for "Remove and Stock Pile (type) Surfacing," for the actual number of square yards satisfactorily removed and placed in stock piles.

Gravel, roadmix, and plantmix surfacing scarified and incorporated in embankments or subgrade shall be measured and paid for as roadway excavation.

Payment as provided above shall constitute full compensation for all labor, materials, tools, equipment, supplies, and incidentals necessary to remove and dispose of existing roadway surfacing.

SECTION 13—ROADWAY AND DRAINAGE EXCAVATION

13.1 Description. This item shall consist of grading necessary for the construction of the highway, intersections, approaches, and waterways in accordance with these specifications, and to the lines and grades shown on the plans and staked by the engineer. It does not include borrow or imported borrow obtained either within or without the right of way limits, nor does it include structure excavation.

13.2 Classification. No classification of roadway excavation shall be made on the basis of materials encountered. Classification may be made by dividing the roadway transversely into sections and designating the classification within any section as "Roadway Excavation A," "Roadway Excavation B," etc. When such classification is made, the designation of each section shall be shown on the plans, and such designation shall not be changed regardless of the character of material encountered.

13.3 General Requirements. Before breaking the ground, clearing and grubbing shall be completed in accordance with Section 10 of these specifications. All excavation shall be made true to the lines and grades staked by the engineer; and, except for a reasonable tolerance, the ground outside these lines shall not be disturbed.

All excavation shall be used in the formation of embankment, subgrade, shoulders, and dikes, unless otherwise indicated on the plans or ordered by the engineer.

13.4 Waterways. All ditches and channels indicated on the plans or ordered by the engineer shall be excavated true to lines and grades staked by the engineer. Suitable excavated material shall be disposed of by placing in roadway embankments or dikes as indicated on the plans or ordered by the engineer.

V-type ditches shall be excavated to the required cross section by means of suitable equipment which will deposit all of the loose material on the downhill side so that the bottom of the finished ditch shall be not less than two feet

below the crest of the loose material in the dike. Absolutely smooth ditches will not be required, but the flow lines shall be in satisfactory shape to provide drainage without overflow.

13.5 Rocks and Boulders. All rocks and boulders within construction limits shall be broken down to such size that they can be placed in the specified thickness of embankment layers, but in no case shall the contractor be required to break down boulders and rock to sizes less than two feet in smallest dimension. If, after so breaking, they cannot be placed in embankments, they shall be disposed of as ordered by the engineer in such manner as not to mar the appearance of the roadside. If, in the opinion of the engineer, a more economical method of disposal is not available, they shall be placed in a trench excavated within the roadway for this purpose.

13.6 Solid Rock. If shown on the plans or ordered by the engineer, solid rock or other material requiring blasting shall be loosened and broken up so that no solid ribs, projections or large fragments extend within six inches of the staked graded surface. When ordered by the engineer, such material shall be removed and the space refilled with suitable material. Where feasible, as determined by the engineer, the material for refilling shall be obtained from roadway excavation.

Overbreak outside staked slope lines shall be removed and placed in embankments or otherwise disposed of as directed by the engineer. Overbreak below grade shall be refilled with suitable material at the contractor's expense up to within 12 inches of the surface of the graded roadway.

13.7 Blasting. Overshooting will not be permitted and the engineer shall have authority to require the contractor to discontinue any method of blasting which results in breaking or loosening material outside of slope lines, or is dangerous, or is destructive to property or the landscape. The use of coyote holes in blasting is prohibited.

13.8 Slides. Slides extending beyond the staked slope lines shall be removed and placed in embankments or otherwise disposed of as directed by the engineer. The slopes

shall then be cut to new lines established by the engineer for the purpose of eliminating, insofar as is feasible, any unsightly appearance caused by the slide.

13.9 Widening Cuts. When so ordered by the engineer, cuts shall be widened and cut slopes flattened over the widths and slopes originally staked, to obtain material for completing embankments.

13.10 Reserved Material. When, in the opinion of the engineer, certain material encountered in excavation should be reserved for finishing, such material shall be saved for this purpose. If feasible, this material shall be left in place until it can be hauled direct to where needed, but if this is not feasible, it shall be excavated, stock piled and later used for finishing.

13.11 Unsuitable Material. Soft or yielding material shall be excavated to the depth shown on the plans or ordered by the engineer, and the resulting space backfilled with suitable material. Sod shall be stripped from the area within construction limits and disposed of as indicated on the plans or directed by the engineer.

13.12 Slopes. All slopes, except in solid rock, shall be trimmed accurately to the lines staked by the engineer. The degree of smoothness shall be that normally obtained by hand shovel operations. A hand raked, sand paper finish is not required. Rock slopes shall conform as nearly as feasible to the required lines and shall be free from decided humps and holes. Such slopes shall be scaled and all loose material removed.

13.13 Method of Measurement. The volume of roadway and drainage excavation to be paid for shall be the number of cubic yards, measured in original position by the method of average end areas, of the following:

(a) Excavation within the lines, grades, and cross section indicated on the plans or staked by the engineer.

(b) Solid rock or other material requiring blasting actually removed to a depth not to exceed 12 inches below the elevation of the graded surface. No measurement shall be made of material broken up, but not removed, nor of any

material removed if the space is backfilled before the engineer makes the necessary measurements.

(c) Overbreak (breakage of slopes outside of neat lines due to blasting) when not caused by improper methods of the contractor, in an amount equal to 50% of that actually occurring.

(d) Slides (breakage outside of neat slope lines due to the action of the elements or inability of the material to stand on the slopes constructed) when not caused by improper methods of the contractor.

(e) Excavation of soft or yielding material below grade where ordered by the engineer.

(f) Stock piles of reserved material without any deduction from the volume of the roadway prism from which they were obtained.

When the proposal includes a separate item for drainage excavation, all excavation for ditches and channels which is not required by the plans to be placed in roadway embankments shall be included in this class of excavation. When there is no proposal item for drainage excavation, all such excavation shall be included as roadway excavation.

V-type ditches shall be measured in lineal feet of ditch and each 100 feet shall constitute a unit of one station. The volume of excavation for such ditches shall not be measured.

13.14 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Roadway Excavation," "Roadway Excavation A," "Roadway Excavation B," "Drainage Excavation," etc., as the case may be, and at the contract unit price per station for "V-Type Ditches." Haul in excess of the free haul specified shall be paid for at the contract unit price for overhaul as provided in Section 17. When cuts are ordered widened or slopes flattened after excavation has been made and sloping completed to the original stakes, any necessary additional hand shaping shall be paid for as extra work.

on a loose account basis

Clearing shall be measured and paid for as specified in Section 10.

The above payments shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 14—BORROW

14.1 Description. This item shall consist of excavating and placing in the subgrade, embankments, or protection dikes, true to lines and grades, material from deposits or pits outside the roadway.

14.2 Materials. Borrow shall be material free from vegetable or other deleterious matter which, in the opinion of the engineer, will form a firm, stable roadbed. It shall be obtained from deposits indicated on the plans or in the special provisions, or designated by the engineer.

14.3 Construction Methods. No borrow pit shall be opened until all other excavation items are complete to the extent necessary to determine the need for borrow. It shall not be assumed that borrow indicated on the plans will be necessary in the amounts indicated, and no such borrow shall be made until it is evident there will not be an unexpected surplus from roadway excavation that should be used in lieu of such borrow. No borrow pit shall be opened until the engineer has staked it and authorized the contractor to enter it.

All materials unsuitable for embankment shall be rejected at the pit and disposed of as directed by the engineer. The excavation shall be made to the lines and grades staked by the engineer, which shall be such as to present a neat appearance and properly drain the pit.

After completing the borrow, the pit shall be finished as required in Article 4.11.

14.4 Method of Measurement. The volume of borrow to be paid for shall be the number of cubic yards, measured in original position by the method of average end areas, of material acceptably excavated, including unsuitable material disposed of as directed by the engineer. Deduction shall be made for material placed outside staked lines of embankments.

14.5 Basis of Payment. When the proposal does not include an item for borrow, the quantity of borrow, determined as provided above, shall be added to, and for

purposes of payment shall be considered as roadway excavation.

When an item is included in the proposal, the quantity, measured as provided above, shall be paid for at the contract unit price for "Borrow," which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Haul in excess of the free haul shall be paid for as provided in Section 17.

Clearing shall be measured and paid for as specified in Section 10.

SECTION 15—IMPORTED BORROW

15.1 Description. This item shall consist of excavating and placing in embankments material from approved deposits, in accordance with these specifications and in conformity with the lines, grades, and cross section shown on the plans or ordered by the engineer.

15.2 Material. The material shall consist of suitable embankment material obtained from deposits indicated on the plans or in the special provisions. Specific requirements will be set up in the special provisions to obtain the best available material for subgrade, and, when necessary, a porous embankment material that will prevent or retard capilarity shall be used.

15.3 Construction Methods. Unsuitable overburden shall be stripped to the required depth and disposed of as directed by the engineer. The imported borrow shall be excavated to the lines and grades set by the engineer and shall be placed in embankment or subgrade in accordance with the requirements of Section 13 for roadway excavation and Section 18 for embankments.

15.4 Method of Measurement. The volume to be paid for shall be the number of cubic yards, measured in original position by the method of average end areas, of suitable material acceptably placed within lines and grades staked by the engineer. The measurement shall not include unsuitable overburden, and deduction shall be made for material placed outside lines and grades.

15.5 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Imported Borrow," which payment shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals, including clearing, grubbing, and stripping the pit, and for all haul required to complete the item.

SECTION 16—ROUNDED AND TRANSITION SLOPES

16.1 Description. This item shall consist of rounding and shaping slopes, when required, in accordance with the typical sections shown on the plans or ordered by the engineer.

16.2 Construction Methods. Cut slopes shall be rounded by excavating the tops of cuts to blend the cut slope with the slope of the adjacent natural terrain. Embankment slopes shall be rounded by filling the bottoms of the embankments to blend the fill slope with the natural ground surface. Where cuts and fills intersect, the slopes shall be warped by flattening the ends of cuts and fills to blend more naturally the adjacent portions of the cut and fill.

Slopes will be staked for flattening and rounding in places where the material is other than solid rock, except that rock such as decomposed sandstone and granite that decomposes to such an extent that it will have the same appearance as earth, shall have the slopes flattened and rounded the same as earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes. Where the depth of cut or fill is insufficient to provide the full rounding required, the distance for rounding shall be proportionately adjusted.

The degree of smoothness required in rounding and warping slopes shall be as specified for trimming cut slopes in Section 13. Slope rounding and warping shall also apply to drainage ditches when such rounding will improve the appearance of the roadside.

16.3 Method of Measurement. The quantity of rounded or transition slope to be paid for shall be the number of stations one hundred feet in length treated as specified in the completed and accepted work, measured along the center line of the roadway or ditch. Rounding of shoulders or bottoms of side ditches, when required, shall not be measured for payment.

16.4 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per station for "Slope Rounding," which price shall be

full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

In addition to the payment specified above, the quantity of excavation required shall be measured and paid for at the contract unit price for the particular item of earthwork involved.

SECTION 17—OVERHAUL

17.1 Description. This item shall consist of the transportation of roadway excavation and borrow when the gross haul exceeds the free haul. The limit of free haul shall be fixed at 500 feet.

17.2 Method of Measurement. When separate payment is provided, overhaul shall be measured by the yard station or by both the yard station and the yard mile. A yard station shall be one cubic yard hauled 100 feet. A yard mile shall be one cubic yard hauled one mile. Computation of overhaul shall be made by means of a mass diagram when practicable.

Except as provided below, measurement shall be made by the yard station and the overhaul distance shall be the distance, less 500 feet, between the center of volume in original position and the center of volume after placing. The number of yard stations shall be the product of the volume of the overhauled material, measured in its original position, and the overhaul distance.

When proposal items are included for both yard station and yard mile overhaul, overhaul for the first 1,000 feet shall be measured in yard stations as specified above. In addition, overhaul on the portion of the gross haul in excess of 1,000 feet shall be measured in yard miles and the overhaul distance shall be the distance, less 1,000 feet, between the center of volume in original position and the center of volume after placing. The number of yard miles shall be the product of the volume of the overhauled material, measured in its original position, and the overhaul distance.

Gross haul shall be measured along the center line of construction in the case of roadway excavation and along the shortest feasible route as determined by the engineer in the case of borrow.

Overhaul shall be computed only on the volume of acceptable roadway excavation and borrow paid for as specified in Sections 13 and 14.

17.3 Basis of Payment. Unless an item is included in the proposal, the contract unit price per cubic yard for

roadway excavation or borrow shall be considered as including payment for overhaul.

If the proposal contains a separate estimate of quantities, this item, measured as provided above, shall be paid for at the contract unit price per yard station for "Overhaul, Yd. Sta.," or the contract unit price per yard station for "Overhaul, Yd. Sta.," and the contract unit price per yard mile for "Overhaul, Yd. Mi.," as the case may be, which price or prices shall be full compensation for all labor, materials, tools, equipment, supplies, and incidentals necessary to complete the work.

SECTION 18—EMBANKMENTS

18.1 Description. This item shall consist of constructing embankments or fills in accordance with these specifications and in conformity with the grades and cross sections shown on the plans or ordered by the engineer.

18.2 Materials. Embankments shall be constructed with acceptable materials excavated under any item of earthwork, except that when shown on the plans or ordered by the engineer, embankments shall be constructed with materials conforming to the specification for the particular item of earthwork shown or ordered. Materials used for embankments shall be free from vegetable matter, soft, spongy, frozen, or other objectionable materials.

18.3 Sequence of Operations. Except as noted below, bridges and culverts shall preferably be completed in advance of grading operations. If not so completed, a sufficient length of embankment, as determined by the engineer, shall be omitted on each side of such structures to permit proper compaction of the embankment adjacent to the structure, in accordance with these specifications, after the structure has been completed. Embankments over and around bridges and culverts shall consist of materials placed as specified under Section 20. Where required on the plans or by the special provisions, or when ordered by the engineer, embankments shall be constructed to a height of one foot above the top of pipe culverts before placing the pipe.

18.4 Foundation. Where indicated on the plans or ordered by the engineer, sod and soft or spongy materials shall be removed from the area to be covered by the embankment and shall be disposed of as shown on the plans or ordered by the engineer.

When an embankment is to be placed over an existing road, the existing roadway shall be scarified to provide ample bond between the old and new materials. When an embankment is placed on old fill slopes or on hillsides with slopes steeper than 20 degrees, and end dumping in the construction of the embankment is permitted, the slopes of the old fill or hillside shall be plowed or benched before the new embankment is started. If the new fill is placed

in layers, the old fill or hillside shall be cut into as successive layers are placed. If indicated on the plans or in the special provisions or ordered by the engineer, a trench shall be cut along the toe line of the fill slope before the embankment is started.

18.5 Placing. Fine material suitable for subgrade shall be placed on top. Clods or hard lumps over six inches in greatest dimension shall be broken up. Rocks or lumps of hard pan, cemented gravel, or similar material which cannot be broken readily, shall be distributed throughout the embankment and the interstices filled with finer material so as to obtain a uniform density. If the plans show solid rock cuts to be excavated or broken up six inches below the graded surface as provided in Article 13.6, no rocks or hard lumps over six inches in size shall be placed above lines six inches below the finished graded surface of embankments.

No sod shall be placed in the embankment within the area of the roadbed, but it may be placed in the toe of the slope if uniformly distributed. Where ordered by the engineer or shown on the plans, sod shall be hauled and distributed uniformly over slopes of rocky embankments.

If rock is used for embankments, no large stones shall be allowed to nest, but shall be distributed over the area to avoid pockets, and all voids shall be carefully filled with small stone or earth.

Except as indicated below, fills shall be placed and compacted in successive, full width layers, keeping the outside slightly higher than the center. If the material is earth, gravel, or small particles of rock, or contains by volume less than 25 percent of rock or boulders larger than six inches in greatest dimensions, the layers shall be not more than eight inches thick before compaction. If the embankment material contains 25 percent or more of rocks or boulders larger than six inches, the thickness of the layers may be increased to a depth sufficient to contain the material, but not to exceed two feet. If the material is solid rock and 25 percent or more by volume breaks too large to be placed in layers two feet thick without rebreaking, the thickness of the layer may be increased to not more than three feet.

End dumping will be permitted on sidehills where the

width of embankment to be built is less than eight feet. Where the ground is swampy and will not support hauling equipment, the lower part of the fill up to a height not greater than necessary to support the hauling equipment, may be made by end dumping.

18.6 Compaction. Each layer, before starting the next, shall be uniformly compacted by heavy hauling equipment, teams, or power rollers. The latter shall be required only where the method of construction does not include heavy hauling equipment or teams which will compact all parts of each layer to a firm bearing. Water shall be added when the material is dry, if required by the special provisions. As embankments become consolidated their sides shall be carefully trimmed to proper slopes.

18.7 Extra Compaction. When required in the special provisions, extra compaction shall be performed. The requirements for this work are in addition to the above requirements of general application.

The ground surface upon which the embankment is to be placed shall be plowed and then compacted as required for each layer of embankment. This will not be required if the ground is rocky or if, in the opinion of the engineer, rolling and watering will result in no material additional compaction.

Embankment material which is not sufficiently moist to compact shall be sprinkled with water as directed by the engineer. If the embankment material is rock, sufficient water shall be applied to flush the finer particles into the interstices of the rock.

Each layer shall be rolled by power or tamping rollers until thoroughly compacted. At least one power roller or one tamping roller shall be provided and kept in operation continuously for each 125 cubic yards or fraction thereof of embankment material placed per hour. The quantity of material placed per hour shall be determined by averaging the total amount of material, measured in excavation, placed within any one day or shift. When several fills each of small area are so isolated from one another that one roller cannot compact the areas satisfactorily, additional rollers shall be provided.

Power rollers for use in compacting embankments shall not weigh less than 10 tons and shall provide a compression on the rear wheels of not less than 325 pounds per lineal inch of tire width. Tamping rollers shall consist of metal rollers, drums, or shells surmounted by metal studs with tamping feet projecting not less than seven inches from the surface of the roller, drum, or shell. Tamping feet shall be spaced not less than six inches nor more than 10 inches measured from center to center in any direction, and the cross-sectional area of each tamper foot measured perpendicularly to the axis of the stud shall not be less than four nor more than 12 square inches. The weight of tamping rollers shall be such that the load on each tamper foot shall not be less than 50 pounds per square inch of cross-sectional area. The load per tamper foot will be determined by dividing the total weight of the roller by the maximum number of tamper feet in one row parallel to, or approximately parallel to, the axis of the roller.

18.8 Maintenance. Embankments shall be maintained true to grade and cross section until the completion of the contract, and the contractor shall be responsible for the stability of all embankments and shall replace any portions which, in the opinion of the engineer, have become displaced due to his carelessness or negligence.

18.9 Method of Measurement and Basis of Payment. Embankments shall not be measured or paid for directly, but shall be considered as incidental to the various items of earthwork except as follows:

(a) Sod or soft areas in the foundation removed shall be measured and paid for as roadway excavation.

(b) Trenches dug along the toe of fill slopes and steps more than three feet wide cut into sidehills as directed by the engineer shall be measured and paid for as roadway excavation. No direct payment shall be made for ploughing embankment areas as specified nor for benching when the required width of bench is less than three feet.

(c) Water used for compaction in accordance with the engineer's instructions shall be paid for as specified in Section 27.

SECTION 19—STRUCTURE EXCAVATION

19.1 Description. This item shall consist of all excavation for foundations for culverts, culvert headwalls, bridges, and all other structures, and the disposal of all material obtained from such excavation. Except as provided under Section 20, it shall include backfilling to the level of the original ground. It shall include all necessary bailing, draining, sheeting, and the construction of cribs or cofferdams, if found necessary, and shall also include the subsequent removal of cofferdams and cribs when required.

19.2 Classification. No classification of structure excavation shall be made on the basis of materials or conditions encountered. Classification of excavation, if any, shall be made on the basis of the material removed between certain elevations, and such classification as shown on the plans or special provisions shall not be changed regardless of the material encountered.

19.3 Notification of Start of Work. 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 existing ground and structure. Any material removed or excavated before these measurements have been taken shall not be paid for. The natural ground adjacent to the structure shall not be disturbed without permission of the engineer.

19.4 Depth of Excavation. Foundation pits shall be excavated according to the outlines of the footings as shown on the plans, and shall be of sufficient size to permit the placing of the full width and length of the 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 necessary to secure a satisfactory foundation.

19.5 Disposal of Material. All excavated material, so far as suitable, shall be utilized as backfill or embankment. The surplus material, whether or not temporarily allowed

to be placed within the stream area, shall finally be disposed of 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.

19.6 Treatment of Foundation Material. Boulders, logs, or any other unforeseen obstacles encountered in excavation shall be removed. All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped, or serrated, as directed by the engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When masonry is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and the final removal of the foundation material to grade shall not be made until just before the masonry is to be placed, except as provided under foundation fill, Section 21. Should the contractor remove foundation excavation below grade, he shall backfill to the required elevation at his own expense with concrete or with foundation fill, as directed by the engineer. 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 solid bed to receive the masonry.

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

Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottom of the footings and shall be well braced and as watertight as practicable. In

general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exterior, 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 sole expense of the contractor.

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

Unless otherwise provided, cofferdams or cribs, with all sheeting and bracing, shall be removed by the contractor after the completion of the substructure. The removal shall be affected in such a manner as not to disturb or mar the finished masonry.

19.8 Foundation Seal. When conditions are encountered which, in the opinion of the engineer, render it impracticable to unwater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary, and of such thickness as to resist any possible uplift. Concrete for such seal shall conform to all the requirements and specifications for concrete for structures. 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 partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib 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.

19.9 Pumping. Pumping from the interior of any foundation enclosure shall be done in such manner as to preclude the possibility of any portion of the concrete materials

being carried away. No pumping shall be permitted during the placing of concrete, or for a period of at least twenty-four hours thereafter, unless it be done from a suitable sump separated from the concrete work by a water-tight wall. Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

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

19.11 Backfilling. After the structure has been completed, the areas around the foundation shall be filled with approved material as required in Section 20.

19.12 Method of Measurement. The quantity to be paid for shall be the yardage, measured in original position, of the material actually removed as hereinbefore prescribed, except that no yardage shall be included of excavation outside of a volume bounded by vertical surfaces 18 inches outside the neat footings and parallel thereto; and in the case of trenching for pipe culverts and pipe culvert extensions, no yardage shall be included of excavation outside of a volume bounded by vertical surfaces 12 inches from the side of the pipe and parallel thereto, for pipes 30 inches or less in diameter, and 18 inches from the side of the pipe and parallel thereto, for pipes 36 inches or over in diameter.

19.13 Basis of Payment. The yardage, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Structure Excavation," which price shall be full compensation for the excavating, backfilling, except as provided in Section 20, disposing of surplus materials, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work; provided, that in the case of bridges when it is found necessary to carry footings more than three feet below the elevation shown on the plans, such work shall be paid for as extra work.

SECTION 20—BACKFILL

20.1 Description. This item shall consist of backfilling all bridges, box and pipe culverts, retaining walls, and other structures within the limits of the roadway, but does not include backfilling minor miscellaneous structures outside the limits of the roadway.

20.2 Materials. Material for backfill shall conform to the requirements for imported borrow.

20.3 Backfill for Structures Other Than Pipe Culverts. No backfilling shall be placed against any abutment, wing wall, or culvert until permission shall have been given by the engineer. In the case of concrete or other masonry, such permission will not be given until the masonry has been in place 21 days, or until tests made by the laboratory establish that the concrete has attained sufficient strength to withstand any pressures created by the methods used and materials placed without damage or strain beyond a safe factor. Adequate provision shall be made for thorough drainage through weep holes.

Backfill shall be deposited in horizontal layers not over eight inches in depth, measured loose, and compacted to the elevation of the finished grade, except that when the structure is to be covered by an embankment, the backfill shall be placed to the elevation of the top of the structure. The bed for the backfill shall be so prepared and serrated, and the backfill shall be so built up in horizontal layers, that at all times there shall be a horizontal berm of thoroughly compacted material behind the structure for a distance at least equal to the height of the abutment or wall to be backfilled, except insofar as undisturbed material obtrudes into this area. Sufficient water shall be applied to each layer to moisten the backfill so it can be compacted properly. Compaction shall be secured by tamping with approved mechanical rammers, or by hand tamping with heavy iron tampers having a tamping face not exceeding 25 square inches in area, except that power or tamping rollers may be used for accessible areas when, in the opinion of the engineer, such equipment will not damage or endanger the structure.

Especial care shall be taken to prevent any wedging action against the structure. Fill around culverts, piers, and rigid frame bridges shall be deposited on both sides to approximately the same elevation at the same time. The use of drop pile hammers, loaded or unloaded clam shells, or other similar equipment unsuitable for this purpose is prohibited within the berm area mentioned above, as well as the dropping of any heavy weight for the purpose more than 10 feet. Jetting and other hydraulic methods are prohibited within the area contiguous to the abutment or wall to be backfilled and for a distance therefrom equal to two and one-half times the height thereof above low water.

20.4 Backfill for Pipe Culverts. After the pipe has been installed, backfill shall be placed alongside the pipe in layers not exceeding eight inches in depth, measured loose, in such manner that on each side of the pipe there shall be a berm of thoroughly compacted material at least as wide as the diameter of the pipe, except insofar as undisturbed material obtrudes into this area. Each layer shall be moistened, if dry, and then compacted by tamping with approved mechanical rammers, or heavy iron hand tampers having a tamping face not exceeding 25 square inches in area, special care being taken to compact thoroughly the fill under the haunches of the pipe. This method of filling and compacting shall be continued until the embankment is at least six inches above the top of the pipe, and where the level of the constructed embankment or original ground is more than six inches above the top of the pipe, the filling and compacting shall be continued to such level.

20.5 Method of Measurement. When an item is included in the proposal, the quantity to be paid for shall be the number of cubic yards of compacted material in place in the completed and accepted work, limited as follows:

(a) For that portion below the top limits of structure excavation, the volume shall be that measured for structure excavation less the volume of the structure therein.

(b) For that portion above the top limits of structure excavation, the volume to be measured shall not exceed that between planes extending from the top limits of structure excavation to the elevation required for backfill and

a distance apart to provide the minimum berms specified above, except that the berm width measured for payment shall not exceed five feet unless otherwise indicated on the plans. The volume of the structure contained shall be deducted from the volume of backfill. Backfill above the top limits of structure excavation for headwalls for pipe culverts 36 inches or less in diameter shall not be measured or paid for directly.

20:6 Basis of Payment. When there is no item in the proposal, backfill shall be considered as incidental to the installation of the structure and compensation shall be included in the contract prices for other items of the work.

When the proposal includes an item, the quantity, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Backfill," which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work. Payment specified above shall not include compensation for roadway excavation, borrow, or imported borrow used for backfill. The quantities of these items required shall be paid for as specified for the particular material used, except that when there is no proposal item for borrow or imported borrow, the quantity required shall be measured and paid for as roadway excavation.

Water applied as directed by the engineer shall be measured and paid for as specified in Section 27.

SECTION 21—FOUNDATION FILL

21.1 Description. This item shall consist of furnishing and placing rock or gravel backfill required to replace unsuitable foundation material below the foundation elevation for culverts, bridges, and all other structures.

21.2 Material. Foundation fill shall consist of suitably graded gravel or rock, as required by the engineer.

21.3 Construction Methods. After the unsuitable material has been excavated as required by the engineer, and piles driven if called for, the foundation fill shall be placed in uniform layers, as directed, to the foundation elevation, and each layer thoroughly compacted.

21.4 Method of Measurement. The yardage to be paid for shall be the yardage, measured in its final position, of the material actually placed as foundation fill, except that no yardage shall be included outside of the vertical planes limiting the payment for structure excavation.

21.5 Basis of Payment. The yardage, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Foundation Fill," which price shall be full compensation for excavating, hauling, depositing, and compacting the materials placed, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 22—DISPOSAL OF SURPLUS MATERIAL

22.1 Description. This item shall consist of the disposal of surplus or waste material of any classification of earthwork.

22.2 Construction Methods. All surplus excavation shall, if feasible, be used to widen embankments uniformly or to flatten slopes. If this is not feasible because of the character of the material, length of culverts in place, or for other reasons, the surplus material shall be disposed of as directed by the engineer at places and in such manner as to be inconspicuous from the highway and cause no interference with drainage. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the engineer.

22.3 Basis of Payment. This work shall not be paid for directly, but shall be considered as subsidiary work pertaining to roadway excavation or other class of earthwork.

Haul of surplus material in excess of the free haul specified shall be measured and paid for as specified under overhaul, Section 17.

SECTION 23—SUBGRADE

23.1 Description. This item shall consist of the construction of the subgrade in accordance with these specifications and in conformity with the lines, grades, and cross section shown on the plans or ordered by the engineer, on that portion of the roadbed upon which base or surface courses are to be placed. The type of construction shall be one of the following, as indicated by the proposal item:

Type A will apply when side forms or headers are required for the surfacing specified.

Type B will generally be indicated when roadmix, plant-mix, or retread surfaces are specified.

Type C will generally be indicated when gravel surfacing without watering or rolling is specified.

23.2 Type A Subgrade. Prior to setting the side forms, the roadbed shall be shaped approximately to grade, watered, and thoroughly rolled.

After the side forms are accurately set to grade, the earth between them shall be loosened to a depth of not less than three inches with a rooter, scarifier or plow so operated that no ribs of compacted material will be left in place, and the loosened material shall be thoroughly pulverized. High spots shall be removed and depressions filled. The pulverized subgrade material shall be roughly shaped to cross section, rolled with a power roller of approved type weighing not less than 10 tons, and then be graded uniformly to the desired height above finished subgrade elevation by means of a subgrader or shaper riding on the headers, and cultivated so as to form a series of shallow longitudinal furrows. The grade shall then be watered uniformly, and after the water has penetrated, rolling shall be continued until no more compression is possible. Any portion not accessible to the roller shall be compacted with hand tampers weighing not less than 25 pounds, and having a face area of approximately 64 square inches. The grade should then be approximately one inch above finished subgrade elevation.

Immediately after the rolling, the subgrade shall be cut true to grade and cross section and the excess earth

removed. After the final cut, the subgrade shall be checked by means of a scratch template. This template shall have nails or rigid projections not more than three inches apart, which shall protrude at least three-quarters of an inch in such manner that the points will form a true line for the depth and surface of the subgrade when the template is placed on the side forms. All variations in the subgrade indicated by the scratch template shall be corrected. After the subgrade is finished true to grade and cross section, it shall be watered thoroughly and allowed to dry.

The subgrade shall be rechecked with a nail template immediately in advance of placing base or surface, and the contractor shall make such corrections as may be necessary to bring the subgrade to exact elevation. Low spots in the subgrade shall not be filled with loose dry material, except that when a Portland cement concrete pavement is to be placed, low subgrade may be filled to the proper elevation with sand, thoroughly watered, struck off, and maintained at the required grade.

The contractor shall protect the subgrade from his own and public traffic, and shall maintain it thoroughly compacted and true to grade and cross section until covered by a base or surface course. No storage piles of fine or coarse aggregate shall be placed directly upon it. The subgrade shall at all times be completed for a sufficient distance ahead of spreading base or surface material to allow adequate opportunity for inspection. No base or surface course shall be placed on the subgrade until it has been checked and approved by the engineer immediately before such base or surface course is laid.

23.3 Type B Subgrade. After the roadway has been finished to the lines and grades staked by the engineer, it shall be scarified to a depth of not less than four inches below final subgrade elevation, and any excess material shall be removed and used in the construction of shoulders or otherwise disposed of as directed. Rocks larger than two inches brought to the surface shall be removed. The subgrade shall then be brought by means of blade graders or other suitable equipment to such elevation that when compacted it will conform to the lines, grades and cross section shown on the plans. Water shall be applied in

amounts sufficient to moisten the material uniformly, and the subgrade shall be compacted by means of a power roller of an approved type weighing not less than 10 tons. Soft or spongy spots shall be removed and replaced with suitable material. Blading and rolling shall continue until the subgrade is thoroughly compacted, smooth, uniform and true to the lines and grades shown on the plans or ordered by the engineer. During the process of blading and rolling, sufficient water shall be added from time to time to keep the subgrade material sufficiently wet to facilitate compaction. The contractor shall protect the subgrade from his own and public traffic, and shall maintain it true to grade and cross section until covered by a base or surface course. The subgrade shall at all times be completed for a sufficient distance ahead of spreading base or surface material to allow adequate opportunity for inspection. No material shall be placed on the subgrade until it has been checked and approved by the engineer.

23.4 Type C Subgrade. Methods of construction for this type shall be the same as for type B except that neither rolling nor watering will be required. The results required shall be the same as for type B subgrade except that the degree of hardness and compaction shall be that obtainable by a uniform distribution of construction hauling equipment over the subgrade.

23.5 Method of Measurement. The quantity of type A subgrade shall be the number of square yards included between side forms or headers.

The quantity of type B and type C subgrade shall be the number of miles measured along the center line of the road.

23.6 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per square yard for "Subgrade, Type A," at the contract unit price per mile for "Subgrade, Type B," or "Subgrade, Type C," as the case may be, which price or prices shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work. Water acceptably applied as directed by the engineer shall be measured and paid for as specified in Section 27.

SECTION 24—SHOULDERS

24.1 Description. This item shall consist of the construction of shoulders of approved materials as indicated on the plans or in the special provisions, to the lines, grades, and cross sections shown on the plans or ordered by the engineer.

24.2 Materials. Where the shoulders are constructed wholly or in part of base course or surface course materials, such materials shall meet all of the requirements specified elsewhere in these specifications for the particular material used.

24.3 Construction Methods. Shoulders shall be constructed to the full width and at least to the level of the subgrade, before constructing the subgrade. Construction to final height and cross section shall proceed in the proper sequence with any base course or surface course to adequately protect the base course, surface course, or forms therefor. At all times the construction shall be so carried on that the subgrade, shoulders, and adjacent ditches will be effectively and completely drained.

When rolling of the subgrade is required, the shoulders likewise shall be rolled. Water shall be applied as directed by the engineer.

In finishing shoulders built of material thrown out from the subgrade, all rocks larger than one and one-half inches shall be removed from the surface.

When base course or surface course materials are required on shoulders, such material shall be placed and finished in accordance with the specifications for base course or surface course applying.

24.4 Basis of Payment. Payment shall be made at the contract unit price or prices for base course or surface course materials used, measured as specified for the particular kinds of materials used. Payment shall also be made for all water acceptably used on the shoulders in accordance with the engineer's instructions as specified in Section 27. Payment for all required shaping, rolling, and finishing shall be considered as included in the contract unit price

for subgrade. These payments shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 25—RESHAPING ROADWAY

25.1 Description. This item shall consist of the preparation of a roadway, constructed under a previous contract, to receive initial or additional surfacing.

25.2 Construction Methods. All slides shall be removed and the roadway ditches shall be cut to the lines and grades shown on the plans. Material removed from slides or ditches shall be used to widen uniformly or build up low places in the embankments or disposed of otherwise, as ordered by the engineer.

In the case of a roadway which is to receive additional surfacing, the shoulders shall be built to the lines and grades shown on the plans, and any material required, in addition to that obtained from slides, ditches and the trench for the additional surface, shall be obtained and placed in accordance with the specifications for the material used, as indicated on the plans or directed by the engineer. When indicated on the plans, a trench shall be cut to receive the surfacing and the material removed from the trench shall be placed on the shoulders. The trench shall be carefully shaped to the required cross section and evened so as to produce a smooth longitudinal profile. If trenching is not required, the entire surface shall be shaped and smoothed in the same manner.

In the case of a roadway which is to receive initial surfacing, embankments shall be reconstructed to the lines and grades shown on the plans, and any material required, in addition to that obtained from slides, ditches, and smoothing of the roadway, shall be obtained and placed in accordance with the specifications for the material used, as indicated on the plans or directed by the engineer. The entire roadway shall then be shaped to the lines and grades shown on the plans, the subgrade cut, and shoulders built as specified in Sections 23 and 24.

25.3 Method of Measurement. Reshaping roadway shall be measured in miles along the center line of the roadway.

25.4 Basis of Payment. This work shall be paid for at the contract unit price per mile for "Reshape Roadway,"

which price shall be full compensation for removing slides of less than five cubic yards in any station of 100 feet, clearing ditches, disposal of material taken from slides and ditches, trimming slopes, trenching, and shaping roadway, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Removal of slides in excess of five cubic yards per station of 100 feet shall be paid for as "Roadway Excavation," or if there is no contract unit price, it shall be paid for as extra work.

Additional material used for building up embankments and shoulders shall be paid for at the contract unit price for the particular material, or if there is no contract unit price, it shall be paid for as extra work.

Haul of roadway excavation and borrow in excess of the free haul shall be measured and paid for as specified under overhaul, Section 17.

SECTION 26—ROADSIDE CLEANUP

26.1 Description. This item shall consist of cleaning and dressing roadside areas. It shall include the removal and disposal of rocks and boulders, logs, dead brush, rubbish, and other objectionable matter; obliteration of old roads to be abandoned; reshaping of old borrow or material pits, and selective clearing and trimming of trees and vegetation; all as indicated on the plans or as directed by the engineer. It shall not include any cleanup or other work made necessary by the contractor's operations as described in Article 4.11.

26.2 Construction Methods. Rocks and boulders designated for removal shall be removed and disposed of, either by depositing in bottoms of fills or by hauling and placing at points where, in the opinion of the engineer, they will not present an unsightly appearance. All logs, dead brush, rubbish, and other objectionable matter shall be burned or otherwise disposed of to the satisfaction of the engineer.

Old roads to be abandoned shall be obliterated by scaring or other approved methods and old borrow or material pits shall be shaped, trimmed, and sloped. This work shall be performed in such manner that the roads or pits will blend with the adjacent landscape and so that the growth of vegetation will be promoted.

It is the intention herein to provide for a pleasing roadside, and all methods used shall be such as to protect and leave undamaged the existing ground surface and all vegetation. The use of scrapers of any kind or blade graders for the removal and disposal of rocks and boulders, logs, dead brush, rubbish, or other objectionable material will not be permitted unless specifically authorized by the engineer. All burning shall be done in such manner that the surrounding ground cover will not be damaged.

When required, the roadside shall be selectively cleared and grubbed. This shall consist of clearing the areas designated of unsatisfactory undergrowth, stumps, and trees as directed by the engineer. Desirable trees and undergrowth shall be protected. Dead and unsatisfactory limbs shall be trimmed as directed. Debris from this operation shall be carefully burned or otherwise satisfactorily disposed of.

26.3 Method of Measurement and Basis of Payment.

Rocks and boulders removed and disposed of as provided herein shall be paid for at the contract unit price per cubic yard, measured in hauling vehicle at point of loading, for "Rock Cleanup," which price shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, including haul.

Removal of logs, dead brush, rubbish, and other objectionable matter; obliteration of old roads to be abandoned; reshaping of old borrow or material pits; and selective clearing and grubbing shall be paid for on a force account basis.

SECTION 27—WATER

27.1 Description. This item shall include furnishing and applying water for compacting embankments, subgrade, surfacing, backfill, and for laying dust caused by grading operations and traffic. It does not include water required for camp uses, mixing or curing Portland cement concrete, water incorporated at the plant in plantmixed products, or for other uses not specifically required to be paid for under these specifications.

27.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

WaterSection 73

27.3 Construction Methods. Water shall be applied in amounts and at locations required by the engineer. It shall be sprinkled uniformly as directed, by means of tank trucks equipped with suitable control apparatus, or by means of approved sprays attached to hose lines. When directed by the engineer, sprinkling shall be done at night or in the early morning hours when evaporation loss is at a minimum.

27.4 Method of Measurement. The quantity to be paid for shall be the number of 1,000 U. S. gallons actually applied as directed by the engineer. Measurement shall be made in tanks or tank trucks of predetermined capacity or by means of meters of a type approved by the engineer, which shall be furnished and installed by the contractor.

27.5 Basis of Payment. The quantity of water, measured as provided above, shall be paid for at the contract unit price per 1,000 gallons (M. Gal.) for "Water," which price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, and incidentals necessary to complete the work.

SECTION 28—SELECT MATERIAL BASE

28.1 Description. This item shall consist of a base course of selected granular material placed upon the completed and accepted subgrade, in accordance with these specifications and in conformity with lines, grades, and cross sections shown on the plans or ordered by the engineer.

28.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

WaterSection 73

Select materialSection 74

28.3 Placing. When the required compacted thickness is three inches or more, the base material shall be placed in layers, none of which shall exceed four inches in depth before compaction. The material shall be distributed uniformly, either directly from the tail gates of the hauling vehicles while in motion or by approved spreader boxes, followed immediately by such blade grader work as is necessary to remove all irregularities and to spread the material uniformly over the subgrade or previous layer. Dumping in piles on the road shall not be permitted. Each layer shall be finished true to lines and grades before starting the succeeding layer.

If irregularities or segregation of materials occur in any layer during or after spreading, that layer shall be bladed into windrows, remixed until the segregations are eliminated, and then respread.

28.4 Watering. When required on the plans or in the special provisions, water shall be applied just prior to and during all blading operations, in amounts directed by the engineer.

28.5 Compacting. Compaction shall be accomplished, to the extent feasible, by hauling equipment and other traffic distributed uniformly over the entire width of each layer, accompanied by frequent blading and, if required, watering as directed by the engineer. The sequence of operations shall be such that all sections of each layer shall be subjected to this traffic before being covered.

Rock particles larger than two inches bladed to the surface shall be removed and disposed of as directed by the engineer.

The finished course shall be smooth, true to lines, grades, and cross sections, and free from loose rocks or pebbles.

28.6 Maintenance. Waves, corrugations, and ruts shall not be allowed to form and the base shall be bladed and dragged as often as necessary to maintain it true to grade and cross section until the work is accepted.

28.7 Method of Measurement. The quantity to be paid for shall be the number of tons of 2,000 pounds or the number of cubic yards, measured in the hauling vehicle at the point of loading, as indicated by unit stated in the proposal form, conforming to all requirements, in the completed and accepted work.

28.8 Basis of Payment. The quantity of base material, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard, for "Select Material Base," which price shall be full compensation for stripping of pit, crushing, screening, loading, hauling, and placing material on the roadway; for maintaining the base; and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, except watering.

The quantity of water acceptably applied shall be measured and paid for as provided in Section 27.

SECTION 29—GRAVEL BASE COURSES

29.1 Description. This item shall consist of a base course of gravel, crushed gravel, or crushed stone placed upon the completed and accepted subgrade, or upon another base course, in accordance with these specifications and in conformity with the lines, grades, and typical sections shown on the plans or ordered by the engineer.

29.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Aggregate for type 1 gravel base (three gradings—choice of size optional unless otherwise specified)	Section 75
Aggregate for type 2 gravel base (two gradings—size as specified) ..	Section 75

29.3 Placing. In producing, handling, and placing the material, care shall be taken to prevent segregation of the fine particles from the coarse. Base material shall be spread in one or more uniform layers of such depth that when compacted the course shall have the thickness shown on the plans. The thickness of each layer before compaction shall not exceed the following:

Material	Maximum thickness before compaction
Type 1 gravel base	5 inches
Type 2 gravel base	4 inches

Initial spreading shall be accomplished by distributing the material uniformly, either directly from the tail gates of the hauling vehicles while in motion or by approved spreading devices. In no case shall the material be dumped on the subgrade in piles. Following the distribution of each layer as closely as working space will permit, the material shall be thoroughly mixed by alternately blading into windrows to the middle of the roadway and back to the edges. It shall then be spread and finished to the required cross section by means of blade graders of a type that will give the desired results as to uniformity and smoothness.

If it is necessary to add additional binder to type 1 gravel base material after the gravel is spread, the necessary additional binder, as determined by the engineer, shall be distributed evenly over the loose gravel and thoroughly mixed with it by appropriate means.

29.4 Watering. When required on the plans or in the special provisions, water shall be applied immediately prior to and during all blading operations in amounts deemed necessary by the engineer to moisten the material and prevent segregation of the fine and coarse particles. Water shall also be applied during the compaction and maintenance stages in sufficient amounts, as determined by the engineer, to assist in compaction and prevent raveling.

29.5 Compacting. When rolling is required in the special provisions, each layer shall be rolled with a three-wheel power roller weighing at least 10 tons. Rolling shall be parallel to the center line of the road and shall begin at the outer edges, progressing gradually to the center. Wheels shall lap each preceding track by not more than one-half the width of the rear wheel. Rolling shall continue until the maximum feasible amount of compaction and bond have been attained. Any irregularities or depressions that develop shall be corrected by loosening the material and adding or removing a sufficient quantity of the base until the surface is smooth and even.

When rolling is not specifically required in the special provisions, compaction shall be obtained by routing hauling equipment and other traffic uniformly over the entire width of each layer. The sequence of operations shall be such that all sections of each layer shall be subjected to such traffic before being covered. Generally, each layer shall be started at the point nearest the plant and placed continuously outward, but where the length from the plant is more than two miles, the procedure may be altered to the extent that no section will be deprived of a reasonable amount of traffic for compaction.

During rolling or compaction by traffic, such blading shall be done as is necessary to keep the surface smooth and free from irregularities.

Sections along curbs, near structures, and all other places

not accessible to the compacting equipment shall be tamped with hand tampers weighing not less than 25 pounds and having a face area of not more than 64 square inches.

29.6 Maintenance. Waves, corrugations, and ruts shall not be allowed to form, and the base shall be bladed and dragged as often as necessary to maintain it true to grade and cross section until the work is accepted or until it is covered with a succeeding course.

29.7 Method of Measurement. The quantity to be paid for shall be the number of tons of 2,000 pounds or the number of cubic yards, measured in the hauling vehicles at the point of loading, as indicated by the unit stated in the proposal form, conforming to all requirements in the completed and accepted base.

29.8 Basis of Payment. The quantity of base material, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard for "Type 1 Gravel Base," "Type 2 Gravel Base, 1 inch," or "Type 2 Gravel Base, one and one-half inch," as the case may be, which price shall be full compensation for stripping of pit, crushing, screening, loading, hauling, placing, compacting, and maintaining the base, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, except watering.

Water applied as directed shall be measured and paid for as specified in Section 27.

SECTION 30—PLANTMIX GRAVEL BASE COURSE

30.1 Description. This item shall consist of a base course of crushed gravel or crushed stone and filler, moistened and mixed in a central plant, and placed upon the completed subgrade or another base course, in accordance with these specifications and in conformity with the lines, grades, and cross sections shown on the plans or ordered by the engineer.

30.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

WaterSection 73

Aggregate for plantmix gravel
baseSection 75

30.3 Proportioning. The crushed material shall be screened into two sizes, each of which shall be stored in a separate bin. One bin shall contain that fraction of the material retained on a No. 3 sieve and the other bin shall contain that fraction passing a No. 3 sieve. These two sizes shall be accurately combined by weight in proportions as directed by the engineer within the grading limits specified. The properly proportioned material shall be mixed thoroughly at a central mixing plant, in either a rotary drum or a pug mill type mixer. During the mixing, sufficient water shall be added to moisten the material and prevent segregation during handling and placing. The amount of water shall not exceed 15 gallons per ton, and the exact amount within this limit shall be determined by the engineer.

30.4 Placing. When the compacted thickness is more than four inches, plantmix gravel base shall be spread in layers, none of which shall exceed a compacted thickness of more than three inches. When the compacted thickness is four inches or less, the base may be spread in one layer. Spreading shall be done with approved types of spreading boxes supplemented by motor graders. Motor graders used for this purpose shall be tightly articulated, shall be equipped with pneumatic tires, shall have a wheel

base of not less than 16 feet, and shall be in good mechanical condition. After each layer has been satisfactorily spread for a distance of not less than 1,000 feet along the road, the top one-half shall be bladed into a windrow along one side of the road and the remaining material bladed smooth and rolled. The windrow shall then be moved to the opposite side of the road and the remainder of the half thickness layer bladed smooth and rolled. The material in the windrow shall then be respread over the full width of the surface, true to lines and cross section. During blading operations sufficient water shall be applied to keep the material moist.

If required by the special provisions, spreading shall be done by means of a paver of the type specified for class F-2 plantmix bituminous surface, Article 41.3, instead of by means of spreader boxes and motor graders as required above.

30.5 Compacting. Each layer shall be compacted with power rollers weighing not less than 10 tons and having a compression under the rear wheels of not less than 350 pounds per lineal inch of wheel. At least one roller shall be provided for each 50 tons laid per hour. Rolling shall follow spreading before the material dries. It shall be parallel to the center line of the road and shall start at the outer edges, progressing gradually to the center. Wheels shall lap each preceding track by not more than one-half the width of the rear wheel. After the initial rolling, water shall be applied as directed by the engineer in sufficient amounts to facilitate compaction. Rolling shall continue on each layer until the material is thoroughly compacted and bonded. Any irregularities which develop during rolling shall be corrected by loosening and removing or adding material.

The top layer shall be finished by adding water and rolling until a thin grout flushes along ahead of the roller wheels. During the rolling such hand brooming shall be done as is necessary to distribute the grout uniformly over the surface.

The finished base shall be smooth and even, with rock uniformly distributed, true to grade and cross section, and

free from elevations and depressions. It shall not deviate more than one-quarter inch from the lower edge of a straightedge 10 feet long placed on the surface parallel to the center line.

30.6 Prime Coat. After the completed base has dried it shall be swept with a power broom until all loose material is removed and the coarse aggregate is uniformly exposed. A prime coat shall then be applied in accordance with Section 33.

30.7 Maintenance. The primed base shall be carefully maintained true to line and grade until it is covered with a succeeding course. Pot holes or ravelled spots shall be filled and such additional quantities of the prime coat as may be necessary shall be applied. The use of an excessive amount of bituminous material in patches shall be avoided.

30.8 Method of Measurement. The quantity to be paid for shall be the number of tons of 2,000 pounds conforming to all requirements in the completed and accepted work.

30.9 Basis of Payment. The quantity of base material, measured as provided above, shall be paid for at the contract unit price per ton for "Plantmix Gravel Base," which price shall be full compensation for stripping of pit, crushing, screening, mixing, hauling, placing, compacting, and maintaining the base, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Water applied after the base has been spread shall be measured and paid for as specified in Section 27.

Application of prime coat shall be measured and paid for as specified in Section 33.

SECTION 31—GRAVEL SURFACE COURSE

31.1 Description. This item shall consist of a surface course of crushed gravel or crushed stone, placed upon the completed and accepted subgrade or base course in accordance with these specifications and in conformity with the lines, grades, and typical sections shown on the plans or ordered by the engineer.

31.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

WaterSection 73

Aggregate for roadmix bituminous
surfaceSection 76

31.3 Construction Methods. This surface course shall be built and finished as specified for type 2 gravel base, Section 29.

31.4 Method of Measurement. The quantity to be paid for shall be the number of tons of 2,000 pounds or the number of cubic yards, measured in the hauling vehicles at the point of loading, as indicated by the unit stated in the proposal form, conforming to all requirements in the completed and accepted surface.

31.5 Basis of Payment. The quantity of surfacing material, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard for "Gravel Surface," which price shall be full compensation for stripping of pit, crushing, screening, loading, hauling, placing, compacting, and maintaining the base, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, except watering. Water applied as directed shall be measured and paid for as specified in Section 27.

SECTION 32—ROAD APPLICATION OF BITUMINOUS MATERIALS

32.1 Description. This specification covers the equipment, methods, and method of measurement applying when bituminous materials (liquid asphalts and asphalt emulsions) are spread on the road as a part of the construction of other items of these specifications.

32.2 Equipment. Distributors for applying bituminous materials shall be approved pressure spraying types, capable of maintaining a constant pressure upon the material as it passes through the nozzles, and having sufficient tractive power to maintain constant speed with varying road conditions. They shall be equipped with pressure and volume gauges, and with tachometers reading speeds in feet per minute. The design, mechanical condition and methods of operation shall be such that true lines are followed without overlapping, and that the material is sprayed upon the road in a uniform sheet at the rate per square yard ordered by the engineer within a tolerance of 10 percent. Trailer type distributors shall be permitted only in cases where the bituminous material is to be mixed on the road with mineral aggregate. Suitable screens shall be installed between the tank and the nozzles and they shall be cleaned frequently to prevent clogging. The Distributors shall be capable of spreading any width required by the engineer up to 12 feet.

32.3 Weather Conditions. Bituminous materials shall be applied only when the temperature is above 50 degrees Fahrenheit and rising, or above 65 degrees Fahrenheit. Bituminous materials, except asphalt emulsions, shall be applied only when the weather is clear and the surface to be covered is dry.

32.4 Temperature of Application. The temperature range for applying liquid asphalt shall be within the following limits for each type, except that penetration applications shall be applied at a temperature above the middle of the range shown.

**TEMPERATURE RANGE FOR ROAD APPLICATION
OF LIQUID ASPHALTS**

Type of Liquid Asphalt	Range, Degrees Fahrenheit
SC-1	100-150
SC-1A	130-200
SC-2	150-225
SC-3	150-225
SC-4	175-250
90-95	325-375
95+	325-375
MC-1	105-135
MC-2	125-200
MC-3	150-200
MC-4	150-200
MC-5	170-220
RC-1	105-135
RC-2	125-155
RC-3	145-175
RC-4	170-200

32.5 Methods. Guard rails, bridges, culverts, posts, and all other structures shall be adequately covered and protected both from direct spraying and from wind blown spray. When such structures are spattered the contractor shall remove all traces of the bituminous material at his own expense.

Effective methods shall be used to insure uniform application without overlapping at the beginning and end of each load. If the distributor is not equipped with a satisfactory trough under the sprays so arranged that full flow can be started or stopped at will, building paper shall be laid for a sufficient distance at each end of the spread to secure this result. The distribution shall be stopped promptly after uniform flow ceases, indicating that the tank is about empty. If any spots are missed, bituminous material shall be applied to these spots by means of a power or hand spray nozzle.

32.6 Conversion Tables—Liquid Asphalts. Where measurement of liquid asphalts by volume is used, a gallon shall be construed to be a gallon in volume at a temperature of 60 degrees Fahrenheit. The following tables shall be used for converting volume to weight, and volume at any temperature to volume at 60 degrees Fahrenheit:

TABLE FOR CONVERTING VOLUME TO WEIGHT

Type of Liquid Asphalt	Gallons per ton at 60° F	Type of Liquid Asphalt	Gallons per ton at 60° F
SC-1	258	MC-2	246
SC-1A	252	MC-3	245
SC-2	247	MC-4	243
SC-3	245	MC-5	242
SC-4	243	RC-1	253
90-95	239	RC-2	248
95+	237	RC-3	246
MC-1	258	RC-4	245

**FACTORS FOR CONVERTING VOLUMES OF LIQUID ASPHALT
FROM VOLUME AT ANY TEMPERATURE TO VOLUME
AT 60° F.**

(This table applies to liquid asphalts SC-2, SC-3, SC-4, 90-95, 95+, MC-2, MC-3, MC-4, MC-5, RC-1, RC-2, RC-3, and RC-4. Coefficient of expansion at 60° F., 0.00035. Gravity range, degrees A. P. I. at 60° F., up to 14.9.)

Temp. °F.	Conversion Factor	Temp. °F.	Conversion Factor	Temp. °F.	Conversion Factor	Temp. °F.	Conversion Factor
60	1.0000	140	0.9724	220	0.9458	300	0.9201
62	0.9993	142	0.9718	222	0.9451	302	0.9195
64	0.9986	144	0.9711	224	0.9445	304	0.9188
66	0.9979	146	0.9704	226	0.9438	306	0.9182
68	0.9972	148	0.9697	228	0.9432	308	0.9176
70	0.9965	150	0.9691	230	0.9425	310	0.9169
72	0.9958	152	0.9684	232	0.9419	312	0.9163
74	0.9952	154	0.9677	234	0.9412	314	0.9157
76	0.9944	156	0.9670	236	0.9406	316	0.9151
78	0.9938	158	0.9664	238	0.9399	318	0.9145
80	0.9931	160	0.9657	240	0.9392	320	0.9138
82	0.9924	162	0.9650	242	0.9386	322	0.9132
84	0.9917	164	0.9643	244	0.9380	324	0.9126
86	0.9910	166	0.9637	246	0.9373	326	0.9119
88	0.9903	168	0.9630	248	0.9367	328	0.9113
90	0.9896	170	0.9623	250	0.9360	330	0.9107
92	0.9889	172	0.9616	252	0.9354	332	0.9101
94	0.9882	174	0.9610	254	0.9347	334	0.9095
96	0.9876	176	0.9603	256	0.9341	336	0.9088
98	0.9869	178	0.9596	258	0.9335	338	0.9082
100	0.9862	180	0.9590	260	0.9328	340	0.9076
102	0.9855	182	0.9583	262	0.9322	342	0.9070
104	0.9848	184	0.9576	264	0.9315	344	0.9064
106	0.9841	186	0.9569	266	0.9309	346	0.9057
108	0.9834	188	0.9563	268	0.9303	348	0.9051
110	0.9827	190	0.9556	270	0.9296	350	0.9045
112	0.9820	192	0.9549	272	0.9290	352	0.9039
114	0.9813	194	0.9543	274	0.9283	354	0.9033
116	0.9806	196	0.9536	276	0.9277	356	0.9027
118	0.9799	198	0.9530	278	0.9271	358	0.9021
120	0.9792	200	0.9523	280	0.9264	360	0.9014
122	0.9785	202	0.9517	282	0.9258	362	0.9008
124	0.9779	204	0.9510	284	0.9252	364	0.9002
126	0.9772	206	0.9504	286	0.9245	366	0.8996
128	0.9765	208	0.9497	288	0.9239	368	0.8990
130	0.9758	210	0.9490	290	0.9233	370	0.8984
132	0.9751	212	0.9484	292	0.9226	372	0.8978
134	0.9745	214	0.9477	294	0.9220	374	0.8972
136	0.9738	216	0.9471	296	0.9214	376	0.8965
138	0.9731	218	0.9464	298	0.9207	378	0.8959

FACTORS FOR CONVERTING VOLUMES OF LIQUID ASPHALT—*Continued*

Temp. °F.	Conversion Factor	Temp. °F.	Conversion Factor	Temp. °F.	Conversion Factor	Temp. °F.	Conversion Factor
380	0.8953	410	0.8863	440	0.8773	470	0.8685
382	0.8947	412	0.8857	442	0.8767	472	0.8679
384	0.8941	414	0.8851	444	0.8762	474	0.8673
386	0.8935	416	0.8845	446	0.8756	476	0.8668
388	0.8929	418	0.8839	448	0.8750	478	0.8662
390	0.8923	420	0.8833	450	0.8744	480	0.8656
392	0.8917	422	0.8827	452	0.8738	482	0.8650
394	0.8911	424	0.8821	454	0.8732	484	0.8644
396	0.8905	426	0.8815	456	0.8726	486	0.8639
398	0.8899	428	0.8809	458	0.8720	488	0.8633
400	0.8893	430	0.8803	460	0.8714	490	0.8627
402	0.8887	432	0.8797	462	0.8709	492	0.8621
404	0.8881	434	0.8791	464	0.8703	494	0.8615
406	0.8875	436	0.8785	466	0.8697	496	0.8610
408	0.8869	438	0.8779	468	0.8691	498	0.8604

FACTORS FOR CONVERTING VOLUMES OF LIQUID ASPHALT
FROM VOLUME AT ANY TEMPERATURE TO VOLUME
AT 60° F.

(This table applies to liquid asphalts MC-1, SC-1, and SC-1A. Coefficient of expansion at 60°F., 0.00040. Gravity range, degrees A. P. I. at 60° F., 15.0 to 34.9.)

Temp. °F.	Conver- sion Factor	Temp. °F.	Conver- sion Factor	Temp. °F.	Conver- sion Factor	Temp. °F.	Conver- sion Factor	Temp. °F.	Conver- sion Factor
60	1.0000	98	0.9849	136	0.9701	174	0.9555	212	0.9412
61	0.9996	99	0.9845	137	0.9697	175	0.9551	213	0.9408
62	0.9992	100	0.9841	138	0.9694	176	0.9547	214	0.9405
63	0.9988	101	0.9837	139	0.9690	177	0.9543	215	0.9401
64	0.9984	102	0.9833	140	0.9686	178	0.9540	216	0.9397
65	0.9980	103	0.9830	141	0.9682	179	0.9536	217	0.9393
66	0.9976	104	0.9826	142	0.9678	180	0.9532	218	0.9390
67	0.9972	105	0.9822	143	0.9675	181	0.9528	219	0.9386
68	0.9968	106	0.9818	144	0.9671	182	0.9524	220	0.9382
69	0.9964	107	0.9814	145	0.9667	183	0.9521	221	0.9378
70	0.9960	108	0.9811	146	0.9663	184	0.9517	222	0.9374
71	0.9956	109	0.9807	147	0.9659	185	0.9513	223	0.9371
72	0.9952	110	0.9803	148	0.9655	186	0.9509	224	0.9367
73	0.9948	111	0.9799	149	0.9651	187	0.9505	225	0.9363
74	0.9944	112	0.9795	150	0.9647	188	0.9502	226	0.9359
75	0.9940	113	0.9791	151	0.9643	189	0.9498	227	0.9356
76	0.9936	114	0.9787	152	0.9639	190	0.9494	228	0.9352
77	0.9932	115	0.9783	153	0.9636	191	0.9490	229	0.9349
78	0.9929	116	0.9779	154	0.9632	192	0.9487	230	0.9345
79	0.9925	117	0.9775	155	0.9628	193	0.9483	231	0.9341
80	0.9921	118	0.9771	156	0.9624	194	0.9480	232	0.9337
81	0.9917	119	0.9767	157	0.9620	195	0.9476	233	0.9334
82	0.9913	120	0.9763	158	0.9616	196	0.9472	234	0.9330
83	0.9909	121	0.9759	159	0.9612	197	0.9468	235	0.9326
84	0.9905	122	0.9755	160	0.9608	198	0.9465	236	0.9322
85	0.9901	123	0.9752	161	0.9604	199	0.9461	237	0.9318
86	0.9897	124	0.9748	162	0.9601	200	0.9457	238	0.9315
87	0.9893	125	0.9744	163	0.9597	201	0.9453	239	0.9311
88	0.9889	126	0.9740	164	0.9594	202	0.9449	240	0.9307
89	0.9885	127	0.9736	165	0.9590	203	0.9446	241	0.9303
90	0.9881	128	0.9732	166	0.9586	204	0.9442	242	0.9300
91	0.9877	129	0.9728	167	0.9582	205	0.9438	243	0.9296
92	0.9873	130	0.9724	168	0.9578	206	0.9434	244	0.9293
93	0.9869	131	0.9720	169	0.9574	207	0.9430	245	0.9289
94	0.9865	132	0.9716	170	0.9570	208	0.9427	246	0.9285
95	0.9861	133	0.9713	171	0.9566	209	0.9423	247	0.9281
96	0.9857	134	0.9709	172	0.9562	210	0.9419	248	0.9278
97	0.9853	135	0.9705	173	0.9559	211	0.9415	249	0.9274

32.7 Conversion Factors—Asphalt Emulsions. Where measurement of emulsified asphalts by volume is used, a gallon shall be construed to be a gallon in volume at a temperature of 77 degrees Fahrenheit, and one ton of the emulsion shall be considered as consisting of two hundred forty gallons at that temperature. Volumes measured at any other temperature may be reduced to volume at 77 degrees Fahrenheit by using a coefficient of expansion of 0.0003 per degree Fahrenheit.

32.8 Method of Measurement. The quantity of liquid asphalt to be paid for shall be the number of tons of 2,000 pounds or the number of gallons ~~at a temperature of 77 degrees Fahrenheit~~, as indicated by the unit in the proposal, of acceptable material placed in accordance with the plans and specifications for the particular item of work into which it enters.

Contract
measured at
add emulsion
60

SECTION 33—BITUMINOUS PRIME COAT

33.1 Description. This item shall consist of the application of a bituminous material on a previously prepared base, road surface, or shoulder and, if required, covering the application with a sand blotter.

33.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Blotter sand	Section 86
Liquid asphalt	Section 88
Emulsified asphalt	Section 89

33.3 Construction Methods. The surface to be covered shall be thoroughly bonded and compacted. Before applying the bituminous material, all loose material and objectionable matter shall be removed from the surface by thorough brooming.

The bituminous material, of the kind indicated on the plans or in the special provisions, shall be applied at the rate of one-fourth to one-half gallon per square yard, as directed by the engineer, in accordance with the specifications for road application of bituminous materials, Section 32. An additional application at the rate ordered by the engineer shall be applied to portions of the road which require and will absorb more than spread in the first application.

After the bituminous material has penetrated for a period of not less than four hours, the treated area, where ordered by the engineer, shall be covered with sand in just sufficient quantity to absorb any excess bituminous material and prevent picking up by traffic. The sand shall be spread uniformly over the area to be covered, and lightly broomed.

33.4 Method of Measurement. Bituminous material shall be measured as specified in Section 32.

The quantity of blotter sand to be paid for shall be the number of tons of 2,000 pounds or the number of cubic yards, measured in the hauling vehicle at the point of loading, as indicated by the unit stated in the proposal,

conforming to all requirements in the completed and accepted work.

33.5 Basis of Payment. Bituminous material, measured as provided above, shall be paid for at the contract unit price per ton or at the contract unit price per gallon for the particular type of material required.

Blotter sand, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard for "Blotter Sand."

Payments specified above shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 34—BITUMINOUS SEAL COAT

34.1 Description. This item shall consist of the application of a bituminous material on a compacted and bonded bituminous surface and, if required, covering the application with a sand blotter.

34.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Blotter sand	Section 86
Liquid asphalts	Section 88
Emulsified asphalt	Section 89

34.3 Construction Methods. Before applying the seal to the surface, all loose materials, earth, or other objectionable matter shall be removed by thorough brooming.

The bituminous material, of the kind indicated on the plans or in the special provisions, shall be applied in accordance with the specifications for road application of bituminous material, Section 32, at the rate of from one twelfth gallon to two-tenths gallon per square yard as directed by the engineer.

An additional application at the rate ordered by the engineer shall be made to portions of the road which require and will absorb more than spread in the first application.

After the bituminous material has been allowed to penetrate and dry for a period not less than four hours, the treated surface, where ordered by the engineer, shall be covered with sand in just sufficient quantity to absorb any excess bituminous material and prevent picking up by traffic. The sand shall be spread evenly over the areas to be covered and lightly broomed.

34.4 Method of Measurement. Bituminous material shall be measured as specified in Section 32.

The quantity of blotter sand to be paid for shall be the number of tons of 2,000 pounds or the number of cubic yards, measured in the hauling vehicle at the point of loading, as indicated by the unit stated in the proposal, conforming to all requirements in the completed and accepted work.

34.5 Basis of Payment. Bituminous material, measured as provided above, shall be paid for at the contract unit price per ton or the contract unit price per gallon for the particular type of material required.

Blotter sand, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard for "Blotter Sand."

Payments specified above shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 35—CLASS A-1 BITUMINOUS SURFACE TREATMENT

35.1 Description. This item shall consist of a surface cover of bituminous material and screenings applied on a previously compacted and bonded bituminized surface complying with the cross section and profile shown on the plans.

35.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Screenings	Section 77
Liquid asphalt	Section 88
Emulsified asphalt	Section 89

35.3 Construction Methods. The surface to be covered shall be broomed with a revolving power broom until all loose particles, earth and other objectionable material have been removed. The bituminous material of the type indicated on the plans or in the special provisions shall be applied at the rate shown in the following table in accordance with the requirements of Section 32 of these specifications.

APPROXIMATE RATE OF SPREADING MATERIALS FOR BITUMINOUS SURFACE TREATMENT

Type of the Bituminous Material	Rate per square yard of surface	
	Bituminous Material, Gallon	Screenings, Pounds
MC-3 or MC-4	1/6	12
RC-3 or RC-4	1/6	12
90-95 or 95+	1/4	20
Emulsified Asphalt	1/5	15

Screenings shall be spread over the bituminous application at the rate per square yard shown above, and shall be rolled into the bituminous material before it materially cools or hardens. Spreading shall be done from trucks operated backward so that the wheels of the truck will not come into contact with the bituminous material, and so equipped as to distribute the material in a thin even sheet

over the surface to be covered. Immediately following the spreading, the screenings shall be broomed with a stiff wire broom attached to the blade of a long wheel base motor grader so as to remove all irregularities and plane the screenings to a smooth, true surface. The surface shall then be rolled with a power roller weighing not less than five tons until the screenings are thoroughly set into the bituminous material. Rolling shall be accompanied by such brooming as is necessary to remove any irregularities that may develop. Additional screenings shall be spread by hand and broomed to cover any thin spots. Roller wheels shall be kept oiled or watered to prevent picking up.

The completed surface shall be smooth and uniform in appearance, thoroughly bonded, and free from ruts, depressions, humps, or other irregularities.

Maintenance of the surface until completion of the contract shall include occasional redistribution of loosened screenings over the surface by brooming and additional rolling.

35.4 Method of Measurement. Bituminous material shall be measured as specified in Section 32.

The quantity of screenings for surface treatment to be paid for shall be the number of tons of 2,000 pounds, or the number of cubic yards measured in the hauling vehicle at the point of loading, as indicated by the unit stated in the proposal, conforming to all requirements in the completed and accepted work.

35.5 Basis of Payment. Bituminous material, measured as provided above, shall be paid for at the contract unit price per ton or the contract unit price per gallon for the particular type of material required.

Screenings, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard for "Screenings," which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 36—CLASS A BITUMINOUS ARMOR COAT

36.1 Description. This item shall consist of the construction of a wearing course composed of three applications of bituminous material, each covered with mineral aggregate, placed upon a previously bituminized surface, or upon a thoroughly compacted surface that has been given a prime coat, and which complies with the lines, grades, and cross section shown on the plans.

36.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Coarse aggregate	Section 77
Key rock	Section 77
Screenings	Section 77
Liquid asphalt (90-95 or 95+)	Section 88
Emulsified asphalt (pen. type)	Section 89

36.3 Equipment. Mineral aggregate shall be spread from trucks equipped with approved devices to distribute the material uniformly at the required rate per square yard.

Rollers shall be tandem type power rollers weighing not less than 10 tons.

The grader used for leveling shall be of the self-propelled type, tightly articulated, having a wheel base of not less than 16 feet and a blade not less than 10 feet long. Stiff brooms with suitable devices for attaching to the blade of the grader and to the rollers shall be provided.

36.4 Construction Methods. When required on the plans or in the special provisions, a prime coat shall be applied in accordance with Section 33. The sequence of the various operations and the approximate amount of materials shall be as shown in the following tables:

**APPROXIMATE AMOUNT MATERIALS AND SEQUENCE
OF OPERATIONS USING LIQUID ASPHALT**

Operation	Materials per Square Yard			
	Liquid Asphalt Gallons	Coarse Aggregate Pounds	Key Rock Pounds	Screen- ings Pounds
1st application	0.15			
1st spread	-----	40		
Blade, broom, roll				
2d application	0.30			
2d spread	-----	---	12	
Blade, broom, roll				
3d application	0.15			
3d spread	-----	---	---	8
Blade, broom, roll	-----	---	---	---
Approx. total	0.60	40	12	8

**APPROXIMATE AMOUNT MATERIALS AND SEQUENCE
OF OPERATIONS USING EMULSIFIED ASPHALT**

Operation	Materials per Square Yard			
	Emulsified Asphalt Gallons	Coarse Aggregate Pounds	Key Rock Pounds	Screen- ings Pounds
1st application	0.10			
1st spread	-----	36		
Blade, roll lightly				
2d application	0.35			
2d spread	-----	---	16	
Blade, broom, roll				
3d application	0.25			
3d spread	-----	---	---	8
Blade, broom, roll	-----	---	---	---
Approx. total	0.70	36	16	8

In hot, dry weather, or when ordered by the engineer, aggregate shall be moistened before applying emulsified asphalt.

Bituminous material of the kind indicated on the plans or in the special provisions, shall be applied in accordance with the specification for road application of bituminous materials, Section 32.

The first application of bituminous material shall be covered immediately with the coarse aggregate which shall be bladed and broomed to a smooth, true, uniform surface. It shall then be rolled until the aggregate is thoroughly

embedded in the asphalt and bonded. Spreading equipment shall be operated in such manner that the wheels will not come in contact with uncovered bituminous material.

Each succeeding spread of aggregate shall be made promptly after applying the bituminous material, and shall be bladed and broomed to a smooth, uniform, true surface, and rolled until thoroughly set into the voids and compacted. Such brooming as is necessary to uniformly distribute the aggregate shall accompany the rolling. Additional aggregate shall be applied by hand during the rolling and brooming operations to cover any bare or inadequately covered places.

The finished surface shall be smooth, uniform in appearance, and thoroughly bonded, except for a slight excess of loose screenings on the surface. Maintenance of the surface until completion of the contract shall include occasional redistribution of loosened screenings over the surface by brooming and additional rolling.

36.5 Method of Measurement. Bituminous material shall be measured as specified in Section 32.

The quantity of aggregate for bituminous armor coat to be paid for shall be the number of tons of 2,000 pounds or the number of cubic yards, measured in the hauling vehicle at the point of loading, as indicated by the unit stated in the proposal, of each of the classes used, conforming to all requirements in the completed and accepted work.

36.6 Basis of Payment. Bituminous material, measured as provided above, shall be paid for at the contract unit price per ton, or the contract unit price per gallon, for the particular type of material required.

Aggregate, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard for "Coarse Aggregate," "Key Rock," or "Screenings," as the case may be.

The quantity of water acceptably applied shall be measured and paid for as provided in Section 27.

Bituminous prime coat, when required, shall be measured and paid for as specified in Section 33.

Payments specified above shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 37—CLASS B-1 ROADMIX BITUMINOUS SURFACE

37.1 Description. This item shall consist of the construction of a surface course of dense graded aggregate and slow curing liquid asphaltic material, mixed in place upon the road and compacted, in accordance with these specifications and in conformity with the lines, grades, and cross section shown on the plans or ordered by the engineer.

37.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Aggregate for bituminous roadmix	
surface	Section 76
Liquid asphalts(SC-2, SC-3, SC-4) ..	Section 88

37.3 Placing Aggregate. When all or part of the aggregate required for the construction of the roadmix surface is to be placed, the surface of the road shall be scarified lightly to a depth just sufficient to permit elimination of irregularities and reshaping true to grade and cross section. The required amount of aggregate shall then be placed and compacted in accordance with the specification for gravel surface course, Section 31. When the aggregate is to be treated with liquid asphalt immediately after being placed, the compaction requirement on the portion to be incorporated in the mix may be waived at the discretion of the engineer, provided that, in his opinion, there will be no segregation of materials nor loss of fines.

37.4 Preparation for Mixing. Prior to spreading the liquid asphalt, the roadway shall be bladed true to lines and grade. The surface shall then be scarified to a uniform depth sufficient to produce the required amount of loose material on an undisturbed base, and the loosened material shall be thoroughly mixed, pulverized and dried. If necessary to eliminate irregularities in grading or excess moisture, the loosened material shall be bladed into windrows and turned until the mass is uniform and dry. It shall then be respread. The aggregate shall not contain more than one and one-half percent of moisture by weight when the liquid asphalt is applied.

37.5 Equipment. Equipment used in the mixing process and for finishing shall be in good mechanical condition and shall be satisfactory to the engineer. Blade graders and motor graders shall be tightly articulated and shall be equipped with rubber tires. Tractors shall have smooth treads, free from lugs. Crawler type tractors will be permitted only for mixing. In the finishing process only motor graders with reasonably smooth pneumatic tires properly inflated and having a wheel base of not less than 16 feet shall be used. Precautions shall be taken to prevent scarring or marking the surface, and any unsatisfactory equipment shall be removed from the work.

Rollers shall be self-propelled tandem-type weighing not less than six tons nor more than eight tons.

37.6 Applying Bituminous Material. The engineer shall estimate the total amount of bituminous material, in gallons per square yard, required for each section of the road, and the amounts applied shall be in accordance with his instructions and of the kind or kinds shown on the plans or in the special provisions. The liquid asphalt shall be distributed in three applications, each approximately one-third of the required total. Each application shall be spread in accordance with the specifications for road application of bituminous material, Section 32.

Immediately following each application, sufficient mixing shall be done with disc and spring-tooth harrows to partially absorb the liquid asphalt and prevent the formation of pools. Liquid asphalt shall be spread only sufficiently in advance of the finishing to permit efficient operation of the mixing and finishing forces.

37.7 Mixing with Blade Graders. After the final application of liquid asphalt and the harrowing specified above, the entire mass of material to be mixed shall be moved by heavy blade graders into a windrow, and the windrow shall be moved by the same means from side to side of the road until completely mixed. During this operation the blade shall be set so as to cause a revolving motion of the mixture. Blading shall be accompanied by constant mixing with disc and spring-tooth harrows. The mix shall be deemed complete when all free bituminous material or

patches with excess bituminous material are scraped up from the base, the mixture is free from lumps and spots with excess bituminous material, all particles are uniformly coated with the bituminous material, and the mass has a uniform color.

If the mixture is found to contain an excess of bituminous material, additional untreated surfacing material shall be loosened and incorporated into the mix, and if it is found to contain a deficiency of bituminous material, the necessary additional amount of liquid asphalt shall be applied in the same manner as the original applications. In either case the mixing shall be resumed and continued until the entire mass is deemed to be completely mixed. Oversize rock or stones appearing in the mix from any cause shall be removed when exposed, and shall be deposited on embankment slopes where such slopes are steeper than four on one, or shall be otherwise disposed of, as directed by the engineer, in such manner as not to mar the appearance of the road.

If rain occurs during the mixing operations, the material shall be windrowed and left undisturbed until it can be mixed and spread under dry conditions, except for such turning as may be deemed necessary to reduce the moisture content of the mix to not more than two percent by weight.

When the mixing has been completed, a trench shall be cut for the thickened edge as shown on the plans, throwing the material from the trench outside the area to be covered by the surfacing. The mixture shall then be spread uniformly to the cross section and profile shown on the plans.

37.8 Applying and Mixing with Other Devices. These specifications are based upon applying the liquid asphalt with distributors and mixing with blade graders, but other methods and equipment will be approved provided results obtained are equal, in the opinion of the engineer, to those obtainable by the specified methods and equipment. Approval of the use of other methods and equipment shall not be construed to relieve the contractor of responsibility for obtaining satisfactory results, and any sections on which a satisfactory finished surface is not secured shall be torn up and refinished as required in Article 37.11.

37.9 Finishing. After the mixture has been spread, the top half shall be bladed into a windrow on one side and then evenly respread over the entire surface. This operation shall be repeated, alternating the windrow from one side of the road to the other and to the center, and gradually decreasing the amount of material moved, until the entire surface has a uniform texture, is smooth, true to cross section and profile, and is uniformly compacted.

37.10 Rolling. Upon completion of the blading and as soon as the surfacing has set sufficiently to prevent shoving under the roller, the surfacing shall be rolled. Rolling shall be longitudinal and shall begin at the outer edges, progressing inward until the entire surface has been covered. Rolling shall continue intermittently, allowing time in between rolling periods for further setting of the surface, until the surface is dense, hard, and free from loose aggregate and traffic marks. Blading shall be resumed during the rolling if necessary to maintain a true surface. No rolling shall be done while the surface is wet.

After rolling has been completed, shoulders and side ditches shall be finished smooth and true to profile and cross section.

37.11 Refinishing. If any excess or deficiency of asphaltic material develops during the compaction period or at any time prior to final acceptance, it shall be remedied by adding more aggregate or liquid asphalt as required, remixing and refinishing.

If rain falls during the compaction period and penetrates into the surface to such an extent that the surface swells and cracks, the surface shall be scarified, bladed into windrows and turned until it has been dried out. It shall then be respread and refinished.

37.12 Widened Sections. At all dips the width of the roadmix bituminous surface shall extend from shoulder to shoulder for the full length of the dip curb. At curves and other points shown on the plans the width of the roadmix surface shall be increased as indicated.

37.13 Road Intersections. At intersections with other roads, including farm entrances, the roadmix surfacing

shall be widened to the extent and for the distance shown on the plans. The widening shall be done by suitable means that will not result in a total thickness of base and surface less than that shown on the plans. If suitable material is in place at the intersection to be surfaced, it may be mixed in place or the material may be moved into the area occupied by normal roadway section and after mixing replaced in the intersection. If suitable material is not in place in the intersection, mixed material may be obtained from the windrow in small amounts over a sufficient distance so as not to materially reduce the thickness of the roadway surfacing. Intersections shall be finished and rolled as specified for the remainder of the road surface.

Intersecting roads or approaches from the outer edge of the mixed portion to the right of way line shall be given a prime coat in accordance with Section 33.

37.14 Seal Coat. After the surface has been finished and under traffic for a period of not less than three weeks, a bituminous seal coat shall be applied in accordance with Section 34.

37.15 Method of Measurement. Liquid asphalt shall be measured as specified in Section 32.

Mixing shall be measured in miles along the center line of the roadway, and no extra allowance shall be made for widened sections and intersections, except as provided below.

When separate payment for mixing intersections is provided as shown by an item in the proposal, the number of intersections mixed shall be measured as units.

37.16 Basis of Payment. Aggregate, when required, shall be measured and paid for as specified in Section 31.

Liquid asphalt used in the mix, measured as provided above, shall be paid for at the contract unit price per ton, or the contract unit price per gallon, for the particular type of material applied.

Mixing, measured as provided above, shall be paid for at the contract unit price per mile for "Roadmix."

If the proposal contains a separate estimate of quantities, intersections mixed, measured as provided above, shall be paid for at the contract unit price each for "Roadmix

Intersections." When the proposal does not include an item, compensation for this work shall be considered as included in the contract prices for other items of the work.

Seal coat shall be measured and paid for as specified in Section 34.

Prime coat applied to intersections shall be measured and paid for as specified in Section 33.

Payments specified above shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 38—CLASS C-1 ROADMIX BITUMINOUS SURFACE

38.1 Description. This item shall consist of the construction of a surface course of dense graded aggregate and medium curing or rapid curing liquid asphalt, mixed in place on the road and compacted, in accordance with these specifications and in conformity with the lines, grades and cross sections shown on the plans or ordered by the engineer.

38.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Aggregate for bituminous roadmix surface	Section 77
Liquid asphalts (MC or RC series) ..	Section 88

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38.3 Construction Methods. All of the requirements of Articles 37.3 to 37.14, inclusive, shall apply with the following additions:

If after the mixing has been completed, the mixed material is not completely aerated, in the opinion of the engineer, it shall be windrowed and allowed to stand for such period as the engineer may direct to secure complete aeration of the solvent. During this period the windrow shall be turned over completely at least twice each day.

38.4 Measurement and Payment. Measurement and payment shall be made in accordance with all of the provisions of Articles 37.15 and 37.16.

SECTION 39—CLASS C-2 BITUMINOUS RETREAD SURFACE

39.1 Description. This item shall consist of a surface course composed of coarse aggregate, key rock, and screenings uniformly mixed, penetrated and bound together with emulsified asphalt, or rapid curing liquid asphalt, and placed upon the approved base in accordance with these specifications and in conformity with the lines, grades, and cross sections shown on the plans. Two types are specified; the type applying shall be as shown on the plans or in the special provisions.

39.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Aggregate for retread.....	Section 77
Liquid asphalt (RC-3 or RC-4).....	Section 88
Emulsified asphalt	Section 89

39.3 Equipment. Trucks for hauling and spreading the coarse aggregate shall be equipped to distribute the material uniformly from the tail gates. For spreading the key rock and the screenings they shall be equipped with mechanical spreaders or other devices that will spread the material in a sheet of uniform thickness over the area to be covered.

Graders for mixing and blading shall be of the self-propelled type with a wheel base of not less than 16 feet, shall have a blade not less than 10 feet long, and pneumatic tires. Stiff brooms with suitable devices for attaching to the blade of the grader shall be provided for the brooming. Mixing may be done with special mixers designed for this purpose, if, in the opinion of the engineer, results are as good as obtainable with blade graders. Should such equipment prove unsatisfactory at any time it shall be removed from the work and blade graders substituted.

Rollers shall be of the self-propelled tandem-type weighing not less than eight tons. At least one roller shall be

provided for each 200 tons of mineral aggregate placed per eight-hour day.

39.4 Preparation of Base. When the base course is a water-bound type, it shall be given a prime coat in accordance with Section 33 of these specifications prior to starting the surface course. Where an old bituminized or cement concrete surface course is to serve as the base, it shall be thoroughly cleaned by brooming to remove all dust and loose material, all soft asphaltic patches and joint material shall be removed, and all holes, depressions, and other irregularities shall be patched, built up, or otherwise corrected as directed by the engineer.

39.5 Construction Methods. Mineral aggregate shall be thoroughly dry when cutback asphalt is applied. During hot, dry weather, coarse aggregate shall be sprinkled with water before applying emulsified asphalt. Bituminous binder shall be applied in accordance with Section 32 of these specifications.

The sequence of the various operations and approximate amounts of material shall be as shown in the following tables:

ESTIMATED QUANTITIES—TYPE 1 RETREAD
(Compacted Thickness $1\frac{1}{2}$ Inches)

Operation	Materials per Square Yard of Surface				
	Cutback Asphalt, Gallon	Emulsified Asphalt, Gal. Mixing	Pene- tration	Coarse Aggre- gate, lbs.	Key Rock lbs. Screen- ings lbs.
1st spread .....	.....	.....	.....	120	
1st application ..	0.30	0.30			
Mix					
2d application....	0.30	0.30			
Mix, shape, roll					
2d spread .....	.....	.....	.....		20
Broom, roll					
3d application....	0.40	.....	0.50		
3d spread .....	.....	.....	.....		10
Broom, roll					
Open to traffic					
4th application..	0.30	.....	0.40		
4th spread .....	.....	.....	.....		15
Broom, roll					
Approx. total	1.30	0.60	0.90	120	20 25

ESTIMATED QUANTITIES—TYPE 2 RETREAD
(Compacted Thickness $1\frac{1}{2}$ Inches)

Operation	Materials per Square Yard of Surface				
	Liquid Asphalt, Gallon	Emulsified Asphalt, Gal. Mixing	Pene- tration	Coarse Aggregate, lbs.	Key Rock lbs. Screen- ings lbs.
1st spread .....	.....	.....	.....	135	
1st application ..	0.35	0.35			
Mix					
2d application....	0.30	0.40			
Mix, shape, roll					
2d spread .....	.....	.....	.....		14
Broom, roll					
3d application....	0.10	.....	0.10		
Curing period					
Open to traffic					
4th application..	0.20	.....	0.20		
4th spread .....	.....	.....	.....	.....	15
Approx. total	0.95	0.75	0.30	135	14 15

Coarse aggregate shall be uniformly spread upon the base and bladed to a smooth surface and uniform cross section. Immediately following the first application of bituminous binder, the coarse aggregate and bituminous binder shall be mixed, either by blading from side to side of the road or by other suitable means. Mixing shall continue until all particles of the aggregate are coated with bituminous binder and the mass has a uniform color. The material shall then be spread and given the second application of bituminous binder before the first application has dried or set. Mixing, as specified above, shall be resumed immediately following the second application of bituminous binder, and shall continue until all particles are coated and the mixture is uniform in appearance. The mixture shall then be bladed to a smooth surface, true to profile and cross section.

When emulsified asphalt is used for the binder and begins to coalesce and strip from the aggregate, mixing or other manipulation shall be discontinued between the beginning of the set and complete adherence to the rock.

During the mixing and spreading, care shall be used to prevent disturbing the base or incorporating shoulder material into the mix.

After the mixture has been spread and is in proper condition of tackiness, it shall be rolled to cover the whole surface once, slightly overlapping each trip of the roller. The roller wheels shall be kept oiled or moistened to prevent picking up the mixture. After rolling once, all irregularities shall be removed by planing with a blade grader, and adding premixed material when required. Spots that tend to ravel shall be removed and replaced with premixed material. The mixture again shall be rolled once over.

After the rolled mixture has cured properly, key rock shall be spread in the required amount as determined by the engineer and approximately as shown by the above table. The amount shall be just sufficient to fill the voids in the coarse aggregate. Key rock shall be broomed until evenly distributed over the surface, and shall then be rolled until embedded into the voids and the whole mass is thoroughly bonded and locked and all surface voids are filled. Rolling shall be accompanied by such brooming as is necessary to sweep the rock into the voids. Additional key rock shall be added by hand to any spots where there is a deficiency.

When the key rock has been rolled into the surface voids as specified above, the third application of bituminous binder shall be applied. When Type 1 retread is specified, the third application of bituminous binder shall be covered immediately with the first spread of screenings. The screenings shall be broomed and rolled, and additional screenings shall be spread where required, as specified above for key rock. Rolling shall be resumed at the proper periods during several days. When Type 2 retread is specified, the third application of bituminous binder shall not be covered, and shall not be disturbed until dry and thoroughly cured. The road shall then be opened to traffic for a period of not less than 10 days. The surface shall then be swept clean of all dirt and loose material, and the fourth application of bituminous binder applied and covered immediately with an application of screenings. Brooming and rolling shall follow as specified above for other applications.

The finished surface shall be smooth, true to the required cross section, and free from irregularities. When tested

by a straightedge 10 feet long placed on the surface parallel to the center line, the surface shall at no point vary more than one-quarter inch from the lower edge of the straight-edge.

Maintenance until completion of the contract shall include frequent brooming to redistribute any loose screenings over the surface.

39.6 Method of Measurement. Bituminous material shall be measured as specified in Section 32.

The quantity of aggregate to be paid for shall be the number of tons of 2,000 pounds or the number of cubic yards, measured in the hauling vehicle at the point of loading, as indicated by the unit stated in the proposal, of each of the classes used, conforming to all requirements in the completed and accepted work.

39.7. Basis of Payment. Scraping and cleaning of old surfaces serving as a base shall not be paid for directly but shall be included in the contract prices for other items.

Bituminous prime coat, when required, shall be measured and paid for as specified in Section 33.

Bituminous material, measured as provided above, shall be paid for at the contract unit price per ton, or the contract unit price per gallon, for the particular type of material required.

Aggregate, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard for "Coarse Aggregate," "Key Rock" or "Screenings" as the case may be.

The quantity of water acceptably applied shall be measured and paid for as provided in Section 27.

Payments specified above shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, including patching or building up depressions, holes, or other irregularities.

SECTION 40—CLASS F-1 PLANTMIX BITUMINOUS SURFACE

40.1 Description. This item shall consist of a surface course of graded aggregate and medium curing or rapid curing liquid asphalt mixed in a central mixing plant, and placed on a compacted base course, in accordance with these specifications, and in conformity with the lines, grades, and cross sections shown on the plans.

40.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Aggregate for plantmix bitumi- nous surface	Section 76
Liquid asphalt (MC or RC series)....	Section 88

40.3 Equipment. The mixing plant shall be designed and assembled so as to properly dry, heat, screen, and mix the materials. The drier shall be equipped to constantly agitate the aggregate while heat is being applied. A registering pyrometer shall be installed at a suitable point at the discharge end of the drier with the registering device so located that it will indicate clearly to the drum fireman the temperature of the aggregate when discharged. The storage bin shall be divided into three compartments, each of which shall be provided with an overflow that will prevent backing up of material and overflowing into another compartment. Screens shall have capacities slightly in excess of the capacity of the mixer when operated at normal speeds. The mixer shall be an approved type, preferably the pug mill type, and shall be equipped with an automatic timing device consisting of either a bell or light signal to prevent undermixing of batches. Steam coils shall be provided for heating the bituminous material, and the coils shall be so arranged that steam will not be introduced into the bituminous material. An armored thermometer reading from 100 degrees Fahrenheit to 500 degrees Fahrenheit shall be fixed in the asphalt line at a suitable location. Both the batch box and the asphalt bucket shall be equipped with approved weighing devices of appropriate

sizes which can be readily adjusted. Scales shall have an accuracy of one-half percent for all loads. The minimum graduation for aggregate scales shall be not more than two pounds and for asphalt scales shall be not more than one-half pound. Weighing devices shall be sealed at the expense of the contractor as often as the engineer may deem necessary to assure accuracy.

Equipment used in the mixing process and for finishing shall be in good mechanical condition and shall be satisfactory to the engineer. Motor graders shall be tightly articulated, shall be equipped with rubber tires, and shall have a wheel base of not less than 16 feet. Crawler type tractors shall not be used for spreading or finishing. Precautions shall be taken to prevent scarring or marking the surface and any unsatisfactory equipment shall be removed from the work.

Rollers shall be approved, self-propelled tandem-type, weighing not less than six tons nor more than eight tons.

40.4 Field Laboratory. The contractor shall provide a field laboratory as specified in Section 72.

40.5 Preparation of the Mix. Fine material or filler, if required to meet the specified grading, shall be blended with the aggregate before screening 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 top of the aggregate pits or dumping it into the hopper at the crushing plant will not be permitted.

Aggregate shall be screened into three sizes, each of which shall be stored in a separate bin. The three sizes shall be that fraction retained on a No. 3 sieve, that passing a No. 3 sieve and retained on a No. 10 sieve, and that passing a No. 10 sieve. Should a bin contain 15 percent or more of material which is undersize for that bin, the bin shall be drawn and the material rescreened. At the time of mixing, the aggregate shall contain not more than one percent of moisture, and shall be introduced into the mix at a temperature suitable for efficient mixing.

The three sizes of aggregate shall be combined in uniform batches by weighing and conveying to the mixer the proportionate amounts of each size required to meet the specified grading. Exact proportions of each size shall be as determined by the engineer, to obtain the most suitable mix falling within the limits of the specified grading. The required quantity of bituminous material of the type shown on the plans or in the special provisions, as fixed by the engineer, shall be measured by weight into each batch, using scales attached to the asphalt bucket, and shall be introduced into the mixture at a temperature suitable for efficient mixing, but within the range specified in Section 32 for road applications. The amount used shall be sufficient to properly coat all particles of the aggregate, ordinarily three percent to six percent of the weight of the mix.

Mixing shall continue until a uniform mixture with all particles thoroughly coated with bituminous material is obtained, but not less than 35 seconds after the bituminous material is introduced.

40.6 Placing. Prior to placing the mix on the road, the primed base shall be cleaned of all loose and foreign material, and shall be acceptable to the engineer.

The material shall leave the plant at such temperature and shall be so protected during transportation that it will be spread at a temperature suitable for manipulation. Operations shall be so planned that there will be no hauling or other traffic over the loose material.

Spreading shall be done only when the base is dry, the air temperature is above 50 degrees Fahrenheit, and weather conditions are otherwise suitable.

Placing and compacting of the bituminous mixture shall be done in long sections, preferably not less than one-half mile in length, and in layers not to exceed two and one-half inches in thickness when compacted. The mixture shall be spread uniformly to the required thickness with approved spreader boxes. After each layer has been satisfactorily spread, the top one half shall be bladed into a windrow along one side of the road and the remaining material bladed smooth, allowed to properly aerate, and then rolled once over. The windrow shall then be moved to the side

that has been rolled and the unrolled portion of the half thickness layer shall be bladed smooth, allowed to properly aerate, and then rolled once over. Material in the windrow shall then be respread uniformly over the surface. The operation of windrowing and respreding shall be repeated, alternating the windrow from one side to the other and to the center, and gradually decreasing the amount of material moved, until the solvent is properly aerated and the entire surface has a uniform texture, is smooth, true to cross section and profile, and is uniformly compacted.

If the mixture, at any time after spreading on the road-bed, should show a moisture content of more than two percent, it shall be bladed and rebladed into windrows, and turned as many times as may be necessary to reduce the moisture content to two percent by weight of the dry aggregate.

Rolling on each layer shall begin after the blading has been completed and as soon as the surfacing has set sufficiently to prevent shoving under the roller. The rolling shall be longitudinal and begin at the outer edges, progressing inward until the entire surface has been covered. Rolling shall continue intermittently, allowing time in between rolling periods for further setting of the surface, until the surface is dense, hard, free from loose aggregate and traffic marks. Blading shall be resumed during the rolling if necessary to maintain a true surface. No rolling shall be done while the surface is wet.

If any areas show an excess of asphaltic material during the compaction period or at any time prior to final acceptance, they shall be removed and replaced with suitable mixture.

The finished surface shall be smooth and true to grade and cross section and free from ruts, bumps, or other irregularities. When tested with a 10 foot straightedge laid on the finished surface parallel to the center line, the surface shall vary in no place more than one-eighth inch from the lower edge of the straightedge.

The edges of the compacted surfacing shall be trimmed uniformly to the required lines and cross section before the shoulders are shaped and rolled.

40.7 Widened Sections. At curves and other points indicated on the plans or ordered by the engineer, the width of the plantmix surface shall be increased as directed.

40.8 Intersections. Intersecting roads and approaches shall be surfaced with plantmix surfacing as indicated on the plans or ordered by the engineer. If plantmix surfacing is not required on such roads or approaches from the normal edge of the roadway surface to the right of way line, the portion between the surfacing and the right of way line shall be given a prime coat in accordance with Section 33.

40.9 Surface Treatment. After the surfacing has been under traffic for a period of not less than two weeks, a bituminous surface treatment shall be applied in accordance with Section 35.

40.10 Method of Measurement. Liquid asphalt shall be measured as specified in Section 32.

The quantity of plantmix bituminous surfacing to be paid for shall be the number of tons of 2,000 pounds, conforming to all requirements, in the completed and accepted work, less the weight of the liquid asphalt incorporated in the mix.

40.11 Basis of Payment. Liquid asphalt used in the mix, measured as provided above, shall be paid for at the contract unit price per ton for the particular type of material used.

The quantity of surfacing, measured as provided above, shall be paid for at the contract unit price per ton for "Class F-1 Plantmix Bituminous Surface."

Prime coat applied to intersections shall be measured and paid for as specified in Section 33.

Surface treatment shall be measured and paid for as specified in Section 35.

Payments specified above shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 41—CLASS F-2 PLANTMIX BITUMINOUS SURFACE

41.1 Description. This item shall consist of a surface course of graded aggregate and slow curing liquid asphalt mixed in a central mixing plant, and placed on a compacted base course, in accordance with these specifications and in conformity with the lines, grades, and cross sections shown on the plans.

41.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Aggregate for plantmix bituminous surface	Section 76
Liquid asphalt (90-95 or 95+)	Section 88

41.3 Equipment. The mixing plant shall be designed and assembled so as to properly dry, heat, screen, and mix the materials. The drier shall be equipped to constantly agitate the aggregate while heat is being applied. A registering pyrometer shall be installed at a suitable point at the discharge end of the drier with the registering device so located that it will indicate clearly to the drum fireman the temperature of the aggregate when discharged. The storage bin shall be divided into three compartments, each of which shall be provided with an overflow that will prevent backing up of material and overflowing into another compartment. Screens shall have capacities slightly in excess of the capacity of the mixer when operated at normal speeds. The mixer shall be an approved type, preferably the pug mill type, and shall be equipped with an automatic timing device consisting of either a bell or light signal to prevent undermixing of batches. Steam coils shall be provided for heating the bituminous material and the coils shall be so arranged that steam will not be introduced into the bituminous material. An armored thermometer reading from 200 degrees Fahrenheit to 500 degrees Fahrenheit shall be fixed in the asphalt line at a suitable location. Both the batch box and the asphalt bucket shall be equipped with approved type weighing

devices of appropriate sizes which can be readily adjusted. Scales shall have an accuracy of one-half percent for all loads. The minimum graduation for aggregate scales shall be not more than two pounds and for asphalt scales shall be not more than one-half pound. Weighing devices shall be sealed at the expense of the contractor as often as the engineer may deem necessary to assure accuracy.

See letter 8-11-22 - Nevada H.D. Review made 1-11-23

The paver shall be an approved, self-propelled type which will spread and strike off a width equal to not less than one travel lane (10 or 11 feet), in such manner that no supplemental shaping will be required. It shall be so designed that neither the traction nor the main load of the paver will be carried on the uncompact mix. It shall be equipped with an agitator, preferably of the pug mill type, and shall spread the material evenly and with uniform density and strike it off true to the required cross section. Screeds shall not follow minor irregularities in the base, shall be readily adjustable, and shall be provided with gauges for accurate control of depth of spread.

Rollers shall be self-propelled tandem rollers weighing not less than eight tons. At least one roller shall be provided for each 50 tons of mixed material placed per hour.

Hauling equipment shall be equipped with pneumatic tires.

41.4 Field Laboratory. The contractor shall provide a field laboratory as specified in Section 72.

41.5 Preparation of the Mix. Fine material or filler, if required to meet the specified grading, shall be blended with the aggregate before screening 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 top of the aggregate pits or dumping it into the hopper at the crushing plant will not be permitted.

Aggregate shall be screened into three sizes, each of which shall be stored in a separate bin. The three sizes shall be that fraction retained on a No. 3 sieve, that passing a No. 3 sieve and retained on a No. 10 sieve, and that passing a No. 10 sieve. Should a bin contain 15 percent

or more of material which is undersize for that bin, the bin shall be drawn and the material rescreened. At the time of mixing, the aggregate shall contain not more than one percent of moisture, and shall be introduced into the mix at a temperature between 225 degrees Fahrenheit and 300 degrees Fahrenheit.

The three sizes of aggregate shall be combined in uniform batches by weighing and conveying to the mixer the proportionate amounts of each size required to meet the required grading. Exact proportions of each size shall be as determined by the engineer to obtain the most suitable mix falling within the limits of the specified grading. The required quantity of bituminous material of the type shown on the plans or in the special provisions, as fixed by the engineer, shall be measured by weight into each batch, using scales attached to the asphalt bucket, and shall be introduced into the mixture at a temperature between 250 degrees Fahrenheit and 325 degrees Fahrenheit. The amount used shall be sufficient to properly coat all particles of the aggregate, ordinarily three percent to six percent of the weight of the mix.

Mixing shall continue until a uniform mixture with all particles thoroughly coated with bituminous material is obtained, but not less than 40 seconds after the bituminous material is introduced.

41.6 Placing. Prior to placing the mix on the road, the primed base shall be cleaned of all loose and foreign material, and shall be acceptable to the engineer.

The material shall leave the plant at such temperature and shall be so protected during transportation that it will be spread at a temperature of between 175 degrees Fahrenheit and 250 degrees Fahrenheit. Operations shall be so planned that there will be no hauling or other traffic over the loose material.

Spreading shall be done only when the base is dry, the air temperature is above 50 degrees Fahrenheit, and weather conditions are otherwise suitable. Where the compacted thickness of the course exceeds two and one-half inches, it shall be laid, spread, and compacted in two layers of equal thickness. When it is not necessary to keep one

travel lane open for traffic, the spreading of the second lane shall follow the spreading of the first lane before the material has cooled so that the entire width of the surfacing can be compacted as a unit. When it is necessary to keep one lane open to traffic, the first lane spread shall be rolled until thoroughly compacted, except approximately six inches along the inside edge, before turning traffic over it and before starting the spread of the second lane. The inner edge of the first lane spread shall be trimmed to a vertical face before spreading the second lane, and all other necessary precautions shall be taken to obtain a tight, smooth joint.

Rolling shall follow spreading in the proper sequence and shall continue until the layer or course is smooth and no further compression is possible. It shall begin at the edges and progress toward the center, overlapping each preceding passage at least one third of the width of the roller wheel. Areas not accessible to the rollers shall be compacted by hand tamping with iron tampers weighing not less than 25 pounds and having a face area of approximately 64 square inches.

The edges of the compacted surfacing shall be trimmed uniformly to the required lines before the shoulders are shaped and rolled.

The compacted surfacing, prior to placing the surface treatment, shall be smooth, true to cross section and grade, and free from irregularities. It shall at no point vary more than one-eighth inch from a straightedge 10 feet long placed parallel to the center line.

41.7 Widened Sections. At curves and other points indicated on the plans, or ordered by the engineer, the width of the plantmix surface shall be increased as directed.

41.8 Intersections. Intersecting roads and approaches shall be surfaced with plantmix surfacing as indicated on the plans or ordered by the engineer. If plantmix surfacing is not placed on such roads or approaches from the normal edge of the roadway surface to the right of way line, the portion between the surfacing and the right of way line shall be given a bituminous prime coat in accordance with Section 33.

41.9 Surface Treatment. After the surfacing has been under traffic for a period or not less than two weeks, a bituminous surface treatment shall be applied in accordance with Section 35.

41.10 Method of Measurement. Liquid asphalt shall be measured as specified in Section 32.

The quantity of plantmix bituminous surfacing to be paid for shall be the number of tons of 2,000 pounds, conforming to all requirements, in the completed and accepted work, less the weight of the liquid asphalt incorporated in the mix.

41.11 Basis of Payment. Liquid asphalt used in the mix, measured as provided above, shall be paid for at the contract unit price per ton for the particular type of material used.

The quantity of surfacing, measured as provided above, shall be paid for at the contract unit price per ton for "Class F-2 Plantmix Bituminous Surface."

Prime coat applied to intersections shall be measured and paid for as specified in Section 33.

Surface treatment shall be measured and paid for as specified in Section 35.

Payments specified above shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 42—SIDE FORMS

42.1 Description. This item shall consist of furnishing and placing side forms for supporting the edges of Portland cement concrete, bituminous concrete, and when required by the plans, other pavements, and for supporting the spreading equipment required for these courses. It also shall include removing and disposing of the side forms when the specifications do not require that they be left in place for a permanent support for the edges of the surfacing.

42.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Timber, Douglas fir, 1600#f joist
and plankSection 110

(Note—Steel forms of a type approved by the engineer may be permitted when it is not required that forms be left in place.)

42.3 General Requirements. Side forms shall be placed along both edges of each strip of cement concrete, bituminous concrete, and, when required on the plans, other types of base and surface courses, except that where the edge butts against a curb, gutter, or a previously placed strip of surfacing, side forms will not be required.

Prior to placing side forms, the foundation upon which they are to rest shall be excavated to the required elevation and shall be thoroughly compacted. Side forms shall have full bearing for their entire length upon hard, compact material, and shall be set to conform accurately to the grade and alignment of the edge of the strip of surfacing to be supported. They shall be so set and supported that during the entire operations of placing, tamping, finishing, and rolling the pavement they will not at any time deviate vertically more than one-eighth inch from the proper elevation.

Forms which are to be removed shall be carefully oiled with an approved form oil and shall be reoiled each time they are reused.

Forms shall be cleaned and restored to their original condition before being reused, and any length of form which fails to fully meet all the requirements shall not be reused.

In advance of placing the pavement, the side forms shall be trued and maintained to the required line and grade for a distance of one day's run ahead of the placing operations. Should the side forms at any time during the placing of the surfacing not conform to the correct line and grade or become loose, operations shall be suspended until the fault is corrected.

42.4 Timber Side Forms. Timber side forms shall be surfaced on both edges and on the side next to the pavement. The nominal thickness shall be not less than four inches, the depth not less than the thickness of the full depth of the pavement edge, the length not less than 16 feet, and the ends shall be sawed square. Timbers with rounded edges, ends or corners damaged, or with any other defects shall not be used.

Timber side forms shall rest upon two-inch by three-inch stakes, spaced not more than four feet apart, and driven into the grade with their tops to the line and elevation for the bottom of the form. These stakes shall be of such length as to rigidly support the forms, but in no case shall be less than eight inches long.

The side forms shall be secured to side stakes, spaced not more than four feet apart, and driven vertically at points midway between the supporting stakes in such manner that their tops will be one inch below the top edge of the form. These stakes shall be three inches wide, one and one-half inches thick, and 18 inches long. Joints between sections of the forms shall be spliced with a piece of timber two feet in length, one inch thick and eight inches wide, which shall be nailed lengthwise, lapping the joints.

Side forms which are to remain as a permanent support shall be nailed to the new pavement with 50 penny nails at intervals of not more than five feet, driven transversely through the side forms from the outside or driven into the side forms from the inside and allowed to project.

42.5 Protective Strips. The top edge of timber side

forms and surfaces of curbs, gutters, or paving strips used to support the paving machine shall be faced temporarily with a steel strip to serve as track for the paving machine. The steel strips shall be not less than five-eighths inch by two and one-half inches in cross section, and not less than eight feet long. Sufficient strips shall be provided to keep the facing well ahead of paving operations and prevent delay to the work. They shall be firmly attached to the surface on which they rest.

42.6 Metal Side Forms. Metal side forms shall be straight, free from warp, of heavy section, and of sufficient rigidity to prevent springing during the placing and tamping of the concrete. Their depth shall be equal to the specified depth of the edge of the pavement, and the width of base shall not be less than eight inches. Forms shall be of the full depth required in one piece.

Forms and form joints shall be installed so that they will support the weight of a heavy finishing machine without settlement or lateral movement and, if necessary to secure such rigidity and supporting power, each length of form shall be supported on at least two stakes. Such stakes shall be two inches by three inches in size and of adequate length to support the form rigidly, but in no case shall the stakes be less than eight inches long. The stakes shall be driven so that their tops will conform to the line and grade for the bottom of the side forms.

Metal forms shall be staked firmly by means of steel stakes spaced not more than five feet apart and shall be so designed that stakes may be driven through the base of the form. "L" shaped forms shall be provided with three stake pockets per section for locking stakes in position. Should the forms be of enclosed trapezoidal section, the use of two stake pockets will be permitted, but the usual number of stakes through the base of the form will be required. Metal side forms shall be laid with an expansion gap of one-quarter of an inch between the ends.

42.7 Removing Forms. Forms which are to be removed shall be allowed to remain in place for at least one full day after the completion of the pavement and, when necessary in the opinion of the engineer, for such additional time as

the pavement edge may require support. They shall be removed in such manner as to avoid breaking or otherwise damaging the edge of the pavement.

42.8 Method of Measurement. When side forms are left in place and an item is included in the proposal, the quantity to be paid for shall be the number of lineal feet of form in place in the completed and accepted work.

42.9 Basis of Payment. Unless an item is included as specified below, the contract price for the particular type of pavement shall be considered as including payment for side forms.

If the proposal contains a separate estimate of quantities for side forms to be left in place, this item, measured as provided above, shall be paid for at the contract unit price per lineal foot for "Side Forms," which price shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 43—CLASS I BITUMINOUS CONCRETE SURFACE

43.1 Description. This item shall consist of a surface of one or more courses, composed of a mixture of coarse aggregate, fine aggregate, mineral filler, and asphalt cement thoroughly mixed in the proportions and placed upon the approved subgrade or base in accordance with these specifications and in conformity with the lines, grades, and cross sections shown on the plans or ordered by the engineer.

43.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Screenings	Section 77
Coarse aggregate for bituminous concrete	Section 78
Fine aggregate for bituminous concrete	Section 83
Mineral filler	Section 84
Liquid asphalt (90-95)	Section 88
Asphalt cement	Section 90

43.3 Side Forms. Side forms shall conform to and be placed in accordance with the requirements of Section 42. Unless otherwise specified, side forms shall be allowed to remain in place along the outside edges of the surfacing.

43.4 Subgrade. Subgrade shall be constructed in accordance with the requirements of Section 23. The subgrade shall be dry before laying the bituminous concrete.

When asphaltic concrete is placed on an old pavement, the pavement surface shall be prepared as indicated on the plans or in the special provisions.

43.5 Methods. The methods employed in performing the work, and all equipment, tools, and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the engineer. All equipment necessary for the laying of pavement shall be on hand and approved before laying operations are begun by the contractor.

43.6 Plant and Equipment. The plant shall be a type suitable for the work and shall be so assembled and maintained that it will at all times properly heat, screen, and mix the materials.

The drier shall be designed and operated to constantly agitate the aggregates during heating. It shall be capable of drying and heating the aggregates to specification requirements and to the full rated capacity of the plant. A registering pyrometer shall be installed at a suitable point at the discharge end, with the registering device so located as to clearly indicate to the drum firemen the temperature of the aggregate when discharged. The drier shall be fed by the belt and bunker or the belt and tunnel method, and approved automatic feeders shall be provided for all aggregates containing material passing the No. 10 sieve.

Suitable screens shall be provided for separating the materials into the various sizes, and the capacity of the screens when operated at normal speeds shall be slightly in excess of the maximum capacity of the mixer.

The plant shall be equipped with an approved type of dust collector, with provision for either wasting the dust collected or returning it uniformly to the mixture, as the engineer directs.

Four metal storage bins shall be provided—three for coarse aggregate and one for fine aggregate. Each of these bins shall have a vent to prevent overflow into adjacent bins.

Material passing through the bins shall be weighed into a weigh box, placed above the mixer, by means of multiple beam charging scales. These scales shall be enclosed in a box which shall be locked after the weights have been set. An indicator that will give positive evidence of overweight or underweight shall be provided, and it shall be so designed that it will be operative during the addition of the last 150 pounds of any weighing. Overtravel of the indicator shall be at least one third of the loading travel. Scales shall have an accuracy of one half of one percent for all loads, and the minimum graduation shall be five pounds. The discharge gate of the weigh box shall be so

arranged as to blend the different sizes of aggregate as they enter the mixer, and any weigh box that permits separation of sizes of materials in the ends of the mixer shall not be used.

Suitable means shall be provided for heating the bituminous cement to the required temperature. An armored thermometer, reading from 200 degrees Fahrenheit to 450 degrees Fahrenheit shall be fixed in the asphalt line at a suitable point. Asphalt cement shall be weighed by means of a dial scale having a capacity not more than three times the weight of the material to be weighed. Pointers shall be set and maintained at zero when the scales are ready for weighing. Scales shall be accurate within one-half of one percent for all loads, and shall be graduated to units of not more than one pound.

A distributing pan, fixed to the side of the mixer, shall be provided for introducing the asphalt cement into the mixer. It shall be equipped with movable vanes to direct the flow of the material across the width of the pan. Vanes shall be provided with means for quick adjustment and shall have a positive lock to prevent shifting.

The mixer shall be of the pug mill type, and shall rotate at a speed of from 70 to 90 revolutions per minute. It shall be equipped with a sufficient number of properly arranged paddles to produce a thoroughly mixed batch. The number and arrangement of the paddles shall be subject to the approval of the engineer. The mixer shall be equipped with a timing device which shall start to operate after the mixer is charged, and shall indicate by a definite signal the expiration of the mixing period. The device shall be accurate within two seconds.

Vehicles for transporting the bituminous concrete shall have pneumatic tires and shall be provided with tarpaulins to protect the material during transportation.

Spreader boxes or other approved equipment shall be provided to distribute the bituminous concrete between the side forms. The distributing devices shall be arranged to provide for breaking up any compressed masses as they leave the truck, or auxiliary equipment may be provided for this purpose.

The paving machine shall be an approved, self-propelled type operating on the side forms and equipped with rakes and strike-off plates, conforming to the crown of the pavement. Rakes shall be designed to operate with a fore and aft raking or lifting motion in addition to the forward motion of the machine. Spacing and depth of rake teeth shall be adjustable.

Rollers shall be self-propelled, in good mechanical condition, smooth running, and shall start and stop without jerking. One roller shall be a 10 ton three-wheel roller with a compression on the rear wheels of not less than 325 pounds per lineal inch of tire width, and the remainder shall be eight ton tandem rollers. The number of rollers used shall not be less than the number specified in the following table:

Tons Laid per Hour	Rollers Required
Less than 75	3
75 to 125	4
125 to 175	5
175 to 225	6

43.7 Proportioning the Mix. Coarse aggregate shall be screened to the following sizes:

Course	Bin No. 1	Bin No. 2	Bin No. 3
Bottom	2 in.— $\frac{3}{4}$ in.	$\frac{3}{4}$ in.— $\frac{1}{4}$ in.	$\frac{1}{4}$ in.—No. 10
Leveling	1 in.— $\frac{3}{4}$ in.	$\frac{3}{4}$ in.— $\frac{1}{4}$ in.	$\frac{1}{4}$ in.—No. 10
Top	1 in.— $\frac{3}{4}$ in.	$\frac{3}{4}$ in.— $\frac{1}{4}$ in.	$\frac{1}{4}$ in.—No. 10

Fine aggregate shall be placed in the fourth bin. Should the material in any bin contain 10 percent or more of material which is undersize for the bin, that bin shall be drawn and the material rescreened.

Aggregates from the bins and mineral filler shall be combined in proportions, as directed by the engineer, to produce a dense, well-graded mixture meeting the following size requirements:

Laboratory Sieve, Square Openings	Percentage by Weight Passing Sieve—		
	Bottom Course	Leveling Course	Top Course
2 inch	95-100		
1 inch	65-80	95-100	95-100
$\frac{1}{2}$ inch	44-58	58-70	60-80
$\frac{1}{4}$ inch	30-40	28-54	40-55
No. 10	20-30	25-38	28-38
No. 40	13-20	15-25	20-27
No. 80	6-13	8-16	13-20
No. 200	1-4	2-6	*5-11

*For top course, the material passing the No. 200 sieve shall be not less than two-thirds mineral filler, the remainder of the material passing the 200 mesh sieve, if not present in uniform proportions in the sand, may be collector dust.

Asphalt cement of the penetration grade shown on the plans or in the special provisions shall be added in the exact percentage determined by the engineer within the following range:

Course	Percent by Weight of Dry Aggregates
Bottom	4 -5 $\frac{1}{2}$
Leveling	4 $\frac{1}{2}$ -5 $\frac{1}{2}$
Top	5 -6 $\frac{1}{2}$

43.8 Mixing. Coarse and fine aggregates shall be heated to a temperature of from 250 degrees Fahrenheit to 350 degrees Fahrenheit and thoroughly dried. The temperature of the coarse and fine aggregates shall not vary from each other by more than 30 degrees Fahrenheit.

Mineral filler shall be added to each batch and shall be introduced separately into the mixer through the weigh box, or as near the center of the mixer as possible.

The hot aggregate and the cold mineral filler, properly proportioned by weight, shall be thoroughly mixed in the pug mill mixer. Asphalt cement, heated to a temperature between 275 degrees Fahrenheit and 350 degrees Fahrenheit, shall be added after a period of preliminary mixing of the aggregates to be fixed by the engineer. Mixing shall then continue until a homogeneous mixture of unchanging appearance is produced. The time of mixing shall not be less than 45 seconds from the time all ingredients are in the mixer until the mixer is half empty. In no case shall

the number of batches from one plant exceed 65 for any hour.

43.9 Placing. The mixture shall leave the plant at a temperature between 290 degrees Fahrenheit and 320 degrees Fahrenheit, and shall be spread upon the highway at a temperature of not less than 280 degrees Fahrenheit. No mixture shall be spread when the atmospheric temperature is below 50 degrees Fahrenheit, or during wet or rainy weather.

The bituminous concrete shall be distributed at a carefully evened thickness between the side forms, and shall then be spread by means of a self-propelled spreading, raking, and finishing machine. The paver shall spread the mixture, rake it into longitudinal furrows, and again strike it off so that it is smooth and true to cross section, free from all hollows and inequalities, and of a uniform density throughout. The spacing of the rake teeth and their depth of penetration into the mixture shall be under the control of the engineer.

If, during the process of raking and spreading, any yielding of the side forms occurs, they shall be reinforced by additional stakes and any other means necessary until they will support the weight of the machine without yielding.

Immediately after the surface course has been spread, shoulder material shall be placed against the side forms in such manner as to facilitate cross rolling.

Where the thickness of any course exceeds four inches, it shall be laid in two or more compressions of approximately equal thickness, none of which shall exceed four inches.

When bituminous concrete is laid over an old pavement having excessive crown, irregularities, or insufficient super-elevation, and the required thickness of the course at any place exceeds four inches, a bituminous concrete course of the appropriate kind shall be laid to fill the low place and permit the succeeding course or compression to be laid in a uniform thickness.

Bottom and leveling courses shall not be laid for a distance exceeding one mile in advance of the succeeding course.

The surface of each course shall be clean and free from foreign matter when the succeeding course is placed. Any surface which has become dirty shall be cleaned and, if ordered by the engineer, the surface shall be painted with a light coat of asphalt cement cut back with naphtha.

43.10 Joints. Placing of all courses shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of a freshly laid course 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 cases where a joint is unavoidable, provision shall be made for a proper bond for the full depth of the course. When the laying of the course is resumed, such joints shall be formed by cutting back the previously laid mixture and exposing a vertical face for the full depth of the course. The exposed face shall then be painted with a thin coat of asphalt cement thinned with naphtha and the fresh mixture raked against the joint. Longitudinal joints between pavement strips shall be painted in the same manner.

43.11 Rolling. After each course of bituminous concrete has been uniformly spread as above specified, it shall be thoroughly rolled. Rolling shall continue on the bottom and leveling courses until the compressed material has a relative specific gravity of not less than 90 percent of the specific gravity of the combined aggregates, and on the top course until it has a relative specific gravity of not less than 92 percent. Places inaccessible to the roller shall be tamped with hot iron tampers. Initial rolling or tamping shall be done with the temperature of the mixture such that the sum of the air temperature plus the temperature of the mixture is between 300 degrees Fahrenheit and 325 degrees Fahrenheit.

The first cross rolling shall be done with the temperature of the mixture between 125 degrees Fahrenheit and 135 degrees Fahrenheit. The final cross rolling shall be done when the temperature of the mixture is approximately 100 degrees Fahrenheit.

The resulting surface shall show an even and smooth surface with rock uniformly distributed, true to grade and cross section, and free from elevations or depressions.

When a straightedge 10 feet long is laid on the rolled mixture parallel with the center line of the highway, the surface shall in no place vary from the lower edge of the straightedge more than one-eighth inch.

No traffic shall be allowed on the pavement until it is thoroughly cooled and set, except such traffic as may be necessary for construction purposes.

43.12 Finish Coat. When required by the special provisions or directed by the engineer, a bituminous surface treatment shall be applied as provided in Section 35.

43.13 Method of Measurement. The quantity of bituminous concrete surface to be paid for shall be the number of tons of 2,000 pounds, conforming to all requirements in the completed and accepted work, less the weight of the asphalt cement incorporated in the mix.

The quantity of asphalt cement to be paid for shall be the number of tons of 2,000 pounds conforming to all requirements in the completed and accepted work.

43.14 Basis of Payment. The quantity of bituminous concrete, measured as provided above, shall be paid for at the contract unit price per ton for "Bituminous Concrete Bottom Course," "Bituminous Concrete Leveling Course," or "Bituminous Concrete Top Course," as the case may be.

The quantity of asphalt cement, measured as provided above, shall be paid for at the contract unit price for "Asphalt Cement, pen."

Liquid asphalt and screenings for finish coat shall be measured and paid for as specified in Section 35.

Payment specified above shall constitute full compensation for furnishing, placing, and compacting the surface, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 44—PORTLAND CEMENT CONCRETE SURFACE

44.1 Description. This item shall consist of a Portland cement concrete surface course, either reinforced or plain, placed on the approved sub-base or subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans or ordered by the engineer.

44.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement con- crete	Section 80
Fine aggregate for Portland cement concrete.....	Section 85
Asphalt joint filler.....	Section 91
Standard Portland cement.....	Section 93
High Early Strength Portland cement (optional unless other- wise specified).....	Section 94
Bar reinforcement	Section 103
Dowels (hard grade).....	Section 103
Mesh reinforcing	Section 104
Premolded expansion joint filler....	Section 115
Traffic lacquer	Section 116

44.3 Methods. The methods employed in performing the work, and all equipment, tools, and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the engineer. All equipment necessary for laying of pavement shall be on hand and approved before concreting operations are begun by the contractor.

The contractor shall develop a good and sufficient supply of water and have it available at all points on the work where it may be needed. The supply shall be adequate to

furnish sufficient water for all purposes for which water is needed, including sprinkling or flooding the earth grade, making subgrade, mixing concrete, and curing pavement. In case of a deficiency of water, the water available shall be devoted to curing of concrete already placed.

44.4 Equipment. Mixing equipment shall conform to the requirements of Article 46.6.

Finishing machines shall be equipped with strike-off screeds and planers. The screeds shall be so constructed that the concrete can be struck off at any elevation above or below the grade of the finished pavement that may be specified. Planers shall be capable of cutting a true surface at or above the grade specified, and the bottom surface of planers shall have the same contour as that specified for the finished pavement surface. Screeds and planers shall be so constructed that they will not spring out of alignment or adjustment. Finishing machines shall have scraping devices that will keep the top and sides of forms free of concrete when the machine is traveling in either direction. Finishing machines shall not be equipped with tamping devices.

Finishing machines shall also be equipped with vibrating pans or rollers so designed and constructed that the concrete for the full width of the pavement can be simultaneously vibrated. Vibrators shall function properly when attached to the finishing machines. The supporting device for the vibrating element shall permit the full weight of the vibrating element to be applied to the concrete. The length of the vibrating element shall be slightly less than the width of the pavement and may be either a cylinder or an elongated pan. When a pan, its bottom surface shall be so curved in front that the concrete will be forced both down and forward during vibrating. The front shall be of sufficient height that concrete will not be forced over the top of the vibrator.

Vibrating generators shall have a frequency of not less than 3,500 pulsations per minute and a vibrating unit shall be used for not over six feet of lineal length of the vibrating element. When more than one vibrating unit is attached to a vibrating element, the vibrating units shall

be mechanically interconnected so that they will rotate in synchronism, the vibrating pulsations being in the same angular direction, of the same duration, and producing equal centrifugal forces which shall be uniformly applied in vertical planes parallel to the axis of the pavement. The centrifugal force applied to the vibrating element by the vibrating generator shall be readily adjustable between 60 pounds and 160 pounds per linear foot of the vibrating element. Locking devices shall be attached to all vibrators so that they may be securely sealed.

Longitudinal floats shall be of wood, not less than 16 feet in length, and not less than eight inches nor more than 10 inches in width, properly stiffened to prevent bending and warping, and shall be reasonably light in weight to prevent sinking into the surface.

Finishing floats shall be constructed of wood and shall be not less than 16 feet nor more than 18 feet in length, not less than four inches nor more than six inches in width, and between one-half inch and one inch in thickness. These floats shall have a rigid rib and shall be fitted with sufficient adjusting screws between the rib and float board to insure a straight, plane surface. Reversible handles shall be provided at each end. At least four finishing floats in good condition shall be available on the work at all times.

Straightedges shall be of wood or metal and shall be so rigidly constructed as to maintain true lines and surfaces. At least three straightedges in good condition shall be on hand at all times. Straightedges shall be carefully checked for trueness as often as the engineer may require and any straightedge which does not remain in accurate adjustment shall be removed from the work.

44.5 Subgrade. Subgrade for Portland cement concrete pavement shall be constructed in accordance with the requirements of Section 23. If the subgrade is dry it shall be sprinkled with as much water as will be readily absorbed before placing the concrete.

44.6 Side Forms. Side forms shall be installed in accordance with Section 42 of these specifications. Unless otherwise required by the special provisions, side forms shall be removed.

44.7 Reinforcement. Marginal reinforcement bars shall be placed in both plain and reinforcement concrete pavement. Mesh and special reinforcement shall be placed only when shown on the plans or ordered by the engineer.

MARGINAL REINFORCEMENT. Outside edges of the pavement and edges along longitudinal and transverse joints shall be reinforced as shown on the plans. Marginal reinforcement shall be held rigidly and accurately in position, without sagging, during the placing and tamping of the concrete, by means of approved supporting devices. The support shall be capable of affording both vertical and lateral support, and shall be designed to support a vertical load of at least 200 pounds.

MESH REINFORCEMENT. Mesh reinforcement, when specified, shall be placed as shown on the plans or ordered by the engineer. It shall be delivered in flat sheets or rolls of such width as to fit the concrete pavement slab. The size and spacing of both longitudinal and transverse wires in the mesh shall be as indicated on the plans. Mesh reinforcement shall be supported in position by metal pins driven into the subgrade and left in place, or by other suitable approved devices. Supports shall be sufficient in number and so designed as to hold the reinforcement accurately and firmly without sagging during the placing and tamping of the concrete.

SPECIAL REINFORCEMENT. Where the pavement joins the ends of bridges or roadway top culverts, and at other locations where subgrade conditions are poor, pavement slabs shall be reinforced as shown on the plans or ordered by the engineer.

44.8 Joints. Expansion, contact, contraction, and construction joints shall be placed at points indicated on the plans and in conformity with the following requirements.

EXPANSION JOINTS. Expansion joints shall be of the thickness and spaced at the intervals shown on the plans or ordered by the engineer. They shall be filled with pre-molded filler cut to the true cross section of the pavement. The top edge of the filler, when placed, shall be one-quarter inch below the surface of the pavement. Filler strips shall be placed perpendicular to the center line of the pavement,

the faces shall be perpendicular to the surface of the pavement, and shall extend in a straight line for the full width of the pavement less one inch. After the side forms have been removed, any concrete which has flowed around the ends of the joint filler shall be removed. The strips shall be firmly supported in position by a metal holder and end plates. The metal holder shall be in the shape of a deep channel, the sides extending down on both sides of the joint strip to a depth of not less than four inches. It shall be slotted and cut away as necessary to permit slipping over the dowels and to allow the concrete to make contact with the joint strips at close intervals. The end plate shall be designed to firmly support the joint strip and holder in correct position.

During the placing and tamping of the concrete, the joint holder and end plates shall be so secured as to insure against movement of the joint strips and keep the top edge of the strips not more than one-half inch nor less than one-quarter inch below the finished surface elevation. After the concrete has been placed and consolidation completed, but before floating, the metal holder and end plate may be removed and a shallow metal channel substituted therefor.

Expansion joints shall be provided with steel dowels of the dimensions, and spaced, as shown on the plans or ordered by the engineer. Dowel bars shall not vary more than one one-hundredth of an inch from the normal size ordered, nor shall they be more than fifteen one-thousandths of an inch out of round. One end of each dowel shall be fitted with a tight metal sleeve which shall allow a free longitudinal movement of the dowel through at least three-fourths of an inch in one of the pavement slabs. While concrete is being poured, the dowel shall be rigidly supported and held parallel to the center line and to the surface of the pavement by means of approved metal chairs or other suitable approved supports.

CONTRACTION JOINTS. Contraction joints shall be of the dimensions and spaced at intervals as shown on the plans or ordered by the engineer.

After the pavement has been finished as specified, a channel shall be cut in the concrete by means of a special tool

so designed that it will make a groove of the required dimensions, with a slight taper to facilitate removal.

Contraction joints shall be provided with steel dowels of the dimensions, and spaced, as shown on the plans, and installed as provided above under expansion joints, except that metal sleeves will not be required. Dowels in contraction joints shall be coated with an approved grease before concrete is poured.

CONTACT JOINTS. Longitudinal contact joints shall be formed between each traffic lane of pavement by pouring the concrete on one side of the joint and allowing it to set before placing the adjacent strip. An interval of at least ten days shall elapse between placing parallel adjacent slabs. When high early strength cement is used, this period may be reduced to five days. All edges shall be protected by planking or other approved methods where traffic is permitted prior to completion of the full pavement width.

When required on the plans or in the special provisions, dowels shall be provided in contact joints as provided on the plans.

CONSTRUCTION JOINTS. Whenever it becomes necessary to stop the mixer, hand mixing shall be resorted to, if necessary, and the work shall be finished square across the pavement by means of a special header four inches in width and conforming to the shape of the pavement. This header shall be set one-half inch below the surface of the pavement in order to secure the construction of a smooth riding joint. At the end of each day's run a similar construction joint shall be formed. Sections less than 10 feet in length between joints shall not be permitted. Construction joints shall be provided with marginal reinforcement and dowels in the same manner as contraction joints.

44.9 Mixing Concrete. Concrete shall be class A concrete for reinforced concrete pavement and class P concrete for unreinforced concrete pavement, proportioned and mixed in accordance with the requirements of Section 46 of these specifications.

44.10 Placing Concrete. Concrete shall be placed before

initial set has taken place and within 30 minutes after the water has been added. No retempering of concrete shall be allowed. No concrete shall be placed on a frozen subgrade.

Concrete shall be deposited on the subgrade in such manner as to require as little rehandling as possible. Any additional spreading necessary shall be done by means of shovels. Spreading with rakes shall not be allowed. Any portion of a batch of concrete which becomes segregated in depositing it on the subgrade shall be thoroughly mixed with the main body of the batch during the process of spreading. The operation of depositing and spreading shall be continuous between transverse joints. If interruptions are necessary, a construction joint shall be placed as provided herein. The concrete shall be thoroughly spaded along the side of the forms before the finishing operations are initiated.

44.11 Tamping. After being properly placed and spread, the concrete shall be consolidated by a power driven finishing machine, equipped with vibrators. The concrete shall be struck off with a strike-off board or screed so adjusted that sufficient surplus concrete remains above the required finished grade to fill all low places and porous spots without being forced, during finishing, below the finished grade. Concrete when struck off shall be consolidated with vibrating elements resting directly on the struck-off concrete surface. The vibrating element shall be carried forward at such a rate of speed that the body of the concrete will be uniform in appearance, dense, and contain sufficient surface mortar for proper finishing. If a single passage of the vibrator over the surface of the concrete is not sufficient to accomplish this, the concrete shall again be vibrated in the same manner. Care shall be exercised, and the operations of the planer and vibrator shall be controlled, to prevent an excess of mortar and water from being worked to the top. Repeated operations over any area, other than to secure the necessary compaction and contour, shall be avoided.

During vibration, the vibrating element shall not come in contact with, or rest upon, the side form, and the amount

of vibration shall be sufficient to eliminate all porosity in the concrete, particularly adjacent to joints and side forms.

When odd widths of pavement are required and, in the opinion of the engineer, the operation of finishing and vibrating as specified will be difficult, striking off may be done with approved hand planers and consolidation secured with internal type vibrators as specified for concrete structures in Section 47.

Side forms must be kept in the proper alignment, firmly anchored in place during vibration and subsequent finishing of the concrete.

44.12 Finishing. When the concrete has been tamped, it shall not be disturbed by walking upon it or by any other cause. All finishing, floating, edging, and other operations shall be done from bridges. Such bridges shall not come in contact with nor rest upon the concrete at any point.

After the concrete has been properly vibrated, it shall be struck off to grade with a finishing machine, with the screed or planer resting on the side forms and the vibrators out of action. If a single strike-off and planing is not sufficient to give the concrete the desired surface contour, it shall be restruck off and planed.

Special attention shall be given to the concrete adjacent to transverse and longitudinal joints to insure that edges of concrete are at the same elevation and have the same contour as the pavement slab. All depressions or projections discovered in the concrete shall be corrected before any initial set develops in the concrete.

44.13 Floating. When proper consolidation and contour have been secured, the surface shall be floated with longitudinal floats. The float shall be operated with its length approximately parallel to the centerline, with a combined longitudinal and transverse motion from the center of the pavement, and slowly worked along and across it to each edge.

After the required surface has been obtained with the longitudinal float, the pavement shall be tested by the contractor with a straightedge 10 feet in length, the testing being carried across all joints. Depressions shall be filled

with fresh concrete and floated, projections shall be removed, and the testing and floating continued until the pavement has the required surface contour and is true to grade and cross section.

Excess water, laitance, or other float material brought to the surface shall not be reworked into the pavement, but shall be removed upon appearance by means of a float or straightedge drawn from the center of the pavement toward the edge.

The surface of the concrete shall then be floated, smooth and true to grade, with three finishing floats.

The edge of the float shall be used to cut down all high areas, and the material so removed shall be floated into the depressions until a true surface is obtained. Each successive passage of the float shall just lap the previous path and upon its completion the float shall be brought back and the overlap between the two passages smoothed.

The last used of the three finishing floats shall be a cutting float and shall be shod with steel or be built with a spring steel floating surface as the engineer may direct. It shall not be used until the pavement surface has dried sufficiently to avoid leaving a troweled finish.

The first two finishing floats shall be spaced equidistant between the longitudinal or diagonal float and the last used finishing float.

44.14 Edging. Immediately after floating has been completed, a trowel shall be inserted between the form and the concrete for a depth of three inches along the entire length of the slab, and on both sides of expansion joints. Edges of longitudinal joints and outside edges of the pavement shall be rounded with an approved edging tool to a radius of one-half inch, and the edges of transverse joints shall be rounded to a radius of one-quarter inch.

44.15 Testing Surface. The finished surface shall be checked by the engineer with a straightedge 10 feet in length placed parallel to the center line so as to bridge any depressions and touch all high spots. The length of pavement tested by each series of tests parallel to the edge of the pavement shall not be greater than two-thirds the length of the straightedge. Ordinates measured from the face of

the straightedge to the surface of the pavement shall at no place exceed one-eighth inch. All variations in excess of one-eighth inch shall be plainly marked and the contractor shall correct them by the use of a carborundum brick and water. In no case shall the rubbing be done in such manner that the bond between the mortar and particles of coarse aggregate will be broken.

44.16 Curing. As soon as the concrete pavement has been finished as specified herein, it shall be protected against rapid drying by covering with a thoroughly wet burlap laid directly upon the surface as soon as the concrete has hardened sufficiently to prevent marring the surface. The covering shall be kept saturated by sprinkling until removed. Sufficient burlap to cover at least the pavement laid in any single day shall be provided. The burlap shall have a width at least two feet greater than the width of slab to be covered.

If evaporation is rapid and the surface shows indications of drying out in advance of placing burlap, the surface of the newly laid pavement shall be kept damp by applying water by means of a nozzle that atomizes the flow and produces a mist.

In case fine cracks or hair checks appear in newly placed concrete before it is thoroughly set, immediate steps shall be taken by the contractor to remedy this condition. Pavement which shows serious checking shall be removed by the contractor and replaced at his expense.

During threatening weather concrete shall be protected with canvas as soon as it is finished. During cold weather the contractor shall take all necessary precautions to prevent the concrete from freezing. These precautions shall be subject to the approval of the engineer, but such approval shall in no way relieve the contractor of any responsibility. Any concrete laid during cold weather shall be at the contractor's risk, and damaged sections shall be removed and replaced by him at his own expense.

Immediately following the removal of forms as specified in Section 42, berms of earth or other suitable moisture-retaining material shall be constructed along each edge of the pavement for a width of not less than 12 inches, and

such berms shall be kept thoroughly saturated with water.

After the concrete pavement has set sufficiently so that earth will not become incorporated in the surface of the concrete, the burlap shall be removed, longitudinal and transverse joints filled with approved asphalt, and a system of transverse and longitudinal earth dikes shall be constructed across the full width of the pavement and at intervals governed by the rate of grade. Dikes shall be constructed by such methods that no equipment or teams shall be allowed upon the pavement. The earth dikes shall be sufficiently high to hold at least two inches of water over the crown of the pavement. Earth for dikes shall be taken from outside the limits of the shoulders. These dikes shall be flooded with water immediately after they are built and shall be kept flooded for a period of 10 days, dating from the time concrete is poured. Before the pavement is opened to traffic, material composing the dikes shall be removed from the surface of the slab.

Where it is not feasible to flood the pavement for curing by means of earth dikes on account of grades or soil conditions, a blanket of earth or sand, free from clods or lumps, two inches or more in thickness, shall be placed on the concrete and kept thoroughly saturated for the same period as specified for ponding. Before the pavement is opened to traffic, material composing the covering shall be removed from the surface of the slab.

When required by the special provisions or directed in writing by the engineer, pavement shall be cured by means of an approved impervious membrane.

The membrane shall consist of a practically colorless impervious liquid of a type approved by the engineer. Any membrane material which would impart a slippery surface to the pavement or alter its natural color will not be permitted.

The liquid shall be applied under pressure with a spray nozzle in such a manner as to cover the entire pavement with a uniform film, and shall be of such character that it will harden within 30 minutes after application. The amount of liquid applied shall be ample to seal the surface of the pavement thoroughly.

The liquid shall be applied immediately after the finishing of the surface and before the set of the cement has taken place or, if the pavement is first covered with burlap as provided above, it may be applied upon removal of the burlap.

44.17 Protection of Pavement. The contractor shall protect the surface of the concrete pavement against all damage and markings. Traffic shall be excluded from the concrete by the erection and maintenance of substantial barricades for the entire period during which the pavement is kept closed to traffic.

When ordered by the engineer, temporary cross-overs, consisting of a four-inch layer of suitable soil free from stone with a three-inch plank roadway sixteen feet wide securely held in place, shall be constructed at street and road intersections and private drives to accommodate traffic.

44.18 Opening to Traffic. Concrete pavement shall not be opened to traffic for a period of 15 days, dating from the time the concrete is poured, nor until such period thereafter as the concrete has developed a modulus of rupture of at least 600 pounds per square inch as indicated by the flexural test set forth below. When high early strength cement is used, the period for opening may be reduced to five days or until the modulus of rupture is at least 600 pounds per square inch.

For determining the modulus of rupture, specimens of concrete for the flexure test shall be six inches by six inches by 30 inches. The contractor shall cast three specimens for testing for each one-half mile of single lane slab laid. The department shall furnish moulds and machines for testing specimens, and the contractor shall make, cure, transport, and break the specimens at his expense under the engineer's direction.

After the pavement has been opened to traffic in accordance with these provisions, the contractor shall not be held responsible for damage resulting from its use by public traffic; provided, however, that the contractor shall be liable for any damage to the newly laid pavement caused by his operations.

Prior to opening the pavement to traffic, all longitudinal and transverse joints shall be carefully cleaned out and refilled with an approved asphalt. Care shall be exercised to prevent the bituminous material from spreading over the surface of the pavement for a width of more than one inch on either side of the joint. The asphalt shall then be covered with a coarse sand.

44.19 Method of Measurement. The quantity of cement concrete pavement to be paid for shall be the number of cubic yards, complete in place and accepted, computed by multiplying the theoretical cross section of the pavement, as shown on the plans or ordered by the engineer, by the total length of pavement measured along its axis. No deduction shall be made for catch basins or manholes unless the surface area is greater than nine square feet.

Dowels shall be measured as units, except that dowels placed in construction joints shall not be measured for payment.

44.20 Basis of Payment. The quantity of pavement, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Cement Concrete Surface," which price shall be full compensation for furnishing aggregates and cement; for mixing, placing, screeding, finishing, curing, and protecting concrete; for furnishing, placing, and removing forms; for forming and filling joints of all kinds; and for all other labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Bar and mesh reinforcement shall be measured and paid for as specified under reinforcing steel, Section 48. Reinforcing steel required for the protection of construction joints shall not be measured for payment.

The number of dowels placed, measured as provided above, shall be paid for at the contract unit price each for "Pavement Dowels," which price shall be full compensation for furnishing and installing dowels, including caps and sleeves when required, and supporting devices, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 45—BRIDGES, CULVERTS, AND RETAINING WALLS

45.1 Description. Bridges, culverts, culvert headwalls, and retaining walls shall be built as indicated on the plans and shall conform to the lines, grades, dimensions, and design shown, and in accordance with the specifications for the various items which constitute the complete structure.

45.2 Materials. All materials shall conform to the requirements prescribed for the several items which constitute each structure.

45.3 Construction Methods. The methods of construction shall conform to the following requirements:

REMOVAL OF EXISTING STRUCTURES. Where the removal and satisfactory disposal of existing structures are required, the work shall be performed as specified under removing structures and obstructions, Section 11.

EXCAVATION. Excavation for foundations and substructures shall be performed as specified under structure excavation, Section 19. Unless otherwise specified, foundations shall be constructed in open excavation and the foundation openings shall be shored, braced, or protected by cofferdams.

PRESERVATION OF CHANNEL. Unless otherwise specified, no excavation shall be made outside of caissons, cribs, cofferdams, steel piling, or sheeting, and the natural stream bed adjacent to the structure shall not be disturbed. Any excavation made at the site of the structure before caissons, cribs, or cofferdams are sunk shall be backfilled to the original ground surface or stream bed with satisfactory material at the contractor's expense. All excavated material and debris occurring in stream channels shall be removed to the level of the original ground line, and the whole site of operations cleaned up in a workmanlike manner.

PILING. Piling, when required or specified, shall be furnished and placed as specified under piling, Section 51.

PLACING CONCRETE. The concrete shall be placed and finished as specified under concrete structures, Section 47. Unless otherwise specified, all foundation excavation shall

be pumped dry and concrete deposited in the open. Necessary reinforcing shall be placed as specified under reinforcing steel, Section 48.

MASONRY. Masonry, when required, shall be placed as specified under dry rubble masonry, Section 52, or mortar rubble masonry, Section 53, according to the type specified.

STRUCTURAL STEEL. Structural steel, including expansion rollers, rockers, and plates, when specified, shall be furnished and placed as specified under structural steel, Section 49.

TIMBER. Timber, when specified, shall be placed as specified under timber structures, Section 50.

PIPES FOR CULVERTS. Pipes for culverts, when required, shall be of the type specified and shall be installed as specified under pipe culverts, Section 54.

SURFACING. When surfacing is included in the contract, a surface of the required kind shall be placed in accordance with the specifications for the type specified.

45.4 Design. Design of bridges and incidental structures shall conform to standard of design as set forth in "Standard Specifications for Highway Bridges and Incidental Structures," adopted by the American Association of State Highway Officials in 1935, with subsequent revisions.

45.5 Method of Measurement. The quantities of the various items which constitute the completed and accepted structure shall be measured for payment according to the plans and specifications for the several pay items and in terms of the prescribed units provided for such items. Only accepted work shall be included, and the dimensions used shall be those shown on the plans or ordered by the engineer.

45.6 Basis of Payment. The quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items constituting the structure and listed in the proposal, which prices shall be full payment for furnishing, hauling, and placing all materials, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work as specified herein.

SECTION 46—PORTLAND CEMENT CONCRETE

46.1 Description. This item shall consist of Portland cement concrete composed of Portland cement, fine aggregate, coarse aggregate, and water, proportioned and mixed as specified herein.

46.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement concrete	Section 80
Fine aggregate for Portland cement concrete.....	Section 85
Standard Portland cement.....	Section 93
High early strength Portland cement (optional unless otherwise specified).....	Section 94

In case the concrete resulting from a mixture of aggregates approaching the extreme limits for gradation is not of a workable character, or when finished does not exhibit a proper surface, as may occur when a fine aggregate having the minimum percentage passing the 16 mesh sieve is used with a coarse aggregate having the maximum permitted percentage passing the one-half inch sieve, the engineer may, if he considers it necessary, require that either a fine aggregate having a sufficiently greater percentage of fine material or a coarse aggregate having a sufficiently smaller percentage of fine material, be used.

Admixtures to prevent segregation and improve the workability of the concrete may be permitted, provided the admixed material proposed is first approved by the engineer, and the proportions of admixture to be used shall be fixed by him. No admixture shall be used without written permission from the engineer, or unless specifically provided in the plans or specifications.

46.3 Classification. Concrete shall be of five classes: Class A, class B, class C, class D, and class P. Each class

of concrete shall be used in that part of the structure in which it is called for on the plans, or where directed, and shall be proportioned in accordance with these specifications. The following requirements shall govern unless otherwise shown on the plans:

Class A concrete shall be used for all superstructures and arch rings, except where class D is required; for all parts of substructures having a least dimension less than one foot; and, excepting footings, for all reinforced concrete, including reinforced concrete pavement.

Class B concrete shall be used for substructures, for footings, and for unreinforced concrete.

Class C concrete shall be used for mass concrete.

Class D concrete shall be used for railings and posts, slabs, beams, girders, and curbs.

Class P concrete shall be used for ordinary Portland cement concrete pavement.

The following sizes of coarse aggregate shall be used for the various classes of concrete previously designated:

Class A.....	No. 4 to $1\frac{1}{2}$ inch
Class B.....	No. 4 to $2\frac{1}{2}$ inch
Class C.....	No. 4 to 3 inch
Class D.....	No. 4 to $\frac{3}{4}$ inch
Class P.....	No. 4 to $2\frac{1}{2}$ inch

If the contractor so elects, the No. 4 to $\frac{3}{4}$ -inch size coarse aggregate may be used for class A concrete or the No. 4 to $1\frac{1}{2}$ -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. The coarse aggregate for class D concrete may be increased to No. 4 to $1\frac{1}{2}$ -inch size in footing seals and lightly reinforced sections, when ordered by the engineer.

46.4 Protecting and Sampling Cement. Suitable means of storing and protecting the cement against moisture or other injurious effects shall be provided by the contractor. Sacks of cement which, for any reason, have become partially set or which contain lumps or caked cement shall be rejected and shall be immediately removed from the work at the contractor's expense.

Different brands of cement, or the same brand from different mills, even if tested and approved, shall not be mixed during use or in storage, nor shall they be used alternately in any one class of construction. The same brand or grade and kind of cement shall be used in a given structure above the ground line.

Cement may be sampled either at the mill or at the site of the work as provided in the specifications. The seals of the cars containing cement which has been sampled shall not be broken except by the engineer; otherwise, additional samples shall be taken from these cars. The contractor shall notify the engineer of dates of delivery so that there will be sufficient time for sampling the cement, either at the mill or upon delivery. If this is not done, or if additional tests are necessary, the contractor may be required to rehandle the cement in the storehouse for the purpose of obtaining samples as directed.

46.5 Storage of Aggregates. If aggregates are stored in stockpiles at the site of the work, the site of each stockpile shall be cleaned of all foreign materials and the ground shall be firm and level. Stockpiles shall be built in layers and each layer shall be completely in place before the next is started.

If both crushed stone and gravel coarse aggregates are used in any one structure, they shall be stored separately. They shall not be mixed for use in successive batches, nor shall they be used alternately in any structure. Coarse aggregates secured from the same or different sources and which vary widely in gradation shall be placed in separate stockpiles or bins and recombined in the proportions required by the engineer.

46.6 Equipment. The methods employed in performing the work, and all equipment, tools, and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the engineer. All equipment necessary shall be on hand and approved before concreting operations are begun by the contractor.

Weighing equipment for aggregates shall be accurate with an allowable error of not more than five-tenths percent for all loads. It shall be arranged so as to allow compensation to be made for changes in weight of moisture

contained in the aggregates, and to permit the convenient removal of overweight material from the weighing hopper. It shall be so arranged as to enable the operator to have convenient access to all control levers and cables. The weighing beam and auxiliary weighing device shall be in full view of the operator when manipulating the gates which deliver material to the weighing hopper. The scales shall be either of the beam or springless dial type. A suitable device consisting of a graduated beam or dial shall be used to register at least the last 100 pounds of either of the aggregates required for the batch. The value of the minimum graduation shall not be greater than two pounds.

Water measuring equipment shall be capable of accurate measurement with an allowable error of not more than two percent and shall be so arranged that the accuracy of measurement shall not be affected by variations in pressure in the water supply line. The water measuring equipment shall preferably include an auxiliary tank from which the measuring tank shall be filled.

Portland cement concrete shall be mixed in batch mixers of approved type at the site of the work, except when the use of transit mixers is permitted, and the mixer shall be equipped with an approved timing device which will automatically lock the discharging device so as to prevent the emptying of the mixer until the materials have been mixed the minimum specified time.

Transit type mixers may be used when approved by the engineer. Transit mixers, when permitted, shall have a capacity at least 25 percent in excess of the batch volume and shall be equipped with an automatic device for recording the number of revolutions of the drum prior to completion of the mixing. Drums of transit mixers shall be water-tight when closed.

46.7 Proportioning. The engineer, subject to the requirements tabulated hereinafter, shall fix and designate the respective amounts of the job materials to be used in the mix for each class of concrete, including the amount of water. The sum of the weights of fine and coarse aggregate designated for each class shall equal the weights shown in the total aggregate column for the respective

types of material. Within the ranges of the tabulation, the engineer shall designate the proportion of fine aggregate which, using the materials furnished, will produce a workable mix of the consistency hereinafter specified with the least amount of water. If, during construction, the concrete at any time is found unsatisfactory, the contractor shall readjust his batch, subject to the requirements tabulated below, as ordered by the engineer, until the mix actually being used on the job complies with all requirements.

The contractor shall combine the cement, water, fine aggregate, and coarse aggregate into uniform batches, by incorporating into each batch the number of bags of cement and the amount of water designated by the engineer, and weighing into each batch the respective weights for fine and coarse aggregate designated by the engineer in accordance with the following tabulation:

Class	Coarse Aggregate Used	—Weight of Fine Aggregate— per Bag of Cement		Total Weight Aggregate per Bag of Cement, Pounds
		Minimum, Pounds	Maximum, Pounds	
A	Gravel	180	220	580
A	Stone	216	264	580
B	Gravel	184	218	640
B	Stone	230	282	640
C	Gravel	230	282	800
C	Stone	288	352	800
D	Gravel	138	169	480
D	Stone	174	214	480
P	Gravel	167	198	580
P	Stone	209	255	580

For each class the pounds of coarse aggregate shall be the difference between the pounds shown in the total aggregate column and the pounds of fine aggregate as fixed and designated. The above tabulation is based on an apparent specific gravity of 2.65 for both fine and coarse aggregate. Corrections shall be made for variations therefrom in the job materials of more than .05 up or down. The weights are based on dry aggregates.

No change in the source, character, or grading of the materials shall be made without due notice to the engineer, and no work shall proceed using such changed or new

materials, or using any materials not possessing all the qualities and properties upon which the designated mix and proportions have been based, until the engineer has duly determined and designated an appropriate mix based on the new or altered material.

46.8 Batching. Concrete of the class indicated shall be made up of material furnished by the contractor and accepted, and shall be batched in the proportions set by the engineer for the specific materials in accordance with the foregoing composition requirements.

Quantities of each ingredient for the batch size to be used shall be set by the engineer and not changed except upon his order. The exact amount of each ingredient so set shall be incorporated in each batch. Corrections based upon laboratory determinations, necessitated by variations from day to day in the moisture content of the raw materials or for other similar reasons, shall be made as directed by the engineer.

Coarse and fine aggregate shall be handled and measured separately. No batch shall be run requiring fractional bags of cement. Cement shall be measured by the bag as packed by the manufacturer, and each bag shall contain 94 pounds net and shall be emptied directly into the charging skip of the mixer. Water shall be measured either by volume or by weight.

46.9 Consistency. The consistency of the various classes of concrete, when determined by the slump test in accordance with the A.S.T.M., "Tentative Method of Test for Consistency of Portland Cement Concrete," serial designation D138-32T, shall be within the following range:

Class A.....	1-4 inches slump
Class B.....	1-3 inches slump
Class C.....	1-2 inches slump
Class D.....	2-4 inches slump
Class P.....	0-1 inches slump

The above ranges represent the extreme limits of allowable slump. In all cases the amount of water used, as determined by the engineer, shall be the minimum necessary to secure the required workability of the concrete within the ranges of slump specified.

46.10 Mixing. The concrete shall be mixed only in such quantities as are required for immediate use, and any which has developed initial set, or which is not in place in the forms within 30 minutes after the water has been added, shall not be used. No retempering of the concrete shall be allowed. Concrete shall be thoroughly mixed for a period of not less than one and one-quarter minutes after all materials, including water, are in the drum. During such period, the drum shall be operated at speeds specified by the mixer manufacturer. The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are placed therein. Concrete mixed in transit mixing equipment shall be agitated continuously until discharged from the drum.

In no case shall the mixer be loaded in excess of its rated capacity.

The first batch of concrete materials placed in the mixer shall contain an additional quantity of sand, cement, and water sufficient to coat the inside surface of the drum without diminishing the mortar content of the mix. Upon cessation of mixing for any considerable length of time the mixer shall be thoroughly cleaned.

46.11 Hand Mixing. Hand mixing shall not be permitted, except in case of an emergency, in which case the following method shall be used: The materials shall be mixed on watertight platforms of iron or of wood and of sufficient size to admit of proper manipulation of ingredients. Fine aggregate shall be spread evenly over the platform and then covered uniformly with the cement. The two materials shall be mixed dry until the mixture is homogeneous and of a uniform color. Water shall be added and the mixing resumed and continued until a mortar of uniform consistency and texture is produced. This mortar shall then be spread in an even layer over the platform. The coarse aggregate, which has been previously wet, shall be distributed over the mortar and mixed therewith until the mortar is evenly distributed throughout the mass and every piece of the coarse aggregate is coated with mortar. Water shall not be dashed upon the mixture in large quantities, but shall be added gradually and in such

manner as not to wash the mortar from the aggregate. Hand-mixed batches shall not exceed one-half cubic yard in volume.

46.12 Cold Weather Operations. No concrete shall be mixed or placed while the air temperature is at or below 40 degrees Fahrenheit without the written approval of the engineer, and only when adequate means are employed to heat the aggregates and water and protect the concrete from freezing after being placed.

Sufficient heating apparatus, such as stoves, salamanders, or steam equipment, and fuel to furnish all required heat, shall be supplied. All water used for mixing concrete shall be heated to a temperature of at least 70 degrees Fahrenheit, but not over 150 degrees Fahrenheit. Aggregates shall be heated either by steam or by dry heat to a temperature of at least 70 degrees Fahrenheit, but not over 150 degrees Fahrenheit. The heating apparatus shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will burn the material. The temperature of the mixed concrete shall not be less than 60 degrees Fahrenheit nor more than 100 degrees Fahrenheit at the time of placing in the forms.

When directed by the engineer, the contractor shall furnish sufficient canvas and framework, or other type of housing, to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature above 50 degrees Fahrenheit for a period of five days after the concrete is placed.

The contractor shall assume all risk in connection with the placing of concrete in cold weather, and permission given to place concrete under the above conditions shall in no way relieve the contractor of responsibility for proper results. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced at the contractor's expense.

46.13 Measurement and Payment. Portland cement concrete shall be measured and paid for as provided under the various items of work in which it is used.

SECTION 47—CONCRETE STRUCTURES

47.1 Description. This item shall consist of furnishing and placing Portland cement concrete masonry in bridges, culverts, headwalls, retaining walls, and all other types of concrete structures. The masonry shall be of the class and shall conform to the shapes, dimensions, and designs shown on the plans or ordered in writing by the engineer.

47.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement con- crete	Section 80
Fine aggregate for Portland cement concrete	Section 85
Asphalt for waterproofing	Section 92
Standard Portland cement.....	Section 93
High - early - strength Portland cement (optional unless other- wise specified).....	Section 94
Sheet copper	Section 102
Premolded expansion joint filler.....	Section 115

47.3 Falsework. The contractor shall submit detailed plans for falsework and centering for examination by the engineer. If such plans are not satisfactory to the engineer, the contractor shall make such changes in them as may be required, but it is understood that the engineer's concurrence in the use of the plans as submitted or corrected shall in no way relieve the contractor of responsibility for obtaining satisfactory results. Falsework shall be designed to withstand the superimposed loads due to form work, concrete, and live loads as specified under forms, Article 47.4, without appreciable deformation or settlement. If appreciable settlement occurs in the falsework, the work shall be stopped, any masonry affected shall be removed, and the falsework thoroughly remodeled to insure a first class product.

Falsework which cannot be founded on a satisfactory footing shall be supported on piling which shall be spaced, driven, and removed in a manner approved by the engineer.

Hardwood wedges or screw jacks shall be used to bring forms or falsework for beams, girders, arch ribs, and other parts of the structure as required, to exact elevation, required camber, and uniform bearing before and during pouring concrete. All wedges shall be double to insure uniform bearing.

Unless otherwise noted on the plans, for single spans, falsework shall be constructed with one-twentieth inch camber for each foot of span, and for multiple spans it shall be constructed with one-thirtieth inch camber for each foot of span, plus allowance for shrinkage and settlement.

47.4 Forms. The contractor shall submit detailed plans for form work for examination by the engineer. If such plans are not satisfactory to the engineer, the contractor shall make such changes in them as may be required, but it is understood that the engineer's concurrence in the use of the plans as submitted or corrected shall in no way relieve the contractor of responsibility for obtaining satisfactory results. Forms shall be so designed and constructed that they may be removed without injuring the concrete.

Forms shall be designed to withstand the pressure of green concrete assuming it to have a horizontal fluid pressure of 85 pounds per foot of depth and a weight of 150 pounds per cubic foot, and in addition, a live load of 50 pounds per square foot on horizontal surfaces. All forms shall be mortar tight, true to line and elevation, and rigidly braced. Timber forms for exposed finished surfaces shall be lined with plywood, hard pressed fiber board, or other approved material which will produce smooth surfaces, and joints between adjacent panels of the lining shall be carefully filled with plastic wood or putty or shall be covered with heavy waterproof adhesive paper. Forms for surfaces which will not be exposed shall be constructed of tongue and groove or ship lap lumber. The unsupported length of wooden columns and compression members shall not exceed 15 times the diameter or least side.

Forms shall be properly braced and tied together with approved tie rods so arranged that when the forms are removed no metal will be within one-half inch of any exposed surface.

Forms shall be filleted at all sharp corners. Triangular moulding used for fillets shall have two equal sides. In general, the width of the equal sides of mouldings shall be three-fourths inch; for the opening through spindle hand rails, construction joints in the hand rail coping, and similar light construction, the width shall be one-half inch; for massive work, such as heavy pier copings, the width shall be one and one-half inches to two inches.

When concrete is placed in excavation, forms shall be provided for all vertical surfaces unless otherwise ordered by the engineer. On thin walls, such as abutments, wing walls, and retaining walls, the forms on one face shall be built up as the concrete is poured, but only to such elevation as will permit proper placing and thorough spading, and in no case greater than the height which can be placed in one day's run. Ports shall be provided in high, thin walls to permit thorough cleaning before placing concrete.

If the forms develop any defects, such as bulging or sagging, after the concrete has been poured, that portion of the work shall be removed and reconstructed, as directed by the engineer, without additional compensation to the contractor. The interior surface of forms shall be adequately oiled or greased to insure the nonadhesion of mortar.

During the erection and after the completion of the forms they shall be protected in such manner as to preclude shrinkage, warping, curling, and distortion. Form lumber used a second time shall be free from bulge or warp and shall be thoroughly cleaned.

The foregoing specifications shall also apply to metal forms. The metal shall be of such thickness that the forms will remain true to shape. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together, and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or line up properly shall not be used. Special care shall be

exercised to keep metal forms free from rust, grease, or other foreign matter which would discolor the concrete.

Forms for concrete over or in the vicinity of operating railroads shall be so constructed and braced that standard clearances demanded by the railroad company will be maintained at all times.

47.5 Proportioning, Batching, Mixing. All concrete shall be proportioned, batched, and mixed as provided in Section 46.

47.6 Placing Concrete. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. Concrete shall be placed in the forms immediately after mixing and in no case shall concrete be used which does not reach its final position in the forms within 30 minutes after the time that water is first added to the mix. The method and manner of placing shall be such as to avoid the possibility of segregation or separation of the aggregates or the displacement of the reinforcement.

The use of long chutes for conveying concrete from the mixing plant to the forms shall not be permitted. Troughs, pipes, or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete are not separated. Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. When pipes are used they shall be kept full of concrete and have their lower ends kept buried in fresh concrete in the same manner that a tremie is used. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Open troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

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

Placing of concrete shall be so regulated that the pressures caused by the wet concrete shall not exceed those used in the design of the forms. Special care shall be taken to fill each part of the forms by depositing concrete directly as near final position as possible, to work the coarser aggregates back from the face, and to force the concrete under and around the reinforcement bars without displacing them. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

Concrete shall be compacted by means of high frequency internal vibrators of a type approved by the engineer. The minimum frequency of the vibrators shall be 4,500 cycles per minute. The number of vibrators employed shall be ample, as determined by the engineer, to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. The vibrators shall not be attached to or held against the forms or the reinforcing steel. The location, manner, and duration of application of the vibrators shall be determined by the engineer, based upon securing maximum consolidation of the concrete, freedom from voids, and proper texture of exposed faces when forms are removed.

On thin sections inaccessible to the vibrator, the concrete shall be thoroughly worked with a steel slicing rod so that faces shall be well spaded and the mortar flushed to the surface of the forms.

The placing of concrete shall be done in such manner that the steel reinforcing is not coated with cement before its final embedment. In depositing concrete around steel shapes and closely spaced reinforcing bars, the concrete shall be deposited on one side of the steel and worked until it flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel. In all cases where, on account of the obstructions produced by reinforcement metal, shape of forms, or any other uncontrollable condition, difficulty is encountered in puddling the concrete adjacent to the forms, the mortar content of the mix shall be brought into proper contact with interior surfaces by vibrating the forms. The vibrations shall be produced by striking the outside surfaces of the

forms with wooden mallets or by any other means satisfactory to the engineer.

When existing walls are faced and raised with concrete, or where walls or columns support slabs or beams, the concrete in the vertical member shall be deposited up to the bottom of the supported member, and a period of at least 12 hours shall elapse for settlement before placing concrete in the horizontal member.

Concrete shall be placed in each predetermined portion of the work in a continuous operation to avoid stoppage planes. The contractor shall furnish sufficient equipment, mixer capacity, and working force to accomplish this. Concrete shall be deposited in horizontal layers, placing thin layers at first that can be thoroughly worked into intimate contact with the concrete beneath it. After a depth of six inches has been built up in this manner the thickness of the layers may be increased to a maximum of 12 inches. The depth of layers used shall be such that the succeeding layer will be placed before the previous layer has attained initial set. Each layer shall be compacted in a manner that will break up and obliterate any tendency to form a plane of separation between the layers. If it is necessary, by reason of an emergency, to stop placing concrete before any section is completed, bulkheads shall be placed as the engineer may direct. Any place where the placing of concrete is discontinued for a sufficient time to allow the concrete to take initial set shall be deemed a construction joint and treated as herein described. After the concrete in finished surfaces has begun to set, it shall not be walked upon or otherwise disturbed in less than 48 hours.

Concrete preferably shall be deposited by beginning at the center of the span and working from the center towards the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. Concrete in slab spans shall be placed in one continuous operation for each span.

Each beam, between the limits shown on the plans or directed by the engineer, shall be cast in one continuous operation. The top of the concrete shall be kept level and it shall be placed in layers, the thickness of which shall

be proportioned to the rate of delivery of the concrete to the forms, so that there will be no planes of initial set in any part of the unit. All key-ways, seats for secondary beams, dowels, and bars that connect the beams with other units of the work shall be in place before the placing of concrete is commenced.

Concrete in T-beam or deck girder spans may be placed in one continuous operation or may be placed in two separate operations, each of which shall be continuous; first, to the top of the girder stems and, second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical and shall be secured by means of suitable shear keys with or without dowels in the top of the girder stem. The size and location of these keys and dowels shall be computed. In general, suitable keys may be formed by the use of timber blocks approximately two inches by four inches in cross section and having a length four inches less than the width of the girder stem. These key blocks shall be spaced along the girder stem as required, but the spacing shall be not greater than one foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal.

Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The columns shall be allowed to set at least 12 hours before the caps are placed. No concrete shall be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least 21 days, unless otherwise permitted by the engineer.

Concrete in arch rings shall be placed in such a manner as to load the centering symmetrically. The centering shall be weighted if necessary to prevent distortion. Arch rings shall be divided into sections of such size that, when working simultaneously at points symmetrically located about the crown, the sections can be cast in one continuous operation without permitting the formation of planes of initial set. The sections shall be bonded together by suitable keys or dowels. Adequate struts shall be provided

to resist any unbalanced thrusts to piers in structures composed of more than one span. The size, arrangement, and sequence of placing concrete sections of all arches shall be subject to the approval of the engineer.

Concrete shall not be exposed to the action of water before setting, or deposited in water, except with the approval of the engineer and under his immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated. All concrete deposited under water shall be mixed in the proportions designated for class D concrete. Concrete deposited under water shall be carefully placed in a compacted mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved methods, and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water, and all form work designed to retain concrete under water shall be watertight. The consistency of the concrete shall be carefully regulated and special care shall be exercised to prevent segregation of the materials. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used, it shall consist of a tube having a diameter of not less than 10 inches, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit the free movement of the discharge end over the entire top surface of the work, and shall be such as to permit its being rapidly lowered when necessary to choke off or retard the flow. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper.

When a batch is dumped into the hopper the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow is then stopped by lowering the tremie. The flow shall be continuous and in no case shall be interrupted until the work is completed.

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 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.

47.7 Joints. All planes where work is temporarily stopped shall be deemed joints, and shall be treated by one of the following methods:

CONSTRUCTION JOINTS, or joints where the placing of concrete is delayed until the concrete has taken its initial set and for which no expansion is provided, shall be planned in advance and shall be subject to approval by the engineer. The placing of concrete shall be continuous from joint to joint. These joints shall be perpendicular to the principal lines of stress and, in general, located at points of minimum shear. No concrete work shall be stopped or temporarily discontinued within 18 inches of the top of any finished surface, unless such work is finished with a coping having a thickness less than 18 inches, in which case the joint shall be made at the under line of the coping. A joint not shown on the plans will not be permitted in a cantilevered member. Horizontal joints in piers and abutments, except where specified, shall generally be avoided, and when used shall not be located within two feet of the normal water level.

All construction joints shall be made with bulkheads provided with keyways whose area is approximately one-quarter of the cross-sectional area of the joint. When making a horizontal construction joint, care shall be taken to have the concrete as dry as possible, and any excess water or creamy material shall be drawn off before the concrete sets. On all exposed surfaces, the line of the proposed joint shall be made truly straight by tacking a temporary straightedge on the inside of the form and pouring the concrete so that it will set flush with the edge as provided. Construction joints not shown on the plans and above ordinary low water, in abutments and retaining walls that retain earth fills, shall be waterproofed on the back with a 36 inch strip of waterproofing, as directed by the engineer, at the contractor's expense. In resuming work, the surface of the concrete

previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft or porous material with stiff wire brushes to expose the sound aggregate beneath, and, if deemed necessary by the engineer, shall be roughened with a steel tool. The surface then shall be thoroughly washed with clean water and painted with a thin coat of neat cement mortar, and the forms tightened to close contact with the previously placed work, after which the concreting may proceed.

When the work is unexpectedly interrupted by breakdowns, storms, or other causes, and the concrete as placed would produce an improper construction joint, the contractor shall either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section on which there is shearing stress, he shall provide an adequate mechanical bond across the joint by inserting reinforcing steel, or by some other means satisfactory to the engineer, which will prevent a plane of weakness.

EXPANSION JOINTS shall be filled with an approved premoulded filler unless otherwise shown on the plans. The thickness of the joints shall be one-quarter inch where the length of the moving concrete is 20 feet or less, one-half inch for lengths 21 feet to 36 feet, and three-quarters of an inch for lengths of 37 feet to 50 feet, unless otherwise shown on the plans. The joint filler shall be cut to the same shape as the area to be covered, but one-quarter inch smaller along all surfaces that will be exposed in the finished work. It shall be firmly fixed against the surface of the concrete already in place in such manner that it will not be displaced when the concrete is deposited against it. Where necessary to use more than one piece to cover any surface, the joint between the separate pieces shall be covered with a layer of two-ply roofing felt, one side of which shall be covered with hot asphalt to insure proper retention. The one-quarter inch space along the edges at exposed faces shall be filled with wooden strips of the same thickness as the joint material. These wooden strips shall be saturated with oil and have sufficient draft to make them readily removable after the

concrete is placed. Immediately after the forms are removed the expansion joints shall be carefully inspected. Any concrete or mortar that has sealed across the joint shall be neatly cut and removed.

SLIDING JOINTS shall be true planes parallel to the direction of movement. Where sliding joints are to be provided at the ends of slabs, girders, or beams, or between walls, etc., the surface of the supporting concrete shall be given a smooth finish and covered with two layers of three-ply roofing felt to separate the concrete.

SPECIAL JOINTS, water-tight and flashed, shall be constructed as shown on the plans.

47.8 Curing. Freshly poured concrete shall be kept continuously wet for a period of not less than seven days by covering with heavy absorbent mats or wet earth, by ponding, or by continuous sprinkling. When absorbent mats are used, they shall be wet sufficiently often to keep the surface adjacent to the concrete surface moist at all times. After the period of water curing, concrete surfaces shall be protected from the direct rays of the sun for an additional three days. During this time the surfaces may be allowed to dry out slowly. In no case shall alternate wetting and drying of the surface be permitted. In cold weather the period of curing shall be extended as directed by the engineer.

When required by the special provisions or approved in writing by the engineer, structures or portions of structures as specified shall be cured by means of an approved impervious membrane.

The membrane shall consist of a practically colorless impervious liquid of a type approved by the engineer. Any membrane material which would alter the natural color of the structure will not be permitted.

The liquid shall be applied under pressure with a spray nozzle in such a manner as to cover the entire surface to be cured with a uniform film, and shall be of such character that it will harden within 30 minutes after application. The amount of liquid applied shall be ample to seal the surface thoroughly. Application of the liquid shall be made

immediately after forms are removed and finishing operations have been completed. Prior to the application of the liquid the concrete shall be protected and kept moist as required herein.

47.9 Removal of Falsework and Forms. In the determination of the time for the removal of falsework, forms, and housing, and the discontinuance of heating, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the materials used in the mix. In general, the forms of any portion of the structure shall not be removed until the concrete gives forth a clear, sharp ring when struck upon a flat surface with a small hammer, and is strong enough to prevent injury to the concrete when the forms are removed. This test is not applicable to frozen concrete.

Methods of form removal likely to cause overstressing of the concrete shall not be used. In general, the forms shall be removed from the bottom upwards. Forms and their supports shall not be removed without the approval of the engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

When required by the engineer, field operations shall be controlled by beam and cylinder tests and the removal of forms, supports, and housing, and the discontinuance of heating and curing may be begun when the moduli of rupture for the concrete reach values which shall be fixed by the engineer for the particular method of testing which is to be used. The beams and cylinders shall be cured under conditions which are not more favorable than the most unfavorable conditions for the portions of the concrete which the specimens represent.

If field operations are not controlled by beam tests, the following periods, exclusive of days when the temperature is below 45 degrees, shall apply to removal of forms:

Arch centers	21 days
Centering under beams	21 days
Floor slabs.....	21 days
Walls	5 days

Columns	10 days
Sides of beams and all other parts.....	7 days

In order to make possible the obtaining of a satisfactory surface finish, forms for ornamental work, railings, and parapets shall be removed in not less than 12 nor more than 48 hours, depending upon the weather condition.

Forms shall always be removed from columns before removing shoring from beneath beams and girders in order to determine the condition of concrete in the columns.

No superimposed load, either live or dead, shall be allowed upon the bridge within the period for which the falsework is required to remain in place. Falsework and centering for arches shall not be struck until the fill back of the abutments has been placed up to the spring line. Falsework for rigid frame structures shall not be removed until the fill has been placed back of the vertical legs as specified in Section 20.

47.10 Patching. The presence of excessive honeycomb areas shall be considered sufficient cause for the rejection of the structure, and upon written notice from the engineer, the contractor shall remove and rebuild the structure in part or in whole as specified, at his own expense. In patching holes or porous spots, all 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 a face perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with a thick, dry mortar composed of one part of Portland cement to two parts of sand, which shall be thoroughly tamped into place. The surface of this mortar shall be floated with a wooden float before initial set takes place, and shall present a neat and workmanlike appearance of the same color as the remainder of the structure. The patch shall be kept continuously wet for a period of five days. For patching large or deep areas, coarse aggregate shall be added to the patching material, if ordered by the engineer, and special precautions shall be taken to insure a dense, well bonded and properly cured patch as required by the engineer.

47.11 Finishing. All concrete surfaces shall be reasonably true and even, free from stone pockets, excessive depressions, or projections beyond the surface. Concrete floors shall be struck off with a template before the concrete has set, to provide the proper crown, and shall be hand finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means. The finished surface shall not show a variation of over one-eighth inch in 10 feet, using a straightedge 10 feet long placed parallel to the center line of roadway, and no variations will be permitted that will tend to prevent complete drainage on all parts of the deck. Concrete bridge-seats and tops of walls and curbs shall be brought flush with the finished top surface and struck off with a straightedge and floated.

All exposed surfaces, which shall include bottom of overhung or cantilever portions of slabs; bottom, and outside of exterior beams or girders; faces of abutments, piers or walls above a point one foot below the ground or fill line; and all sides of curbs, handrails, columns, arch ribs, and struts shall be finished by rubbing with a carborundum stone.

The entire surface to be finished shall be thoroughly wet and rubbed with a No. 16 carborundum stone, or an abrasive of equal quality, bringing the surface to a paste. The rubbing shall be continued sufficiently to remove all form marks and projections, producing a smooth dense surface without pits or irregularities. The material which, in the above process, has been ground to a paste, shall be carefully spread or brushed uniformly over the entire surface and permitted to reset. The final finish shall be obtained by a thorough rubbing with a No. 30 carborundum stone or an abrasive of equal quality. This rubbing shall continue until the entire surface is of a smooth texture and uniform in color. Immediately following the rubbing process, the finished surface shall be thoroughly washed with water. A cement wash or plaster coat shall not be used.

47.12 Waterproofing. Concrete surfaces shall be waterproofed where and as designated on the plans.

47.13 Drainage and Weep Holes. Drainage and weep holes shall be constructed in the manner and where indicated on the plans or directed by the engineer. Drains and

weep holes in the faces of abutments shall be connected with roadway drains wherever indicated on the plans. Ports or vents for equalizing hydrostatic pressure shall be placed below low water. Weep holes shall be placed at the elevations shown on the plans or as directed.

47.14 High Early Strength Cement. When high early strength cement is used, the curing period may be reduced to five days and the period for which supporting forms and falsework shall remain in place may be reduced to seven days if the results of field tests are satisfactory. If, in the opinion of the engineer, the concrete has not cured sufficiently within this period, the curing shall continue, and the forms shall be left in place for such an additional length of time as he may deem necessary.

47.15 Method of Measurement. The quantity to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No measurements or other allowances will be made for work or material for forms, falsework, cofferdams, pumping, bracing, etc.

If the proposal contains an item, concrete hand railing shall be measured in linear feet, each side, along the center line of the bridge, in which case no allowance shall be made for the yardage contained in the railing.

47.16 Basis of Payment. The yardage, determined as provided above, shall be paid for at the contract unit price per cubic yard for "Class A Concrete," "Class B Concrete," "Class C Concrete," or "Class D Concrete," as the case may be. If an item is shown in the proposal form, concrete railing shall be paid for at the contract unit price per linear foot for "Concrete Rail." Such payment shall be full compensation for the concrete; for all materials including expansion joint filler, timber bumpers, forms, falsework, placing, and finishing, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the item. Reinforcing steel, including drains, water stops, and expansion joint angles, when there is no item for structural steel in the proposal, shall be measured and paid for as specified in Section 48.

SECTION 48—REINFORCING STEEL

48.1 Description. This item shall consist of furnishing and placing in concrete, reinforcing steel of the quality, type, size, and quantity designated, all as required by these specifications and as shown on the plans.

48.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Bar reinforcement.....Section 103

Mesh reinforcementSection 104

48.3 Bending Diagrams. When bar bending diagrams are not shown on the plans, detailed plans showing the bending of reinforcing bars shall be submitted to the engineer for approval. Such approval shall not be construed as relieving the contractor of full responsibility for the accuracy of the diagrams.

48.4 Protection of Material. Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil, or other foreign substances. However, when steel has, on its surface, rust, loose mill scale, or dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the engineer.

48.5 Bending and Cutting. When bending is required, it shall be accurately done without the use of heat, and bars having cracks or splits at the bends shall be rejected. Unless otherwise noted on the plans, radii of bends shall be equal to or greater than twice the diameter of the bar measured from the inside of the curved bar, except for stirrups in which the radii of bends shall be equal to or less than the diameter of the bar. Reinforcing bars shall be cut and bent at the mill or shop before shipment to the work. Bending in the field shall not be permitted except to correct errors, deformations due to handling, or minor omissions in shop fabrication.

48.6 Placing and Fastening. All reinforcing steel shall be accurately placed and, during the placing of concrete, firmly held in the positions shown on the plans. Distances

from the forms shall be maintained by means of stays, concrete blocks, ties, hangers, or other approved supports. Unless otherwise indicated on the plans, the minimum clearance between bars and forms shall be one and one-half inches, except that in slabs the minimum clearance between bars and bottom forms shall be one inch. Bars in footings shall have a minimum covering of three inches of concrete. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shape and dimensions. Layers of bars shall be separated by precast mortar blocks which may be reinforced and which shall have slots to receive the bars and hold them in place. The blocks shall be short enough to permit their ends to be covered with concrete. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks shall not be permitted. Before any concrete is placed, all mortar shall be cleaned from the reinforcement. Reinforcement in any member shall be placed, and then inspected and approved by the engineer, before the placing of concrete begins. Concrete placed in violation of this provision shall be rejected and removed.

48.7 Splices. All reinforcement shall be furnished in the full lengths indicated upon the plans. No splicing of bars, except where shown on the plans, shall be permitted without the written approval of the engineer.

Splices which are permitted shall have a length of not less than 50 times the nominal diameter of the bars, and shall be well distributed or else located at points of low tensile stress. No splices shall be permitted at points where the section is not sufficient to provide a minimum distance of two inches between the splice and the nearest adjacent bar or the surface of the concrete. The bars shall be rigidly clamped or wired at all splices in a manner approved by the engineer.

Sheets of metal mesh shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges.

48.8 Method of Measurement. The quantity of bar steel to be paid for shall be the total weight in pounds actually in place as shown on the plans or revised by authority of

the engineer, based on calculated weights shown in the table below. The quantity of metal mesh or expanded metal to be paid for shall be the total weight in pounds, computed from the theoretical dimensions as shown on the plans. The weight paid for in either case shall not include the extra metal used when bars larger than those specified are substituted by permission of the engineer, the extra metal necessary for splices not indicated on the plans, nor weight of any device used to support or fasten the steel in its correct position. In the case of structures of reinforced concrete where there is no proposal item for structural steel, such minor metal parts as expansion joints, bolts, drains, and the like shall, unless otherwise specified, be measured as reinforcement.

If an item is shown in the proposal form, the quantity of mesh reinforcement to be paid for shall be the number of square yards computed by multiplying the width of the section to be reinforced by its length. No allowance shall be made for laps.

The calculated weights of plain and deformed bars shall be based on the following table:

Size	Weight per foot
$\frac{1}{4}$ -inch round.....	0.167 lbs.
$\frac{3}{8}$ -inch round.....	0.376 lbs.
$\frac{1}{2}$ -inch round.....	0.668 lbs.
$\frac{1}{2}$ -inch square.....	0.850 lbs.
$\frac{5}{8}$ -inch round.....	1.043 lbs.
$\frac{3}{4}$ -inch round.....	1.502 lbs.
$\frac{7}{8}$ -inch round.....	2.044 lbs.
1-inch round.....	2.670 lbs.
1-inch square.....	3.400 lbs.
$1\frac{1}{8}$ -inch square.....	4.303 lbs.
$1\frac{1}{4}$ -inch square.....	5.313 lbs.

48.9 Basis of Payment. Reinforcing steel, measured as provided above, shall be paid for at the contract unit price per pound for "Reinforcing Steel," which price shall be payment in full for furnishing the fabricated and bent material, placing, material used for fastening the steel in place, and for all labor, materials, tools, equipment, and incidentals necessary to complete the installation of the steel in the structure, as specified herein.

If a separate item is provided in the proposal form, mesh reinforcement shall be paid for at the contract unit price per square yard for "Mesh Reinforcement," which price shall be full compensation for furnishing the mesh, placing, material used for fastening the steel in place, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the installation of the mesh.

SECTION 49—STRUCTURAL STEEL

49.1 Description. This item shall consist of furnishing, fabricating, preparing, erecting, and painting all structural steel, rivet and eyebar steel, steel forgings, castings, and other metal of the type, shape, dimensions, and quality required by these specifications or as shown on the plans.

49.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Material	Section
Structural, rivet and eyebar steel.....	95
Steel forgings	96
Steel castings.....	97
Gray iron castings	98
Malleable castings	99
Wrought iron	100
Bronze	101
Sheet copper	102
Paints and paint materials.....	116

49.3 Shop and Mill Inspection. Ample notice must be given the engineer by the contractor regarding the source of materials and the name and location of the fabricating company in order to allow for arrangement for both mill and shop inspection of all materials and fabrication. No material shall be manufactured or work done in the shop before arrangements for adequate inspection have been completed. The engineer shall have full access at all times to all parts of the shop and mill where material under his inspection is being manufactured. The acceptance of any material or finished members shall not be a bar to their subsequent rejection if found defective.

The contractor shall furnish the engineer with three copies of mill orders and shipping statements. The weights of the individual members shall be shown on the statements.

49.4 Test Specimens. The contractor shall furnish test specimens as required free of charge.

49.5 Shop Plans. The contractor shall furnish the engineer with all shop detail plans required for fabrication of

the steel. The original drawings may be made either on paper or cloth, but the details must be drawn in ink so that the prints will be clear and legible. Shop drawings shall be 22 inches by 36 inches in size. Only complete sets of drawings, which have been checked, will be accepted for approval. Casting details, however, may be submitted for approval previous to the other details. Shop plans shall follow the design plans and the required strength shall be developed as shown in the plans and specifications. When submitting shop plans for approval, two sets of shop plans shall be furnished the engineer, who will retain one set and return the other either approved or with corrections marked thereon. After the plans have been approved, five sets of shop plans and the original tracings or Van Dyke negatives thereof shall be furnished the engineer. All shop plans shall be submitted for approval at least 15 days before fabrication is started and no material shall be fabricated until the plans have been finally approved by the engineer.

49.6 Changes and Substitutions. No changes shall be made in any drawing after it has been approved except by the consent or direction of the engineer in writing.

Substitutions of sections having different dimensions than those shown on the plans shall be made only when approved in writing by the engineer. Should the substitution of heavier members be allowed upon the contractor's request, no extra weight will be allowed over the original design section.

49.7 Methods and Equipment. Before starting the work of erection, the contractor shall inform the engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the engineer. The approval of the engineer shall not be considered as relieving the contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done until such approval by the engineer has been obtained.

49.8 Quality of Workmanship. Workmanship and finish

shall be equal to the best general practice in modern bridge shops.

49.9 Finish. Finished members shall be true to line and free from twists, bends, and open joints. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping shall be done carefully and accurately.

49.10 Storage. Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter, shall be well drained, and shall be protected as far as practicable from corrosion.

Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection.

49.11 Handling. The loading, transportation, unloading, and storing of structural material shall be conducted so that the metal will be kept clean and free from injury.

49.12 Straightening. Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends may be cause for rejection of the material.

The straightening of plates and angles or other shapes in the field shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the engineer, in which case the heating shall not be to a higher temperature than that producing a dark cherry red color. After heating, the metal shall be cooled as slowly as possible.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

49.13 Punched Work. If general reaming is not required, all main material forming parts of a member composed of not more than five thicknesses of metal, may be punched with a punch one-sixteenth inch larger than the nominal size of the rivets, whenever the thickness of the metal is

not greater than three-fourths inch. When there are more than five thicknesses, or when any of the main material is thicker than three-fourths inch, all of the holes shall be punched with a punch three-sixteenths inch smaller, and after assembling reamed one-sixteenth inch larger than the nominal size of the rivets, except that when the metal is thicker than the size of the rivet, the holes shall be drilled.

Holes punched full-size shall be one-sixteenth inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than three thirty-seconds inch. Holes shall be clean cut and without torn or ragged edges.

The punching of holes shall be done so accurately that, after assembling the component parts of a member, a cylindrical pin one-eighth inch smaller than the nominal diameter of the punched hole may be passed through at least 75 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes. If this requirement is not fulfilled, the badly punched pieces may be rejected. If 10 percent of any group of 100 or fewer holes will not pass a pin three-sixteenths inch smaller than the nominal diameter of the punched hole, the mispunched pieces may be rejected.

49.14 Reamed Work. General reaming will be required unless otherwise provided in the plans or special provisions.

When general reaming is required, holes shall be sub-punched and reamed in material forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes may be punched full-size in material used for lateral, longitudinal, and sway bracing, lacing bars, stay plates, and diaphragms not forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes shall be drilled in material the thickness of which is greater than the nominal diameter of the rivet.

Sub-punched and reamed holes for rivets having diameters greater than three-fourths inch shall be punched three-sixteenths inch smaller than the nominal diameter of the

rivet. For rivets having diameters of three-fourths inch, the holes shall be punched eleven-sixteenths inch in diameter. For rivets having diameters of five-eighths inch or less, the holes shall be punched full-size and spear-reamed. The punch and die shall have the same relative sizes as specified for full-size punched holes.

After assembling, sub-punched holes shall be reamed to a diameter one-sixteenth inch larger than the nominal diameter of the rivet.

Reaming shall be done after the pieces forming a built member are assembled and firmly bolted together. Reamed parts shall not be interchanged.

Reaming of rivet holes shall be done with twist drills or with short taper reamers. Reamers, preferably, shall not be directed by hand. If oil or grease is used as a lubricant when reaming, it shall be applied so as not to soil surfaces which are to be painted. Burrs resulting from reaming shall be removed.

49.15 Drilled Holes. Drilled holes shall be one-sixteenth inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed. If members are drilled while assembled, the parts shall be held securely together while the drilling is being done.

49.16 Accuracy of Drilled and Reamed Holes. Reamed or drilled holes shall be cylindrical and perpendicular to the member. After reaming or drilling, 85 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes, shall not show an offset greater than one thirty-second inch between adjacent thicknesses of metal.

49.17 Shop Assembling. Surfaces of metal in contact shall be cleaned before assembling.

The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends, and other deformation.

Preparatory to the shop riveting of full-size punched material, the rivet holes, if necessary, shall be spear-reamed for the admission of the rivets. The reamed holes shall not

be more than three thirty-seconds inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct position and bolted, clamped, or otherwise firmly held in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts, insofar as practicable, to prevent damage in shipment and handling.

The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

If general reaming is required, riveted trusses and skew portals shall be assembled in the shop, the parts adjusted to line and fit, and holes for field connections drilled or reamed while so assembled. Holes for other field connections, except those in lateral, longitudinal, and sway bracing, shall be drilled or reamed in the shop with the connecting parts assembled, or else drilled or reamed to a metal template without assembling.

Field connections in punched work, except those for lateral, longitudinal, and sway bracing, shall be reamed to a metal template or else with the parts assembled.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the engineer.

49.18 Field Assembling. The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets

in railings shall not be driven until the span has been swung. Splices and field connections shall have one half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have three-fourths of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be one thirty-second inch larger.

49.19 Rivets. Rivets, before driving, shall be of the diameter specified. They shall be free from furnace scale.

Rivet heads shall be of approved shape, concentric with the shank, true to size, full, neatly formed, and free from fins.

Field rivets shall be furnished in excess of the nominal number required to the amount of 10 percent plus 10 rivets for each diameter and length.

49.20 Shop Riveting. Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. Rivets, when heated and ready for driving, shall be free from slag, scale, and other adhering matter. When driven, they shall completely fill the holes. The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins, and in full contact with the surface of the member.

Loose, burned, or otherwise defective rivets shall be replaced. In removing rivets, care shall be taken not to injure the adjacent metal, and, if necessary, they shall be drilled out. Caulking or recupping will not be permitted.

Rivets shall be driven by direct-acting riveters where practicable. The riveters shall retain the pressure after the upsetting is completed. If rivets are driven with a pneumatic hammer, a pneumatic buckler shall be used if practicable.

49.21 Field Riveting. Pneumatic hammers shall be used for field riveting. Cup-faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts

into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out.

49.22 Field Bolts. Bolted connections shall not be used unless specifically authorized. If bolted connections are permitted, the bolts shall be unfinished bolts or turned bolts, as specified. Bolts shall have hexagonal heads and nuts and shall be of such length that they will extend entirely through the nut but not more than one-fourth inch beyond. Bolts in tension shall have two nuts.

Unfinished bolts in shear shall have not more than one thread within the grip. The diameter of the unfinished bolt shall not be more than one-sixteenth inch smaller than the diameter of the hole.

The threads of turned bolts shall be entirely outside the grip. The bolts shall be given a finishing cut. Approved nut locks or flat washers one-fourth inch thick shall be furnished, as specified. The holes for turned bolts shall be reamed and their diameters shall be not more than one thirty-second inch greater than the diameter of the finished bolt.

Special types of lock bolts may be used with the written approval of the engineer.

In bolted connections, the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool.

49.23 Edge Planing. Sheared edges of plates more than five-eighths inch in thickness and carrying calculated stress shall be planed to a depth of one-fourth inch. Reentrant cuts shall be filleted before cutting.

49.24 Facing of Bearing Surfaces. The top and bottom surfaces of steel slabs and base plates and cap plates of columns and pedestals shall be planed, or else the plates or slabs hot straightened. Parts of members in contact with them shall be faced.

Sole plates of beams and girders shall have full contact with the flanges. Sole plates and masonry plates shall be planed or hot straightened. Cast pedestals shall be planed on surfaces to be in contact with steel and shall have the surface to be in contact with masonry rough-finished.

Surfaces of bronze bearing plates intended for sliding contact, shall be finished.

In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

49.25 Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed one-fourth inch.

49.26 End Connection Angles. Floor beams, stringers, and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall be not less than that shown on the detail drawings.

49.27 Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

49.28 Web Plates. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than one-eighth inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be one-half inch less in width than the distance back to back of flange angles.

At web splices, the clearance between the ends of the web plates shall not exceed three-eighths inch. The clearance at the top and bottom ends of web splice plates shall not exceed one-fourth inch.

49.29 Fit of Stiffeners. End stiffener angles of girders

and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within one-fourth inch at each end.

49.30 Eyebars. Eyebars shall be straight, true to size, and free from twists, folds in the neck and head, and other defects. The heads shall be made by upsetting and rolling or forging, and not by welding. The form of the heads will be determined by the dies in use at the works where the eyebars are made, if they are satisfactory to the engineer. The thickness of the head and neck shall not overrun more than one-sixteenth inch.

Eyebars that are to be placed side by side in the structure shall be bored so accurately that upon being placed together, pins one-thirty second inch less in diameter than the pin holes will pass through the holes at both ends at the same time without driving.

49.31 Annealing. Steel that has been heated partially shall be annealed, unless it is to be used in minor parts. Crimped stiffeners need not be annealed.

49.32 Pins and Rollers. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. The final surface shall be produced by a finishing cut.

Pins more than seven inches in diameter shall be forged and annealed. In pins larger than nine inches in diameter, a hole not less than two inches in diameter shall be bored full length along the axis. Pin holes shall be bored true to the specified diameter, smooth, and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than one thirty-second inch. Boring of holes in built-up members shall be done after the riveting is completed.

The diameter of the pin hole shall not exceed that of

the pin by more than one-fiftieth inch for pins five inches or less in diameter, or one thirty-second inch for larger pins.

Screw threads shall make close fits in the nuts and shall be U. S. Standard, except that for pin ends of diameters greater than one and one-half inches, they shall be made with six threads to the inch.

Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

49.33 Bearings and Anchorage. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the engineer, they shall be placed on a layer of canvas and red lead applied as follows:

Thoroughly swab the bridge seat bearing area with red lead paint and place upon it three layers of 12 to 14 ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic.

The contractor shall drill the holes and set the anchor bolts, except where the bolts are built into the masonry. The bolts shall be set accurately and fixed with Portland cement grout, completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span.

49.34 Misfits. The correction of minor misfits involving nonharmful amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication, or deformation resulting from handling and transportation, which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the inspector and his approval of the

method of correction obtained. The correction shall be made in his presence.

49.35 Welding. Structural steel shall not be welded unless called for on the plans or in the special provisions or upon written permission of the engineer, except that minor defects in structural steel may be remedied in accordance with the requirements of Article 95.4.

Welding, when permitted, shall be done by the electric arc method using heavily coated metallic electrodes. Welds shall be of the size, type, and length as noted on the plans.

The wire for the electrode shall conform to grade E 15 as provided in the American Welding Society "Specifications for Filler Metal for use in Fusion Welding," Rev. Feb. 1, 1936. The electrodes shall be uniformly coated with a coating which will not chip or peel under ordinary handling and shall provide protection of the arc stream, the deposited metal, and the adjacent structure metal from contamination from the atmosphere and other sources. The electrode shall be bare at the holder end from three-fourths inch to one and one-eighth inches and for three sixteenths of an inch at the arc striking end. The electrodes shall function satisfactorily in producing welds in flat, vertical, or overhead positions.

The generator shall be an approved type direct current welding generator with the proper appurtenances for regulating the wattage and amperage.

All welding shall be done by experienced workmen and when required by the engineer all welders shall qualify by tests specified in the "Standard Specifications for Arc Welding Metal Bridge Structures," dated 1935.

Surfaces to be welded shall be thoroughly cleaned of all loose scale, rust, paint, or other foreign matter by brushing, chipping, hammering, or other satisfactory methods. Where joints are to be butt welded and the parent metal thickness is more than one-quarter inch in thickness, the plates shall be beveled so the weld can be made full thickness of the plate.

The weld metal shall be deposited in a manner which will minimize the expansion and contraction effects of the localized welding heat, and thereby counteract and relieve the stresses tending to produce structure deformations and

distortions. Welds over five-sixteenths inch in thickness shall be made in multiple layers.

Upon the completion of each run, including the final one, the surface of the weld shall be wire brushed or otherwise abraded to remove slag or other adhering foreign matter and permit the observation of the deposited weld metal. The finished surface may be undulating, but, in general, shall be slightly convex, uniform, and even, with terminating portions blending into the surface of the structural metal.

All craters shall be filled with weld metal whether occurring within the intermediate lengths of the welds or at their extremities; they shall be freed from slag or other harmful material before continuing or completing the depositing of weld metal.

49.36 Falsework. Falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The contractor, if required, shall prepare and submit to the engineer, for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the contractor's plans shall not be considered as relieving the contractor of any responsibility.

Upon completion of the erection and before final acceptance, the contractor shall remove all falsework, excavated or useless materials, rubbish, and temporary buildings, replace or renew any fences damaged, and restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of this work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the contractor before final acceptance.

49.37 Marking and Shipping. Members weighing more than three tons shall have the weight marked thereon. Bolts and rivets of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts, and small packages of bolts, rivets, washers, and nuts shall be shipped in boxes, crates, kegs, or barrels, but the gross weight of any package shall not exceed 300

pounds. A list and description of the contained material shall be plainly marked on the outside of each package.

Anchor bolts, washers, and other anchorage or grillage materials shall be shipped in time to suit the requirements of the masonry construction.

49.38 Painting. Structural steel, unless otherwise specified, shall be painted as specified in Section 68.

49.39 Method of Measurement. The quantities to be paid for under this item shall be the weight of metal in the fabricated structure completed and accepted, which weight shall include the weight of the actual number of field rivets required. 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 shall be excluded. For the purpose of measurement for payment, steel plates and shapes for pier protection, all metal conduits, scuppers, pipes, and drains in the superstructure, and all zinc and other similar metals required in the superstructure shall be considered as structural steel. Expansion plates and rockers or castings of any kind, regardless of the type of material specified, shall also be considered as structural steel.

The weights to be paid for shall be shop scale weights, unless otherwise provided. Finished work shall be weighed in the presence of the engineer's shop inspector, if practicable. The contractor shall supply satisfactory scales and shall perform all work involved in handling and weighing the various parts. When it is not practicable to obtain the shop scale weights of the individual members in the presence of the inspector, and it is so ordered, payment will be based on the computed weight. In any case, if the total scale weight of any member exceeds the computed weight by more than two percent, the weight in excess of two percent over the computed weight shall not be paid for. If the weight of any member is more than two percent less than the computed weight it shall be cause for rejection at the option of the engineer.

The computed weight shall be obtained by the use of the following rules and assumptions:

(a) The weight of steel shall be assumed at 0.2833 pounds per cubic inch. The weight of cast iron shall be assumed at 0.26 pounds per cubic inch. The weight of bronze shall be assumed at 0.315 pounds per cubic inch.

(b) 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 copes, cuts, and open holes.

To the nominal weights of plates more than 36 inches in width, there shall be added one half the allowed percentage of overrun in weight given in the specifications for structural steel for bridges provided for in Section 95.

(c) The weight of heads of shop driven rivets shall be included in the computed weight, assuming the weights to be as follows:

Diameter of rivet, inches	Weight per 100 heads, pounds
$\frac{1}{2}$	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

(d) The weights of fillet and other welds deposited outside the lines and surfaces of the parts connected shall be computed from the weight of steel and their cross-sectional areas. However, unequal legged fillet welds shall be assumed as equal legged welds having the dimension of the shorter legs.

The weight of fillet welds shall be assumed as follows:

Size of fillet	Weight per lineal foot of weld, pounds
$\frac{1}{8}$ inch	0.03
$\frac{3}{16}$ inch	0.06
$\frac{1}{4}$ inch	0.11
$\frac{5}{16}$ inch	0.17
$\frac{3}{8}$ inch	0.24
$\frac{1}{2}$ inch	0.43
$\frac{5}{8}$ inch	0.67
$\frac{3}{4}$ inch	0.96

(e) The weight of castings shall be computed from the dimensions shown on the approved shop drawings, with an addition of 10 percent for fillets and overrun.

(f) To the total computed weight of metal shall be added four-tenths of one percent as an allowance for shop paint.

49.40. Basis of Payment. The weight determined as provided above shall be paid for at the contract unit price per pound for "Structural Steel," which price shall be full compensation for furnishing, fabricating, delivering, erecting, and painting, and all materials, labor, equipment, tools, and incidentals necessary to complete the item, including furnishing of mill test reports and test specimens, except specimens for full size tests, in accordance with the plans and these specifications.

Full size eyebars or members which are tested and meet the requirements of these specifications shall be paid for at the same rate as for the structure. Bars which fail to meet these requirements, and all bars rejected as a result of tests, shall not be paid for.

SECTION 50—TIMBER STRUCTURES

50.1 Description. This item shall consist of the furnishing, framing, and installation of timber of the kind, sizes, and dimensions, and in accordance with the lines, grades, and sections shown on the plans.

50.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Material	Section
Structural, rivet and eyebar steel.....	95
Steel castings	97
Gray iron castings	98
Wrought iron	100
Hardware	105
Timber	110
Timber preservative.....	112
Paints and paint materials.....	116

50.3 Inspection. The contractor shall furnish an inspection certificate from either the West Coast Lumbermen's Association, the Pacific Lumber Inspection Bureau, or the California Redwood Association with each shipment of lumber, whether treated or untreated.

When treated Douglas fir is specified, the contractor shall inform the engineer of the name of the plant at which timber is to be treated, sufficiently far in advance of starting work, in order that arrangements may be made for the inspection of treatment. The contractor shall furnish facilities for the inspection of material and workmanship, and the inspector shall be allowed free access to the necessary parts of the plant.

50.4 Storage of Material. Lumber and timber on the site of the work shall be stored in piles. Untreated material shall be open-stacked at least 12 inches above the ground surface and piled to shed water and prevent warping. When required by the engineer, it shall be protected from the weather by suitable covering. Creosoted timber shall be close-stacked, piled to prevent warping, and the tops of the stacks shall be covered with a two-inch layer of earth.

The ground underneath and in the vicinity of all material piles shall be cleared of weeds and rubbish.

50.5 Workmanship. Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed, and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements specified in Section 49—Structural Steel.

50.6 Treated Timber. Treated timber and piling shall be carefully handled without sudden dropping, breaking of outer fibers, bruising, or penetrating the surface with tools. It shall be handled with rope slings. Cant hooks, peaveys, pikes, or hooks shall not be used.

All cutting, framing, and boring of treated timbers shall be done before treatment insofar as is practicable. When treated timbers are to be placed in waters infested by marine borers, untreated cuts, borings or other joint framings below high water elevation shall be avoided.

All cuts in treated piles or timbers, and all abrasions, after having been carefully trimmed, shall be covered with two applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch.

Before driving bolts in treated piles or timbers, all bolt holes shall receive a pressure treatment of hot creosote oil applied with an approved bolt hole treater. Any unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

50.7 Untreated Timber. In structures of untreated Douglas fir, the following surfaces shall be thoroughly coated with two coats of hot creosote oil before assembling: Ends, tops, and all contact surfaces of sills, caps, floor beams, and stringers; and all ends, joints, and contact surfaces of bracing and truss members. The back faces of

bulkheads and all other timber which is to be in contact with earth, metal, or other timber shall be similarly treated.

50.8 Holes for Bolts, Dowels, Rods, and Lag Screws.

Holes for round drift-bolts and dowels shall be bored with a bit one-sixteenth inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit one-sixteenth inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

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

All bolts shall be effectually checked after the nuts have been finally tightened.

50.10 Countersinking. Countersinking shall be done wherever smooth faces are required. Recesses formed for countersinking shall be painted with hot creosote oil, and, after the bolt or screw is in place, shall be filled with hot pitch.

50.11 Framing. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted.

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

Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels or straps for anchoring the sills or posts, as indicated on the plans, shall be set in them when they are cast.

Sills shall have true and even bearing on mud sills, piles, or pedestals. They shall be drift-bolted to mud sills or piles with bolts of not less than three-quarter inch diameter

and extending into the mud sills or piles at least six inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

Posts shall be fastened to pedestals and sills with dowels or straps as shown on the plans.

50.12 Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift-bolts of not less than three-quarter inch diameter, extending at least nine inches into the posts or piles. The drift-bolts shall be approximately in the center of the post or pile.

50.13 Bracing. The ends of bracing shall be bolted through the pile, post or cap with a bolt of not less than five-eighths inch diameter. Intermediate intersections shall be bolted and spiked with wire or boat spikes, as indicated on the plans. In all cases spikes shall be used in addition to bolts.

50.14 Stringers. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least one-half inch for the circulation of air and shall be securely fastened by drift-bolting where specified. When stringers are two panels in length the joints shall be staggered.

Cross bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails in each end.

50.15 Wheel Guards and Railing. Wheel guards and railing shall be accurately framed in accordance with the plans and erected true to line and grade.

Unless otherwise specified, wheel guards shall be surfaced one side and one edge (S1S1E) and rails and rail posts shall be surfaced on four sides (S4S).

Wheel guards shall be laid in sections not less than 12 feet long.

50.16 Trusses. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection and, in vertical projection, shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

The carpentry on truss housings shall be equal in all respects to the best house carpentry. The finished appearance of the housing is considered of primary importance and special care shall be taken to secure a high quality of workmanship and finish on this portion of the structure. Workmen wearing shoes with caulks shall not be permitted on the roof.

Unless otherwise directed by the engineer, housing and railings shall be built after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

50.17 Laminated Floors. Laminated floors shall be composed of three inch by six inch, or two inch by six inch timbers, as indicated on the plans, laid on edge. The flooring may be of random length and multiples of the stringer spacing. No single piece shall be less than six feet long. All splices shall be made on the center line of the stringer and shall not occur oftener than once in six inches on any one stringer.

Laminations shall be laid with a finished edge down. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than one-eighth inch from a true plane, except treated stringers, shall be surfaced to meet such a requirement. Treated stringers which do not meet the requirement may be rejected but shall not be framed or adzed after treatment.

Each lamination shall be fastened to the adjacent piece by spikes of sufficient length to pass through two strips and at least half way through the third, and spaced at 18 inches center to center, staggered six inches in adjacent

pieces. Each piece of flooring shall be toe-nailed to alternate stringers with 20d or 30d nails. Adjacent laminations shall be toe-nailed to other alternate stringers. Each end of all pieces shall be fastened to the stringer with one toenail and to the preceding piece with one horizontal nail. Floor timbers shall be brought to true bearing on stringers before spiking.

50.18 Painting. Rails and rail posts of untreated timber, or timber treated with preservative salts, shall be painted with three coats of paint as specified in Section 68.

Parts of the structure, other than rails and rail posts, which are to be painted, shall be designated on the plans or in the special specifications.

Metal parts, except hardware, shall be given one coat of shop paint and, after erection, two coats of field paint, as specified in Section 68.

50.19 Method of Measurement. Timber shall be measured by the number of thousand feet, board measure, remaining in place in the completed and accepted structure, based on the nominal dimensions.

50.20 Basis of Payment. The quantity of timber, measured as provided above, shall be paid for at the contract unit price per thousand feet board measure for "Untreated Douglas Fir," "Treated Douglas Fir," or "Redwood," as the case may be, complete in place, which price shall be full compensation for furnishing all materials, including hardware, treating when specified, furnishing and applying paint, framing, erecting, and for all labor, material, tools, supplies, equipment, and incidentals necessary to complete the work. The contract price shall include the cost of furnishing inspection certificates. The cost of inspection of creosote treatment shall be borne by the department.

Metal parts, other than hardware, shall be measured and paid for as specified for structural steel, Section 49.

SECTION 51—PILING

51.1 Description. This item shall consist of furnishing, driving, and cutting off piling of the kind and dimensions specified. The piles shall conform to and be driven in accordance with these specifications and in the location and to the elevations, bearing, and penetration shown on the plans or ordered by the engineer.

51.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Steel piles (Min. 0.20% copper).....	Section 95
Timber piles.....	Section 111
Timber preservative	Section 112

51.3 Treated Piles. When treated piles are required, the preservative treatment shall be as specified in Section 65.

51.4 Inspection. The contractor shall furnish an inspection certificate from either the West Coast Lumberman's Association or the Pacific Lumber Inspection Bureau with each shipment of timber piling.

When treated Douglas fir is specified, the contractor shall inform the engineer of the name of the plant at which piling is to be treated, sufficiently far in advance of starting work, in order that arrangements may be made for inspection of treatment. The contractor shall furnish facilities for the inspection of material and workmanship, and the inspector shall be allowed free access to the necessary parts of the plant.

51.5 Test Piles. The contractor shall drive test piles of lengths and at the locations designated by the engineer, which locations shall be such that the piles may be cut off and used in the completed structure. These piles shall be of the length specified on the plans or ordered by the engineer, and shall be long enough to provide for any variation in soil conditions. Piling shall not be ordered until the actual lengths required have been determined by means of the test piles. The contractor shall furnish piles in accordance with an itemized list, which shall be furnished by the

engineer after test piles have been driven, showing the number and length of all piles.

51.6 Preparing Timber Piles. Timber piles shall be carefully handled when and after unloading from cars. They shall not be dragged across the ground at any time and shall be handled only with rope slings or with wooden equipment. Sharp tools shall be permitted only when used for the necessary field cutting and trimming. All places where the surface of treated piling is broken by cutting, boring, or otherwise, shall be thoroughly coated with three applications of hot creosote. Each application shall be allowed to become reasonably dry before the succeeding one is given.

The piles for any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.

Heads of piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design, 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. When the area of the head of any timber pile is greater than that of the face of the hammer, a suitable cap shall be provided to distribute the blow of the hammer throughout the cross section of the pile and thus avoid, as far as possible, the tendency to split or shatter the pile. Collars or bands to protect piles against splitting and brooming shall be provided when necessary. Timber piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes of a design satisfactory to the engineer, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.

A cast steel driving head shall be used for driving steel piles.

51.7 Driving Piles. Full length piles shall always be used where practicable, but if splices cannot be avoided an approved method of splicing shall be used. Piles shall not be spliced except by permission of the engineer. Piles shall

not be driven until after the excavation is complete. Any material forced up between the piles shall be removed to correct elevation before masonry for the foundation is placed. Piles shall be driven with a steam, air, or gravity hammer, or a combination of water jets and hammer.

Gravity hammers for driving timber piles shall weigh not less than 3,000 pounds. The fall shall be so regulated as to avoid injury to the piles, and in no case shall exceed 15 feet. Steam and air hammers, either single or double action, shall be operated at pressures and speeds recommended by the manufacturer. For driving timber piles the total weight of single acting hammers shall be not less than 6,500 pounds, and of double acting hammers not less than 5,500 pounds. Steam or air hammers for driving steel piles shall develop not less than 15,000 foot pounds of energy per blow. Sufficient storage capacity for steam or air shall be provided to prevent drop in pressure. Gauges shall be attached to the storage reservoir and, when required, to the hammer.

Leads shall be used with all types of hammers. Pile driver leads shall be constructed in such manner as to afford freedom of movement to the hammer, and they shall be held in a vertical position by guys or stiff braces. Except where piles are driven through water, the leads preferably shall be of sufficient length so that the use of a follower will not be necessary.

The driving of piling with followers shall be avoided, if practicable, and shall be done only under written permission of the engineer. When followers are used, one pile from every group of ten shall be a long pile driven without a follower, and shall be used as a test pile to determine the average bearing power of the group.

When water jets are used, the number of jets and the volume and pressure of water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least 100 pounds per square inch pressure at two three-quarter inch jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration.

Unless otherwise specified, the minimum penetration of piles shall be not less than 10 feet in hard material and not less than 20 feet in soft material, and they shall be driven to obtain a bearing power of 20 tons for timber piles, or 35 tons for steel bearing piles. Piles shall be jetted if necessary to secure the required penetration.

All piles raised by the driving of adjacent piles shall be driven down again if required by the engineer.

Assembled sections of steel sheet piling shall be watertight.

51.8 Bearing Values. When required, safe loads shall be determined by actual loading tests on piles designated by the engineer. These tests shall consist of the application of a test load placed upon a suitable platform supported by the pile, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. The safe allowable load shall be considered as 50 percent of that load which, after a continuous application of 48 hours, produces a permanent settlement not greater than one-quarter inch measured at the top of the pile. This maximum settlement shall not be increased by a continuous application of the test load for a period of 60 hours or longer.

In the absence of loading tests, the safe bearing values for piles shall be determined by the following formulas:

$$P = \frac{2WH}{S+1.0} \text{ for gravity hammers,}$$

$$P = \frac{2WH}{S+0.1} \text{ for single-acting steam hammers,}$$

$$P = \frac{2H(W+Ap)}{S+0.1} \text{ for double-acting steam hammers,}$$

where P = safe bearing power in pounds,

W = pounds weight of striking parts of hammer,

H = height of fall in feet,

A = area of piston in square inches,

p = steam pressure in pounds per square inch at the hammer,

S = average penetration in inches per blow for last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam hammers.

The foregoing formulas are applicable only when—

- (a) The hammer has a free fall.
- (b) The head of the pile is not broomed or crushed.
- (c) The penetration is reasonably quick and uniform.
- (d) There is no sensible bounce after the blow.

Twice the height of the bounce shall be deducted from "H" to determine its value in the formula.

The bearing powers of timber piles, as determined by the foregoing formulas, shall be considered effective only when they are less than the crushing strengths of the piles. However, the character of the soil penetrated, conditions of driving, distribution, sizes and lengths of the piles involved, and the computed load per pile shall be given due consideration in determining the reliability of driven piles.

In case water jets are used in connection with the driving, the bearing power shall be determined by the above formulas from the results of driving after the jets have been withdrawn, or a load test may be applied.

51.9 Defective Piles. The procedure incident to the driving of piles shall not subject them to excessive and undue abuse producing injurious splitting, splintering, and brooming of the wood. Any pile broken by reason of internal defects, or by improper driving or driven out of its proper location shall be removed or, at the option of the engineer, a second pile may be driven adjacent thereto, if this can be done without detriment to the structure. All piles so driven shall be at the expense of the contractor.

Piles shall be driven with a variation of not more than one-fourth inch per foot from the vertical or from the batter shown on the plans or determined by the engineer. Wooden piles driven below the elevation fixed by the plans or by the engineer shall be withdrawn and replaced by new and, if necessary, longer piles 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.

51.10 Cutting Off Piles. The tops of all piling shall be sawed to a true plane, as shown on the plans, and at the

elevation fixed by the engineer. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the superimposed structure. The length of pile above the elevation of cut-off shall be sufficient to permit the complete removal of all material injured by driving.

51.11 Treatment of Pile Heads. Pile heads, after cutting to receive the caps and prior to placing the caps, shall be treated to prevent decay.

The heads of creosoted piles shall be treated as follows:

The sawed surface shall be covered with three applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch, or thoroughly brush coated with three applications of hot creosote oil and covered with hot roofing pitch. Upon this shall be placed a covering of medium weight roofing felt or galvanized iron, which shall be bent down over the sides of the pile to shed water. Edges shall be trimmed to present a workmanlike appearance.

The heads of untreated piles shall be given one of the following treatments, as may be specified or directed by the engineer:

(a) The sawed surface shall be thoroughly brush coated with two applications of hot creosote oil.

(b) The sawed surface shall be heavily coated with red-lead paint, after which it shall be covered with cotton duck, of at least eight-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 workmanlike appearance. The duck shall then be waterproofed by being thoroughly saturated and coated with one or more applications of red-lead paint.

The above does not apply to pile heads encased in concrete.

51.12 Method of Measurement. Timber and steel bearing piles shall be paid for at the price per lineal foot for furnishing piles and the lump sum price per pile for driving.

The length of furnished pile shall be the actual length in lineal feet of piling placed in the leads in accordance with the pile order list approved by the engineer.

The number of piles driven shall be the actual number of piles remaining in the completed structure, irrespective of the length of pile driven.

The quantity of steel sheet piling to be paid for shall be the number of pounds of steel, including wales and tie-backs, when shown on the plans, complete in place in the accepted work. No allowance shall be made for material cut off. In calculating the weight, the theoretical weight of the approved section shall be used.

51.13 Basis of Payment. Load tests, when ordered, shall be paid for at the contract unit price each for "Load Tests," which price shall be full compensation for constructing the loading platform, procuring and placing the loading material, disposing of all materials upon completion of the test, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work. When there is no item for this work, it shall be paid for as extra work.

The quantity of piling furnished, measured as provided above, shall be paid for at the contract unit price per lineal foot for "Foundation Piles," "Untreated Timber Piles," "Treated Timber Piles," or "Steel Bearing Piles," as the case may be, which price shall be full compensation for furnishing and delivering the piles at the site ready for driving, and shall include the cost of inspection certificates. The cost of inspection of steel piles and creosote treatment for timber piles shall be borne by the Department.

The number of bearing piles driven, measured as provided above, shall be paid for at the contract unit price each for "Drive Timber Piles," or "Drive Steel Piles," as the case may be, which price shall be full compensation for preparing, framing, furnishing collars and shoes, driving, jetting, blasting, cutting off, treating pile heads, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work. In the case of steel piles, the contract unit price per pile shall include furnishing and welding pile cap plates as shown on the plans.

The quantity of steel sheet piling, measured as provided above, shall be paid for at the contract unit price per

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pound for "Steel Sheet Piles," which price shall be full compensation for furnishing and driving the piles, for all excavation, necessary tie-backs and deadmen, except when shown on the plans, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work. *or as*

Test piles shall be measured and paid for in the same manner as specified above for the particular type of piling.

Necessary splices due to shortness in the approved order list shall be paid for as extra work.

Accepted piles ordered and not driven shall be paid for on the basis of cost plus 15 percent, and shall become the property of the department.

Steel shoes, when ordered by the engineer, shall be paid for as extra work. No payment shall be made for trimming the piles and fitting the shoes.

SECTION 52—DRY RUBBLE MASONRY

52.1 Description. This item shall consist of the furnishing and construction of roughly dressed stone, laid without mortar, so as to fit firmly and neatly in such shapes and at such places as indicated on the plans or ordered by the engineer. Dry rubble masonry, as here specified, shall include the classes commonly known as coursed, random, and random range.

52.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Masonry stoneSection 82

52.3 Laying Stone. The masonry shall be laid to line and in courses roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones and all courses shall be laid with bearing beds parallel to the natural bed of the material. Face joints shall not exceed one inch in width.

Headers shall occupy not less than one-fifth of the face area of the wall and shall be evenly distributed. They shall hold in the heart of the wall the same size shown in the face and shall extend not less than 12 inches into the core or backing. Headers in walls two feet or less in thickness shall extend entirely through the wall.

In laying dry rubble masonry, care shall be taken that each stone takes a firm bearing at not less than three separate points upon the underlying course. Open joints, both front and rear, shall be "chinked" with spalls fitted to take firm bearing upon their top and bottom surfaces, for the purpose of securing firm bearing throughout the length of the stone.

When required by plans or special provisions, the open joints on the rear surfaces of abutments or retaining walls shall be "slushed" thoroughly with mortar to prevent seepage of water through the joints.

52.4 Copings, Bridge Seats, and Backwalls. Copings, bridge seats, and backwalls, when required, shall be of class A concrete conforming to the requirements for concrete

structures, or shall conform to the requirements for mortar rubble masonry, as specified.

52.5 Method of Measurement. The quantity of stone masonry to be paid for under this item shall be the number of cubic yards measured in the completed work and the limiting dimensions shall not exceed those shown upon the plans or fixed by the engineer.

52.6 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Dry Rubble Masonry," which price shall be full compensation for furnishing and placing all materials, and for all labor, tools, equipment, supplies, and incidentals necessary to complete the work.

When concrete or mortar rubble copings, bridge seats, or backwalls are required they shall be measured and paid for as provided under concrete structures, Section 47, or mortar rubble masonry, Section 53.

Necessary excavation shall be measured and paid for as specified under structure excavation, Section 19.

SECTION 53—MORTAR RUBBLE MASONRY

53.1 Description. This item shall consist of the construction of masonry composed of approved stones laid in mortar beds, constructed in such shapes and at such places as are indicated on the plans or ordered by the engineer. Mortar rubble masonry, as here specified, shall include the classes commonly known as coursed, random, and random range.

53.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Masonry stone	Section 82
Mortar sand	Section 87
Standard Portland cement.....	Section 93

53.3 Mortar. Mortar shall be composed of one part of Portland cement and three parts of sand unless otherwise provided. The mortar shall be hand or machine mixed, as may be required by the engineer. In the preparation of hand mixed mortar, the sand and cement shall be thoroughly mixed together in a clean, tight mortar box until the mixture is of uniform color, after which clean water shall be added in such quantity as to form a stiff paste. Machine mixed mortar shall be prepared in an approved mixer and shall be mixed not less than one and one-half minutes. Mortar shall be used within 45 minutes after mixing. Retempering of mortar will not be permitted.

53.4 Laying Stone. Stone masonry shall not be constructed in freezing weather or when the stone contains frost, except by written permission of the engineer and subject to such conditions as he may require.

The masonry shall be laid to line and in courses roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones and all courses shall be laid with bearing beds parallel to the natural bed of the material.

Each stone shall be cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be cleaned and well moistened. All stones shall be well bedded in freshly made mortar. The mortar joints shall be full and the stones carefully settled in place before the mortar has set. No spalls shall be permitted in the beds and face joints. Joints and beds shall have an average thickness of not more than one inch.

Headers shall occupy not less than one-fifth of the face area of the wall and shall be evenly distributed. They shall hold in the heart of the wall the same size shown in the face and shall extend not less than 12 inches into the core or backing. Headers in walls two feet or less in thickness shall extend entirely through the wall.

Whenever possible, the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of two inches before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joints or that used in pointing.

The vertical joints in each course shall break joints with those in adjoining courses at least six inches. In no case shall a vertical joint be so located as to occur directly above or below a header.

In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done and in hot or dry weather the masonry and pointing shall be protected from the sun and kept wet for a period of at least three days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.

53.5 Copings, Bridge Seats and Backwalls. Copings, bridge seats and backwalls shall be of the dimensions and

materials shown on the plans and when not otherwise specified shall be of class A concrete which shall conform to the requirements for concrete structures, Section 47.

53.6 Method of Measurement. The quantity of stone masonry to be paid for under this item shall be the number of cubic yards measured in the completed work and the limiting dimensions shall not exceed those shown upon the plans or fixed by the engineer. Copings, bridge seats, and backwalls, except when constructed of concrete, shall be considered as a mortar rubble masonry, and shall be measured for payment as such.

53.7 Basis of Payment. The quantity of masonry, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Mortar Rubble Masonry," which price shall be full compensation for furnishing and placing all materials and for all labor, equipment, tools, supplies, and incidentals necessary to complete the work.

When concrete copings, bridge seats, or backwalls are specified, this part of the work shall be measured and paid for as provided under Section 47—Concrete Structures.

Necessary excavation shall be measured and paid for as provided under Section 19—Structure Excavation.

SECTION 54—PIPE CULVERTS

54.1 Description. This item shall consist of furnishing corrugated metal, vitrified clay, or reinforced concrete pipe culverts conforming to these specifications and of the kind, sizes, and dimensions shown on the plans, and installing such pipe where and in conformity with the lines and grades shown on the plans or ordered by the engineer. This item shall also include the furnishing and construction of such joints or connections to existing pipes, catch basins, endwalls, etc., as may be required to complete the work as shown on the plans.

54.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Corrugated metal culvert pipe.....Section 106

Vitrified clay culvert pipe.....Section 107

Reinforced concrete culvert pipe....Section 108

54.3 Handling Pipe. Culvert pipe shall be carefully handled in unloading, transporting, and laying. ~~Corrugated metal pipe must not have the spelter coat bruised or broken, the metal dented or bent, or the pipe deformed from a straight line or true circular shape. Reinforced~~ Concrete and vitrified clay pipe must not show surface chips or hair cracks. ~~Culvert~~ pipes which show defects due to handling shall be rejected at the site of installation regardless of prior acceptance.

54.4 Laying Pipe—~~General~~. When pipe is placed in a trench, the width of the 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 by the engineer. 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 to provide for expected settlement and insure tight joints in the lower half of the pipe. ~~Recesses shall be excavated for any bells involved.~~

Pipe shall be bedded in an earth foundation 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 a manner as to provide a compacted earth cushion having a thickness under the pipe of not less than one-half inch per foot height of fill over the top of the pipe, with a minimum allowable thickness of eight inches. Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, 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 material properly compacted to provide adequate support for the pipe line.

When shown on the plans or ordered by the engineer, embankments shall be constructed and compacted before excavating trenches for installing pipe culverts. The height to which such embankments are built shall be as follows:

Diameter of Pipe, inches	Height of Fill above Pipe, inches
15	12
18	12
24	12
30	15
36	18
48	24

54.5 Laying Corrugated Metal Pipe. Culverts under the highway shall be placed so that the minimum distance from finished grade of roadway to the top of pipe shall be not less than one-half the diameter of the pipe with a minimum of one foot.

Corrugated metal pipe shall be laid in the trench with the separate sections firmly joined together, with outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Any metal in joints which is not thoroughly protected by galvanizing shall be coated with an approved asphaltum paint.

All corrugated metal culverts 48 inches in diameter under fills 15 feet or over in height, and all culverts over

48 inches in diameter under all heights of fill shall be jacked out of round and strutted as follows:

After the culvert is placed in the trench, the vertical diameter shall be forced out of round five percent of the nominal diameter, and timber struts placed to retain the culvert in this position. The struts shall be left in the culvert until the fill has been completed and settlement has taken place. No headwalls shall be placed until struts have been removed and final settlement of the fill has occurred.

54.6 Laying Vitrified Clay or Reinforced Concrete 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~~ ^{ends} upgrade, ends fully and closely jointed, and true to lines and grades as given. Each section shall be securely attached to the adjoining sections. All joints shall be filled with stiff mortar composed of one part Portland cement and two parts sand. The mortar shall be placed so as to form a durable watertight joint. After any section of pipe is laid, and before any succeeding section is laid, the lower portion of the ~~hub~~ of the preceding section 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 thoroughly wetted earth or burlap cover. Any pipe which is not in true alignment, or which shows any undue settlement after laying, or is damaged, shall be taken up and relaid without extra compensation.

54.7 Backfilling. Pipe culverts shall be backfilled as specified in Section 20.

54.8 Method of Measurement. The length of pipe culvert to be paid for shall be the actual number of lineal feet of culvert in place, but this length shall not be greater than shown on the plans or specified by the engineer. No allowance shall be made for cut-offs on pipes placed on a skew

~~when the pipe is ordered mitered at the factory. When skew cut-offs are ordered in the field, full allowance shall be made for necessary lengths of pipe cut off due to skew.~~

54.9 Basis of Payment. This item, measured as provided above, shall be paid for at the contract unit price per lineal foot for ~~"...inch Corrugated Metal Pipe," "...inch Vitrified Pipe," "...inch Reinforced Concrete Pipe," or "...inch Corrugated Metal Siphon Pipe,"~~ as the case may ~~be~~, which price shall be full payment for all labor, materials, tools, supplies, and incidentals necessary to complete the culvert in accordance with the plans and these specifications, including ~~band~~ couplings or other devices to connect additional lengths to existing culverts.

Necessary excavation shall be measured and paid for as provided under structure excavation, Section 19, ~~except that when embankments are ordered constructed prior to installation of culverts, no quantities shall be measured for payment outside required elevations above the pipe.~~

Backfill, including the amount necessary to replace excavation below the grade of the pipe when required due to the character of material encountered, shall be paid for as specified under backfill, Section 20.

SECTION 55—RELAYING CULVERT PIPE

55.1 Description. This item shall consist of cleaning and relaying corrugated metal culvert pipe, previously removed, at the points called for on the plans or ordered by the engineer.

55.2 Construction Methods. The pipe shall be thoroughly cleaned to remove all foreign matter. Rust spots shall be thoroughly brushed with a wire brush and such cleaned spots shall be painted with an approved asphaltum paint. The pipe shall then be laid in the manner prescribed for setting culvert pipe in Section 54.

55.3 Method of Measurement. The quantity to be paid for shall be the actual number of lineal feet of culvert pipe, regardless of size, relayed in the completed and accepted work.

55.4 Basis of Payment. The quantity of culvert pipe relayed, measured as provided above, shall be paid for at the contract unit price per lineal foot for "Relay Culvert Pipe," which price shall be full compensation for cutting to lengths, cleaning and relaying the pipe, for necessary couplings to attach to existing pipes, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Necessary excavation shall be measured and paid for as provided under structure excavation, Section 19, except that when embankments are ordered constructed prior to installation of culverts, no quantities shall be measured for payment outside required elevations above the pipe.

Backfill, including the amount necessary to replace excavation below the grade of the pipe when required due to the character of material encountered, shall be paid for as specified under backfill, Section 20.

SECTION 56—UNDERDRAINS

56.1 Description. This item shall consist of the installation of tile or perforated pipe underdrains, as specified, of the size and at the locations, true to line and grade, shown on the plans or ordered by the engineer.

56.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Gravel for bedding and backfill.....Section 81

Perforated corrugated metal pipe..Section 106

Drain tile (sewer pipe).....Section 109

56.3 Trenching. A trench shall be excavated with a minimum width equal to the exterior diameter of the pipe plus 12 inches, and to the depth shown on the plans or ordered by the engineer.

A three-inch bed of clean gravel or broken stone shall be spread in the bottom of the trench throughout its entire length, thoroughly compacted, and brought to a uniform grade. All material excavated from trenches not required for backfilling, nor usable in the roadway shall be removed and disposed of by the contractor.

56.4 Laying Pipe. Bell and spigot tile shall be laid upgrade with the bell end upgrade and the spigot end fully entered in the adjacent bell. Pipe shall be laid, true to line and grade, with a uniform bearing under the full length of the barrel. The pipe joints shall then be covered with two-ply tar paper strips not less than six 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 three inches.

Perforated pipe shall be laid with the perforations at the bottom of the pipe and the sections joined with band couplers. The pipe shall be firmly bedded throughout its length.

56.5 Backfilling. After the pipe has been laid and approved by the engineer, gravel backfill shall be placed carefully around and over the pipe to within 12 inches of the ground surface. This material shall be placed in layers not exceeding 12 inches in thickness, and each layer shall

be thoroughly tamped and compacted with an approved iron tamping tool. The upper 12 inches of the trench shall then be filled with suitable material of either the porous or impervious type, as directed by the engineer, and thoroughly compacted.

56.6 Method of Measurement. The length of underdrain to be paid for shall be the actual number of lineal feet, measured along its axis, complete in place and accepted.

The quantity of excavation to be paid for shall be the number of cubic yards removed to the depth specified, except that the width to be paid for shall be limited by vertical surfaces whose distance apart shall be the exterior diameter of the pipe plus 12 inches.

The quantity of gravel bedding and backfill to be paid for shall be the number of cubic yards of backfill complete in place and accepted, except that no quantities shall be paid for outside of vertical planes whose distance apart is equal to the exterior diameter of the drain plus 12 inches. Backfill placed to a depth greater than three inches below the drain shall not be paid for unless ordered by the engineer.

56.7 Basis of Payment. The quantity of underdrain laid, measured as provided above, shall be paid for at the contract unit price per lineal foot for "....inch Tile Underdrain," or "....inch Perforated Underdrain," as the case may be, which price shall be full compensation for furnishing and installing the pipe, including special sections where needed, for all connections to existing pipes or structures, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

The quantity of excavation, measured as provided above, shall be paid for as specified under structure excavation, Section 19.

The quantity of bedding and backfill, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Drain Backfill," which price shall be full compensation for stripping pit, crushing, screening, loading, hauling, placing, and tamping backfill and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 57—HAND-LAID RIPRAP

57.1 Description. This item shall consist of the construction of slope and bank protection of hand-laid riprap at the places and of the design and dimensions shown on the plans or ordered by the engineer.

57.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Stone for riprapSection 82 .

57.3 Construction Methods. The slopes upon which the riprap is placed shall not be steeper than the angle of repose of the material unless otherwise indicated. The riprap shall commence in a trench below the toe of the slope and shall progress upward. The stones shall be placed with their beds at right angles to the slope, the larger stones being used in the bottom courses and the smaller stones at the top. They shall be laid in close contact so as to break joints, and in such manner that the weight of the stone is carried by the earth and not the adjacent stones. The spaces between the larger stones shall be filled with spalls securely rammed into place. The finished work shall present an even, tight, and reasonably plane surface, varying not more than three inches from the required contour.

57.4 Method of Measurement. The quantity to be paid for shall be the number of cubic yards, measured in place, in the completed and accepted work, except that the dimensions used shall not exceed those shown on the plans or ordered by the engineer.

57.5 Basis of Payment. The yardage, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Hand-Laid Riprap," which price shall be full compensation for furnishing and placing all materials, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Excavation for trenches at toe of slope shall be measured and paid for as specified for structure excavation, Section 19.

SECTION 58—GROUTED HAND-LAID RIPRAP

58.1 Description. This item shall consist of the construction of slope and bank protection of hand-laid riprap with interstices filled with Portland cement mortar at the places and of the design and dimensions shown on the plans or ordered by the engineer.

58.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Stone for riprap.....	Section 82
Mortar sand	Section 87
Standard Portland cement.....	Section 93

58.3 Construction Methods. The riprap stone shall be placed as specified for hand-laid riprap, Section 57, after which all interstices shall be completely filled with a thin Portland cement mortar thoroughly broomed and tamped to completely fill the voids and form a smooth, solid surface true to lines and grades.

Mortar shall be composed of one part of Portland cement and three parts of sand unless otherwise provided. The mortar shall be hand or machine mixed, as may be required by the engineer. In the preparation of hand mixed mortar, the sand and cement shall be thoroughly mixed together in a clean, tight mortar box until the mixture is of uniform color, after which clean water shall be added in such quantity as to form a stiff paste. Machine mixed mortar shall be prepared in an approved mixer and shall be mixed not less than one and one-half minutes. Mortar shall be used within 45 minutes after mixing. Retempering of mortar will not be permitted.

Weep holes shall be constructed through the riprap as directed by the engineer.

Grouted hand-laid riprap shall not be laid in freezing weather, and any work damaged by frost shall be removed and replaced by the contractor at his own expense.

After grouting, the riprap shall be protected from the sun and kept moist for a period of not less than five days.

58.4 Method of Measurement. The quantity to be paid

for shall be the number of cubic yards, measured in place, in the completed and accepted work, except that the dimensions used shall not exceed those shown on the plans or ordered by the engineer.

58.5 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Grouted Hand-laid Riprap," which price shall be full compensation for furnishing and placing all materials, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Excavation for trenches at toe of slope shall be measured and paid for as specified for structure excavation, Section 19.

SECTION 59—MOVING PIPE CULVERT HEADWALLS

59.1 Description. This item shall consist of the removal of existing corrugated metal pipe culvert headwalls and the resetting of the headwall at the location and to the elevations shown on the plans or ordered by the engineer.

59.2 Construction Methods. The earth shall be removed from around the headwall and for about two feet along the pipe, and the pipe shall be cut smoothly along a plane perpendicular to the center line of the pipe at a point about one foot back of the headwall. The headwall shall then be removed to its new location as directed by the engineer and placed upon a firm foundation to the lines and grades as staked by the engineer. Care shall be exercised in the moving operation, and any headwall broken or damaged by the contractor's negligence shall be replaced by him at his expense. A new piece of pipe shall be inserted and connected with band couplings to the two ends of the existing pipe and on the same grade and alignment. The pipe and method of laying and backfilling shall conform to the specifications set forth under pipe culverts, Section 54.

59.3 Method of Measurement and Basis of Payment. The number of headwalls moved in the completed and accepted work shall be paid for at the contract unit price each for "Move Pipe Culvert Headwalls," which price shall be full compensation for cutting the existing pipe, moving and resetting the headwall, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Excavation necessary for removing and resetting the headwall and for placing the additional pipe shall be measured and paid for as set forth under structure excavation, Section 19.

Culvert pipe installed shall be measured and paid for as set forth under pipe culverts, Section 54, or under relaying culvert pipe, Section 55, as the case may be.

Backfill shall be measured and paid for as specified in Section 20.

SECTION 60—CONCRETE CURB AND GUTTER

60.1 Description. This item shall consist of concrete curb, concrete gutter, or combined concrete curb and gutter, constructed with class A concrete in accordance with these specifications, at the locations, and of the design and dimensions shown on the plans or ordered by the engineer.

60.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement con- crete	Section 80
Fine aggregate for Portland cement concrete	Section 85
Standard Portland cement.....	Section 93
High early strength Portland cement (optional unless other- wise specified).....	Section 94
Bar reinforcement	Section 103
Premolded expansion joint filler....	Section 115

60.3 Subgrade. Prior to placing curb and gutter, a satisfactory subgrade shall be prepared true to lines and grades established by the engineer. It shall be thoroughly watered and compacted by rolling and tamping until hard and smooth. All soft and unsuitable material shall be removed and replaced with suitable material. When indicated on the plans or ordered by the engineer, a layer of approved, thoroughly compacted porous material shall be placed under the curb and gutter.

60.4 Forms. Forms shall be of metal or wood, straight and free from warp, and of sufficient strength to resist springing during the placing of concrete. Timber forms, if used, shall be surfaced on the top edge and on the face next to the concrete and shall be not less than one and five-eighths inches thick. Forms shall be of a depth equal to the full depth of the curb and gutter. They shall be securely staked, braced, and tied together with clamps and

spreaders to insure rigidity, and shall be sufficiently tight to prevent leakage of mortar. All forms shall be thoroughly cleaned and oiled before placing concrete. Curb returns shall be rigidly formed and the use of light metal or wood shall not be permitted.

60.5 Drainage Openings. Drainage openings of the size required shall be made through the curb and gutter where indicated or directed.

60.6 Mixing and Placing Concrete. Subgrade and forms shall be checked and approved by the engineer before any concrete is placed. Concrete shall be class A concrete, proportioned and mixed as specified in Section 46. It shall be deposited in layers not exceeding four inches in thickness and each layer shall be thoroughly compacted and spaded away from the forms to eliminate stone pockets and bring mortar to the surface. The top of the curb and gutter shall then be floated smooth with a wooden float and the edges rounded to the radius shown on the plans. Combined concrete curb and gutter shall be placed in one operation and a construction joint shall not be allowed between the curb and gutter. Before the concrete is given the final finishing, the surface of the gutter shall be checked with a straightedge 10 feet long, and any irregularities of more than one-quarter inch in 10 feet shall be eliminated.

60.7 Expansion Joints. Expansion joints shall be formed in curbs and gutters at intervals of $12\frac{1}{2}$ feet, using pre-molded filler one-quarter inch in thickness cut to the required shape. Expansion joints shall be set vertical and at right angles to the face of the curb and gutter.

60.8 Finishing. Forms shall be removed within 24 hours after the concrete has been placed. Minor defects shall be filled with mortar composed of one part cement and two parts fine aggregate, which shall be applied with a wood float. While still green, the face and top of the curb shall be troweled smooth with a steel trowel and then brushed with a medium bristle brush to produce a lightly sanded surface. The gutter shall be finished by wetting a cement mortar brick or wood block and rubbing the surface until it is smooth and has a uniform color and texture. Sufficient water shall be used during finishing to keep the portion

being rubbed moist. Edges of gutter and expansion joints shall be finished with an approved edging tool.

60.9 Curing. As soon as the curb and gutter has been finished and is sufficiently hard to prevent marring, it shall be protected against rapid drying by covering with thoroughly wet burlap slightly wider than the width of the curb and gutter and laid directly on the surface. The covering shall be kept saturated until removed. After the concrete has set sufficiently, the burlap shall be removed and the curb and gutter shall be covered with heavy absorbent mats or earth and kept continuously wet for a period of not less than seven days. Alternate wetting and drying shall not be permitted.

60.10 Backfilling. When curing is complete, the curb and gutter shall be backfilled, as indicated on the plans, in layers with approved material thoroughly compacted with rollers and iron tamping tools.

60.11 Method of Measurement. The quantity to be paid for shall be the number of cubic yards of concrete in the curb and gutter, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on the plans or ordered by the engineer.

60.12 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Class A Concrete Curb and Gutter," which price shall be full compensation for the concrete, expansion joint filler, preparing the subgrade, forms, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Reinforcing steel shall be measured and paid for as specified in Section 48.

When a layer of porous material is required under the curb and gutter, it shall be paid for at the contract unit price for the material specified.

Excavation shall be measured and paid for as roadway excavation, Section 13, except that no payment shall be made for material removed outside vertical planes 12 inches from the neat lines of the curb and gutter and parallel thereto.

Backfill made with material excavated in preparing the

subgrade shall not be paid for directly, and compensation therefor shall be included in the contract price for the curb and gutter. When backfill consisting of material other than roadway excavation is specified, it shall be paid for at the contract unit price for the material required.

SECTION 61—GROUTED RUBBLE GUTTER

61.1 Description. This item shall consist of a grouted rubble gutter constructed of the dimensions and at points indicated on the plans or ordered by the engineer, and in conformity with these specifications.

61.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Screenings, (no crushing requirement).....	Section 77
Rubble stone	Section 82
Mortar sand.....	Section 87
Standard Portland cement	Section 93

61.3 Construction Details. A foundation shall be excavated to the required depth and parallel with the finished surface of the gutter. All soft and yielding or other unsuitable material shall be removed and the subgrade compacted thoroughly and finished to a smooth, firm surface. When the character of the subgrade material is such that it will not afford a firm, true bearing for the gutter, the foundation shall be excavated below grade and the subgrade constructed with an approved coarse sand.

The gutter stone shall be bedded in the foundation perpendicular to the finished surface, with the flat surface up, in straight rows with the longest dimension at right angles to the center line of the gutter and in close contact. They shall break joints satisfactorily, and no interstices exceeding one and one-half inch in width shall be permitted. The stones shall be rammed thoroughly until the surface is firm and conforms to the finished grade, alignment, and cross section. Any gutter having an irregular or uneven surface shall be taken up and reset.

After the stone has been rammed into place and the surface is satisfactory, the spaces or voids between and around the stones shall be filled with screenings to within four inches of the surface, after which grout composed of one part Portland cement to three parts sand shall be poured and broomed into the spaces between the stones

until it is flush with the surface. The grout shall be of such consistency that it will not separate but will flow readily into the spaces between the stones. After completion, the gutter shall be kept continuously wet for a period of not less than five days.

61.4 Method of Measurement. The quantity to be paid for shall be the number of square yards, measured in horizontal projection, of grouted gutter in place in the completed and accepted work.

61.5 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per square yard for "Grouted Rubble Gutter," which price shall be full compensation for the gutter, preparing subgrade, backfilling when required, filler screenings, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 62—CONCRETE SIDEWALK

62.1 Description. This item shall consist of concrete sidewalk, constructed with class A concrete in accordance with these specifications, at the locations, and of the design and dimensions shown on the plans or ordered by the engineer.

62.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement concrete	Section 80
Fine aggregate for Portland cement concrete	Section 85
Standard Portland cement.....	Section 93
High early strength Portland cement (optional unless otherwise specified).....	Section 94
Bar reinforcement	Section 103
Premolded expansion joint filler....	Section 115

62.3 Subgrade. Prior to placing sidewalk, a satisfactory subgrade shall be prepared true to lines and grades established by the engineer. It shall be thoroughly watered and compacted by rolling and tamping until hard and smooth. All soft and unsuitable material shall be removed and replaced with suitable material. When indicated on the plans or ordered by the engineer, a layer of approved, thoroughly compacted porous material shall be placed under the sidewalk.

62.4 Forms. Forms shall be of metal or wood, straight and free from warp, and of sufficient strength to resist springing during the placing of concrete. Timber forms, if used, shall be surfaced on the top edge and on the face next to the concrete and shall be not less than one and five-eighths inches thick. Forms shall be of a depth equal to the full depth of the sidewalk. They shall be securely staked and braced to insure rigidity and shall be sufficiently

tight to prevent leakage of mortar. All forms shall be thoroughly cleaned and oiled before placing concrete.

62.5 Mixing and Placing Concrete. Subgrade and forms shall be checked and approved by the engineer before any concrete is placed. Concrete shall be class A concrete, proportioned and mixed as specified in Section 46. It shall be deposited between the forms upon the wetted subgrade and shall then be levelled off and tamped sufficiently to eliminate voids and bring the mortar to the surface. It shall be floated smooth with a wooden float and the edges and both sides of expansion joints rounded to the radius shown on the plans. The surface shall be checked with a straightedge 10 feet long and any irregularities of more than one-quarter inch in 10 feet shall be eliminated. The sidewalk shall be blocked into squares as shown on the plans or ordered by the engineer.

62.6 Expansion Joints. Expansion joints shall be formed in sidewalks at intervals of 25 feet, using premolded filler one-half inch in thickness cut to the required shape. Expansion joints shall be set vertical and at right angles to the face of the sidewalk.

62.7 Curing. As soon as the sidewalk has been finished and is sufficiently hard to prevent marring, it shall be protected against rapid drying by covering with thoroughly wet burlap slightly wider than the width of the sidewalk and laid directly on the surface. The covering shall be kept saturated until removed. After the concrete has set sufficiently, the burlap shall be removed and the sidewalk covered with heavy absorbent mats or earth and kept continuously wet for a period of not less than seven days. Alternate wetting and drying shall not be permitted. Forms shall be removed in not less than 24 hours nor more than 48 hours after the concrete has been placed. Upon removal of the forms an earth shoulder not less than one foot wide shall be placed against the edge of the concrete and kept moist during the curing period. When curing is complete, the sidewalk shall be cleaned and the shoulders constructed to the final elevation and cross section.

62.8 Method of Measurement. The quantity to be paid for shall be the number of cubic yards of concrete in the

sidewalk, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on the plans or ordered by the engineer.

62.9 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Class A Concrete, Sidewalk," which price shall be full compensation for the concrete, expansion joint filler, preparing the subgrade, forms, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Reinforcing steel shall be measured and paid for as specified in Section 48.

When a layer of porous material is required under the sidewalk, it shall be paid for at the contract unit price for the material specified.

Excavation shall be measured and paid for as roadway excavation, Section 13, except that no payment shall be made for material removed outside vertical planes 12 inches from the neat lines of the sidewalk and parallel thereto.

Shoulders made with material excavated in preparing the subgrade shall not be paid for directly, and compensation therefor shall be included in the contract price for the sidewalk. When shoulders consisting of material other than roadway excavation are specified, they shall be paid for at the contract unit price for the material required.

SECTION 63—CATCH BASINS, INLETS, AND MANHOLES

63.1 Description. This item shall consist of the construction of catch basins, inlets, or manholes of Portland cement concrete, together with the necessary drains, grates, or covers at points and of the designs shown on the plans and in conformity with these specifications.

63.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement con- crete	Section 80
Fine aggregate for Portland cement concrete	Section 85
Standard Portland cement.....	Section 93
High early strength Portland cement (optional unless other- wise specified).....	Section 94
Gray iron castings.....	Section 98

63.3 Construction Details. Catch basins, inlets, and manholes shall be constructed in accordance with all of the requirements of Section 47—Concrete Structures. The concrete shall be proportioned and mixed in accordance with the requirements of Section 46—Portland Cement Concrete. Inlet and outlet pipes shall be placed prior to pouring concrete.

Cast iron grates shall be set in full mortar beds or otherwise secured as shown on the plans. Mortar for setting castings shall be mixed in the proportions of one part cement to two parts of fine aggregate. Castings shall be set accurately to the final elevation so that no subsequent adjustments will be necessary. Concrete covers, when indicated on the plans, shall be constructed in such manner that they will fit snugly and be readily removable.

63.4 Method of Measurement. Castings shall be measured in pounds. The weight of castings shall be computed

from the dimensions shown on the approved shop drawings, assuming the iron to weigh 450 pounds per cubic foot, with an allowance of 10 percent for fillets and overrun.

63.5 Basis of Payment. Concrete shall be measured and paid for as specified in Section 47—Concrete for Structures.

Reinforcing steel shall be measured and paid for as specified in Section 48—Reinforcing Steel.

Castings, measured as provided above, shall be paid for at the contract unit price per pound for "Castings," which price shall be full compensation for furnishing, fabricating, and installing castings, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Necessary excavation shall be measured and paid for in accordance with Section 19—Structure Excavation.

Backfill shall be measured and paid for in accordance with Section 20—Backfill.

Inlet and outlet pipes shall be measured and paid for in accordance with the specifications for the particular type of pipe required.

SECTION 64—BITUMINOUS TREATED FOOTPATH

64.1 Description. This item shall consist of a bituminous footpath constructed in accordance with these specifications at points and of the design and dimensions shown on the plans or ordered by the engineer.

64.2 Materials. All materials shall conform to the requirements for the several items which constitute the footpath.

64.3 Construction Methods. The area for the footpath shall be graded to the lines and grades indicated on the plans or ordered by the engineer in accordance with the applicable portions of Sections 10 to 18, inclusive, and Section 22. Subgrade shall then be prepared as specified for type B subgrade in Section 23, except that the rolling may be done with a roller providing a compression of not less than 200 pounds per linear inch of roller width.

When required by the plans or special provisions, forms shall be set as staked by the engineer and shall have a height equal to the total thickness of base and surface courses for the footpath. Forms may be either timber or metal and shall have sufficient strength to avoid displacement during rolling and maintain the footpath true to line and grade until the surface is completed. Timber forms shall not be less than one and five-eighths inches thick.

Base and surface courses shall be constructed in accordance with the specifications for the particular items required.

Subgrade and base and surface courses shall be rolled until thoroughly compacted with a roller providing a compression of not less than 200 pounds per linear inch of roller width. After rolling has been completed, the forms may be removed and the spaces occupied by the form back-filled with approved material thoroughly compacted to form a solid supporting shoulder.

The footpath shall be protected from damage during construction, and any damage due to the contractor's operations shall be repaired by the contractor at his own expense.

The completed footpath shall be true to lines, grades,

and cross section, and the surface shall be smooth, hard, and compact.

64.4 Method of Measurement. When the proposal contains a separate item, the quantity to be paid for shall be the number of square yards of footpath complete in place in the accepted work, measured between the side forms.

When the proposal does not contain a separate item, the quantities of the various items which constitute the completed and accepted footpath shall be measured for payment according to the plans and specifications for the several pay items and in terms of the units provided for such items.

64.5 Basis of Payment. When the proposal contains a separate item, the quantity, measured as provided above, shall be paid for at the contract unit price per square yard for "Bituminous Footpath," which price shall be full compensation for preparing the subgrade, setting and removing forms, placing base and surface courses, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, except that excavation, borrow, select borrow, and overhaul shall be paid for as prescribed for those items.

When the proposal does not contain a separate item, the quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items constituting the footpath and listed in the proposal, which prices shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 65—PRESERVATIVE TREATMENTS FOR TIMBER

65.1 Description. This item shall consist of the treatment of Douglas fir timber, when required, with creosote, or creosote-coal tar preservative in conformity with these specifications.

65.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Timber preservatives.....Section 112

65.3 Air Seasoning. Materials to be treated, preferably, shall be air-seasoned until the moisture remaining in the wood will not prevent the injection and proper distribution of the specified amount of preservative. For air-seasoning the materials shall be stored as follows: Lumber shall be segregated according to size and each layer in the pile shall be separated by at least one-inch strips with an air space of one inch or more between each two pieces of lumber in any layer; for caps, stringers, posts, or large timbers, at least two-inch strips shall be used to separate the layers. Alleys at least three feet wide shall be left between rows of stacks and the material shall be at least 12 inches off the ground on concrete or treated timber sills. Piles shall be stored in like manner, placing as nearly as practical only one length in a stack, using at least two-inch strips or saplings of equal size between each layer, and reversing all sticks in every other layer in order to keep the stack level. The space under and between the rows of stacks shall be kept free at all times of rotting wood, weeds, or rubbish. The yard shall be so drained that no water can stand under the stacks or in their immediate vicinity.

65.4 Oil Seasoning for Douglas Fir. Douglas fir may be seasoned by boiling in oil under a vacuum until the moisture remaining in the wood will not prevent the injection and proper distribution of the specified amount of preservative.

The material shall be boiled in creosote under a vacuum

at temperatures which do not exceed 220 degrees Fahrenheit for piling and 200 degrees Fahrenheit for sawed timber and lumber. A minimum vacuum of 20 inches shall be maintained during boiling. The seasoning period shall be maintained until condensation passing off from the timber is at the rate of approximately one tenth of a pound per cubic foot of timber per hour.

65.5 Preparation for Treatment. Each cylinder charge shall consist of pieces approximately equal in size and moisture and sapwood content, into which approximately equal quantities of preserving fluid can be injected. Pieces shall be so separated as to insure contact of steam and preservatives with all surfaces.

65.6 Plant Equipment. Treating plants shall be equipped with the thermometers and gauges necessary to indicate and record accurately the conditions at all stages of treatment, and all equipment shall be maintained in a condition satisfactory to the engineer. The apparatus and chemicals necessary for making the analyses and tests required by the engineer shall also be provided by plant operators, and kept in condition for use at all times.

65.7 Penetration. The range of pressure, temperature, and time duration shall be controlled so as to result in a maximum penetration by the quantity of preservative injected. The vacuum requirements stipulated are in inches of mercury at sea level, and necessary corrections shall be made for altitude.

In Douglas fir the minimum penetration for the specified amount of creosote oil shall be as follows:

ITEM	—SPECIFIED AMOUNT OF CREOSOTE— PER CUBIC FOOT			
	10 lbs. inch	12 lbs. inch	14 lbs. inch	16 lbs. inch
Piling	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1
Timbers 12 inches by 12 inches and larger.....	.65	.75	.85	1.00

For timbers less than 12 inches by 12 inches the required depth of penetration shall be determined by the formula:

$$P = Ps \frac{R}{Rs}$$

where P = required penetration.

P_s = specified penetration for 12 - inch by 12 - inch timbers.

R = ratio of the volume of the piece in question to its superficial area.

R_s = ratio of the volume of a 12 - inch by 12 - inch timber to its superficial area.

The penetration of the preservative shall be based on black or dark oil, and in no case will light discoloration of the wood, due to treatment, be taken into consideration in measuring the depth of penetration.

Tests for penetration shall be made by taking borings with an increment borer, or a five-eighths inch auger, all holes so bored to be plugged by the contractor with tight-fitting creosoted plugs.

As many penetration tests of lumber and piling shall be made as is considered necessary by the inspector. In the case of piling, the holes shall be bored midway between the ends.

In the case of timber and lumber, every fourth stick of the charge may be bored.

65.8 Quantity of Preservative. The amount of preservative to be used shall be as shown on the plans or specified, and this amount shall be retained in the timber unless the oil has been injected to refusal. Unless otherwise specified, preservative shall be grade one creosote oil and the amount of preservative retained shall be as follows:

Creosote or Creosote-Coal Tar—

For piles and timber in general road and bridge construction:

Full-cell process, not less than 12 pounds of oil per cubic foot of timber, or

Empty-cell process, not less than eight pounds of oil per cubic foot of timber.

65.9 Pressure Treatments for Douglas Fir. The following pressure processes shall be used for oil treatment of Douglas fir:

HEATING WITH OIL. It is not required that air-seasoned or kiln-dried Douglas fir be boiled under a vacuum, but it may be desirable to hold the material in a creosote bath

maintained at a temperature of 180 degrees Fahrenheit to 190 degrees Fahrenheit for a length of time which, combined with the pressure period, is, in the judgment of the operator, necessary to secure the specified absorption.

(a) **FULL-CELL PROCESS.** Following the heating period, in the case of air-seasoned material, and the period of seasoning under vacuum in the case of material artificially seasoned, the cylinder shall be filled with creosote and pressure applied, as required, to a maximum limit of 175 pounds per square inch and maintained, taking into consideration the quantity of creosote absorbed during the bath, until the specified absorption of creosote has been obtained.

Temperature of the creosote during the pressure period shall be as high as possible, with a minimum limit of 160 degrees Fahrenheit and a maximum limit of 200 degrees Fahrenheit.

After pressure is completed, the cylinder shall be emptied of creosote and a vacuum of at least 20 inches promptly created and maintained for a sufficient period of time to free the material of dripping creosote.

(b) **EMPTY-CELL PROCESS WITH INITIAL AIR.** Following the heating period, in the case of air-seasoned material, and the period of seasoning under vacuum in the case of material artificially seasoned, the material shall be subjected to air pressure of an intensity and duration which, in the judgment of the operator, is sufficient to secure the final retention of the specified quantity of creosote.

The preservative shall then be introduced, the air pressure being maintained constant, until the cylinder is completely filled.

Creosote shall then be pressed from the measuring tanks into the wood in a quantity which, in the opinion of the operator, is sufficient to leave the required retention at the completion of the process herein described. Maximum pressure shall in no case exceed 200 pounds per square inch. The temperature of the creosote during the pressure period shall be as high as possible, within a minimum limit of 160 degrees Fahrenheit and a maximum limit of 200 degrees Fahrenheit.

After pressure is completed, the cylinder shall be quickly

emptied of creosote and a vacuum of at least 20 inches promptly created and maintained for such a period of time as may be required to remove dripping creosote from the material.

65.10 Open-Tank Treatments. Open-tank treatment shall consist of a hot bath treatment or a hot and cold bath treatment as may be specified.

All tanks used in the open tank process shall be of sufficient size to allow free circulation of the liquid around the largest amount of timber being treated in any operation.

Sufficient liquid shall be maintained in the tanks to completely immerse the timber. When a number of pieces are being treated at each operation, each stick shall be separated from the others on all sides by square or round spacers not less than one-quarter inch in least dimension. Suitable slings and handling devices shall be provided for the transfer of material necessary during the complete process without disturbing the stacked position of the pieces in the bundle.

For hot bath treatments at least one tank shall be supplied having suitable steam coils or other heating device to keep the liquid at a uniform temperature of not less than 240 degrees Fahrenheit throughout the tank during the complete process.

For hot and cold bath treatments at least one hot tank shall be supplied as for the hot bath treatment and one cold tank having the same capacity as the hot tank. The cold tank shall be equipped with suitable cold water coils or water jackets, so that the temperature of the liquid at the time of immersion of each batch of timber shall be no higher than the surrounding atmospheric temperature.

All timber to be treated shall be free from dirt, grease, or other foreign matter which will in any way hinder the free penetration of the preservative. Framing shall be done before treatment. Round timber or timber with wane shall have the rough bark and inner bark removed as specified for wood piling in Section 111.

(a) SINGLE OR HOT BATH TREATMENT. The timber shall be completely immersed in preservative in the hot tank, which shall be maintained at a temperature of 190 degrees

Fahrenheit for seasoned timber and 230 degrees Fahrenheit for timber not seasoned. A tolerance of 10 degrees in either direction is permissible. For seasoned timber the immersion shall be for a period of not less than 25 minutes for two-inch timber with an increase of eight minutes in the immersion period for each additional inch in thickness. For unseasoned timber, the immersion period shall be doubled.

(b) **HOT AND COLD TREATMENT.** The timber shall be completely immersed in preservative in the hot tank, which shall be maintained at a temperature of 190 degrees Fahrenheit for seasoned timber and 230 degrees Fahrenheit for timber not seasoned. A tolerance of 10 degrees in either direction is permissible. For seasoned timber the immersion shall be for a period of not less than 25 minutes for two-inch timber with an increase of eight minutes in the immersion period for each additional inch in thickness. For unseasoned timber the immersion period shall be doubled. At the end of this period the timber shall be removed from the hot tank and immediately immersed in the cold tank. At the time of transfer the preservative in the cold tank shall have a temperature as low as possible, but in no case higher than the surrounding air temperature. The timber shall be completely immersed in the cold tank for a period one half as long as for the hot bath.

Successive charges from the hot tank may be placed first in one cold tank and the next in a second cold tank in order to keep the cold tank temperature as low as possible at the time of immersion. Should the contractor supply a cold tank capable of handling all material and with a cooling system which will secure the specified temperature at the time of all cold treatment as specified, only one cold tank may be required. Single cold tank equipment shall be subject to the approval of the engineer.

65.11 Brush Treatment. All timber to be given brush treatment shall be free from atmospheric moisture, and in no case shall brush treatment be applied when the surface of the timber is wet. The surfaces to be treated shall be free from dirt, grease, or other foreign matter which will in any way hinder the maximum penetration of the preservative.

The preservative shall be heated in proper receptacles immediately adjacent to the point of application and shall be applied within the temperature range of 170 degrees Fahrenheit to 190 degrees Fahrenheit for seasoned wood and 220 degrees to 240 degrees Fahrenheit for unseasoned wood.

A minimum of two coats shall be applied to all surfaces to be treated except cut ends, joints, and mortises, which shall be given three coats. Each coat shall be allowed to penetrate before applying the next coat. All checks, bolt holes, and cracks shall be run full of the preservative oil and an extra heavy treatment shall be given to knotty spots.

65.12 Spray Treatment. The condition of the timber prior to spray treatment shall conform to the requirements specified for brush treatment.

The temperature of the preservative shall be maintained at 240 degrees Fahrenheit. The shortest length of hose practicable shall be used to prevent undue chilling between the spray tank and nozzle. Preservative shall be renewed frequently in the spray tank to prevent chilling. The spray shall be applied with a good pressure and only fine enough to prevent waste, until the preservative begins to run. Equipment employing air pressure which has a cooling effect on the hot preservative shall not be used.

Two liberal applications shall be made, allowing sufficient time for the absorption of the first application before the second is made.

65.13 Measurement and Payment. Payment shall be made in accordance with the specifications for the particular item of work into which the treated timber enters.

SECTION 66—GUARD RAIL

66.1 Description. This item shall consist of furnishing all materials and erecting a metal plate guard rail, conforming to the plans and these specifications, at points and to the lines and grades shown on the plans or ordered by the engineer.

66.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Treated Douglas fir guard rail posts (1100#c).....	Section 110
Redwood guard rail posts (1100#c close grained).....	Section 110
Timber preservatives	Section 112
Guard rail materials.....	Section 114
Paints and paint materials.....	Section 116

66.3 Construction Details. Unless otherwise specified, metal guard rail may be constructed with either redwood or treated Douglas fir posts and floating, nonfloating or beam type plates, springs, and fittings at the option of the contractor. Douglas fir posts shall be given a preservative treatment as specified in Section 65. Post spacing shall be as shown on the plans.

Posts shall be set plumb, except on superelevated curves where they shall be set perpendicular to the roadway. Front faces of posts shall form a straight line, except on curves where they shall be a uniform distance from the edge of the roadway. Post holes shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool in such manner as not to displace the bottoms of posts from correct alignment. All surfaces of the posts in contact with fittings shall receive one coat of the prescribed paint before the fittings are placed.

The rail shall be erected in the manner shown on the plans. Workmanship shall be first class in all respects and framing shall be done and fittings attached in such manner that the rail, after erection, shall be true to line and grade and shall have the proper tension in the rail plates. Care

shall be taken to prevent the disturbance of posts during the erection of the rail and, when necessary, temporary braces shall be installed to insure against post displacement.

Nonfloating and floating type rails shall be erected so that all slack is eliminated, and the resilient details or springs are only partially taken up in tension. The tension shall be uniform throughout the length of the rail. Where slotted holes are used for movement of rail elements, the brackets shall be adjusted so that when the rail is under proper tension the bolts are in the middle of the slotted holes. Beam type rails shall be erected so that the bolts at expansion joints are located at the centers of the slotted holes.

The maximum length between anchorages shall not exceed 500 feet nor one-half the radius if the rail is on a curve. In any length of rail, the anchorages shall divide the length into approximately equal divisions. Intermediate anchorages shall be constructed to result in a continuous, resilient rail with an overlapping expansion joint at each intermediate anchorage. Anchorages, springs, and take-ups, as required by the rail type used, equivalent to those at the end of the rail, shall be provided each side of each expansion joint. Floating take-ups will not be permitted.

After erection, all metal parts and fittings, free from coatings of any kind including dirt, rust, and oil and grease, shall be given three coats of paint as specified in Section 68, except that the prescribed priming coat shall be omitted on all metal parts and fittings which have been galvanized, but such parts, prior to applying paint, shall be slightly etched with a solution composed of one quart of vinegar to two gallons of water. The surface shall be rinsed with clear water and allowed to dry thoroughly before painting.

66.4 Method of Measurement. The quantity to be paid for shall be the number of lineal feet of rail, complete in place and accepted, measured along the front face of the rail between centers of end posts.

66.5 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price per lineal foot for "Metal Guard Rail" when type is optional, or at the contract unit price per lineal foot for "Nonfloating

Type Metal Guard Rail," "Floating Type Metal Guard Rail," or "Beam Type Metal Guard Rail," as the case may be, when type is specified, which price shall be full compensation for furnishing all materials, treating posts, inspection certificates, excavating and backfilling post holes, erecting the rail, painting, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 67—CULVERT MARKERS AND GUIDE POSTS

67.1 Description. This item shall consist of furnishing all materials and erecting timber posts for culvert markers or guide posts, conforming to these specifications, at points shown on the plans or ordered by the engineer.

67.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Timber posts, Douglas fir, select

merchantable plankSection 110

Paints and paint materials.....Section 116

67.3 Construction Methods. Culvert markers and guide posts shall be spaced and erected in the manner indicated on the plans, and shall be set plumb, except on superelevated curves where they shall be set perpendicular to the roadway. Holes shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool.

After erection, and when the wood is dry and clean, posts shall be given three coats of paint and stenciled numbers and trim shall be applied as specified in Section 68. Posts shall be painted at least nine inches below ground.

67.4 Measurement and Payment. The number of culvert markers and guide posts in the completed and accepted work shall be paid for at the contract unit price each for "Culvert Markers" or "Guide Posts," as the case may be, which price shall be full compensation for furnishing, erecting and painting the posts, for inspection certificates, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, including excavation and backfill.

SECTION 68—PAINTING

68.1 Description. This item shall consist of the preparation of surfaces to be painted and the application, protection, and drying of the required number of coats of paint of the kinds and at points specified or ordered by the engineer.

68.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Paints and paint materials.....Section 116

68.3 Number of Coats. Unless otherwise required on the plans or in the special provisions, the number and kind of coats of paint shall be as follows:

Structural steel and metal parts—

First coat (shop)—Formula A

Second coat—Formula B

Third coat—Formula G or H

Wood and Timber—

First coat—Formula D

Second coat—Formula F

Third coat—Formula G or H

Black trim—Formula I

68.4 Preparation of Surface. Surfaces to be painted shall be thoroughly cleaned before paint is applied. Rust, loose mill scale, dirt, oil or grease, and other foreign substances shall be removed from metal surfaces by the use of sand blasts, metal brushes, scrapers, chisels, hammers or other effective means. Oil and grease shall be removed by the use of gasoline or benzine. Bristle brushes shall be used for removing loose dust. Timber surfaces shall be cleaned of dust, dirt, and other foreign matter by brushing or other effective means.

68.5 Application—General. Paint shall be applied only when the air temperature is at or above 40 degrees Fahrenheit. It shall not be applied upon damp surfaces or surfaces containing frost, nor shall it be applied when the air is misty, or otherwise unsatisfactory for the work, in the opinion of the engineer.

Materials painted under cover in damp or cold weather

shall remain under cover until dry, or until weather conditions permit its exposure in the open. Painting in open yards or upon erected structures shall not be done when the material has absorbed sufficient heat to cause the paint to blister and produce a porous paint film.

Paint shall be applied with brushes unless otherwise permitted in writing by the engineer. When permission is granted to employ paint spraying machines, it shall be upon the condition that the work done by them will be equivalent in all respects, in the opinion of the engineer, to that obtained with hand brushes, and should results obtained prove unsatisfactory, the use of the machines shall be immediately discontinued.

Paint shall be applied with round or oval brushes unless otherwise permitted in writing by the engineer. The paint when applied shall be so manipulated under the brush as to produce a uniform, even coating in close contact with the surface and shall be done in a neat, workmanlike manner. In general, the primary movement of the brush shall describe a series of small circles to fill thoroughly all irregularities in the surface, after which the coating shall be smoothed and thinned by a series of parallel strokes. Paint shall be evenly spread and thoroughly brushed out. The appearance of any considerable amount of brush marks shall be considered as evidence that the paint is not being brushed out sufficiently. On all surfaces which are inaccessible for brushing, the paint shall be applied by sheepskin daubers especially constructed for the purpose.

A mechanical paint mixer shall be used to stir the paint in the original containers prior to drawing the paint off into the painter's buckets. Mechanical agitation shall be continued sufficiently long to mix the pigment and vehicle thoroughly. Paint shall be kept thoroughly stirred while being applied to keep the pigments in suspension.

If it is necessary in cool weather to thin the paint in order that it will spread more freely, this shall be done only by heating the containers in hot water. No thinners shall be added except as provided in the paint formulas.

68.6 Protection. The contractor shall protect pedestrian, vehicular, or other traffic adjacent to all work being

painted, and shall also protect all parts of the structure or adjacent structures against disfigurement by spatters, splashes, and smirches of paint or paint materials. When necessary, canvas shields or other protective means shall be used to guard against such damage. Paint stains which result, in the opinion of the engineer, in an unsightly appearance shall be removed or satisfactorily obliterated.

The contractor shall furnish and erect such signs as the engineer may deem necessary to control the speed of traffic and give warning of the painting operations. When traffic causes an objectionable amount of dust, the contractor shall sprinkle the adjacent roadway sufficiently to eliminate this condition.

68.7 Shop Painting Steel. Surfaces to be riveted in contact, either in the shop or field, shall not be painted, but such surfaces shall be thoroughly cleaned of rust, mill scale, dirt, grease, or other foreign matter at the time of bolting up and riveting. Surfaces not in contact but which will be inaccessible after assembly or erection shall receive two coats of the specified shop paint.

When fabrication is complete and the work has been accepted, surfaces not painted before assembling, except surfaces to be in contact after erection, shall be painted one coat of the specified shop paint. Material shall not be loaded for shipment until the paint is dry.

Erection marks shall be painted on painted surfaces.

With the exception of abutting chord and column splices and column and truss shoe bases, machine surfaces shall be coated as soon as practicable after being accepted, and before removal from the shop, with a hot application of lead and tallow.

Surfaces of iron and steel castings which have been machine finished in order to remove scales, scabs, fins, blisters, or other surface deformities shall be painted with one coat of shop paint.

68.8 Field Painting Steel. As soon as the field cleaning has been satisfactorily completed, the heads of field rivets and bolts, and any surfaces from which the shop coat of paint has been worn off or has become otherwise defective,

shall be covered with one coat of the same paint as was used in the shop.

Small cracks and cavities which have not been sealed in a water-tight manner by the first field coat shall be filled with red lead paste before the second field coat is applied.

When the paint applied for touching up rivet heads and abraded surfaces has become dry, the first field coat may be applied. In no case shall a coat be applied until the previous coat has dried throughout the full thickness of the paint film.

To secure a maximum thickness of paint film on rivet heads and edges of plates, angles, and other rolled shapes, these parts shall be painted an extra coat in advance of the general application of each field coat.

68.9 Painting Timber. After the priming coat has dried, all cracks and openings in the timber and surfaces that are checked shall be puttied. Succeeding coats of paint shall not be applied until at least three days after the preceding coat has hardened enough to prevent breaking under the brush.

68.10 Measurement and Payment. No direct payment shall be made for painting. Compensation for this work shall be considered as included in the contract prices for the particular item requiring painting.

SECTION 69—FENCING

69.1 Description. This item shall consist of furnishing all materials and erecting new fences, or reconstructing fences perviously removed, in conformity with these specifications and of the types and at points shown on the plans or ordered by the engineer.

69.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Fence posts and fence materials....Section 113

69.3 Construction Methods. All clearing which would interfere with proper construction shall be done in advance of constructing the fence. Material so removed shall be disposed of in accordance with the requirements of Section 10. Fences shall be constructed on the highway right of way line unless otherwise specified. Posts shall be firmly set into the ground and spaced as indicated on the plans. Each end, corner, and gate post shall be firmly braced and shall be set in concrete when required. When wood posts are used, each gate, end, and corner post shall be spaced at one-half the regular interval from the adjacent line post. Posts shall be braced as indicated on the plans. Brace posts shall be placed in the fence line at intervals of not more than 280 feet unless a gate intervenes.

The wire shall be stretched taut without warping and securely fastened to each post with one and three-quarters inch galvanized staples or approved galvanized wire ties. Gates shall be installed at points indicated on the plans or directed by the engineer.

At all grade depressions and alignment angles, where stresses tending to pull the posts from the ground are created, the fencing shall be snubbed or guyed at the critical point by means of a double strand of 6-gauge wire connected to each horizontal line of fence wire and to a deadman weighing approximately 100 pounds buried in the ground not less than two feet. The fencing shall be pulled snug to the ground before being snubbed or guyed.

Reconstructed fences shall be carefully erected, using salvaged materials, and shall be similar in type to the original

construction. Any new materials necessary to rebuild the fence shall be furnished by the contractor, shall be of the same kind as those in the original fence, and the cost thereof shall be included in the contract price for the work. The resulting reconstructed fence shall be equal or better than before removing. In reconstructed fences, the department reserves the right to furnish the contractor with such new materials as it deems advisable, and these materials shall be used in the reconstruction of the fence in lieu of the salvaged materials which they replace.

The finished fence shall be true to line, with tops of posts cut square and paralleling the general contour of the ground, and the whole shall be taut and solid at all points.

69.4 Method of Measurement. The quantity of new fencing to be paid for shall be the number of linear feet of fence, exclusive of gates, measured in place in the completed and accepted work.

The quantity of reconstructed fencing to be paid for shall be the number of linear feet of fence, including gates, measured in place in the completed and accepted work, except that when new gates are required, the length of such gates shall be excluded.

The number of new gates installed in the completed and accepted work shall be measured as units.

69.5 Basis of Payment. The quantity of new fence constructed, or fence reconstructed, measured as provided above, shall be paid for at the contract unit price per linear foot for "Construct Fence" or "Reconstruct Fence," as the case may be.

The number of new gates installed, measured as provided above, shall be paid for at the contract unit price each for "..... ft. Gates."

Payment provided above shall be full compensation for furnishing and installing fences and gates, including clearing, excavation, backfill, and concrete, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 70—TRAFFIC STRIPE

70.1 Description. This item shall consist of furnishing materials and painting traffic stripes for traffic lane division, in accordance with these specifications, at points indicated on the plans or ordered by the engineer.

70.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Traffic lacquer.....Section 116

70.3 Spotting Alignment. On sections where no previously applied stripe is available to serve as a guide, the line of the proposed stripe shall be spotted with lacquer in advance of the machine application.

A rope approximately one-half inch in diameter shall be stretched between control points and the spotting effected by means of a narrow brush or spraying apparatus applied over the top of the rope at intervals of not less than 15 inches nor more than 45 inches. Control points on tangent sections shall be spaced not more than 600 feet apart, and on curves shall be spaced as directed by the engineer at such intervals as will insure the accurate location of the line.

70.4 Application. The portion of the pavement on which the traffic stripe is to be painted shall be cleaned by means of compressed air immediately before painting and shall be clean and dry when the lacquer is applied. Lacquer shall not be applied on damp pavement.

Lacquer shall be applied at its original consistency without the addition of thinner, by means of an approved pressure spray painting machine or by hand methods. Lacquer shall be kept thoroughly agitated while it is being applied.

Where traffic stripe is painted over an existing stripe, lacquer shall be applied at the rate of from 8 to 12 gallons per mile of stripe, and where new stripe is painted, lacquer shall be applied at the rate of from 12 to 18 gallons per mile of stripe, the exact rates of application to be determined by the engineer.

The stripe shall be four inches wide with clear, true edges without sharp breaks and shall be applied within one-half inch of the average center line of the existing stripe or the

spotted line. Any deviation either side of the painted or spotted line which exceeds one-half inch in any 50-foot length shall be obliterated and the stripe corrected. A uniform covering of lacquer shall be applied and the finished stripe shall be free from light spots and paint skims.

The painting equipment shall be so operated that it will be unnecessary for traffic to cross the newly painted stripe behind the equipment in order to enter the proper traffic lane.

The newly painted stripe shall be so protected that the paint will not be picked up by the tires of passing vehicles. During painting operations, one large warning sign shall be placed at the beginning of each day's work and another one kept well ahead of the painting equipment. Small flags shall be placed adjacent to the newly painted stripe at frequent intervals in order to reduce as much as possible the tendency of traffic to cross the painted line. The contractor shall repaint at his own expense any portions of the stripe damaged by passing traffic.

70.5 Method of Measurement. The quantity of acceptable traffic stripe in the completed work shall be measured in miles along the center line of each stripe.

70.6 Basis of Payment. The quantity of traffic stripe painted, measured as provided above, shall be paid for at the contract unit price per mile for "Traffic Stripe," which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 71—MONUMENTS

71.1 Description. This item shall consist of furnishing and erection of Portland cement concrete monuments of the design and at the locations indicated on the plans or directed by the engineer.

71.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 73
Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement con- crete	Section 80
Fine aggregate for Portland cement concrete	Section 85
Standard Portland cement.....	Section 93
Bar reinforcement	Section 103

71.3 Construction Methods. Monuments shall be fabricated from class D concrete in accordance with the specifications for Portland cement concrete, Section 46.

Suitable forms and methods shall be used for obtaining clean, sound, and uniform monuments conforming to the design and dimensions shown on the plans.

Monuments shall be set to define the right of way lines and, unless otherwise specified, they shall be set at the beginning and end of each project, at the beginning and end of each curve, at all corners of irregular right of way lines, and approximately one mile apart on long tangents. Monuments shall be set in compacted soil exactly in accordance with the lines as staked by the engineer. The holes shall be backfilled with approved materials, in layers, thoroughly rammed with a steel tamping tool in such manner that the monument will not be displaced from its true position.

71.4 Method of Measurement and Basis of Payment. This work shall be paid for at the contract unit price each for "Monuments" complete in place, which price shall be full compensation for all labor, material, tools, supplies, equipment, and incidentals necessary to complete the work, including excavation and backfill.

SECTION 72—FIELD LABORATORY

72.1 Description. This item shall consist of furnishing all materials and erecting a field laboratory for the exclusive use of the engineer, in conformity with these specifications and of the design and dimensions shown on the plans.

72.2 Construction Details. When required herein or by the special provisions, the contractor shall erect a field laboratory. The building shall have a floor plan with the approximate dimensions shown on the plans, shall be located conveniently as directed by the engineer, and shall be independent of any building used by the contractor. It shall be constructed of wood or other approved material and shall be weathertight. The ceiling height shall be not less than eight feet and it shall have windows, doors, tables, lockers, and other equipment as shown on the plans or ordered by the engineer. If the work is prosecuted in cold weather, the contractor shall provide heat for the building.

Upon completion of the work, the building shall become the property of the contractor and he shall remove or otherwise dispose of it to the satisfaction of the engineer.

72.3 Method of Measurement and Basis of Payment. Unless an item is included in the proposal, this work shall not be paid for directly and compensation for the construction of the laboratory shall be considered as included in the contract prices for other items of the work.

When an item is included in the proposal, this work shall be paid for at the contract lump sum price for "Field Laboratory," which price shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

PART III

MATERIAL DETAILS

SECTION 73—WATER

73.1 Material Covered. This specification covers the quality of water for use in concrete and for application to the roadway.

73.2 Quality. Water for use with cement in mortar or concrete shall not be salt or brackish and shall be reasonably clear and free from oil, acid, injurious alkali, or vegetable matter. Water for subgrade, curing, base and surface courses shall be reasonably free from alkali or other substances likely to cause damage to base or surface courses. The quality of water shall be subject to the approval of the engineer.

73.3 Tests. Quality of water for mixing with cement shall be determined by method T-26 "Tests for Quality of Water to be Used in Concrete," as provided in the Tentative Standard Methods of Sampling and Testing of the American Association of State Highway Officials. In sampling water for testing, care shall be taken that the containers are clean and that the samples are representative. When comparative tests are made with a water of known satisfactory quality, any indication of unsoundness, marked change in time of setting, or a reduction of more than 10 percent in mortar strength, shall be sufficient cause for rejection of the water under test. Water which is suitable for drinking or for ordinary household use may be accepted for use without being tested. Samples of water forwarded to the laboratory shall be shipped in glass containers.

SECTION 74—SELECT MATERIAL

74.1 Material Covered. This specification covers the quality and size of select material.

74.2. General Requirements. The material shall be disintegrated granite from approved deposits, and shall be free from vegetable matter, an excess of soluble salts, and other deleterious matter. When the material is to be treated with liquid asphalt, it shall be of such character that when once coated with bituminous material, the coating will not slough off upon contact with water.

74.3 Physical Properties. The fraction passing the No. 40 sieve shall have a plasticity index of not more than six and a liquid limit of not more than 25.

74.4 Size Requirements. The material shall conform to the following sieve analysis:

Laboratory sieve, square openings	Percentage by weight passing sieve
2 inch	98-100
$\frac{3}{4}$ inch	85-100
No. 10	40-85
No. 40	15-50
No. 200	*0-25

*The fraction passing the No. 200 sieve shall be less than two thirds of the fraction passing the No. 40 sieve.

74.5 Sampling and Testing. Sampling and testing of select material shall be in accordance with the following standard test methods:

Sampling	A.A.S.H.O. T-2
Portion passing 200 mesh.....	A.A.S.H.O. T-11
Size	A.A.S.H.O. T-27
Liquid limit	A.A.S.H.O. T-89
Plasticity index	A.A.S.H.O. T-91

SECTION 75—AGGREGATES FOR GRAVEL BASE COURSES

75.1 Material Covered. This specification covers the quality and size of gravel, crushed gravel, crushed stone, sand, stone screenings, and filler for the following base courses:

- (a) Type 1 Gravel Base.
- (b) Type 2 Gravel Base.
- (c) Plantmix Gravel Base.

75.2 General Requirements. The aggregate shall be the product of approved deposits and shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces, alkali, and vegetable matter.

The minimum amount of crushed material in the finished product shall be as follows:

- (a) Type 1 Gravel Base—No requirements.
- (b) Type 2 Gravel Base—That obtainable by crushing and incorporating into the finished product all particles in the pit-run material larger than the maximum size specified for the finished product and less than six inches in largest dimension.
- (c) Plantmix Gravel Base—Not less than 50 percent of the particles in the fraction retained on a No. 4 sieve shall have at least one fractured face.

75.3 Physical Properties. The aggregate shall conform to the following requirements:

Physical Property	Type 1 Gravel Base	Type 2 Gravel Base	Plantmix Base
Percentage of wear (L. A. Rattler 500 Rev.) % max. ....	.....	.....	45
Cementing value, lbs. per sq. in., min. ....	.....	100	100
Fraction passing No. 40 sieve—			
Plasticity index, max.	6	6	6
Liquid limit, max.	25	25	25
Lineal shrinkage, % max. ....	.....	.....	4

75.4 Size Requirements, Type 1 Gravel Base. The aggregate shall conform to one of the following sieve analyses, the size selection to be optional with the contractor unless otherwise specified:

Laboratory sieve, square openings	Percentage by weight passing sieve		
	3-inch size	2-inch size	1½-inch size
3 inch	95-100		
2 inch	-----	95-100	
1½ inch	-----	-----	95-100
1 inch	45-80	50-85	55-95
No. 10	20-45	20-55	25-65
No. 200	0-15	0-18	0-20

NOTE—If the product of any deposit is deficient in the fraction passing the No. 10 sieve, additional filler from other approved deposits meeting the physical requirements shall be provided.

75.5 Size Requirements, Type 2 Gravel Base. The aggregate shall conform to one of the following sieve analyses, as specified:

Laboratory sieve, square openings	Percentage by weight passing sieve	
	1½-inch size	1-inch size
1½ inch	100	
1 inch	-----	100
¾ inch	60-80	80-100
No. 4	35-50	45-70
No. 10	25-40	35-50
No. 40	10-30	15-35
No. 200	*5-15	*5-12

*The fraction passing the No. 200 sieve shall be less than one-half the fraction passing the No. 40 sieve.

NOTE—If the product of any deposit is deficient in the fraction passing the No. 10 sieve, additional filler from other approved deposits meeting the physical requirements shall be added at the crushing and screening plant.

75.6 Size Requirements, Plantmix Base. The aggregate shall conform to the following sieve analysis:

Laboratory sieve, square openings	Percentage by weight passing sieve
1½ inch	100
¾ inch	60-85
No. 4	30-45
No. 10	25-40
No. 40	10-30
No. 200	*5-15

*The fraction passing the No. 200 sieve shall be less than one-half the fraction passing the No. 40 sieve.

NOTE—If the product of any deposit is deficient in the fraction passing the No. 10 sieve, additional filler from other deposits meeting the physical requirements shall be added at the crushing and screening plant.

75.7 Sampling and Testing. Sampling and testing of aggregate for gravel base courses shall be in accordance with the following standard test methods:

Sampling	A.A.S.H.O. T-2
Portion passing 200 mesh.....	A.A.S.H.O. T-11
Size	A.A.S.H.O. T-27
Liquid limit	A.A.S.H.O. T-89
Cementing value	*Nevada
Plasticity index	A.A.S.H.O. T-91
Lineal shrinkage	A.A.S.H.O. T-92
Percentage of wear	A.A.S.H.O. T-96

*Cementing value test is made as follows: The sample is separated into coarse and fine portions by passing over a No. 10 sieve. A sufficient quantity of the fine portion to prepare two four-inch by four-inch cylinders is mixed with water until the entire mass is uniform. The percent of water in the resulting mixture shall be the optimum required to secure maximum density of the compacted specimen. The mixture is placed into the molds in three layers and each layer is tamped 25 times with a one inch round wooden tamp. The tops are struck off level and the specimens are dried in an oven at a temperature of 110 degrees Centigrade for a period of five hours. The dried specimens are capped, if necessary, with plaster of paris and are tested for compressive strength in a suitable testing machine. The average compressive strength of the two cylinders expressed in pounds per square inch is recorded as the cementing value.

SECTION 76—AGGREGATE FOR ROADMIX AND PLANTMIX BITUMINOUS SURFACES

76.1 Material Covered. This specification covers the quality and size of crushed stone, crushed gravel, and filler for the following bituminous surface courses:

- (a) Class B 1 Roadmix Bituminous Surface.
- (b) Class C 1 Roadmix Bituminous Surface.
- (c) Class F 1 Plantmix Bituminous Surface.
- (d) Class F 2 Plantmix Bituminous Surface.

76.2 General Requirements. The aggregate shall be the product of approved deposits and shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces, alkali, and vegetable matter. The material shall be of such character that when once coated with bituminous material the coating will not slough off upon contact with water.

The minimum amount of crushed material in the finished product shall be as follows:

(a) Class B 1 and C 1 Roadmix Bituminous Surface—That obtainable by crushing and incorporating into the finished product all particles in the pit-run material larger than the maximum size specified for the finished product and less than six inches in the largest dimension.

(b) Class F 1 and F 2 Plantmix Bituminous Surface—Not less than 50 percent of the particles in the fraction retained on a No. 4 sieve shall have at least one fractured face.

76.3 Physical Properties. The aggregate shall conform to the following requirements:

Percentage of wear (L. A. Rattler—500 Rev.), Max. %.....	45
Fraction passing No. 40 sieve—	
Plasticity index, max.....	6
Liquid limit, max.....	25
Swell test, % max.....	1.5

76.4 Size Requirements. The aggregate shall conform to the following sieve analyses:

Laboratory sieve, square openings	Percentage by weight passing sieve	
	Class B-1 and C-1	Class F-1 and F-2
1 inch	100	100
$\frac{3}{4}$ inch	80-100	
$\frac{1}{2}$ inch	-----	65-80 ✓
No. 4	45-70	45-60
No. 10	35-50	30-45 ✓
No. 40	15-35	15-35
No. 200	*5-12	*5-12 ✓

*The fraction passing the No. 200 sieve shall be less than one half the fraction passing the No. 40 sieve.

NOTE—If the product of any deposit is deficient in the fraction passing the No. 10 sieve, additional filler from other approved deposits meeting the physical requirements shall be added at the crushing and screening plant.

76.5 Sampling and Testing. Sampling and testing of aggregate for gravel base courses shall be in accordance with the following standard test methods:

Sampling	A.A.S.H.O. T-2
Portion passing 200 mesh.....	A.A.S.H.O. T-11
Size	A.A.S.H.O. T-27
Liquid limit	A.A.S.H.O. T-89
Plasticity index	A.A.S.H.O. T-91
Percentage of wear.....	A.A.S.H.O. T-96
Swell	*Nevada

*The swell test shall be made as follows: A sample of the aggregate, if not sufficiently dry, is warmed and stirred at a temperature not to exceed 140 degrees Fahrenheit until it appears dry to touch and to visual inspection. One thousand grams of the dry sample is prepared by proportioning the various sizes to conform to grading requirements for the product desired. Asphaltic material of the desired grade is added in an amount equal to the theoretical quantity required by the aggregate. The aggregate and asphaltic material are heated to a temperature within the range of field mixing temperatures and are mixed until all particles are coated and color of the entire mass is uniform.

The molding apparatus consists of a metal cylindrical mold to the outer surface of which is attached a rod for supporting a measuring device, a close-fitting cylindrical plunger for compressing the sample, a machined metal base plate, and a hardwood tamping rod. The mold has an inside diameter of four inches, is six inches in height, and has a wall thickness of three-eighths inch. The rod attached to the mold is one-quarter inch in diameter and projects two inches above the top of the mold. The plunger is six inches in height, has a diameter one sixty-fourth inch less than the inside

diameter of the mold, and its top is bored and threaded to accommodate a three-eighths inch bolt with a crossbar head to facilitate removal from the mold. The base plate may be either square or rectangular, is three-eighths inch thick, and its least dimension across the machined face is made at least one inch larger than the outside diameter of the mold. The tamping rod is three-quarters inch in diameter, 12 inches long, and bullet-pointed at the lower end.

The prepared sample, while still warm, is placed in two layers into the mold which rests upon the machined surface of the base plate. Initial compaction is obtained by rodding each layer 25 strokes with the tamping rod. The strokes are uniformly distributed over the cross section of the mold. Final compaction is obtained by inserting the plunger, placing the apparatus in a suitable testing machine and subjecting the sample to an ultimate load of 1,000 pounds per square inch. The ultimate load is held as nearly constant as possible for a period of two minutes. The apparatus is then removed from the testing machine and the plunger is disengaged from the mold. After the mold with its contents has cooled to room temperature, the surface of the specimen is covered with distilled water to a depth of two and one-half inches.

Apparatus for measuring the swell consists of a dial of the Starret type, or equivalent, capable of measuring to one one-thousandth inch, a device for attaching the dial to the rod support, and a rod for transferring the vertical movement of the sample, while it is undergoing swell, to the dial. A suitable rod for transfer of uplift is three and one-half inches long over-all, one-half inch in diameter, and to its lower end and made integral with the rod is a disc which serves as a footing for contact with the sample. The disc is one-quarter inch in thickness, one and one-half inches in diameter and its lower surface is machined.

At the time the sample is covered with water, the measuring apparatus is fixed into position so as to measure the swell at the central portion of the specimen. At the end of a 24-hour period the swell is measured to the nearest one one-thousandth inch.

SECTION 77—CRUSHED ROCK AND SCREENINGS FOR ROAD TREATMENT WITH BITUMINOUS MATERIALS

77.1 Material Covered. This specification covers the quality and size of crushed rock and screenings for the following surface courses:

- (a) Class A1 Bituminous Surface Treatment.
- (b) Class A Bituminous Armor Coat.
- (c) Class C2 Retread Surface.

77.2 General Requirements. Coarse aggregate and key rock shall be the product obtained by crushing material from approved deposits of ledge rock or gravel. When crushed from gravel, coarse aggregate and key rock shall be the product of crushing particles retained on a screen with square openings not less than one and one-half times the nominal maximum size of the material produced.

Screenings may be either stone chips, the product of an approved gravel deposit, or a combination of stone chips and gravel.

All aggregate, key rock, and screenings shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces, alkali, and vegetable matter. The material shall be of such character that when once coated with a bituminous material the coating will not slough off upon contact with water.

77.3 Physical Properties. The aggregate shall conform to the following requirements:

Percentage of wear—

L. A. Rattler, 100 Rev., % max.....	8
L. A. Rattler, 500 Rev., % max.....	37
Removed by decantation, % max.....	2

When subjected to five alternations of the sodium sulphate soundness test the weighted percentage of loss shall not be more than 10 percent by weight.

77.4 Size Requirements, Bituminous Retread Surface.

The aggregate shall conform to one of the following sieve analyses, as specified:

TYPE 1

Laboratory sieve, square openings	Percentage by weight passing sieve		
	Coarse aggregate	Key rock	Screenings
2 inch	100		
1½ inch	95-100		
¾ inch	0-5	100	
½ inch	-----	95-100	100
⅜ inch	-----	-----	90-100
No. 4	-----	0-5	
No. 10	-----	-----	0-5

TYPE 2

Laboratory sieve, square openings	Percentage by weight passing sieve		
	Coarse aggregate	Key rock	Screenings
1 inch	100		
¾ inch	95-100		
½ inch	-----	-----	100
⅜ inch	20-55	100	95-100
No. 4	0-10		
No. 10	-----	0-10	0-05

77.5 Size Requirements, Bituminous Armor Coat. The aggregate shall conform to the following sieve analyses:

Laboratory sieve, square openings	Percentage by weight passing sieve		
	Coarse aggregate	Key rock	Screenings
1 inch	100		
¾ inch	95-100	100	
½ inch	0-10	95-100	100
⅜ inch	-----	-----	95-100
No. 4	-----	0-10	
No. 10	0-5	0-5	0-5

77.6 Size Requirements, Screenings for Bituminous Surface Treatment. The aggregate shall conform to the following sieve analysis:

Laboratory sieve, square openings	Percentage by weight passing sieve
½ inch	100
⅜ inch	95-100
No. 10	0-5

77.7 Sampling and Testing. Sampling and testing of aggregate for coarse aggregate, key rock and screenings shall be in accordance with the following standard test methods:

Sampling	A.A.S.H.O. T-2
Removal by decantation.....	A.A.S.H.O. T-11
Size	A.A.S.H.O. T-27
Soundness	A.A.S.H.O. T-76
Percentage of wear.....	A.A.S.H.O. T-96

SECTION 78—COARSE AGGREGATE FOR BITUMINOUS CONCRETE

78.1 Material Covered. This specification covers the quality and size of crushed rock or crushed gravel to be used in the construction of bituminous concrete surfaces. It covers the coarse aggregate for base, leveling, and top courses.

78.2 General Requirements. Coarse aggregate shall be the product obtained by crushing material from approved deposits of ledge rock or gravel. Crushed stone or crushed gravel shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces, and free from particles coated with other objectionable matter. The material shall be of such character that when once coated with the bituminous cement proposed for the work, it will not slough off upon contact with water.

When crushed from gravel, coarse aggregate shall be the product of crushing particles, all of which are retained on a screen with two-inch square openings and at least 50 percent of which are retained on a screen with three-inch square openings. Material passing the two-inch sieve, and retained on the three-quarter-inch sieve, may be crushed to such size that all will pass a screen with three-quarter inch square openings. This product shall then be blended uniformly with corresponding sizes produced by crushing the larger particles of gravel.

78.3 Physical Properties. When tested by the methods specified below, the material shall meet the following requirements:

Percentage of wear—

L. A. Rattler, 100 Rev., % max.....	8
L. A. Rattler, 500 Rev., % max.....	37

78.4 Size Requirements. When tested by means of laboratory sieves, the coarse aggregate shall be well graded between the largest and the smallest sizes permissible, and the different courses also shall meet the grading requirements shown in the following table:

Laboratory sieve, square openings	Percentage by weight passing sieve		
	Bottom course	Leveling course	Top course
2 inch	95-100		
1 inch	55-70	95-100	95-100
$\frac{1}{2}$ inch	30-45	35-55	35-55
No. 10	0-5	0-5	0-5

78.5 Sampling and Testing. Sampling and testing of the coarse aggregate shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	A.A.S.H.O. T-2
Size	A.A.S.H.O. T-27
Percentage of wear.....	A.A.S.H.O. T-96

SECTION 79—CRUSHED STONE FOR PORTLAND CEMENT CONCRETE

79.1 Material Covered. This specification covers the quality and size of crushed stone for use in Portland cement concrete.

79.2 General Requirements. Crushed stone shall consist of particles of clean, hard, tough, durable rock, free from adherent coatings.

79.3 Physical Properties. The maximum percentages of deleterious substances shall not exceed the following values:

	Percent by weight
Removed by decantation.....	1
Shale.....	1
Coal.....	1
Clay lumps	$\frac{1}{4}$
Soft fragments	5
Other local deleterious substances (such as alkali, friable, thin, elongated or lami- nated pieces)	--
Total shale, coal, clay lumps, and soft frag- ments	5

Crushed stone shall be obtained from ledges conforming to the following requirements:

Percentage of wear—

L. A. Rattler, 100 Rev., % max.....	8
L. A. Rattler, 500 Rev., % max.....	37

When the coarse aggregate is to be used in the construction of concrete bridges or incidental structures, the requirements for percentage of wear may be waived at the discretion of the engineer.

When subjected to five alternations of the sodium sulphate soundness test the weighted percentage of loss shall not be more than 15 percent by weight.

79.4 Size Requirements. Crushed stone shall be well

graded, between the limits specified, and the size or sizes designated shall conform to the following requirements:

—PERCENTAGE BY WEIGHT PASSING LABORATORY SIEVE— WITH SQUARE OPENINGS				
Sieve size, inches	No. 4 to $\frac{3}{4}$ in. size	No. 4 to $1\frac{1}{2}$ in. size	No. 4 to $2\frac{1}{2}$ in. size	No. 4 to 3 in. size
$3\frac{1}{2}$	-----	-----	-----	100
3	-----	-----	100	95-100
$2\frac{1}{2}$	-----	-----	95-100	70-85
2	-----	100	70-85	-----
$1\frac{1}{2}$	-----	95-100	-----	40-75
1	100	-----	40-75	-----
$\frac{3}{4}$	95-100	35-70	-----	20-40
$\frac{3}{8}$	20-55	10-30	-----	-----
No 4	0-10	0-5	0-5	0-5

(Attention is called to the fact that the shape of aperture specified for determining compliance with specifications for size of coarse aggregate has no relation to the size or shape of aperture or type of screen used in the production of the material.)

The above gradation for coarse aggregate represents the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples, submitted by the contractor, from such sources as he proposes to use. Coarse aggregate from any one source having a variation in fineness modulus greater than 0.30 either way from the fineness modulus of the representatives sample submitted by the contractor may be rejected. Coarse aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix without permission from the engineer.

(The fineness modulus of an aggregate is determined by adding the percentages by weight retained on the following sieves having square openings, and dividing by 100: 3 in., $1\frac{1}{2}$ -in., $\frac{3}{4}$ -in., $\frac{3}{8}$ -in., No. 4, No. 8, No. 16, No. 30, No. 50, No. 100.)

79.5 Sampling and Testing. Sampling and testing of crushed stone shall be in accordance with the following

standard methods of the American Association of State Highway Officials:

Sampling.....	T-2
Soft fragments.....	T-8
Coal.....	T-10
Shale.....	T-10
Removed by decantation.....	T-11
Size.....	T-27
Soundness.....	T-76
Percentage of wear.....	T-96

SECTION 80—GRAVEL FOR PORTLAND CEMENT CONCRETE

80.1 Material Covered. This specification covers the quality and size of gravel for use in Portland cement concrete.

80.2 General Requirements. The gravel shall be composed of hard, durable particles of stone, thoroughly clean, and shall be free from an excess of thin or elongated pieces, frozen lumps, vegetable, or other deleterious matter.

80.3 Physical Properties. The maximum percentages of deleterious substances shall not exceed the following values:

	Percent by weight
Removed by decantation.....	1
Shale.....	1
Coal.....	1
Clay lumps.....	$\frac{1}{4}$
Soft fragments.....	5
Other local deleterious substances (such as alkali, friable, thin, elongated or laminated pieces)	..
Total shale, coal, clay lumps, and soft fragments.....	5
Percentage of wear—	
L. A. Rattler, 100 Rev., % max.....	8
L. A. Rattler, 500 Rev., % max.....	37

When the coarse aggregate is to be used in the construction of concrete bridges or incidental structures, requirements for percentage of wear may be waived at the discretion of the engineer.

When subjected to five alternations of the sodium sulphate soundness test, the weighted percentage of loss shall not be more than 15 percent by weight.

80.4 Size Requirements. Coarse aggregate shall be well

graded, between the limits specified, and the size or sizes designated shall conform to the following requirements:

—PERCENTAGE BY WEIGHT PASSING LABORATORY SIEVE— WITH SQUARE OPENINGS				
Sieve size, inches	No. 4 to $\frac{3}{4}$ in. size	No. 4 to $1\frac{1}{2}$ in. size	No. 4 to $2\frac{1}{2}$ in. size	No. 4 to 3 in. size
$3\frac{1}{2}$	-----	-----	-----	100
3	-----	-----	100	95-100
$2\frac{1}{2}$	-----	-----	95-100	70-85
2	-----	100	70-85	-----
$1\frac{1}{2}$	-----	95-100	-----	40-75
1	100	-----	40-75	-----
$\frac{3}{4}$	95-100	35-70	-----	20-40
$\frac{3}{8}$	20-55	10-30	-----	-----
No 4	0-10	0-5	0-5	0-5

(Attention is called to the fact that the shape of aperture specified for determining compliance with specifications for size of coarse aggregate has no relation to the size or shape of aperture or type of screen used in the production of the material.)

The above gradation represents the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples, submitted by the contractor, from such sources as he proposes to use. Coarse aggregate from any one source having a variation in fineness modulus greater than 0.30 either way from the fineness modulus of the representative sample submitted by the contractor may be rejected. Coarse aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix, without permission from the engineer.

(The fineness modulus of an aggregate is determined by adding the percentages by weight retained on the following sieves having square openings, and dividing by 100: 3 in., $1\frac{1}{2}$ in., $\frac{3}{4}$ in., $\frac{3}{8}$ in., No. 4, No. 8, No. 16, No. 30, No. 50, No. 100.)

80.5 Sampling and Testing. Sampling and testing of the gravel shall be in accordance with the following

standard methods of the American Association of State Highway Officials:

Sampling.....	T-2
Soft fragments.....	T-8
Coal.....	T-10
Shale.....	T-10
Loss by decantation.....	T-11
Size.....	T-27
Percentage of wear.....	T-96

SECTION 81—GRAVEL FOR BEDDING AND BACKFILL

81.1 Material. This specification covers the size and quality of gravel or crushed stone for bedding and backfilling underdrains.

81.2 General. The gravel or stone shall consist of reasonably tough, durable particles and shall not contain an injurious amount of alkali or organic matter. The quality of the material shall be subject to approval by the engineer.

81.3 Size of Bedding Material. Gravel or stone for bedding shall be well graded and shall pass a screen with one inch square openings and be retained on a No. 4 sieve.

81.4 Size of Backfill Material. Gravel or stone for backfill shall be well graded and shall pass a screen with three inch square openings and be retained on a screen with three-quarter inch square openings.

SECTION 82—STONE FOR MASONRY

82.1 Material Covered. This specification covers the quality and size of stone for rubble masonry, rubble gutters and riprap.

82.2 Quality. One-man and derrick stone used in rubble masonry and riprap shall consist of tough, sound, and durable rock. The stone shall be free from coatings, dries, seams, or flaws of any character. In general, the percentage of wear for 500 revolutions shall be not greater than 45 percent as determined by Method T-96, Standard Method of Test for Abrasion of Coarse Aggregate by the use of the Los Angeles Testing Machine of the American Association of State Highway Officials. Stone shall be angular in shape and shall have a rough surface such as will thoroughly bond with the surrounding mortar.

82.3 Size of Masonry Stone. Individual stones shall have a thickness of not less than eight inches and a width not less than one and one-half times the thickness. No stones, except headers, shall have a length less than one and one-half times their width. Stones shall decrease in thickness from bottom to top of wall.

82.4 Shaping Masonry Stone. The stones shall be roughly squared on joints, beds, and faces. Selected stone, roughly squared and pitched to line, shall be used at all angles and ends of walls. All shaping or dressing of stone shall be done before the stone is laid in the wall.

82.5 Size of Riprap Stone. The size of riprap stone shall be as large as can be conveniently placed in the layer thickness specified. In layers two feet or less in thickness, stones shall weigh not less than 50 pounds and at least 60 percent of them shall weigh more than 100 pounds each. In layers more than two feet in thickness, at least 50 percent of the mass shall be stones having a volume of two cubic feet or more.

82.6 Size of Rubble Stone for Gutters. The stone shall be not less than six inches nor more than eight inches in thickness, with approximately flat top surface, and with a width of not less than two inches and a length of not less than six inches.

SECTION 83—FINE AGGREGATE FOR BITUMINOUS CONCRETE

83.1 Material Covered. This specification covers the quality and grading of sand for bituminous concrete mixtures.

83.2 General Requirements. The material may be either a natural or a manufactured product, or a combination of both. It shall be clean, hard grained, moderately sharp, and shall contain not more than three percent of clay or loam nor sufficient quantities of mica or other impurities to be detrimental. It also shall be suitable for mixing with the bituminous material proposed for the work as determined by laboratory trial mixtures.

83.3 Size Requirements. When tested by means of laboratory sieves it shall meet the following requirements:

Laboratory sieve, square openings	Percentage by weight passing sieve
No. 4	100
No. 10	95-100
No. 40	55-75
No. 80	25-50
No. 200	0-12

83.4 Sampling and Testing. Sampling and testing shall be in accordance with the following standard method of the American Association of State Highway Officials:

Sampling	T-2
Removed by decantation	T-11
Size	T-27

SECTION 84—MINERAL FILLER

84.1 Material Covered. This specification covers the quality and grading of mineral filler for use in the construction of bituminous concrete pavements.

84.2 General Requirements. The mineral filler shall consist of limestone dust, Portland cement, or other inert mineral matter from sources approved by the engineer.

84.3 Physical Properties. The material shall be thoroughly dry and free from lumps consisting of aggregations of fine particles. It shall meet the following requirements for mechanical analysis:

Laboratory sieve, square openings	Percentage by weight passing sieve
No. 30	100
No. 80	95-100
No. 200	65-100

84.4 Sampling and Testing. Sampling and testing of mineral filler for use in construction of bituminous concrete pavements shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T-36
Fineness	T-37

SECTION 85—FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE

85.1 Material Covered. This specification covers the quality and grading of fine aggregate for use in Portland cement concrete.

85.2 General Requirements. Fine aggregate shall consist of sand or other approved inert materials with similar characteristics, or a combination thereof, having hard, strong, durable particles.

85.3 Physical Properties. The maximum percentage of deleterious substances shall not exceed the following values:

	Percent by weight
Removed by decantation.....	3
Coal	1
Clay lumps.....	1
Other local deleterious substances (such as shale, alkali, mica, coated grains, soft and flaky particles).....	..
Total coal, clay lumps, shale, soft frag- ments, and other local deleterious sub- stances	5

All fine aggregate shall be free from injurious amounts of organic impurities. Aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified hereinafter.

When subjected to five alternations of the sodium sulphate soundness test, the weighted percentage of loss shall not be more than 10 percent by weight.

Fine aggregates, when subjected to the mortar strength test, shall have a compressive strength, at the age of 7 and 28 days, equal to or greater than that developed by mortar of the same proportions and consistency made of the same cement and Ottawa sand having a fineness modulus of 2.40 ± 0.10 .

85.4 Size Requirements. Fine aggregate shall be well graded from coarse to fine and when tested by means of

laboratory sieves shall conform to the following requirements:

Laboratory sieve, square openings	Percentage by weight passing sieve
No. 4	95-100
No. 16	45-80
No. 50	5-30
No. 100	0-10

The above gradation represents the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples, submitted by the contractor, from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample submitted by the contractor may be rejected. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix, without permission from the engineer.

(The fineness modulus of an aggregate is determined by adding the percentages by weight retained on the following sieves having square openings, and dividing by 100: 3 in., $1\frac{1}{2}$ in., $\frac{3}{4}$ in., $\frac{3}{8}$ in., No. 4, No. 8, No. 16, No. 30, No. 50, No. 100.)

85.5 Sampling and Testing. Sampling and testing of fine aggregate shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T-2
Coal.....	T-10
Shale.....	T-10
Removed by decantation.....	T-11
Organic impurities.....	T-21
Concrete strength.....	T-22
Size.....	T-27
Mortar strength.....	T-71

SECTION 86—SAND BLOTTER

86.1 Material Covered. This specification covers the quality and grading of sand for absorbing unpenetrated bituminous material applied as prime coat or seal coat.

86.2 General Requirements. The sand shall be reasonably free from clay, organic matter and other injurious impurities.

86.3 Size Requirements. The sand shall conform to the following sieve analysis:

Laboratory sieve, square openings	Percentage by weight passing sieve
No. 4	90-100
No. 16	30-75
No. 200	0-12

86.4 Sampling and Testing. Sampling and testing shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T-2
Portion passing 200 mesh.....	T-11
Organic impurities.....	T-21
Size	T-27

SECTION 87—MORTAR SAND

87.1 Material Covered. This specification covers fine aggregate for use in cement mortar.

87.2 General Requirements. Sand for mortar shall consist of hard, strong, durable, uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious substances.

87.3 Size Requirements. Sand for mortar shall be uniformly graded from fine to coarse within the following limits:

Laboratory sieve, square openings	Percentage by weight passing sieve
No. 8	100
No. 50	15-40
No. 100	*0-10

*Weight removed by decantation not more than five percent.

87.4 Physical Properties. Mortar sand, when subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless it is shown by adequate tests that the impurities causing the color are not harmful in mortar.

87.5 Sampling and Testing. Sampling and testing of sand shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T-2
Removed by decantation	T-11
Organic impurities	T-21
Size	T-27

SECTION 88—LIQUID ASPHALTS

88.1 Material Covered. This specification covers the quality of slow curing, medium curing, and rapid curing liquid asphalts for penetration treatments of road surfaces, roadmix surfaces, plantmix surfaces, and similar uses.

88.2 Test Reports, Shipping Notice, and Preliminary Sample. At the time of the contract award, the contractor shall furnish the department with the name and address of the company furnishing the asphalt. When required, representative samples of the asphalt shall be submitted for testing and approval prior to ordering shipment.

A certified test report shall be furnished in triplicate by the contractor at the time of shipment of each carload of asphaltic road material or fraction thereof. The original copy shall be mailed to the State Highway Engineer in Carson City, the duplicate to the division engineer of the division to which shipment is made, and the triplicate to the resident engineer or inspector assigned to the contract for which the material is intended. A test report or a shipping notice must be in possession of the resident engineer or inspector before the material is used. Both the test report and shipping notice shall show the following: consignee, project designation, delivery point, date shipped, car number, grade of material, quantity in car when loaded, loading temperature, and net quantity. The test report in addition shall show results of each of the tests for the specified grade.

88.3 Properties and Test Methods. Liquid asphalts shall be homogeneous and shall conform to the requirements set forth in the following tables. Medium and rapid curing liquid asphalts shall be free from water:

SLOW CURING LIQUID ASPHALTS

TEST	A.S.T.M. Test Method	TYPES					
		SC-1	SC-1A	SC-2	SC-3	SC-4	90-95
Asphaltic residue of 80 penetra- tion, % min.	D 243-36	30	50	65	71	76	95
Asphaltic residue of 80 penetra- tion, % max.	D 243-36	35	.....	.....	.....	.....	95
Water and sediment, % max.	D 96-35	2	2	2	2	2	1.5
Water, % max.	D 95-30	.....	.....	.....	.....	.....	0.5
Sediment, % max.	D 96-35	.....	.....	.....	.....	.....	1.0
Flash point, Cleveland open cut, °F., min.	D 92-33	150	175	200	200	250	400
Viscosity—							
Saybolt Furol @ 77°F.	D 88-36	20-40	.....	.....	.....	.....	.....
Saybolt Furol @ 122°F.	D 88-36	.....	40-80	200-320	.....	.....	.....
Saybolt Furol @ 140°F.	D 88-36	.....	.....	.....	150-300	350-550	.....
Float test @ 77°F., max.	D 139-27	.....	.....	200	250	.....	250
Float test @ 122°F., min.	D 139-27	.....	.....	.....	.....	.....	.....
Penetration of residue after loss on heating at 325°F. for 5 hrs., min.	D 5-25	.....	.....	.....	.....	.....	125
Distillation, % by volume—							
Total to 437°F., % max.	D 402-36	.....	3	2	2	2	.....
Total to 600°F., % max.	D 402-36	.....	25	15	10	8	.....
Total to 680°F., % max.	D 402-36	50	30	25	20	18	.....
Tests of residue from distillation—							
Float test @ 122°F., max.	D 139-27	50	50	.....	.....	.....	.....
Float test @ 122°F., min.	D 139-27	.....	.....	25	25	25	.....
Bitumen soluble in CS ₂ , % min.	D 4-27	99.0	99.0	99.0	99.0	99.0	99.0
Bitumen soluble in CCl ₄ , % min.	D 145-27	99.65	99.65	99.65	99.65	99.65	99.65

MEDIUM CURING TYPES

TEST	A. S. T. M. Test Method	TYPES				
		MC-1	MC-2	MC-3	MC-4	MC-5
Flash point Tagliabue, open cup, °F. min.		.....	150	150	150	150
Viscosity-Saybolt-Furol—						
At 77° F.	D 88-36	40-150				
At 140° F.	D 88-36	.....	150-250	300-500	500-800	170-280
At 180° F.	D 88-36	.....	.....	.....	.....	.....
Distillation, % by volume—						
Total to 437° F., % max.	D402-36	10	2	2	1	1
Total to 600° F., % min.	D402-36	25	10	8		
Total to 600° F., % max.	D402-36	.....	20	20	16	14
Total to 680° F., % max.	D402-36	50	27	25	25	20
Tests on residue from distillation—						
Penetration at 77° F., 100 g., 5 sec.	D 5-25	70-300	100-300	100-300	100-300	100-300
Ductility at 77° F., cm. min.	D113-35	60	60	60	60	60
Bitumen soluble in CS ₂ , % min.	D 4-27	99.5	99.5	99.5	99.5	99.5
Bitumen soluble in CCl ₄ , % min.	D165-27	99.65	99.65	99.65	99.65	99.65

RAPID CURING TYPES

TEST	A.S.T.M. Test Method	TYPES			
		RC-1 80	RC-2 80	RC-3 80	RC-4 80
Flash point, Tagliabue, open cut, °F. min.....					
Viscosity-Saybolt-Furol—					
At 122° F.	D 88-36	80-160	200-400	275-400	700-1400
At 140° F.	D 88-36	.....	.....	.....	.....
Distillation, % by volume—					
Total to 374° F., % min.....	D402-36	5	10	3	0.5
Total to 437° F., % min.....	D402-36	12	20	14	7
Total to 600° F., % min.....	D402-36	25	35	23	15
Total to 680° F., max.....	D402-36	40			
Tests on residue from distillation—					
Penetration at 77° F., 100 g., 5 sec.....	D 5-25	80-120	80-120	80-120	80-120
Ductility at 77° F., cm. min.....	D113-35	70	70	70	70
Bitumen soluble in CS ₂ , % min.....	D 4-27	99.5	99.5	99.5	99.5
Bitumen soluble in CCl ₄ , % min.....	D165-27	99.65	99.65	99.65	99.65

SECTION 89—EMULSIFIED ASPHALT

89.1 Material Covered. This specification covers the quality of penetration grade or quick setting emulsified asphalt, and mixing grade or slow setting emulsified asphalt for surface treatments, and penetration and mixed in place surfaces.

89.2 Test Reports, Shipping Notice and Preliminary Sample. At the time of the contract award, the contractor shall furnish the department with the name and address of the company furnishing the asphalt. When required, representative samples of the asphalt shall be submitted for testing and approval prior to ordering shipment.

A certified test report shall be furnished in triplicate by the contractor at the time of shipment of each carload of asphaltic road material or fraction thereof. The original copy shall be mailed to the State Highway Engineer in Carson City, the duplicate to the division engineer of the division to which shipment is made, and the triplicate to the resident engineer or inspector assigned to the contract for which the material is intended. A test report or a shipping notice must be in possession of the resident engineer or inspector before the material is used. Both the test report and shipping notice shall show the following: consignee, project designation, delivery point, date shipped, car number, grade of material, quantity in car when loaded, loading temperature, and net quantity. The test report in addition shall show results of each of the tests for the specified grade.

89.3 Properties and Tests. [Emulsified asphalt shall be homogeneous. It shall show no separation of asphalt after thorough mixing within 30 days after delivery, provided separation has not been caused by freezing.

It shall conform to the following requirements] for each type:

Test	Penetration type	Mixing type
Viscosity, Saybolt-Furol, 60 ml. at 77° F., sec...	20-100	20-100
Sieve test, retained on 20 mesh sieve, % max...	0.05	0.05
Settlement, 5 days, % max.....	2.0	2.0
*Demulsibility, 35 ml. of 0.02 N calcium chloride, % min.....	40	
*Demulsibility, 50 ml. of 0.1 N calcium chloride, % max.....		1.0
Cement mixing test		†
Residue by distillation, %.....	55-60	55-60

*The demulsibility test shall be made within 30 days after date of shipment.

†No appreciable separation.

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

Test	Penetration type	Mixing type
Penetration at 77° F. 100 g., 5 sec.....	150-300	150-300
Ash, % max.....	2.0	2.0
Ductility at 77° F., cm., min.....	70	70
Soluble in carbon disulphide, min.....	97	97
Specific gravity at 77° F., min.....	1.00	1.00

89.4 Testing. Testing of emulsified asphalt shall be in accordance with American Association of State Highway Officials' Standard Method T-59,] except that the cement mixing test shall be made as follows:

Two parts by volume of the emulsion to be tested shall be added to one part by volume, loose measurement, of dry Portland cement previously sieved through an 80-mesh sieve. These materials shall be thoroughly mixed for a period of 10 minutes by stirring with a one-half inch round steel rod moved with a circular motion. At the expiration of this period there shall be no appreciable breaking up or separation of the emulsion, and the mixture shall be uniform and smooth.

SECTION 90—ASPHALT CEMENT

90.1 Material Covered. This specification covers quality of asphalt cement prepared from petroleum for use in bituminous mixes.

90.2 General Requirements. The asphalt cement shall be homogeneous, free from water, and shall not foam when heated to a temperature of 175 degrees Centigrade.

90.3 Test Reports, Shipping Notice and Preliminary Sample. At the time of the contract award, the contractor shall furnish the department with the name and address of the company furnishing the asphalt. When required, representative samples of the asphalt shall be submitted for testing and approval prior to ordering shipment.

A certified test report shall be furnished in triplicate by the contractor at the time of shipment of each carload of asphaltic road material or fraction thereof. The original copy shall be mailed to the State Highway Engineer in Carson City, the duplicate to the division engineer of the division to which shipment is made, and the triplicate to the resident engineer or inspector assigned to the contract for which the material is intended. The test report or a shipping notice must be in possession of the resident engineer or inspector before the material is used. Both the test report and the shipping notice shall show the following: consignee, project designation, delivery point, date shipped, car number, grade of material, quantity in car when loaded, loading temperature, and net quantity. The test report, in addition, shall show results of each of the tests for the specified grade.

90.4 Properties. The asphalt cement shall conform to the following requirements:

Penetration at 25° C., 100 g., 5 sec.....	(*)
Total bitumen (soluble in carbon disulphide), not less than..	99.5%
Proportion of bitumen soluble in carbon tetrachloride, not less than	99.0%
Ductility at 25° C., not less than.....	30 cms.
Flash point, not less than.....	175° C.
Loss at 163° C., 5 hrs., not more than.....	1.0%
Penetration of residue at 25° C., 100 g., 5 sec., as compared to penetration before heating, not less than.....	60.0%

*As specified in special provisions.

90.5 Sampling and Testing. Sampling and testing of asphalt cement shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T-40
Total bitumen	T-44
Bitumen soluble in carbon tetrachloride.....	T-45
Loss at 163° C.....	T-47
Flash point	T-48
Penetration	T-49
Ductility	T-51

SECTION 91—ASPHALT JOINT FILLER

91.1 Material Covered. These specifications cover the quality of asphalt for use in filling joints in concrete work.

91.2 General Requirements. The asphalt filler shall be homogeneous, free from water, and shall not foam when heated to a temperature of 177° C.

91.3 Properties. The filler shall conform to the following requirements:

Flash point, not less than.....	230° C.
Softening point	75° to 85° C.
Penetration, 0° C., 200 g., 1 min., not less than.....	10
Penetration, 25° C., 100 g., 5 sec.....	30 to 45
Penetration, 46° C., 50 g., 5 sec., not more than.....	90
Loss at 163° C., 5 hrs., not more than.....	1.0%
Penetration, 25 C., 100 g., 5 sec. on residue from evaporation loss (basis of original penetration at 25° C., 100 g., 5 sec.) not less than.....	50.0%
Ductility, centimeters, 25° C., not less than.....	4
Total bitumen (soluble in carbon disulphide), not less than	99.0%
Proportion of bitumen soluble in carbon tetrachloride, not less than.....	99.0%

91.4 Sampling and Testing. Sampling and testing of oil asphalt filler shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T-40
Total bitumen	T-44
Bitumen soluble in carbon tetrachloride.....	T-45
Loss at 163° C.....	T-47
Flash point.....	T-48
Penetration	T-49
Ductility	T-51
Softening point	T-53

SECTION 92—ASPHALT FOR WATERPROOFING

92.1 Prime Coat. Asphalt for priming coat shall conform to the requirements for Primer for Use with Asphalt in Damp-Proofing and Waterproofing Below and Above Ground Level, serial designation D-41-36-T, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society.

92.2 Main Coat. Asphalt for main coat shall conform to the requirements for Asphalt for Use in Damp-Proofing and Waterproofing above Ground Level, serial designation D-144-36-T of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society.

SECTION 93—STANDARD PORTLAND CEMENT

93.1 Material Covered. Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

93.2 Chemical Properties. The following limits shall not be exceeded:

Loss on ignition, percent.....	4.00
Insoluble residue, percent.....	0.85
Sulfuric anhydride (SO_3), percent.....	2.00
Magnesia (MgO), percent	5.00

93.3 Physical Properties. The specific surface as determined by the turbidimeter shall not be less than 1,600 sq. cm. per gram.

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

The cement shall not develop initial set in less than 45 minutes when the Vicat needle is used or 60 minutes when the Gillmore needle is used. Final set shall be attained within 10 hours. If necessary to secure proper workability and finish in concrete construction during warm weather, the engineer reserves the right, upon due notice to the producer, to lengthen the initial set requirements.

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

Age at test, days	Storage of briquets	Tensile strength, lbs. per sq. in.
7	One day in moist air, six days in water	275
28	One day in moist air, 27 days in water	350

The average tensile strength of standard mortar at 28 days shall be higher than the strength at seven days.

93.4 Packing, Marking and Storing. The cement shall be delivered in packages as specified with the brand and

name of the manufacturer plainly marked thereon, unless shipped in bulk. When shipped in bulk, this information shall be contained in the shipping advices accompanying the shipment. A bag shall contain 94 pounds net. A barrel shall contain 376 pounds net. All packages shall be in good condition at the time of inspection.

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

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

93.6 Rejection. The cement may be rejected if it fails to meet any of the requirements of these specifications. At the time cement is incorporated in the work it shall meet all of the requirements specified herein. The provisional acceptance of cement at the mill or upon delivery to the work shall not deprive the engineer of the right to resample it and to reject the material for failure to meet any of the requirements.

Cement remaining in storage prior to shipment for a period greater than six months after test shall be retested and shall be rejected if it fails to meet any of the requirements of these specifications.

Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter.

Packages varying more than five percent from the specified weight may be rejected; and if the average weight of

packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

93.7 Methods of Sampling and Testing. Sampling and testing of Portland cement shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling and testing.....	T-1
Specific surface.....	T-98

SECTION 94—HIGH EARLY STRENGTH PORTLAND CEMENT

94.1 Material Covered. High early strength Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

94.2 Chemical Properties. The following limits shall not be exceeded:

Loss on ignition, percent.....	4.00
Insoluble residue, percent.....	0.85
Sulfuric anhydride (SO_3), percent.....	2.50
Magnesia (MgO), percent	5.00

94.3 Physical Properties. The specific surface as determined by the turbidimeter shall not be less than 1,900 sq. cm. per gram.

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

The cement shall not develop initial set in less than 45 minutes when the Vicat needle is used or 60 minutes when the Gillmore needle is used. Final set shall be attained within 10 hours. If necessary to secure proper workability and finish in concrete construction during warm weather, the engineer reserves the right, upon due notice to the producer, to lengthen the initial set requirement.

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

Age at test, days	Storage of briquets	Tensile strength, lbs. per sq. in.
1	One day in moist air.....	275
3	One day in moist air, two days in water	375

If, at the option of the engineer, a 28-day test (with storage of one day in moist air and 27 days in water) is required, the average tensile strength obtained at 28 days shall be higher than the strength obtained at three days.

94.4 Packing, Marking, and Storage. The cement shall be delivered in packages as specified with the brand and name of the manufacturer plainly marked thereon, unless shipped in bulk. When shipped in bulk, this information shall be contained in the shipping advices accompanying the shipment. A bag shall contain 94 pounds net. A barrel shall contain 376 pounds net. All packages shall be in good condition at the time of inspection.

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

94.5 Inspection and Rejection. Every facility shall be provided the engineer for careful sampling and inspection at either the mill or at the site of the work, as may be specified by the engineer. At least six days from the time of sampling shall be allowed for the completion of the one-day tests, eight days for the three-day tests, and at least 33 days shall be allowed for the completion of the 28-day tests. The cement shall be tested in accordance with the methods hereinafter prescribed.

The cement may be rejected if it fails to meet any of the requirements of these specifications. At the time cement is incorporated in the work it shall meet all of the requirements specified herein. The provisional acceptance of cement at the mill or upon delivery to the work shall not deprive the engineer of the right to resample it and to reject the material for failure to meet any of the requirements.

Cement remaining in storage prior to shipment for a period greater than six months after test shall be retested and shall be rejected if it fails to meet any of the requirements of these specifications.

Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter.

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

94.6 Methods of Sampling and Testing. Sampling and testing of high early strength cement shall be in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling and testing.....	T-1
Specific surface.....	T-98

SECTION 95—STRUCTURAL, RIVET AND EYEBAR STEEL

95.1 General. All structural and eyebar steel, except where alloy steel is specified, shall conform to the requirements of the Standard Specifications for Steel for Bridges, Designation A7-36, of the American Society for Testing Materials, and all rivet steel shall conform to the requirements of the "Standard Specifications for Structural Rivet Steel, Designation A141-36" of that society. These requirements shall apply with the subsequent amendments and additions thereto adopted by the society, but are supplemented by the following requirements:

95.2 Mill Test Report. Two certified copies of the mill test report showing the chemical and physical characteristics of each heat from which metal is used shall be furnished by the contractor.

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

95.4 Defects in Material. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects; provided, however, that surface imperfections in material three-eighths inch or more in thickness may be corrected in the following manner:

When the imperfections are less than one-sixteenth inch in depth, they may be removed by grinding. When the imperfections are one-sixteenth inch or more in depth, they shall be chipped and, unless otherwise permitted by the engineer, they shall be welded in accordance with this specification.

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

- $\frac{1}{16}$ inch in metal from 0.375 to 0.499 inch in thickness.
- $\frac{1}{8}$ inch in metal from 0.500 to 0.999 inch in thickness.
- $\frac{3}{16}$ inch in metal from 1.000 to 1.499 inch in thickness.

$\frac{1}{4}$ inch in metal from 1.500 to 2.249 inch in thickness.

$\frac{3}{8}$ inch in metal from 2.250 to 3.500 inch in thickness.

The cross-sectional area of the piece shall not be reduced at any point in its length more than 1.5 percent by the removal of the defects.

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

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

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

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

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

99.5 Full-Size Tests. When full-size tests of built-up structural members and eyebars are required by the contract, the contractor shall supply testing machines of the proper type and capacity, and shall provide all facilities and labor incidental to the making of tests. In all tests involving the determination of tensile and compressive strengths, the ultimate strength, deformation, and other pertinent data shall be recorded.

When tests of full-sized eyebars are required, the number and size of the bars to be tested shall be designated by

the engineer before the mill order is placed. The number shall not exceed five percent of the whole number of bars ordered, with a minimum of two bars on small orders.

Test bars shall be of the same section as the bars to be used in the structure and of the same length if within the capacity of the testing machine. They shall be selected by the inspector from the finished bars, preferably after annealing. Test bars representing bars too long for the testing machine shall be selected from the full-length bar material after the heads on one end have been formed, and shall have the second head formed upon them after being cut to the greatest length which can be tested.

Full-size tests of eyebars shall show a yield point of not less than 33,000 pounds per square inch, an ultimate strength of not less than 60,000 pounds per square inch, and an elongation, including the fracture, of not less than 12 percent in a length of 18 feet measured in the body of the bar.

If an eyebar fails to fulfill the specified requirements, two additional bars of the same size and from the same melt shall be tested. The bars represented by the test may be reannealed before the additional bars are tested.

If two of the three test bars fail to give satisfactory results, the bars of that size and melt shall be rejected.

A record of the annealing charges shall be furnished the engineer, showing the bars included in each charge and the treatment they received.

96.8 Annealing. Forgings shall be annealed. The procedure shall be as follows: Allow the objects, immediately after forging, to cool to a temperature below the critical

range under suitable conditions to prevent injury by too rapid cooling; then reheat uniformly to a proper temperature to refine the grain, and allow to cool uniformly. A group of objects thus simultaneously reheated and cooled constitutes an annealing charge.

96.9 Physical Properties. The forgings, after annealing, shall conform to the following requirements as to physical properties:

Tensile strength, minimum pounds per square inch..	60,000	
Yield point, pounds per square inch.....	0.5 tensile str.	
But not less than.....	33,000	
Elongation in 2-inch, minimum, percent—		
Not over 12-inch diam.....	$\frac{1,700,000}{\text{ten. str.}}$	not under 25
Over 12-inch to 20-inch diam., inclusive.....	$\frac{1,600,000}{\text{ten. str.}}$	not under 24
Reduction of area, minimum percent—		
Not over 12-inch diam.....	$\frac{2,700,000}{\text{ten. str.}}$	not under 38
Over 12-inch to 20-inch diam., inclusive.....	$\frac{2,500,000}{\text{ten. str.}}$	not under 36

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

Tests of forgings shall be made only after final treatment.

96.10 Speed of Testing Machine. The crosshead of the testing machine shall move at a speed insuring uniformity in the application of the load and accuracy in its determination. It shall not exceed the limits specified in T-68, Standard Methods of Tension Testing of Metallic Materials of the American Association of State Highway Officials (A.S.T.M. designation E8-36).

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

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

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

Tension test specimens shall conform to the dimensions shown in Figure 9, Standard 2-inch Gage Length Tension Test Specimen, T-68, Methods of Tension Testing of Materials of the A.A.S.H.O.

96.12 Number of Tests. Tests shall be made as follows:

One tension test shall be made from each annealing charge, except that when more than one melt is involved in an annealing charge, one tension test shall be made from each melt.

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

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

When the percentage of elongation of a test specimen is less than that specified and any part of the fracture is more than three-quarters inch from the center of the gage length, as indicated by scribe scratches marked upon the specimen before testing, a retest shall be made.

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

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

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

Identification marks shall be stamped legibly on each forging and on each test specimen.

96.15 Inspection. The engineer or his representative shall be allowed free access at all times to the parts of the works involved in the manufacture of the material ordered, while work thereon is in progress. The manufacturer shall, without charge, provide the facilities for making inspections and shall furnish the required number of test specimens.

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

96.16 Rejection. Unless otherwise provided, any rejection based upon tests made shall be reported within five working days from the receipt of the specimens.

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

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

SECTION 97—STEEL CASTINGS

97.1 Material Covered. This specification covers the quality of steel castings. The steel shall be made by one or more of the following processes: open hearth, electric furnace, converter, or crucible.

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

Manganese, percent	0.50 to 1.00
Phosphorus, percent	not over 0.05
Sulphur, percent	not over 0.06
Silicon, percent	0.20 to 0.75

97.3 Ladle Analysis. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, sulphur, and silicon. This analysis shall be made from drillings taken at least one-fourth inch beneath the surface of a test ingot secured during the pouring of the melt. Two certified copies of the chemical composition thus determined shall be furnished to the engineer, and if it fails to conform to the required chemical composition the melt shall be rejected.

97.4 Check Analysis. An analysis may be made by the engineer from a broken tension test specimen or from a casting representing each melt. The chemical composition thus determined shall conform to the requirements specified. Drillings for analysis shall be taken at least one-fourth inch beneath the surface.

97.5 Annealing. All castings shall be annealed unless otherwise provided. The procedure shall be as follows:

After pouring, allow the castings to cool to a temperature below the critical range, then reheat uniformly to a proper temperature and for the required time, to refine the grain, and allow to cool slowly in the furnace until the pyrometer shows that the furnace temperature has fallen to 500 degrees Fahrenheit. The furnace temperature shall be controlled effectively by pyrometers.

97.6 Physical Properties. The castings, after annealing,

shall conform to the following requirements as to physical properties:

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

97.7 Speed of Testing Machine. The crosshead of the testing machine shall move at a speed insuring uniformity in the application of the load and accuracy in its determination. It shall not exceed the limits specified in T-68, Standard Methods of Tension Testing of Metallic Materials of the American Association of State Highway Officials (A.S.T.M. designation E8-36).

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

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

Tension test specimens shall conform to the dimensions shown in Figure 9, Standard 2-inch Gage Length Tension Test Specimen, T-68, Methods of Tension Testing of Metallic Materials of the A.A.S.H.O.

97.9 Number of Tests. Tests shall be made as follows:

One tension test shall be made from each annealing charge, except that, when more than one melt is involved in an annealing charge, one test shall be made from each melt. One tension test shall be made from each casting weighing 500 pounds or more.

When a test specimen shows defective machining or develops flaws, it may be discarded and another specimen from the same charge and melt substituted.

When the percentage of elongation of a test specimen is less than that specified and any part of the fracture is more than three-fourths inch from the center of the gage length, as indicated by scribe scratches marked upon the specimen before testing, a retest shall be made.

When the results of the test of an annealing charge fails to conform to the requirements specified, the manufacturer may reanneal the charge, but not more than twice; and following each annealing treatment, test specimens shall be made and tested as required above.

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

97.11 Workmanship and Finish. Steel castings shall be true to pattern in form and dimensions without sharp, unfilleted angles or corners, and shall be free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

Blow holes appearing upon finished castings shall be so located that a straight line laid in any direction will not cut a total length of cavity greater than one inch in any one-foot, nor shall any single blow hole exceed one inch in any dimension or have an area greater than one-half square inch.

Blow holes shall not have a depth injuriously affecting the strength of the castings. Minor defects which do not impair the strength may, with the approval of the engineer, be welded by an approved process. The defects shall be removed to solid metal by chipping, drilling or other satisfactory methods, and, after welding, the castings shall be annealed, if required by the engineer. Castings which have been welded without the permission of the engineer shall be rejected.

Large castings shall be suspended and hammered all over. No cracks, flaws or other defects shall appear after such treatment.

The name or brand of the manufacturer and the pattern number shall be cast, when practicable, in each casting.

The melt number shall be stamped lightly on each casting and each test specimen.

97.12 Inspection. The engineer or his representative shall be allowed free access at all times to the parts of the works involved in the manufacture of the castings, while the work thereon is in progress. The manufacturer shall, without charge, provide the facilities for making inspections, and shall furnish the required number of test specimens.

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

97.13 Rejection. Unless otherwise provided, any rejection based upon tests made shall be reported within five working days from the receipt of the specimens.

Specimens representing castings rejected as a result of tests made shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the result, the manufacture shall be allowed a rehearing within that time.

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

SECTION 98—GRAY IRON CASTINGS

98.1 General. Iron castings shall conform to the requirements of the Standard Specifications for Gray Iron Castings, Designation A48-36, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society.

Castings shall be boldly filleted at angles, and the arrises shall be sharp and perfect.

98.2 Structural Defects. Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

SECTION 99—MALLEABLE CASTINGS

99.1 General. Malleable castings shall conform to the requirements of the Standard Specifications for Malleable Castings, Designation A47-33, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society.

The castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. The surfaces shall have a workmanlike finish.

99.2 Structural Defects. Malleable castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

SECTION 100—WROUGHT IRON

100.1 Wrought Iron Bars. Wrought iron bars shall conform to the requirements of the Standard Specifications for Refined Iron Bars, Designation A41-36, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society.

100.2 Wrought Iron Plates. Wrought iron plates shall conform to the requirements of the Standard Specifications for Wrought Iron Plates, Designation A42-36T, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society.

SECTION 101—BRONZE

101.1 General. Bronze for expansion bearing plates shall conform to the Standard Specifications for Bronze Castings for Turntables and Movable Bridges, Designation B22-36T, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society and with the following modifications:

Class B, C, or D bronze shall be used, except that the bronze shall conform to the following requirements as to composition:

Elements considered	CLASS		
	B	C	D
Copper, percent	Remainder	Not over 82	Not over 89
Tin, max., percent.....	17	11	11
Lead, max., percent	---	20	---
Zinc, max., percent.....	---	---	2.25
Iron, max., percent.....	---	---	0.2
Phosphorus, max., percent.....	1.0	0.7-1.0	0.25
Other elements, max., percent..	0.5	0.5	0.5

SECTION 102—SHEET COPPER

102.1 Material Covered. This specification covers the quality of copper sheets for use as water stops.

102.2 General Requirements. The copper seals shall be made from copper sheets weighing not less than 16 ounces per square foot and rolled from the best grades of virgin metal or virgin metal and scrap of known and approved composition. The sheets shall be made from soft copper only, one-eighth hard, cold rolled, and annealed. They shall contain not less than 99.5 percent of copper, silver being included in the copper.

102.3 Physical Requirements. The tensile strength of the copper shall be not less than 30,000 pounds per square inch. The minimum elongation in a length of two inches shall be not less than 15 percent. The copper shall withstand being bent cold through an angle of 180 degrees flat upon itself without fracture on the outside of the bent portion.

102.4 Test Reports and Specimens. The contractor shall furnish without charge certified test reports showing the physical and chemical properties of the metal, and shall also furnish specimens for testing purposes.

SECTION 103—BAR REINFORCEMENT

103.1 Material Covered. These specifications cover plain and deformed billet-steel concrete reinforcement bars.

Plain and deformed bars are of three grades, namely, structural-steel, intermediate, and hard. Unless otherwise specified, only deformed intermediate grade steel shall be furnished under this specification, except that dowel bars for cement concrete surface shall be hard grade.

103.2 Manufacture. The steel shall be made by one or more of the following processes: open-hearth, electric-furnace, or acid-Bessemer.

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

103.3 Chemical Properties and Tests. The steel shall conform to the following requirements as to chemical composition:

Phosphorus, max., percent:

Acid-Bessemer	0.10
Open-hearth or electric-furnace—	
Basic	0.05
Acid	0.08

An analysis of each melt of steel shall be made by the manufacturer to determine the percentage of carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the engineer, and the percentage of phosphorus shall conform to the requirement specified.

Analyses may be made by the engineer from finished bars representing each melt of open-hearth or electric-furnace steel, and each melt or lot of 10 tons of Bessemer steel. The phosphorus content thus determined shall not exceed that specified by more than 25 percent.

103.4 Physical Properties and Tests. The bars shall conform to the following requirements as to tensile properties:

TENSILE REQUIREMENTS**PLAIN BARS**

Properties considered	Structural steel grade	Inter- mediate grade	Hard grade
Tensile strength, lb. per sq. in.....	55,000 to 70,000	70,000 to 90,000	80,000 min.
Yield point, min. lb. per sq. in.....	33,000	40,000	50,000
Elongation in 8 in. min. percent.....	<u>1,400,000</u> ten. str.	<u>*1,300,000</u> ten. str.	<u>1,200,000</u> ten. str.

DEFORMED BARS

Properties considered	Structural steel grade	Inter- mediate grade	Hard grade
Tensile strength, lb. per sq. in.....	55,000 to 70,000	70,000 to 90,000	80,000 min.
Yield point, min. lb. per sq. in.....	33,000	40,000	50,000
Elongation in 8 in. min. percent.....	<u>1,250,000</u> ten. str.	<u>†1,125,000</u> ten. str.	<u>1,000,000</u> ten. str.

*But not less than 16%.

†But not less than 14%.

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

For plain and deformed bars over three-fourths inch in thickness or diameter, a deduction from the percentages of elongation specified of twenty-five one-hundredths percent shall be made for each increase of one thirty-second inch of the specified thickness or diameter above three-quarters inch.

For plain and deformed bars under seven-sixteenths inch in thickness or diameter, a deduction from the percentages of elongation specified of five-tenths percent shall be made for each decrease of one thirty-second inch of the specified thickness or diameter below seven-sixteenths inch.

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

BEND-TEST REQUIREMENTS**PLAIN BARS**

Thickness or diameter of bar	Structural steel grade	Intermediate grade	Hard grade
Under $\frac{3}{4}$ in.	180 deg. $d = t$	180 deg. $d = 2t$	180 deg. $d = 3t$
$\frac{3}{4}$ in. or over.....	180 deg. $d = t$	90 deg. $d = 2t$	90 deg. $d = 3t$

DEFORMED BARS

Thickness or diameter of bar	Structural steel grade	Intermediate grade	Hard grade
Under $\frac{3}{4}$ in.	180 deg. $d = t$	180 deg. $d = 3t$	180 deg. $d = 4t$
$\frac{3}{4}$ in. or over.....	180 deg. $d = 2t$	90 deg. $d = 3t$	90 deg. $d = 4t$

EXPLANATORY NOTE— d = the diameter of pin about which the specimen is bent.
 t = the thickness or diameter of the specimen.

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

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

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

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

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

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

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

One tension and one bend test shall be made from each melt of open-hearth or electric-furnace steel, and from each melt or lot of ten tons of Bessemer steel; except that if material from one melt differs three-eighths inch or more in thickness or diameter, one tension and one bend test

shall be made from both the thickest and the thinnest material rolled.

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

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

103.5 Permissible Variations in Weight. The weight of any lot of bars shall not vary more than three and one-half percent under or three and one-half percent over the theoretical weight of the lot. The weight of any individual bar shall not vary more than five percent under the theoretical weight for bars over three-eighths inch in diameter; nor more than 10 percent for bars three-eighths inch and less. The theoretical weight of deformed bars shall be the theoretical weight of plain round or square bars of the same nominal size. The term "lot" used in this paragraph means all of the bars of the same nominal weight per linear foot in a carload.

Dowel bars shall not vary more than one one-hundredth of an inch from the normal size as ordered, nor shall they be more than fifteen one-thousandths of an inch out of round.

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

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

103.8 Inspection and Rejection. The inspector representing the engineer shall have free entry, at all times while work is being performed, to all parts of the manufacturer's works which concern the manufacture of the bars. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the bars are being furnished in accordance with these specifications.

The manufacturer shall submit to the department's laboratory two representative samples of each size of bar from each heat or melt to be furnished in any one shipment for pretesting. Final acceptance shall be based on check samples cut by the engineer after delivery to the work.

In lieu of the above procedure, when permitted by the engineer, the manufacturer may submit certified test reports from a recognized commercial agency approved by the engineer covering the required tests. Final acceptance shall be based on check samples cut by the engineer after delivery to the work.

Unless otherwise specified, any rejection based on tests shall be reported within five working days from the receipt of samples.

Bars which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Samples which represent rejected bars, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

103.9 Testing. Testing of billet-steel concrete reinforcement bars shall be in accordance with American Association of State Highway Officials standard method T-68.

SECTION 104—MESH REINFORCEMENT

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

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

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

104.3 Manufacture. The steel shall be made by one or more of the following processes: open-hearth, electric-furnace, or acid-Bessemer.

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

104.4 Physical Properties and Tests. The wire, except as specified below, shall conform to the following minimum requirements as to tensile properties:

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

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

The yield points shall be determined by the drop of the

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

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

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

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

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

Tension and bent-test specimens shall be of full-size section of the wire as drawn.

One tension and one bend test shall be made for each 10 tons or less of each size of wire.

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

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

104.6 Wire Mesh. Parallel members of mesh reinforcing shall be of the size and spaced as required by the engineer. Intersecting member shall be rigidly welded at right angles in such manner as to develop the full strength of the wire across the welds.

104.7 Finish. The finished wire or mesh shall be free from injurious defects and shall have a workmanlike finish with smooth surface.

104.8 Inspection and Rejection. The inspector representing the engineer shall have free entry, at all times while work is being performed, to all parts of the manufacturer's works which concern the manufacture of the wire or mesh ordered. The manufacturer shall afford the

inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

The manufacturer shall submit to the department's laboratory two representative samples of each size of wire or mesh from each heat or melt to be furnished in any one shipment for pretesting. Final acceptance shall be based on check samples cut by the engineer after delivery to the work.

In lieu of the above procedure, when permitted by the engineer, the manufacturer may submit certified test reports from a recognized commercial agency, approved by the engineer, covering the required tests. Final acceptance shall be based on check samples cut by the engineer after delivery to the work.

Wire or mesh which show injurious defects subsequent to their acceptance at the manufacturer's works shall be rejected, and the manufacturer shall be notified.

104.9 Testing. Testing of cold drawn steel wire fabric for concrete reinforcement shall be in accordance with the American Association of State Highway Officials standard method T-68.

SECTION 105—HARDWARE

105.1 Material Covered. This specification covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings.

105.2 General Requirements. Hardware for use with redwood or treated Douglas fir timber shall be galvanized. Unless otherwise specified on the plans, hardware for use with untreated timber need not be galvanized.

105.3 Bolts, Dowels, and Drift Pins. Bolts, dowels, and drift pins shall conform to "Standard Specifications for Billet-Steel Concrete Reinforcement Bars," serial designation A15-35, of the A.S.T.M. They may be either structural or intermediate grade. Bolts and nuts shall have square heads.

105.4 Washers. Washers shall be standard cast O-gee or malleable cast washers, or they may be cut from medium steel or wrought-iron plate, as specified.

105.5 Nails and Spikes. Nails shall be cut or round wire of standard form. Spikes shall be cut or wire spikes, or boat spikes, as specified.

105.6 Galvanizing. Galvanizing on hardware shall conform to "Tentative Specifications for Zinc Coating (Hot-Dip) on Hardware and Fastenings," serial designation A153-33T of the A.S.T.M.

SECTION 106—CORRUGATED METAL CULVERT PIPE

106.1 Material Covered. This specification covers the quality of corrugated metal culvert pipe for use in culverts and drains.

106.2 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 which produces genuine wrought iron. The base metal shall conform to one of the following chemical requirements:

Elements	—Chemical composition by ladle analysis, percent— (Position of base metals does not indicate preference)					Tolerance by check analysis of finished sheets, percent
	Kind of base metal					
	Pure iron	Copper bearing pure iron	Copper iron	Copper molyb- denum iron	Cop- per steel	
	Genuine wrought iron*					
Carbon, max.					0.05	0.01
Manganese, max.					0.06	0.01
Phosphorus, max.	0.015	0.015	0.015	0.015	0.12	
Sulphur, max.	0.040	0.040	0.040	0.040	0.050	0.04
Silicon, max.					0.15	
Copper, min.		0.20	0.20	0.40	0.20	0.02
Molybdenum, min.				0.05		
Sum of first 5 elements, max.		0.10	0.25	0.25	0.70	0.04
Sum of first 6 elements, max.	0.10					0.04

*Genuine wrought iron is a combination of iron and silicate slag. The above analysis covers the metalloids found in both the base iron and the silicate slag. It is defined as a ferrous material aggregated from a solidifying mass of pasty particles of highly refined metallic iron, with which, without subsequent fusion, is incorporated a minutely and uniformly distributed quantity of slag. All sheet bars shall be made from wrought iron blooms, and shall be entirely free from any admixture of steel. Genuine wrought iron sheets shall be rolled only from such bars.

All rivets shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized.

106.3 Spelter Coating. Weight of 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 equal shall be applied at the rate of not less than two ounces per square foot of double-exposed surface. If the average spelter coating as determined from the required samples is less than two ounces of spelter per square foot,

or if any one specimen is less than one and eight-tenths 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 from injurious defects, such as blisters, flux, and uncoated spots.

106.4 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 from the mill the chemical analysis of any heat. 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. Any material or pipe which has been previously rejected at the mill or shop and included in a later lot, will be considered sufficient cause for the rejection of the entire lot.

106.5 Sampling. Chemical analysis of the base metal of the finished sheet, when required, may be made of the samples taken for weight of spelter coating test. For testing coating of sheets before fabricating, a sample strip about three inches wide shall be cut crosswise or diagonally across the sheet, the full width, from one sheet of each lot of the same identification symbol. From this strip and along the newly sheared edge, samples two and one-quarter 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 two and one-quarter inches square, or a sample of equivalent area, shall be selected from each 20 culverts of a shipment, provided that not less than three samples, each from a different section, shall represent any one shipment.

106.6 Analysis of Finished Sheet. When not otherwise provided, chemical analysis, when required, shall be in accordance with the methods of the American Society for Testing Materials, serial designation E30-36T.

106.7 Tests for Spelter Coating. The tests for weight of spelter coating shall be made in accordance with Standard

Method T-65 of the American Association of State Highway Officials.

106.8 Accepted Brands of Metal. No metal will be accepted under this specification 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 of any brand under this specification, and notice sent to the sheet manufacturer of the discontinuance of acceptance of any brand will be considered to be notice to all culvert companies which handle that particular brand. 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.

106.9 Sheet Manufacturers' Certified Analysis. The manufacturer of each brand shall file with the engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of carbon, manganese, phosphorus, sulphur, silicon, and copper; also molybdenum, when provided for under the particular kind of base metal. The certificate shall be sworn to for the manufacturer by a person having legal authority to bind the company.

106.10 Sheet Manufacturer's Guarantee. The manufacturer of the sheets shall submit with the certified analysis a guarantee providing that all metal furnished shall conform to the certified analysis filed, shall bear a suitable identification brand or mark, and shall be replaced without cost to the engineer when not in conformity with the specified analysis, gage, or spelter coating; and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.

106.11 Identification. No culverts will be accepted unless the metal is identified by a stamp on each section, showing:

- (1) Name of sheet manufacturer.
- (2) Name of brand and kind of base metal.

- (3) Gage number.
- (4) Weight of spelter coating.
- (5) Identification symbols showing { Heat No.
Pot No.

Identification symbols showing heat numbers will not be required for wrought iron. However, identification by pot number will be required.

The identification brands shall be placed on the sheets by the manufacturer of the sheets in such a way that, when rolled into culverts, such identification shall appear on the outside of each section of each pipe. Pipe having any sections not so stamped shall be promptly rejected. The kind of base metal shall be designated independently of the brand or trade mark so as to clearly identify the base metal furnished with one of the kind of base metal enumerated in the table. The designation of the "Kind of Base Metal" may be accomplished by placing on the sheets the initials of the exact name of the base metal given in the table for chemical composition by ladle analysis, 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.

106.12 Corrugations. Corrugations shall not be less than two and one-quarter inches nor more than two and three-quarters inches center to center. The corrugations shall have a depth of not less than one-half inch.

106.13 Perforated Pipe. Perforations shall be approximately one-quarter inch in diameter, punched one and one-half inch centers lengthwise in 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 following table:

Diameter of culvert	No. of rows of holes
8	8
10	8
12	10
15	10
18	15
21	15
24	20
30	22

106.14 Siphon Pipe. Corrugated metal pipe for use as siphons shall be close riveted and soldered, and so fabricated as to require a minimum number of field connections. Rivets on circumferential seams shall be spaced at approximately two and one-half inch centers with a maximum spacing of three inches. Circumferential and longitudinal seams on the outside of the pipe, where the edges of the sheets lap, shall be soldered in a workmanlike manner, the solder being sweated into the joints by means of a torch properly regulated for the purpose. Soldering irons shall not be used on factory seams. Sections of siphon pipe shall be joined on the work by means of an approved, watertight coupling.

106.15 Gage Determinations and Tolerances. The gage of the culvert metal shall be determined from the weight of the galvanized sheets. The theoretical weights per square foot, together with permissible tolerances, on the flat galvanized sheets, shall be as indicated below:

Galvanized sheet gage number	Weight of galvanized sheet, oz. per sq. ft.	—Permissible tolerances in weights of— sheets, plus or minus in percentage of theoretical weight*		
		All of one gage and size in shipment†	Single packages	Single sheets
8	112.5	5.0	7.0	10.0
10	92.5	5.0	7.0	10.0
12	72.5	5.0	7.0	10.0
14	52.5	5.0	7.0	10.0
16	42.5	5.0	7.0	10.0

*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.

†All of one gage and size in shipment shall apply to lots of not less than 6,000 pounds.

106.16 Shape. Culverts furnished under this specification shall be of the full circle, riveted type, with lap joint construction, and shall be perforated when specified by the engineer.

106.17 Dimensions and Weights. The length of sheets, widths of laps, gages, and computed weights per linear foot of the finished culverts, shall be as specified in the following table. The dimensions given for diameter of pipe are nominal. The average weight per linear foot of a finished culvert, exclusive of end finish, shall not

underrun the computed weight specified by more than five percent.

Nominal diameter (inches)	Length of sheet before forming (inches)	Minimum width of lap (inches)	Galvanized sheet gage number	Computed weight per linear foot of finished culvert exclusive of end finish (pounds)	Connecting bands galvanized sheet gage number (or heavier)
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	3	10	108.9	12
72	2-117	3	10	130.4	12
84	2-137	3	8	185.2	12

*Two sheets may be used by allowing sufficient total sheet lengths to provide for an additional standard lap.

106.18 Rivets and Riveting. Rivets shall be of the following diameters for the gages specified:

No. 16 gage material.....	5/16 in.
No. 14 gage material.....	5/16 in.
No. 12 gage material.....	6/16 in.
No. 10 gage material.....	6/16 in.
No. 8 gage material.....	6/16 in.

All rivets shall be driven cold in such a manner that the plates shall be drawn tightly together throughout the entire lap. The center of no rivet shall be closer than twice its diameter from the edge of the metal. All rivets shall have neat, workmanlike, and full hemispherical heads or heads of a form acceptable to the engineer, shall be driven without bending, and shall completely fill the hole. Longitudinal seams shall be riveted with one rivet in the valley of each corrugation. The longitudinal seams of all pipe 42 inches or more in diameter shall be double riveted. Circumferential, shop-riveted seams shall have a maximum rivet spacing of six inches, except that six rivets will be sufficient in 12-inch pipe.

106.19 Net Length of Culvert Pipe. The length of culvert specified shall be the net length of the finished culvert which does not include any material used to procure an end finish on the pipe. If the average deficiency in length of any shipment of pipe is greater than one percent, the shipment shall be rejected.

106.20 End Finish. The inlet and outlet of all culverts fabricated of 16 or 14-gage sheets shall be reinforced in a manner approved by the engineer when required on plans or special provisions.

106.21 Asphaltic Coating. Pipe culverts and band couplings shall be coated with an approved asphaltic pipe dip at the plant 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 adhere firmly to the spelter.

106.22 Coupling Bands. Field joints shall be made with bands of the same base metal as the culverts and shall be not less than seven inches wide for diameters of eight inches to 30 inches, inclusive, 12-inch band for culverts with diameters 36 inches to 48 inches, inclusive, and 24-inch band for culverts with diameters 54 inches to 84 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 shall be connected at the ends by galvanized angles having minimum dimensions of two inches by two inches by three-sixteenths inch. The seven-inch band shall have at least two galvanized bolts of not less than one-half inch diameter. The 12-inch band shall have three and the 24-inch band shall have five one-half inch bolts. Other equally effective methods of connecting the coupling bands may be used if approved by the engineer.

106.23 Workmanship. It is the essence of these specifications that in addition to compliance with the details of construction, the completed pipe shall show careful, finished workmanship in all particulars. Culvert pipe on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship, shall be rejected. This requirement applies not only to the individual pipe, but to the shipment on any contract

as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert pipe or in general in any shipment shall constitute sufficient cause for rejection:

1. Uneven laps.
2. Elliptical shaping.
3. Variation from a straight center line.
4. Ragged or diagonal sheared edges.
5. Loose, unevenly lined or spaced rivets.
6. Poorly formed rivet heads.
7. Unfinished ends.
8. Illegible brand.
9. Lack of rigidity.
10. Bruised, scaled, or broken spelter coating.
11. Dents or bends in the metal itself.

106.24 Field Inspection and Acceptance. The field inspection shall be made by the engineer who shall be furnished by the seller with an itemized statement of the sizes and lengths of culvert pipe in each shipment. This inspection shall include an examination of the culvert pipe for deficiency in lengths of sheets used, nominal specified diameter, net length of finished culvert pipe, and any evidence of poor workmanship as outlined above. The inspection may include the taking of samples for chemical analysis, and determination of weight of spelter coating. The pipe making up the shipment shall fully meet the requirements of these specifications, and if 25 percent of the pipe in any shipment fails to meet these requirements, the entire shipment may be rejected.

SECTION 107—VITRIFIED CLAY CULVERT PIPE

107.1 Material Covered. This specification covers the quality of vitrified clay culvert pipe for installation as culverts under the roadway. Vitrified clay culvert pipe shall be of the hub and spigot type. It shall be of the first quality, salt-glazed, sound, well-burned, and impervious to moisture. The pipe shall be manufactured from clay or shale or a combination of these materials. The material shall possess such physical and chemical properties that when molded into pipes and subjected to suitable temperature, will produce a strong, durable, and serviceable pipe free from objectionable defects and in compliance with these specifications.

107.2 Dimensions. The culvert pipe shall conform to the following requirements:

Size, inches	Minimum length, feet	Thickness, inches	Depth of bell, inches
12	2	1	2½
15	2	1¼	2½
18	2	1½	3
21	2	1¾	3
24	2	2	3
27	2½	2¼	3½
30	2½	2½	3½
33	2½	2⅝	4
36	2½	2¾	4
42	2½	3	4

107.3 Strength. When tested by the three-point method of applying load and supporting, the pipe shall show no crack under a load in pounds of 1500D per foot of length, where D is the inside diameter of the barrel in feet. When tested by the sand-bearing method for both support and load with each bearing covering an arc of 90 degrees of the cross section of the barrel, the pipe shall show no crack under a load in pounds of 2250D per foot of length.

107.4 Absorption. The absorption shall not exceed eight percent.

107.5 Retests. Should any specimen fail to meet the requirements for strength or absorption, a retest will be allowed on two similar specimens for each specimen in each lot that failed, and the pipe shall be acceptable only

when all these retest specimens fulfill the test requirements. No further tests will be permitted.

107.6 Workmanship and Finish. Pipes shall be substantially free from fractures, large or deep cracks and blisters, laminations, and surface roughness. The glaze shall consist of a continuous layer of salt glaze substantially free from large blisters or large pimples. No blisters shall exceed three inches in diameter and no blisters or pimples shall project more than one-eighth inch above the surrounding surface of the pipe for sizes up to and including 18 inches internal diameter. For sizes over 18 inches internal diameter, no blisters shall exceed two inches in diameter for each foot of the internal diameter of the pipe, nor project above the surrounding surface of the pipe more than one-eighth inch per foot of the internal diameter of the pipe. Not more than 10 percent of the inner surface of any pipe barrel shall be bare of glaze except the socket, where it may be entirely absent. Glazing shall not be required on the outer surface of the barrel at the spigot end for a distance from the end of the pipe equal to the specified depth of the socket. There shall be no well-defined network of crazing lines or hair cracks.

The ends of the pipe shall be practically square with their longitudinal axis.

107.7 Visual Inspection. All pipes shall be given a visual inspection to cull and reject pipes which, independent of the physical tests herein specified, fail to conform to the requirements of these specifications. Pipes shall be subject to rejection on account of the following:

(a) Dimensions less than the minimum permitted.

(b) Fractures and cracks passing through the shell or socket, except that a single crack at the spigot end of the pipe not exceeding 75 percent of the depth of the socket, or a single fracture in the socket not exceeding three inches in width nor two inches in length; chips or fractures on the interior of the pipe exceeding two inches in length, one inch in width, and a depth of more than one-quarter of the thickness of the shell.

(c) Blisters which are broken or exceed the dimensions specified in these specifications.

(d) Fire cracks or hair cracks sufficient to impair the strength, durability, or serviceability of the pipe.

(e) Variation of more than one-eighth inch per lineal foot in alignment of a pipe intended to be straight.

(f) Glaze does not conform to the requirements of these specifications.

(g) Failure to give a clear, ringing sound when placed on end and tapped with a light hammer.

107.8 Marking. All pipes shall bear the initials or name of the person, company, or corporation by whom they are manufactured, and the location of the mill. The markings shall be indented on the exterior of the barrel near the socket and shall be plainly legible for the purpose of identification.

107.9 Sampling and Testing. Not more than two percent of each lot shall be furnished by the contractor or manufacturer for tests except that the number tested shall be not less than two.

The average crushing strength shall be determined by the three-edge bearing method. This test and the absorption test are described in A.A.S.H.O. method T-33. Facilities for testing shall be provided as may be required by the engineer.

SECTION 108—REINFORCED CONCRETE CULVERT PIPE

108.1 Material Covered. These specifications cover reinforced concrete pipe intended to be used for the construction of culverts.

Pipe manufactured according to these specifications shall be of two classes known respectively as "Standard Strength Reinforced Concrete Culvert Pipe" and "Extra Strength Reinforced Concrete Culvert Pipe."

The acceptability of pipe shall be determined by the results of the strength and absorption tests specified herein, if and when required, and by inspection to determine whether the pipe conforms to the specifications in design and freedom from defects.

108.2 Materials. Materials used in the manufacture of reinforced concrete culvert pipe shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Crushed stone for Portland cement concrete	Section 79
Gravel for Portland cement con- crete	Section 80
Fine aggregate for Portland cement concrete	Section 85
Standard Portland cement.....	Section 93
High early strength Portland Cement (optional).....	Section 94
Bar reinforcement	Section 103
Mesh reinforcement.....	Section 104

The aggregate shall be so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the test and design requirements of these specifications. In no case, however, shall the proportion of Portland cement in the mixture be less than six U. S. standard bags (94 lb.) per cubic yard of concrete.

In circular pipe having one line of circular reinforcement, the reinforcement shall be placed equally distant from the inner and outer surfaces of the pipe. In circular

pipe having two lines of circular reinforcement, each line shall be so placed that the net protective covering of concrete over the reinforcement shall be one inch. In circular pipe having elliptical reinforcement, and in elliptical pipe having circular reinforcement, the reinforcement shall be so placed that the net protective covering of concrete along the vertical diameter of the pipe shall be one inch from the inside surface of the pipe, and the net protective covering of concrete along the horizontal diameter of the pipe shall be one inch from the outside surface of the pipe. The location of the reinforcement shall be subject, however, to the tolerance permitted hereinafter.

STANDARD-STRENGTH REINFORCED-CONCRETE CULVERT PIPE

CONCRETE, 3500 LB. PER SQ. IN.						
Minimum reinforcement,						
sq. in. per linear ft. of pipe						
Internal diameter of pipe, inch	Minimum shell thickness, inch	Circular reinforcement in circular pipe	Elliptical reinforcement in circular pipe and circular reinforcement in elliptical pipe	STRENGTH TEST— REQUIREMENT, LB. PER LINEAR FT. OF PIPE		
				Three-edge bearing*		
				Load to produce a 0.01-in. crack	Ultimate load	
12.....	2	1 line	0.07	2,250	3,500	
15.....	2 $\frac{1}{4}$	1 line	0.09	2,625	4,065	
18.....	2 $\frac{1}{2}$	1 line	0.12	3,000	4,500	
24.....	3	1 line	0.17	3,000	5,000	
30.....	3 $\frac{1}{2}$	2 lines, ea.	0.17	3,375	5,750	
36.....	4	2 lines, ea.	0.18	4,050	6,600	
42.....	4 $\frac{1}{2}$	2 lines, ea.	0.21	4,725	7,350	
48.....	5	2 lines, ea.	0.25	5,400	8,000	

CONCRETE, 4500 LB. PER SQ. IN.						
Minimum reinforcement,						
sq. in. per linear ft. of pipe						
Internal diameter of pipe, inch	Minimum shell thickness, inch	Circular reinforcement in circular pipe	Elliptical reinforcement in circular pipe and circular reinforcement in elliptical pipe	STRENGTH TEST— REQUIREMENT, LB. PER LINEAR FT. OF PIPE		
				Three-edge bearing*		
				Load to produce a 0.01-in. crack	Ultimate load	
12.....	1 $\frac{1}{4}$	1 line	0.08	2,250	3,500	
15.....	2	1 line	0.11	2,625	4,065	
18.....	2 $\frac{1}{4}$	1 line	0.14	3,000	4,500	
24.....	2 $\frac{3}{8}$	1 line	0.20	3,000	5,000	
30.....	3	1 line	0.28	3,375	5,750	
36.....	3 $\frac{3}{8}$	2 lines, ea.	0.22	4,050	6,600	
42.....	3 $\frac{1}{2}$	2 lines, ea.	0.25	4,725	7,350	
48.....	4 $\frac{1}{4}$	2 lines, ea.	0.31	5,400	8,000	

*Test loads for sand-bearing tests shall be one and one-half times those specified in this table for the three-edge-bearing tests.

EXTRA-STRENGTH REINFORCED-CONCRETE CULVERT PIPE

CONCRETE, 4500 LB. PER SQ. IN.						
Minimum reinforcement, sq. in. per linear ft. of pipe				STRENGTH TEST REQUIREMENT, LB. PER LINEAR FT. OF PIPE		
Internal diameter of pipe, inch	Mini- mum shell thick- ness, inch	Circular reinforce- ment in circular pipe	Elliptical reinforce- ment in circular pipe and circular reinforce- ment in elliptical pipe	Three-edge bearing*— Load to produce a 0.01-in. crack		
24.....	3	1 line	0.26	1 line 0.20	4,000	6,000
30.....	3½	2 lines, ea.	0.24	1 line 0.24	5,000	7,500
36.....	4	2 lines, ea.	0.28	1 line 0.28	6,000	9,000
42.....	4½	2 lines, ea.	0.33	1 line 0.33	7,000	10,500
48.....	5	2 lines, ea.	0.38	1 line 0.38	8,000	12,000

*Test loads for sand-bearing tests shall be one and one-half times those specified in this table for the three-edge-bearing tests.

108.3 Design. The shell thickness and the amount of circumferential reinforcement shall not be less than that given in the table for the classes and sizes of pipe therein specified.

The contractor may submit, for approval, designs other than those given in the table, provided that such pipe shall meet the same physical tests and inspection requirements as herein prescribed for the pipe for which it is substituted. In no alternative design, however, shall the shell thickness be less than given in the tables.

The ends of the pipe shall be of such design that the pipe when laid shall form a continuous conduit with a smooth and uniform interior surface.

Each line of circumferential reinforcement shall be assembled into a cage which shall contain sufficient longitudinal bars or members, extending through the barrel of the pipe, to maintain the reinforcement rigidly in exact shape and correct position within the form.

If the splices are not welded, the reinforcement shall be lapped not less than 30 diameters for bars, and 40 diameters for cold-drawn wire. If welded, the members at either a welded splice or intersection shall develop a tensile strength across the weld not less than the minimum strength required for the reinforcement by the applicable specifications. The spacing center to center of adjacent rings of circumferential reinforcement in a cage shall not exceed four inches for pipe up to and including 48 inches

in diameter, and shall not exceed the shell thickness for larger pipe, and shall in no case exceed six inches.

The joint shall have a circumferential reinforcement equal in unit area to that of a single line within the barrel of the pipe.

108.4 Curing. Pipe shall be subjected to any one of the methods of curing described in the following paragraphs or to any other method approved by the engineer that will give satisfactory results:

(a) Pipe may be placed in a curing chamber, free from outside drafts, where the pipe shall be subjected to the action of thoroughly saturated steam at a temperature between 100 degrees and 130 degrees Fahrenheit for a period of not less than 36 hours, or, when necessary, for such additional time as may be needed to enable the pipe to meet the strength requirements (see note). When a curing chamber is not available, pipe may be placed in an enclosure of canvas or other closely woven material and subjected to saturated steam at the temperature and for the time specified above. The enclosure shall be so erected as to allow full circulation of steam around the entire pipe. The interior surfaces of the curing room or canvas jackets and the surfaces of the pipe shall be entirely moist at all times.

(b) Under the conditions of enclosure prescribed in paragraph (a), pipe may be cured by subjecting it to a continuous or frequently applied fine spray of water in an enclosure maintained at a temperature of not less than 70 degrees Fahrenheit for a period of not less than 72 hours, or such additional time as may be necessary to meet the strength requirements (see note). If the enclosure is maintained at a temperature of less than 70 degrees Fahrenheit, the curing period shall be increased as may be necessary to meet the strength requirements.

(c) The sides and top of each pipe may be covered with heavy burlap, or other suitable material, saturated with water before applying and kept saturated with water at a temperature of not less than 70 degrees Fahrenheit for 72 hours, or such additional time as may be necessary to meet the strength requirements (see note). The ends of

the pipe shall be so enclosed as to prevent the free circulation of air through or around the pipe. If the temperature of the water is less than 70 degrees Fahrenheit, the curing period shall be increased as may be necessary to meet the strength requirements.

NOTE—When high early strength Portland cement is used, the time of curing specified for each of the methods prescribed may be reduced to 24 hours, or such additional time as may be necessary to meet the requirements of the engineer.

108.5 Physical Test Requirements. The ultimate load, as determined by either the sand-bearing or three-edge-bearing test shall be not less than the ultimate load specified in the tables. ~~When the test load reaches the cracking load given in the tables,~~ for the size and class of pipe tested, there shall be in the barrel of the pipe no crack having a width of one one-hundredth inch or more for a length of one foot or more. The crack shall be considered one one-hundredth inch in width when the point of the standard gage leaf will penetrate it one-sixteenth inch at close intervals throughout the specified distance of one foot. The width of crack shall be measured by means of a gage made from a leaf one one-hundredth inch in thickness (as in a set of standard machinist's gages), ground to a point one-sixteenth inch in width, with corners rounded, and a taper of one-fourth inch per inch.

Elliptical pipe shall conform to the test requirements for circular pipe having the same horizontal internal diameter.

The absorption shall not exceed eight percent of the dry weight. Pipe shall be considered as conforming to these specifications for absorption when not less than 80 percent of the number of specimens tested, including any retested, conform to the test requirements. When the initial absorption specimen from a pipe fails to conform to these specifications, the absorption test shall be made on another specimen from the same pipe and the results of the retest shall be substituted for the original test results.

108.6 Size and Permissible Variations. Pipe of the internal diameters listed in the tables shall be the standard sizes for culvert construction. ~~In elliptical pipe, the inside~~

diameter at the minor axis shall be equal to the diameter of the corresponding size of circular pipe.

Variation of the internal diameter shall not exceed one percent for pipe having an internal diameter of 36 inches or less, and shall not exceed three-fourths percent for larger pipe. The shell thickness shall not be less than that intended in the design by more than five percent at any point.

Variations of the position of the reinforcement shall not exceed one-fourth inch from the position provided in the design for pipe having an internal diameter of 48 inches or less, and shall not exceed one-half inch for larger pipe; but the cover on the reinforcement shall not be less than three-fourths inch at any point.

108.7 Workmanship and Finish. Pipe shall be substantially free from fractures, large or deep cracks, and surface roughness. The planes of the ends of the pipe shall be perpendicular to the longitudinal axis.

108.8 Marking. The following shall be clearly stenciled on the pipe:

(a) The pipe class { by an "S-C" for standard-strength pipe, and
by an "X-C" for extra-strength pipe;

(b) The date of manufacture;

(c) The name or trade mark of the manufacturer; and

(d) Elliptical pipe with circular reinforcing and circular pipe with elliptical reinforcing shall have the word "Top" or "Bottom" clearly stenciled on the inside of the pipe at the correct place to indicate the proper position when laid.

108.9 Inspection and Rejection. Pipe shall be considered ready for shipment when they conform to the requirements as indicated by the specified tests.

All materials, processes of manufacture, and finished pipe shall be subject to inspection and approval by the engineer. The contractor, when so directed, shall have holes cut in such sections of the finished pipe (not exceeding one hole in every 50 sections delivered), as desired, so that a proper inspection may be made of the quantity and placement of the reinforcement.

Pipe shall be subject to rejection on account of failure

to meet any of the specification requirements or on account of any of the following:

(a) Fractures or cracks passing through the shell, except that a single end-crack that does not exceed the depth of the joint shall not be cause for rejection. If a single end-crack that does not exceed the depth of the joint exists in more than 10 percent of the pipe inspected, however, the defective pipe shall be rejected.

(b) Defects which indicate imperfect mixing and molding.

(c) Surface defects indicating honeycombed or open texture.

(d) Spalls deeper than one-half the depth of the joint or extending more than four inches around the circumference. If spalls not deeper than one-half the depth of the joint or extending not more than four inches around the circumference exist in more than 10 percent of the pipe, however, the defective pipe shall be rejected.

(e) ~~Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.~~

108.10 Methods of Testing. Testing of ~~reinforced~~ concrete culvert pipe shall be in accordance with standard method T-33 of the American Association of State Highway Officials.

SECTION 109—SEWER PIPE

109.1 General. Sewer pipe shall conform to the requirements of "Standard Specifications for Clay Sewer Pipe," serial designation C13-35, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the society.

SECTION 110—TIMBER

110.1 Material Covered. These specifications cover the quality of Douglas fir and redwood for use in highway and bridge construction.

110.2 Grading Rules. Douglas fir (coast region) shall be of the grade specified and shall be graded in accordance with the current standard grading and dressing rules of the West Coast Lumbermen's Association, except where such rules conflict with the grades and rules specified for stress-graded timbers hereinafter.

Redwood shall be of the grade specified and shall be graded in accordance with the current standard specifications for grades of California redwood lumber of the California Redwood Association, except where such rules conflict with the grades and rules specified for stress-graded timbers hereinafter.

110.3 Treated Timber. Treated timber shall conform to all of the requirements set forth herein, except that for all timber to be pressure treated, there shall be no heartwood requirement, and the amount of sapwood shall not be limited. Preservative treatments shall conform to Section 65 of these specifications.

110.4 Test Reports. An inspection certificate from either the West Coast Lumbermen's Association, the Pacific Lumber Inspection Bureau, or the California Redwood Association shall be furnished without extra charge with each shipment of timber.

110.5 Select Merchantable Dimension, Framing, Plank, Etc. This grade shall be of a general fine appearance. It shall be side cut and medium grain and will admit the following:

Knots—sound, tight, if not in clusters, approximately:

- 1 inch in 4-inch widths
- $1\frac{1}{4}$ inch in 6-inch widths
- $1\frac{1}{2}$ inch in 8-inch widths
- $1\frac{3}{4}$ inch in 10-inch widths
- 2 inch in 12-inch widths
- $2\frac{1}{4}$ inch in 14-inch widths

Spike knots—equivalent.

Checks—seasoning.

Pitch.

Pitch pockets—medium.

Sap stain—medium, 25 percent.

Skips—slight.

Torn grain—heavy.

Variation in sawing — occasional, slight, in rough stock.

110.6 Stress Grades. The following general provisions apply to all stress-grades:

All material shall be well manufactured. All sizes prescribed in the specifications applying to lumber and timber refer to nominal sizes, and the American standard rough and dressed sizes hereinafter enumerated shall be accepted as conforming thereto.

All timber to be used without preservative treatment shall contain not less than 85 percent heartwood on the girth, or on each face, side, or edge, measured at the point where the greatest amount of sapwood occurs.

No piece of exceptionally light weight shall be permitted.

Only pieces consisting of sound wood, free from any form of decay, shall be acceptable.

Slope of grain shall be measured over a distance sufficiently great to determine the general slope, disregarding slight local deviations. Within the middle half of the length of the piece the slope of grain shall not be steeper than specified.

Knot holes and holes from causes other than knots shall be measured and limited as provided for knots.

Cluster knots and knots in groups shall not be permitted.

110.7 Knots in Joist and Plank. The size of a knot on a narrow face shall be taken as the width between lines enclosing the knot and parallel to the edges of the piece. The only knots measured on narrow faces, except spike knots which cross the corners of side-cut pieces, shall be those that do not show on wide faces.

The size of a knot on a wide face shall be the average of its largest and smallest diameters. A spike knot which crosses a corner of a side-cut piece and contains the intersection of the adjacent faces, or which extends entirely

across a face of a piece, shall be measured only on its end or ends, between lines parallel to the edges of the piece.

The sizes of knots on narrow faces and at the edges of wide faces may increase proportionately from the size permitted in the middle third of the length to twice that size at the ends of the piece. The sizes of knots on wide faces may increase proportionately from the size permitted at the edge to the size permitted along the center line.

The sum of the sizes of all the knots within the middle half of the length of any face, measured as specified above for the face under consideration, shall not exceed four and one-half times the size of the largest knot allowed on that face.

110.8 Knots in Beams and Stringers. The size of a knot on a narrow face shall be taken as the width between lines enclosing the knot and parallel to the edges of the piece, except that when a knot on a narrow face extends into the adjacent one-fourth of the width of a wide face, its least dimension shall be taken as its size.

The size of a knot on a wide face shall be its smallest diameter. Knots at the edges of wide faces are limited to the same sizes as on narrow faces, but shall be measured according to this article.

The sizes of knots on narrow faces and at the edges of wide faces may increase proportionately from the size permitted in the middle third of the length to twice that size at the ends of the piece, except that the size of no knot shall exceed the size permitted along the center line of the wide face. The sizes of knots on wide faces may increase proportionately from the size permitted at the edge to the size permitted along the center line.

The sum of the sizes of all knots within the middle half of the length of any face, measured as specified above for the face under consideration, shall not exceed four times the size of the largest knot allowed on that face.

110.9 Knots in Posts and Timbers. The size of a knot shall be half the sum of its largest and smallest diameter. A spike knot which crosses a corner of a side-cut piece and contains the intersection of the adjacent faces, or which extends entirely across a face of a piece, shall be measured

only on its end or ends, between lines parallel to the edges of the piece.

The sum of the sizes of all the knots in any six inches of the length of the piece, measured as specified above, shall not exceed twice the maximum permissible size of the knot. Two knots of maximum permissible size shall not be allowed in the same six inches of length on any face.

110.10 Shakes, Checks, Splits in Joist and Plank and Beams and Stringers. Shakes, checks, and splits, where permitted in the grade specified hereto, shall be measured at the ends of the piece. Only those within the middle half of the height are considered. (Height equals the width of the wide face.) The size of the shake shall be the distance between lines enclosing the shake and parallel to the wide faces of the piece. Permissible size shall be determined by the width of the narrow face of the piece.

Checks and splits shall be measured and limited in the same way as shakes. The following limitations shall apply to both ends, but only within the middle half of the height of the piece and within three times the height from the end. (Height equals the width of the wide face.) The size of the checks within this portion of the piece shall be taken as their estimated area, along the horizontal section showing the maximum area, divided by three times the height of the piece (see note). When the checks on two parallel faces are opposite or approximately so, the sum of their sizes shall be taken. The sum of the sizes of shakes, checks, and splits shall not exceed the permissible size of the shake.

NOTE—A practical method of inspection in the field to determine the size of checks and splits under the above specification is as follows:

The size of checks within the specified portion of the piece shall be taken as the sum of seven depth measurements, one on the end and three on each side, divided by three. Each measurement shall represent the greatest depth of any check within the center half of the height; the measurement on the end shall be taken at the center of the width, and the three measurements on each side shall be taken at distances of one, two and three times the height of the piece from the end in joist, plank, beams and stringers, and the width of the piece from the end in posts and timbers. Each measurement shall be determined by the penetration into the piece of a probe one sixty-fourth inch thick and one-fourth inch wide.

Checks extending entirely across the end within the middle half

of the height shall not extend into the piece at the center of the width of the end a distance greater than the size of the allowable shake.

110.11 Shakes, Checks, and Splits in Posts and Timbers.

Shakes, checks, and splits, where permitted in the grade specified hereto, shall be measured at the ends of the piece. The size of a shake shall be the distance between the lines enclosing the shake and parallel to a pair of opposite faces.

Checks and splits shall be measured and limited in the same way as shakes. The size of checks within three times the width of the piece from either end shall be taken as their estimated area, along the longitudinal section showing the maximum area, divided by three times the width of the piece. The sum of the sizes of shakes, checks, and splits shall not exceed the permissible size of the shake.

Checks extending entirely across the end shall not extend into the piece at the center of the width of the end, a distance greater than the size of the allowable shake.

110.12 Density. Dense Douglas fir shall average on either one end or the other of each piece not less than six annual rings per inch, and, in addition, one-third or more summerwood (the dark portion of the annual ring), measured over three inches on a line at a right angle to the annual rings, located as described below. The contrast in color between summerwood and springwood shall be distinct.

Coarse-grained material excluded by this rule shall be accepted as dense if averaging one-half or more summerwood.

In boxed-heart pieces, the line shall run from the pith to the corner farthest from the pith except, when the line is not representative, it shall be shifted sufficiently to present a fair average, but the distance from the pith to the beginning of the three-inch portion of the line shall not be changed. When the least dimension is six inches or less, the three-inch portion of the line shall begin at a distance of one inch from the pith. When the least dimension is more than six inches, the three-inch portion of the line shall begin at a distance from the pith equal to one-fourth the least dimension of the piece.

In side-cut pieces (pith not present) the center of the three-inch portion of the line shall be at the center of the end of the piece.

If a three-inch portion of the line cannot be obtained, the measurement shall be made over as much of a three-inch portion as is available.

In case of disagreement, two radial lines shall be chosen, and the summerwood and number of rings shall be taken as the average on these lines.

110.13 Close Grain. Close-grained Douglas fir or redwood shall average on either one end or the other of each piece not less than six nor more than 20 annual rings per inch in Douglas fir, or not less than 10 nor more than 35 annual rings per inch in redwood, measured over three inches on a line at right angle to the annual rings located as described below.

In boxed-heart pieces, the line shall run from the pith to the corner farthest from the pith except, when the line is not representative, it shall be shifted sufficiently to present a fair average, but the distance from the pith to the beginning of the three-inch portion of the line shall not be changed. When the least dimension is six inches or less, the three-inch portion of the line shall begin at a distance of one-inch from the pith. When the least dimension is more than six inches, the three-inch portion of the line shall begin at a distance from the pith equal to one-fourth the least dimension of the piece.

In side-cut pieces (pith not present) the center of the three-inch portion of the line shall be at the center of the end of the piece.

If a three-inch portion of the line cannot be obtained, the measurement shall be made over as much of a three-inch portion as is available.

In case of disagreement, two radial lines shall be chosen and the number of rings shall be taken as the average on these lines.

Pieces of Douglas fir averaging five rings or more than 20 shall be accepted if containing one-third or more summerwood.

110.14 Standard Sizes Structural Joist and Plank with Load Applied to Either the Wide Face or the Narrow Face.

Nominal thicknesses, 2 inches, 3 inches and 4 inches.

Permissible minimum rough thicknesses in not to exceed 20 percent of pieces in any one shipment—2 inches, $\frac{1}{8}$ -inch off; 3 inches and 4 inches, $\frac{3}{16}$ -inch off.

Dressed thicknesses, S1S or S2S, $\frac{3}{8}$ -inch off.

Nominal widths, 4 inches and wider.

Permissible minimum rough widths in not to exceed 20 percent of pieces in any one shipment—4 inches and 6 inches, $\frac{3}{16}$ -inch off; 8 inches and wider, $\frac{1}{4}$ -inch off.

Dressed widths, S1E or S2E—4 inches and 6 inches, $\frac{3}{8}$ -inch off; 8 inches and wider, $\frac{1}{2}$ -inch off.

110.15 Standard Stress-Grades and Working Stresses—Structural Joist and Plank.

Grades and species	Fiber stress in bending or tension	Maximum horizontal shear	Compression perpen- dicular to grain	Modulus of elasticity
1,800 #f dense Douglas Fir (Coast)	1,800	120	380	1,600,000
1,600 #f close-grained Douglas Fir (Coast) ..	1,600	100	345	1,600,000
1,600 #f close-grained Redwood	1,600	80	267	1,200,000
1,400 #f close-grained Redwood	1,400	80	267	1,200,000
1,200 #f Douglas Fir (Coast)	1,200	100	325	1,600,000
1,200 #f close-grained Redwood	1,200	70	267	1,200,000

110.16 1800#f Dense Douglas Fir (Coast Region), Structural Joist and Plank.

Maximum slope of grain.....1 in 12.

Nominal width of face, inches	—MAXIMUM PERMISSIBLE SIZE OF KNOT, INCHES—		
	On narrow face, middle third of length	At edge of wide face, middle third of length	At center line of wide face
2	$\frac{5}{8}$		
3	1		
4	$1\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{4}$
6	---	1	$1\frac{7}{8}$
8	---	$1\frac{3}{8}$	$2\frac{1}{2}$
10	---	$1\frac{3}{4}$	$3\frac{1}{4}$
12	---	$2\frac{1}{8}$	$3\frac{7}{8}$
14	---	$2\frac{1}{4}$	$4\frac{1}{8}$
16	---	$2\frac{1}{2}$	$4\frac{1}{2}$

—WIDTH OF NARROW FACE—
When green When seasoned
 $\frac{1}{6}$ $\frac{1}{4}$

Maximum shakes, checks, splits.....

Maximum wane, $\frac{1}{6}$ width of any face.

110.17 1600#f Close-Grained Douglas Fir (Coast Region), Structural Joist and Plank.

Maximum slope of grain.....1 in 12.

Nominal width of face, inches	—MAXIMUM PERMISSIBLE SIZE OF KNOT, INCHES—		
	On narrow face, middle third of length	At edge of wide face, middle third of length	At center line of wide face
2	$\frac{5}{8}$		
3	1		
4	$1\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{4}$
6	---	1	$1\frac{7}{8}$
8	---	$1\frac{3}{8}$	$2\frac{1}{2}$
10	---	$1\frac{3}{4}$	$3\frac{1}{4}$
12	---	$2\frac{1}{8}$	$3\frac{7}{8}$
14	---	$2\frac{1}{4}$	$4\frac{1}{8}$
16	---	$2\frac{1}{2}$	$4\frac{1}{2}$

—WIDTH OF NARROW FACE—
When green When seasoned
 $\frac{1}{6}$ $\frac{1}{4}$

Maximum shakes, checks, splits.....

Maximum wane, $\frac{1}{6}$ width of any face.

110.18 1600#f Close-Grained Redwood, Structural Joist and Plank.

Maximum slope of grain.....1 in 16.

Nominal width of face, inches	—MAXIMUM PERMISSIBLE SIZE OF KNOT, INCHES—		
	On narrow face, middle third of length	At edge of wide face, middle third of length	At center line of wide face
2	$\frac{3}{8}$		
3	$\frac{5}{8}$		
4	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{7}{8}$
6	---	$\frac{5}{8}$	$1\frac{1}{4}$
8	---	$\frac{7}{8}$	$1\frac{3}{4}$
10	---	$1\frac{1}{8}$	$2\frac{1}{8}$
12	---	$1\frac{1}{4}$	$2\frac{1}{2}$
14	---	$1\frac{3}{8}$	$2\frac{3}{4}$
16	---	$1\frac{1}{2}$	3

	—WIDTH OF NARROW FACE—	
	When green	When seasoned
Maximum shakes, checks, splits.....	$\frac{1}{7}$	$\frac{2}{9}$
Maximum wane, $\frac{1}{8}$ width of any face.		

110.19 1400#f Close-Grained Redwood, Structural Joist and Plank.

Maximum slope of grain.....1 in 14.

Nominal width of face, inches	—MAXIMUM PERMISSIBLE SIZE OF KNOT, INCHES—		
	On narrow face, middle third of length	At edge of wide face, middle third of length	At center line of wide face
2	$\frac{1}{2}$		
3	$\frac{7}{8}$		
4	$1\frac{1}{8}$	$\frac{5}{8}$	$1\frac{1}{8}$
6	---	$\frac{7}{8}$	$1\frac{5}{8}$
8	---	$1\frac{1}{4}$	$2\frac{1}{4}$
10	---	$1\frac{1}{2}$	$2\frac{7}{8}$
12	---	$1\frac{7}{8}$	$3\frac{3}{8}$
14	---	2	$3\frac{5}{8}$
16	---	$2\frac{1}{8}$	$3\frac{7}{8}$

	—WIDTH OF NARROW FACE—	
	When green	When seasoned
Maximum shakes, checks, splits.....	$\frac{1}{7}$	$\frac{2}{9}$
Maximum wane, $\frac{1}{6}$ width of any face.		

110.20 1200#f Douglas Fir (Coast Region), Structural Joist and Plank.

Maximum slope of grain.....1 in 10.

Nominal width of face, inches	—MAXIMUM PERMISSIBLE SIZE OF KNOT, INCHES—		
	On narrow face, middle third of length	At edge of wide face, middle third of length	At center line of wide face
2	$\frac{7}{8}$		
3	$1\frac{1}{4}$		
4	$1\frac{3}{4}$	1	$1\frac{3}{4}$
6	---	$1\frac{1}{2}$	$2\frac{5}{8}$
8	---	2	$3\frac{1}{2}$
10	---	$2\frac{1}{2}$	$4\frac{1}{4}$
12	---	3	$5\frac{1}{4}$
14	---	$3\frac{1}{4}$	$5\frac{5}{8}$
16	---	$3\frac{3}{8}$	6

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{1}{6}$ $\frac{1}{4}$

Maximum wane, $\frac{1}{4}$ width of any face.

110.21 1200#f Close-Grained Redwood, Structural Joist and Plank.

Maximum slope of grain.....1 in 12.

Nominal width of face, inches	—MAXIMUM PERMISSIBLE SIZE OF KNOT, INCHES—		
	On narrow face, middle third of length	At edge of wide face, middle third of length	At center line of wide face
2	$\frac{3}{4}$		
3	$1\frac{1}{8}$		
4	$1\frac{1}{2}$	$\frac{7}{8}$	$1\frac{3}{8}$
6	---	$1\frac{1}{4}$	$2\frac{1}{8}$
8	---	$1\frac{5}{8}$	$2\frac{7}{8}$
10	---	2	$3\frac{5}{8}$
12	---	$2\frac{3}{8}$	$4\frac{3}{8}$
14	---	$2\frac{5}{8}$	$4\frac{3}{4}$
16	---	$2\frac{3}{4}$	5

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{1}{4}$ $\frac{1}{3}$

Maximum wane, $\frac{1}{6}$ width of any face.

110.22 Standard Sizes, Structural Beams and Stringers with Load Applied to the Narrow Face.

Nominal thicknesses, 5 inches and thicker.

Permissible minimum rough thicknesses in not to exceed 20 percent of pieces in any one shipment, 5 inches and 6 inches, $\frac{3}{16}$ -inch off; 8 inches and wider, $\frac{1}{4}$ -inch off.

Dressed thicknesses, S1S or S2S, $\frac{1}{2}$ -inch off.

Nominal widths, 8 inches and wider.

Permissible minimum rough widths in not to exceed 20 percent of pieces in any one shipment, $\frac{1}{4}$ -inch off.

Dressed widths, S1E or S2E, $\frac{1}{2}$ -inch off.

110.23 Standard Stress-Grades and Working Stresses—Structural Beams and Stringers.

Grades and species	Fiber stress in bending or tension	Maximum horizontal shear	Compression perpen- dicular to grain	Modulus of elasticity
1,800#f dense Douglas Fir (Coast)	1,800	120	380	1,600,000
1,600#f close-grained Douglas Fir (Coast) ..	1,600	100	345	1,600,000
1,600#f close-grained Redwood	1,600	80	267	1,200,000
1,400#f close-grained Redwood	1,400	80	267	1,200,000
1,200#f close-grained Redwood	1,200	70	267	1,200,000

110.24 1800#f Dense Douglas Fir (Coast Region), Structural Beams and Stringers.

Maximum slope of grain.....1 in 16.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	On narrow face, middle third of length	At center line of wide face
5	$1\frac{1}{8}$	
6	$1\frac{3}{8}$	
8	$1\frac{5}{8}$	$1\frac{7}{8}$
10	$1\frac{3}{4}$	$2\frac{1}{4}$
12	$1\frac{7}{8}$	$2\frac{5}{8}$
14	$2\frac{1}{8}$	$2\frac{7}{8}$
16	$2\frac{1}{4}$	$3\frac{1}{8}$
18	---	$3\frac{3}{8}$
20	---	$3\frac{1}{2}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{1}{6}$

$\frac{1}{4}$

Maximum wane, $\frac{1}{8}$ width of any face.

110.25 1600#f Close-Grained Douglas Fir (Coast Region), Structural Beams and Stringers.

Maximum slope of grain.....1 in 15.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	On narrow face, middle third of length	At center line of wide face
5	$1\frac{1}{8}$	
6	$1\frac{3}{8}$	
8	$1\frac{5}{8}$	$1\frac{7}{8}$
10	$1\frac{3}{4}$	$2\frac{1}{4}$
12	$1\frac{7}{8}$	$2\frac{5}{8}$
14	$2\frac{1}{8}$	$2\frac{7}{8}$
16	$2\frac{1}{4}$	$3\frac{1}{8}$
18	----	$3\frac{3}{8}$
20	----	$3\frac{1}{2}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits..... $\frac{1}{6}$ $\frac{1}{4}$

Maximum wane, $\frac{1}{6}$ width of any face.

110.26 1600#f Close-Grained Redwood, Structural Beams and Stringers.

Maximum slope of grain.....1 in 20.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	On narrow face, middle third of length	At center line of wide face
5	$\frac{3}{8}$	
6	$\frac{3}{4}$	
8	$\frac{1}{2}$	$\frac{1}{2}$
10	$\frac{1}{2}$	$\frac{5}{8}$
12	$\frac{5}{8}$	$\frac{3}{4}$
14	$\frac{5}{8}$	$\frac{7}{8}$
16	$\frac{3}{4}$	$\frac{7}{8}$
18	----	1
20	----	1

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits..... $\frac{1}{4}$ $\frac{2}{9}$

Maximum wane, $\frac{1}{10}$ width of any face.

110.27 1400#f Close-Grained Redwood, Structural Beams and Stringers.

Maximum slope of grain.....1 in 18.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	On narrow face, middle third of length	At center line of wide face
5	$\frac{7}{8}$	
6	$1\frac{1}{8}$	
8	$1\frac{1}{4}$	$1\frac{1}{2}$
10	$1\frac{3}{8}$	$1\frac{3}{4}$
12	$1\frac{1}{2}$	$2\frac{1}{4}$
14	$1\frac{5}{8}$	$2\frac{3}{8}$
16	$1\frac{3}{4}$	$2\frac{1}{2}$
18	---	$2\frac{3}{4}$
20	---	$2\frac{3}{4}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{1}{4}$ $\frac{2}{9}$

Maximum wane, $\frac{1}{8}$ width of any face.

110.28 1200#f Close-Grained Redwood, Structural Beams and Stringers.

Maximum slope of grain.....1 in 14.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	On narrow face, middle third of length	At center line of wide face
5	$1\frac{1}{2}$	
6	$1\frac{3}{4}$	
8	$2\frac{1}{8}$	$2\frac{3}{8}$
10	$2\frac{3}{8}$	3
12	$2\frac{5}{8}$	$3\frac{5}{8}$
14	$2\frac{3}{4}$	$3\frac{7}{8}$
16	3	$4\frac{1}{4}$
18	---	$4\frac{1}{2}$
20	---	$4\frac{3}{4}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{1}{4}$ $\frac{1}{3}$

Maximum wane, $\frac{1}{8}$ width of any face.

110.29 Standard Sizes Structural Posts and Timbers to Carry Longitudinal Loads.

Nominal thicknesses, 5 inches and thicker.

Permissible minimum rough thicknesses in not to exceed 20 percent of pieces in any one shipment, 5 inches and 6 inches, $\frac{3}{16}$ -inch off; 8 inches and wider, $\frac{1}{4}$ -inch off.

Dressed thicknesses, S1S or S2S, $\frac{1}{2}$ -inch off.

Nominal widths, 5 inches and wider.

Permissible minimum rough widths in not to exceed 20 percent of pieces in any one shipment, 5 inches and 6 inches, $\frac{3}{16}$ -inch off; 8 inches and wider, $\frac{1}{4}$ -inch off.

Dressed widths, S1E or S2E, $\frac{1}{2}$ -inch off.

110.30 Standard Stress-Grades and Working Stresses—Structural Posts and Timbers.

Grades and species	Compression parallel to grain short columns*
1,200# c close-grained Douglas Fir (Coast)	1,200
1,200# c close-grained Redwood	1,200
1,100# c Douglas Fir (Coast)	1,100
1,100# c close-grained Redwood	1,100
1,100# c close-grained Redwood	1,000

*For stresses in compression perpendicular to grain and modulus of elasticity, see Beams and Stringers.

110.31 1200# c Close-Grained Douglas Fir (Coast Region), Structural Posts and Timbers.

Maximum slope of grain.....1 in 12.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	At any point on any face
5	$1\frac{1}{8}$
6	$1\frac{3}{8}$
8	$1\frac{7}{8}$
10	$2\frac{3}{8}$
12	$2\frac{3}{4}$
14	3
16	$3\frac{1}{4}$
18	$3\frac{3}{8}$
20	$3\frac{5}{8}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{4}{10}$

$\frac{1}{2}$

Maximum wane, $\frac{1}{8}$ width of any face.

110.32 1200# c Close-Grained Redwood, Structural Posts and Timbers.

Maximum slope of grain.....1 in 14.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	At any point on any face
5	$\frac{3}{4}$
6	$\frac{7}{8}$
8	$1\frac{1}{4}$
10	$1\frac{1}{2}$
12	$1\frac{7}{8}$
14	2
16	$2\frac{1}{8}$
18	$2\frac{1}{4}$
20	$2\frac{3}{8}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{1}{3}$

$\frac{4}{9}$

Maximum wane, $\frac{1}{8}$ width of any face.

110.33 1100# c Douglas Fir (Coast Region), Structural Posts and Timbers.

Maximum slope of grain.....1 in 12.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	At any point on any face
5	$1\frac{1}{4}$
6	$1\frac{1}{2}$
8	2
10	$2\frac{1}{2}$
12	3
14	$3\frac{1}{4}$
16	$3\frac{1}{2}$
18	$3\frac{3}{4}$
20	$3\frac{7}{8}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{4}{10}$

$\frac{1}{2}$

Maximum wane, $\frac{1}{6}$ width of any face.

110.34 1100#^c Close-Grained Redwood, Structural Posts and Timbers.

Maximum slope of grain.....1 in 12.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	At any point on any face
5	$1\frac{1}{8}$
6	$1\frac{3}{8}$
8	$1\frac{3}{4}$
10	$2\frac{1}{4}$
12	$2\frac{5}{8}$
14	$2\frac{7}{8}$
16	$3\frac{1}{8}$
18	$3\frac{1}{4}$
20	$3\frac{1}{2}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{3}{8}$

$\frac{1}{2}$

Maximum wane, $\frac{1}{8}$ width of any face.

110.35 1000#^c Close-Grained Redwood, Structural Posts and Timbers.

Maximum slope of grain.....1 in 10.

KNOTS: MAXIMUM PERMISSIBLE SIZE IN INCHES

Nominal width of face	At any point on any face
5	$1\frac{1}{2}$
6	$1\frac{3}{4}$
8	$2\frac{3}{8}$
10	$2\frac{7}{8}$
12	$3\frac{1}{2}$
14	$3\frac{3}{4}$
16	$4\frac{1}{8}$
18	$4\frac{3}{8}$
20	$4\frac{5}{8}$

—WIDTH OF NARROW FACE—
When green When seasoned

Maximum shakes, checks, splits.....

$\frac{3}{7}$

$\frac{1}{2}$

Maximum wane, $\frac{1}{6}$ width of any face.

SECTION 111—TIMBER PILES

111.1 Material Covered. This specification covers the quality of timber piles.

111.2 Species of Wood. Foundation piles which will be below water level at all times may be of any species of wood which, in the opinion of the engineer, will satisfactorily withstand driving. This type of piling shall be used only when specifically noted on the plans or ordered by the engineer.

Treated and untreated piles shall be Douglas fir (coast region).

111.3 Quality. All wood piling shall be cut from sound and live trees, preferably during the winter season. They shall contain no unsound knots. Sound knots will be permitted provided the diameter of the knot does not exceed four inches or one-third of the diameter of the stick at the point where it occurs. Any defect or combination of defects which will impair the strength of the pile more than the maximum allowable knot shall not be permitted. The butts shall be sawed square and the tips shall be sawed square or tapered to a point not less than four inches in diameter as directed by the engineer.

Unless otherwise specified, all piles shall be peeled by removing all of the rough bark and at least 80 percent of the inner bark. No strip of inner bark remaining on the stick shall be over three-fourths inch wide or over eight inches long, and there shall be at least one 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.

Piles shall be cut above the ground swell and shall taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside of the center of the pile at any point more than one percent of the length of the pile. In short bends, the distance from the center of the pile to a line stretched from the center of the pile above the bend to the center of the pile below the bend shall not exceed four percent of the length of the bend or

two and one-half inches. All knots shall be trimmed close to the body of the pile.

111.4 Dimensions. Round piles shall have a minimum diameter at the tip, measured under the bark, as follows:

Length of pile	Tip diameter
Less than 40 feet	8 inches
40 to 60 feet	7 inches
Over 60 feet	6 inches

The minimum diameter of piles at a section four feet from the butt, measured under the bark, shall be as follows:

Length of pile	DIAMETER IN INCHES	
	Douglas fir	All other species
20 feet and under.....	11	11
21 to 30 feet.....	12	12
31 to 40 feet.....	12	13
Over 40 feet.....	13	14

The diameter of the pile at the butt shall not exceed 20 inches.

Square piles shall have the dimensions shown on the plans.

111.5 Preservative Treatment. Preservative treatment, when required, shall conform to Section 65 of these specifications.

111.6 Inspection. Each shipment of piles shall be accompanied by an inspection certificate issued by the West Coast Lumbermen's Association, Pacific Lumber Inspection Bureau, or by a recognized commercial inspector approved by the engineer prior to inspection, certifying that each pile meets the quality requirements specified herein. The cost of inspection certificates shall be included in the price paid for the piles.

When treated piles are required, the contractor shall inform the engineer of the name of the plant at which the piles are to be treated, sufficiently far in advance of starting work, in order that arrangements may be made for inspection. The contractor shall furnish facilities for the inspection of material and workmanship, and the inspector shall be allowed free access to the necessary parts of the plant. The cost of inspection of creosote treatment will be borne by the department.

SECTION 112—TIMBER PRESERVATIVE

112.1 Material Covered. This specification covers the quality of creosote oils and creosote-coal-tar for use as timber preservatives.

112.2 Preservative Oils. The preservative oil used shall be as specified or directed by the engineer, and shall be one of the following, depending on the type of treatment:

Creosote oils shall be distillates of coal-gas tar or coke-oven tar. The creosote-coal-tar solution shall be a coal-tar product, of which at least 80 percent shall be a distillate of coal-gas tar or coke-oven tar, and the remainder shall be refined or filtered coal-gas tar or coke-oven tar.

Specification requirement	PRESSURE TREATMENT			SURFACE TREATMENT	
	Grade 1	Grade 2	Grade 3	Creosote coal-tar solution	(Open tank and spray) Heavy creosote oil
1. Water, percent max...	3	3	3	3	1
2. It shall be fluid at 15° C. and crystal free at 38° C.....	---	---	---	---	Required
3. It shall not contain matter insoluble in benzol in excess of, percent	0.5*	0.5*	0.5*	2	0.5
4. The specific gravity at 38°/15.5° C. shall not be less than.....	1.03	1.03	1.03	1.05 to 1.12	1.06
5. The distillate, based on water-free oil:					
To 210° C., percent max.	5	8	10	5	1
To 235° C., percent max.	25	35	40	25	10
To 355° C., percent max.	---	---	---	---	65
6. The float test of residue above 355° C. shall not exceed 50 seconds at 70° C., if the distillation residue above 355° C. exceeds, percent	5	5	5	26	10
7. Coke residue of oil shall not exceed, percent	2	2	2	6	2

*An increase of one percent in matter insoluble in benzol shall be permitted for used oil in the working tanks, provided it can be shown that the oil when fresh was of the quality specified.

112.3 Sampling and Testing. Preservative oils shall be sampled and tested in accordance with method T-60 of the American Association of State Highway Officials, "Methods of Sampling and Analysis of Creosote Oil," 1935. (A.S.T.M. D38-33, D117-33, D367-33, D368-33, and D370-33 insofar as they apply.) Coke residue shall be determined in accordance with method T-61 of the above association, "Method of Test for Coke Residue of Creosote Oil," 1935. (A.S.T.M. D168-30.)

SECTION 113—FENCE POSTS AND FENCE MATERIALS

113.1 Material Covered. This specification covers the quality of fence posts, wire fencing, and gates.

113.2 Split Redwood Line and Brace Posts. Split redwood posts shall be sound, live timber free of bark, decay, splits, large or numerous knots, or knot holes, etc., that will impair their strength or durability. Not to exceed 20 percent of the pieces in any shipment may contain a thin or narrow strip of sapwood extending not over one-half the length from one end only. Posts shall be approximately four inches by five inches in cross section with a tolerance of one-half inch under one way or one-quarter inch both ways. The minimum perimeter at any point shall not be less than 17 inches. Posts shall be cut square on both ends. A variation of three inches under or over in length on some pieces will be permitted.

113.3 Redwood Gate, End, and Corner Posts. Redwood gate, end, and corner posts, and braces for such posts, shall be 1000#^c close-grained redwood structural posts and timbers conforming to the requirements of Section 110.

113.4 Split Cedar Line and Brace Posts. Split cedar posts shall be sound, live timber free of bark, decay, splits, large or numerous knots, or knot holes, etc., that will impair their strength or durability. The minimum perimeter at any point shall not be less than 18 inches. Posts shall be cut square on both ends. A variation of three inches under or over in length on some pieces will be permitted.

113.5 Douglas Fir Gate, End, and Corner Posts. Douglas fir gate, end, and corner posts, and braces for such posts, shall be 1100#^c Douglas fir structural posts and timbers conforming to the requirements of Section 110.

113.6 Metal Line Posts. Metal line posts shall be iron or steel of "L," "T," "I," or other approved shape weighing not less than one and four-tenths pounds per lineal foot, and shall be painted light gray. Posts shall be provided with slots, lugs, hooks, or other suitable device to hold wire firmly in position.

" U "

113.7 Metal Gate, End, Corner, and Brace Posts. Metal gate, end, corner, and brace posts shall be iron or steel, tubular in section, not lighter than No. 8 guage, two and one-half inches in diameter, and hot-dip zinc galvanized. Posts shall be provided with slots, lugs, hooks, or other suitable device to hold wire firmly in position.

113.8 Plain, Barbed, and Woven Wire and Staples. Wire and staples shall conform to the requirements of the "Standard Specifications for Zinc-Coated (Galvanized) Iron or Steel Farm, Field and Railroad Right of Way Wire Fencing," serial designation A116-30, of the A.S.T.M.

Barbed wire shall consist of two strands of No. 12½ gauge wire twisted with No. 14 gauge barbs spaced not more than three inches apart.

Plain wire shall be not lighter than No. 10 gauge. *End*

Woven wire shall have continuous vertical stays not more than twelve inches apart. Top and bottom wires shall be not lighter than No. 10 gauge and intermediate wires and stays not lighter than No. 12½ gauge. *50"*

113.9 Metal Gates. Metal gates shall have galvanized tubular steel frames not less than 54 inches high filled with not lighter than No. 9 gauge galvanized woven wire fabric.

113.10 Timber Gates. Timber gates shall be constructed of redwood or Douglas fir conforming to the requirements of Section 110.

*To be modified
in specials:*

SECTION 114—GUARD RAIL MATERIALS

114.1 Material Covered. This specification covers the quality of metal guard rail plates and spring supports.

114.2 General Requirements. Before any type rail is used, the manufacturer's plans and specifications shall be submitted and approved by the engineer, and the rail shall be constructed in accordance with such plans, except as herein provided. The plans shall show full details of all assemblies.

114.3 Nonfloating Type Rail. Rail plates shall be rolled from steel conforming to the following requirements:

Carbon.....	0.40-0.60%
Manganese.....	0.30-0.90%
Phosphorus, not more than.....	0.055%
Sulphur, not more than.....	0.055%

The plates shall be properly tempered for toughness and shall have a tensile strength of not less than 75,000 pounds per square inch.

The rail plates shall be not less than 12 inches wide, not lighter than No. 12 gauge, and shall be rolled or rounded so as to present no sharp edges. All connections and splices shall be made with flat, round-headed bolts or other similar detail so that no appreciable projections will obstruct a vehicle sliding along the rail.

An offset bracket shall support the rail element five to six inches from the face of post and shall be rounded and springlike on the outer face. It shall deflect at least one inch under a compression of 4,500 pounds perpendicular to the line of the rail and shall, upon release of this load held for one minute, show a permanent set of not greater than five percent of the measured deflection. It shall not collapse under a compression of 9,000 pounds. The bracket and connection to the post combined shall be capable of supporting a horizontal load of 4,500 pounds at the rail parallel to the rail.

The resilient detail at or near the end post shall completely deform or take up when the rail is placed under a tension of not less than 3,000 nor more than 5,000 pounds.

It shall not take a permanent set greater than five percent of the total deformation under a rail tension of 23,000 pounds held for one minute, and shall not collapse under a rail tension of 70,000 pounds.

The connection between the rail and end post shall have an ultimate tensile strength of 70,000 pounds and when subjected to a tensile stress of 23,000 pounds held for one minute shall not take a permanent set greater than five percent of the deformation. The connection shall consist of at least two bolts, and the eccentricity between bolt and plate shall not be greater than two inches.

114.4 Floating Type Rail. Rail plates shall be rolled from steel conforming to the following requirements:

Carbon.....	0.40-0.60%
Manganese.....	0.30-0.90%
Phosphorus, not more than.....	0.055%
Sulphur, not more than.....	0.055%

The plates shall be properly tempered for toughness and shall have a tensile strength of not less than 75,000 pounds per square inch.

Spring supports shall be rolled from steel conforming to the following requirements:

Carbon.....	0.60-0.80%
Manganese.....	0.30-0.90%
Phosphorus, not more than.....	0.055%
Sulphur, not more than.....	0.055%

The supports shall be tempered to give a tensile strength of not less than 135,000 pounds per square inch.

The rail plates shall be not less than 12 inches wide, not lighter than No. 14 gauge, and shall be rolled or rounded so as to present no sharp edges. Connections and splices shall be made with flat, round-headed bolts or other similar detail so that no appreciable projections will obstruct a vehicle sliding along the rail.

End spring assemblies for floating type rail shall consist of at least two springs. The eccentricity between springs and plate shall be not greater than three inches. The springs shall close at least four inches under a total tension in the rail of 7,500 pounds. The spring assembly shall

have an ultimate tensile strength of 70,000 pounds, and under a rail tension of 23,000 pounds held for one minute shall not take a permanent set greater than five percent of the deformation.

The connection between the end springs and end posts shall consist of at least two bolts, and shall have an ultimate tensile strength of 70,000 pounds.

114.5 Beam Type Rail. Rail plates shall be rolled from steel conforming to the following requirements:

Carbon.....	0.40-0.50%
Manganese.....	0.50-0.80%
Phosphorus, not more than.....	0.045%
Sulphur, not more than.....	0.055%

The plates shall be properly tempered for toughness, and shall have tensile strength of not less than 85,000 pounds per square inch.

Spring supports shall be rolled from steel conforming to the following requirements:

Carbon.....	0.90-1.05%
Manganese.....	0.25-0.50%
Phosphorus, not more than.....	0.040%
Sulphur, not more than.....	0.050%

The supports shall be tempered to give a tensile strength of not less than 100,000 pounds per square inch.

The plate shall be shaped into a beam not less than 12 inches wide and to not less than one inch deep. Where the plate is corrugated or shaped into any other form and the depth as a horizontal beam perpendicular to the line of the rail is three inches or more, the thickness of metal shall be at least 10 gauge. Where this depth is less than three inches, the thickness of metal shall be at least nine gauge. The rail element shall be spliced at each post by lapping in the direction of traffic. The holes in the plate farthest from the traveled way shall be slotted to facilitate erection and to permit expansion. The splice for beams three inches or more in depth shall have an ultimate tensile strength of 30,000 pounds. The splice for beams less than three inches in depth shall have an ultimate tensile strength of 45,000 pounds.

The edges of the rail shall be rolled or rounded so that they present no sharp edges. The projecting heads of all connections and splice bolts shall be rounded and shallow so that no appreciable projection shall obstruct a vehicle sliding along the rail. Each end of each length of rail shall be finished with a section of rail bent or turned so that the end shall be in line with the back face of the end post. These end pieces shall be of the same metal as the rail element and shall be spliced with it as at any other post.

Beams shall be supported five to six inches from the face of the post with a spring-like bracket which shall deflect at least one inch under a load of 4,500 pounds perpendicular to the line of the rail, and shall, upon release of this load when held for one minute, show a permanent set not greater than five percent of the measured deflection. It shall not collapse under a compression of 9,000 pounds. The bracket and connection to the post combined shall support a load of 3,000 pounds at the rail parallel to the rail.

114.6 Mill Test Report. Two certified copies of mill test report showing the chemical and physical characteristics of each heat from which metal is used shall be furnished by the contractor.

114.7 Test Specimens. The contractor shall furnish the engineer with specimens of rails, plates and fittings for testing purposes, free of charge.

SECTION 115—PREMOLDED EXPANSION JOINT FILLER

115.1 General. Expansion joint filler shall be preformed of rubber, cork or a combination of the two materials or of an approved vegetable fiber impregnated with asphalt and shall conform to the requirements specified hereinafter. Unless otherwise specified the type of filler is optional.

Preformed joint fillers shall have a thickness equal to the width of the joint required, and shall be furnished in lengths equal to the widths of the slabs in which they are to be installed unless, for special joints such as turnouts, parking areas, connections, and bridge floors, the use of two or more shorter pieces is authorized by the engineer.

115.2 Rubber Expansion Joint Filler. Rubber expansion joint filler shall consist of preformed strips composed essentially of a durable elastic rubber compound, which may be reinforced on each side with a layer of asphalt-treated felt. The strips shall be of such character that the filler will not be deformed or broken by twisting, bending or other ordinary handling after having been subjected for 12 hours to a temperature of 125 degrees Fahrenheit, or when subjected to freezing temperatures. The joint shall weigh not less than 40 nor more than 50 pounds per cubic foot. It shall also conform to the requirements specified hereinafter.

115.3 Cork Expansion Joint Filler. Cork expansion joint filler shall consist of preformed strips composed essentially of a durable elastic compound of cork. The joint filler shall be formed from clean particles bound together by a synthetic resin of an insoluble nature, the particles being present in their original state. They shall not have been exposed to a temperature exceeding 300 degrees Fahrenheit during the process of manufacture. The joint filler shall withstand boiling for one-half hour in concentrated hydrochloric acid without showing any indication of disintegration. Discoloration or a small amount of swelling shall not be considered failure. The joint filler shall meet the requirements hereinafter specified, both when tested as received and when tested after

having been maintained for a period of 120 hours at a temperature of 165 degrees Fahrenheit.

115.4 Cork-Rubber Expansion Joint Filler. Cork-rubber expansion joint filler shall consist of preformed strips formed from clean cork particles securely bound together by a durable elastic rubber compound. The cork particles contained in this filler shall be in their original state and shall not have been exposed in the process of manufacture to a temperature exceeding 325 degrees Fahrenheit and shall meet the test requirements hereinafter specified.

115.5 Fiber Expansion Joint Filler. Fiber expansion joint filler shall consist of an approved vegetable material of cellular nature impregnated and bound together with an approved asphaltic binder. The weight of the asphaltic binder shall not be less than 35 percent by weight of the joint. A specimen compressed to 50 percent of its original thickness as described herein shall not lose more than two percent by weight of the asphaltic binder. When immersed in water for a period of not less than 16 hours nor more than 20 hours, a full-size section of the joint filler 12 inches in length shall not absorb more than 15 percent by weight.

115.6 Sampling. Each test sample shall be at least one square foot in area and of the full thickness specified. One representative sample shall be selected from each shipment of 1,000 linear feet or less of each thickness ordered.

115.7 Tests. Test specimens shall be free from warping, bending or localized protrusions. They shall measure four by four inches plus or minus one-tenth inch, and shall be freshly and squarely cut immediately prior to test from the sample furnished for test. The original thickness shall be determined when the test specimen is subjected to a load of not over 0.25 pound per square inch.

The test specimen prepared as described above shall be placed in a suitable steel mold so constructed as to confine the lateral movement of the specimen under compression to one side only. The specimen shall then be covered with a one-half inch metal plate which will fit snugly without binding within the three restraining sides of the steel mold. A metal cylinder or other suitable device for transferring the load from the moving head of the testing machine

around the measuring apparatus to the plate covering the specimen shall be placed upon the plate and a spherical bearing block mounted between the upper end of the cylinder and the moving head of the testing machine.

The dead weight of the load-transferring apparatus and the spherical bearing block may compress the test specimen to a noticeable extent. This initial compression shall be considered as a portion of the 50 percent compression to which the test specimen shall be subjected during the test. Correction for this initial compression shall be made in the measuring apparatus so that the thickness to which the specimen is compressed shall be 50 percent of the original thickness of the material.

For the determination of the percentage of recovery the specimen shall be given three applications of a load sufficient to compress it to 50 percent of its original thickness. The load shall be applied without shock and at such a rate that the specimen will be compressed approximately 0.05 inch per minute. After the first and second applications the load shall be immediately released, and the specimen permitted to recover five minutes before again applying the load. After the third application the specimen shall be permitted to recover one hour, after which the thickness shall again be measured by the method used for original thickness. The percentage of recovery shall be computed as follows:

$$\text{Recovery} = \frac{t'}{t} \times 100,$$

in which t = the thickness of the specimen before test and t' = the thickness one hour after the completion of the third application of load.

The total maximum load in pounds required for the first application as specified above shall be recorded and the unit compression calculated in pounds per square inch from the cross sectional area of the specimen.

The amount of extrusion in inches shall be determined by measuring the movement of the free edge of the test specimen during the first application of load made as hereinbefore specified. The extrusion shall be measured by

means of a dial or other suitable device reading to 0.001 inch.

One hour after the release of the third application of load, when tested as described above, the specimens of rubber, cork or cork-rubber joint filler shall have recovered to at least 90 percent of their original thickness, and specimens of fiber joint filler shall have recovered to at least 70 percent of their original thickness.

When the test specimen is compressed to 50 percent of its original thickness the load upon the specimen or sample shall be not less than 100 nor more than 750 pounds per square inch.

When the test specimen is compressed to 50 percent of its original thickness, the extrusion shall be not more than 50 percent of the original thickness of the sample. During the test the specimen shall not show appreciable continued extrusion under constant pressure. It shall not show any breaking or deterioration after the test.

SECTION 116—PAINTS AND PAINT MATERIALS

116.1 Material Covered. These specifications cover paints and paint materials for use on steel, timber, and other materials. Paint may be furnished ready-mixed, or the individual components may be combined on the job, prior to use, in the presence of the engineer.

Paint shall be well mixed in the manufacture by proper grinding of the pigment. The pigment shall not settle badly or cake in the container, shall not thicken in storing to cause change in consistency, shall be readily broken up with a paddle to a smooth, uniform condition, capable of easy application with a brush or mechanical distributor in the ordinary manner according to the rules of good standard practice.

116.2 Certified Analysis and Guarantee. The contractor furnishing paint under these specifications shall furnish without additional charge a certified copy of the analysis of each shipment of paint and a manufacturer's guarantee, which provides that the paint conforms to the certified analysis. This guarantee shall be sworn to by a person having legal authority to bind the manufacturer by his acts. He shall, in addition, furnish without charge representative samples of the paint for confirmatory tests.

116.3 Red Lead. Red lead paste shall conform to the requirements of standard specifications for red lead, serial designation D83-31, of the A.S.T.M. It shall be 95 per cent grade.

116.4 White Lead. White lead paste shall conform to the requirements of standard specifications for basic carbonate white lead, serial designation D81-34, of the A.S.T.M.

116.5 Zinc Oxide. Zinc oxide paste shall conform to the requirements of standard specifications for zinc oxide, serial designation D79-24, of the A.S.T.M.

116.6 Linseed Oil. Raw linseed oil shall conform to the requirements of standard specifications for raw linseed oil, serial designation D234-28, of the A.S.T.M.

116.7 Turpentine. Turpentine shall conform to the

requirements of standard specifications for spirits of turpentine, serial designation D13-34, of the A.S.T.M.

116.8 Liquid Drier. Liquid drier shall conform to the requirements of Federal Specification TT-D-651, type 1 for general use, containing lead.

116.9 Spar Varnish. Varnish shall conform to the requirements of Federal Specification TT-V-81, mixing varnish for aluminum paint.

116.10 Aluminum Bronze. Aluminum bronze shall conform to the requirements of standard specifications for aluminum powder for paints, serial designation D266-31, of the A.S.T.M.

116.11 Lamp Black. Lamp black paste in oil shall conform to the requirements of standard specifications for lamp black, serial designation D209-30, of the A.S.T.M.

116.12 Prussian Blue. Prussian blue paste in oil shall conform to the requirements of standard specifications for prussian blue, serial designation D261-28, of the A.S.T.M.

116.13 Aluminum Bronze Paste. Aluminum bronze paste shall consist of aluminum bronze powder conforming to the requirements set forth above, ground to form a paste with a liquid completely volatile at 105 degrees Centigrade. The paste shall contain not less than 63 percent by weight of metallic aluminum. There shall be no appreciable settling of the metallic portion of the paste in the container and no free liquid shall be present. When mixed with spar varnish in proportions of two pounds of paste to one gallon of vehicle, the resulting paint shall have satisfactory leafing properties, and shall give a free flowing, smooth, continuous coating free from breaks or sags.

116.14 Titanium Barium Pigment. Titanium barium pigment shall conform to the requirements of standard specifications for titanium barium pigment, serial designation D382-35, of the A.S.T.M.

116.15 Tung Oil. Tung oil shall conform to the requirements of standard specifications for raw tung oil, serial designation D12-33, of the A.S.T.M.

116.16 Butanol. Butanol (Normal Butyl Alcohol) shall

conform to the requirements of the standard specifications for butanol, serial designation D304-33, of the A.S.T.M.

116.17 Acetone. Acetone shall conform to the requirements of the standard specifications for acetone, serial designation D329-33, of the A.S.T.M.

116.18 Paint Formulas. Unless otherwise specified, paints shall conform to the following formulas:

FORMULA A—PRIMER

Structural Steel and Metal Parts—Required unless otherwise specified.

Red lead paste.....	100 pounds
Raw linseed oil.....	1.85 gallons
Japan drier.....	1 pint
Turpentine.....	1 pint

Weight per gallon of mixed paint not less than twenty-seven pounds.

FORMULA B—SECOND COAT

Structural Steel and Metal Parts—Required unless otherwise specified.

Red lead paste.....	100 pounds
Lamp black paste.....	0.75 pounds
Raw linseed oil.....	2.65 gallons
Drier.....	1 pint
Turpentine.....	1 pint

Weight per gallon of mixed paint not less than twenty-four pounds.

FORMULA C—THIRD COAT

Structural Steel and Metal Parts—To be used only when specified.

Red lead paste.....	100 pounds
Lamp black paste.....	52 pounds
P Russian blue paste.....	16 pounds
Raw linseed oil.....	14 gallons
Drier.....	$\frac{1}{2}$ gallon
Turpentine.....	$\frac{1}{2}$ gallon

Weight per gallon of mixed paint not less than eleven and one-half pounds.

FORMULA D—PRIMER

New Timber or Old Timber with Paint in Good Condition—Required unless otherwise specified.

White lead in oil.....	80 pounds
Zinc oxide in oil.....	20 pounds
Raw linseed oil.....	4 gallons
Turpentine.....	2 gallons
Japan drier.....	1 pint

FORMULA E—PRIMER

Old Seasoned Timber—To be used only when specified.

White lead in oil.....	80 pounds
Zinc oxide in oil.....	20 pounds
Raw linseed oil.....	7 gallons
Japan drier.....	1 pint

FORMULA F—SECOND AND THIRD COATS

Timber—Second coat, required; third coat, to be used only when specified.

White lead in oil.....	80 pounds
Zinc oxide in oil.....	20 pounds
Raw linseed oil.....	5 gallons
Japan drier.....	1 pint

FORMULA G—THIRD COAT

Steel and Timber—Required unless otherwise specified; optional with Formula H.

Aluminum bronze.....	2 pounds
Spar varnish.....	1 gallon

FORMULA H—THIRD COAT

Steel and Timber—Required unless otherwise specified; optional with Formula G.

Aluminum bronze paste.....	2 pounds
Spar varnish.....	1 gallon

FORMULA I—THIRD COAT

Timber, Black Bands, Etc.—Required unless otherwise specified.

White lead in oil.....	80 pounds
Zinc oxide in oil.....	20 pounds
Lamp black paste.....	10 pounds
Raw linseed oil.....	5½ gallons
Japan drier.....	1 pint

FORMULA J—TRAFFIC LACQUER

The lacquer shall be ready-mixed at the factory and shall dry so that it will not tack in from 15 to 30 minutes.

Solvent

Raw Tung oil.....	15% (by volume)
Butanol.....	17% (by volume)
Acetone.....	34% (by volume)
Denatured alcohol, formula No. 1..	34% (by volume)

The butanol, acetone and denatured alcohol shall be mixed and then the tung oil added to form a clear solution at 70 degrees Fahrenheit.

Gum Vehicle

Gum (East Indian D.B.B.)....	34% to 37% (by weight)
Solvent (as above).....	66% to 63% (by weight)

Lacquer

Titanium-Barium pigment.....	42% to 45% (by weight)
Gum vehicle (as above).....	58% to 55% (by weight)

NOTE—Sufficient Prussion blue shall be added to overcome the yellowish tint. The volatile material shall have a minimum solvent action on asphalt and shall be of such nature that the gums and nonvolatile components will entirely dissolve therein and will not precipitate on standing. The nonvolatile matter shall be of such quality that it will not darken or become yellowish when exposed to sunlight in thin sections.

SECTION 117—ASPHALT PLANK

117.1 Material Covered. This specification covers asphalt plank of two types as used for bridge floors: (a) Plain asphalt plank and (b) mineral surfaced asphalt plank. The type shall be as shown on the plans.

117.2 Physical Requirements. Asphalt plank of the thickness and dimensions specified shall conform to the following requirements:

Thick- ness, inches	Dimensions*	Absorp- tion maximum, percent	Average minimum impact value, ft.-lb.	Compression shear 350 lb. per sq. in. at 51° C. max.	Brittle- ness† nail size
$\frac{3}{4}$ -----	Shown on plans	1.0	8	0.320	12d
1 -----	Shown on plans	1.0	14	0.400	16d
$1\frac{1}{4}$ -----	Shown on plans	1.0	22	0.480	20d
$1\frac{1}{2}$ -----	Shown on plans	1.0	32	0.570	30d
2 -----	Shown on plans	1.0	56	0.740	30d

*Tolerance of plus or minus one-sixteenth inch thickness, one-eighth inch width, and one-quarter inch length will be permitted.

†At least 80 percent of the samples of each thickness of plank tested shall meet the brittleness test.

117.3 Weight. The asphalt plank shall weigh not less than 85 pounds per cubic foot exclusive of the weight of mineral surfacing material.

117.4 Composition. The asphalt plank shall conform to the following requirements for composition:

	Percent
Asphalt cement	35-50
Organic or vegetable fiber.....	8 min.
Mineral filler (the mineral surfacing material is not included in the per- centage of mineral filler).....	35 min.

117.5 Characteristics of Constituent Materials. The asphaltic cement shall have such characteristics that, when combined with the other ingredients, a plank of desired quality will result.

Fiber shall be free from lumps and be in a flocculent condition when used and shall be finely divided whole threads or shreds. This fabric and fibrous material shall be free from all foreign materials such as metal wool, leather, rubber, straw, wood, cornstalks, or other deleterious materials.

The mineral filler shall be finely crushed slate, limestone, silica, or other aggregate which has been proven suitable for use with asphalt cement in constructing pavement wearing surfaces.

In case of mineral surfaced plank, at least 15 ounces per square foot of tough, hard, durable, coarse aggregate well graded from one-quarter inch to three-quarter inch shall be imbedded under pressure into one surface of the freshly extruded hot plank to such a depth that none extends above the intended wearing surface; provided, however, the top surface of the mineral surfacing material shall not be covered with matrix of the plank proper.

117.6 Manufacture. Asphalt plank shall be formed by extrusion under sufficient pressure to expel the air and form a dense mass.

117.7 Sampling and Testing. Sampling and testing of premolded asphalt plank shall be in accordance with the American Association of State Highway Officials standard method T-77.

PART IV

STANDARD FORMS

SECTION 118—FORMS

Standard forms required by the Nevada Highway Department in the prequalification of contractors and in the preparation and execution of contracts include contractor's statement of experience, financial statement, proposal, contract, and contractor's bond. The samples of these forms as shown herein are not to be used. Standard forms will be furnished to bidders complying with the requirements of these specifications.

**SECTION 119—STATEMENT OF EXPERIENCE AND
FINANCIAL STATEMENT
STATEMENT OF EXPERIENCE**

SUBMITTED BY..... { ☐ A Corporation
☐ A Copartnership
☐ An Individual

PRINCIPAL OFFICE.

The signatory of this questionnaire guarantees the truth and accuracy of all statements and all answers to interrogatories hereinafter made

1. How many years has your organization been in business as a contractor under your present business name?_____

2. How many years experience in.....construction work has your organization had:

(a) As a general contractor?.....(b) As a subcontractor?.....

3. Show the projects your organization has completed in the following tabulation:

Year	Type of Work	Contract Amount	Location of Work and for whom Performed

4. Have you ever failed to complete any work awarded to you?
..... If so, where and why?

5. Has any officer or partner of your organization ever been an officer or partner of some other organization that failed to complete a construction contract?..... If so, state name of individual, other organization and reason therefor.....

6. Has any officer or partner of your organization ever failed to complete a construction contract handled in his own name?.....
If so, state name of individual, name of owner and reason therefor

7. In what other lines of business are you financially interested?

8. For what corporations or individuals have you performed work, when and to whom do you refer?.....

9. For what cities have you performed work, when and to whom do you refer?

10. For what counties have you performed work, when and to whom do you refer?

11. For what State Bureaus or Departments have you performed work, when and to whom do you refer?.....

12. For what U. S. Government Bureaus or Departments have you performed work, when and to whom do you refer?.....

13. Name the persons with whom you have been associated in business as partners or business associates in each of the last five years _____

14. What is the construction experience of the principal individuals of your present organization?

[illegible]

FINANCIAL STATEMENT

NAME YOUR BANKER.....

NAME YOUR SURETY COMPANY.....

Condition at close of business.....19.....

ASSETS		DETAIL	TOTAL
CURRENT ASSETS :			
1. Cash.....			
2. Notes receivable			
3. Accounts Receivable from completed contracts, exclusive of claims not approved for payment.....			
4. Sum earned on incomplete contracts as shown by Engineer's estimate			
5. Accounts receivable from sources other than con- struction contracts			
6. Deposits for bids or other guarantees.....			
7. Interest accrued on loans, securities, etc.....			
8. Negotiable securities, stocks, bonds, etc.....			
9. Materials in stock not included in Item 4.....			
Total.....			
FIXED ASSETS :			
10. Real estate			
11. Construction plant and equipment, book value.....			
12. Furniture and fixtures, book value.....			
Total.....			
13. OTHER ASSETS.....			
Total Assets			
LIABILITIES AND CAPITAL			
CURRENT LIABILITIES :			
1. Notes payable, exclusive of equipment obligations			
2. Accounts payable.....			
Total.....			
FIXED OR SECURED LIABILITIES :			
3. Real estate encumbrances.....			
4. Equipment obligations secured by equipment.....			
Total.....			
5. OTHER LIABILITIES.....			
6. RESERVES.....			
7. CAPITAL STOCK PAID UP.....			
8. SURPLUS (net worth).....			
Total Liabilities and Capital.....			
CONTINGENT LIABILITIES			
1. Liability on notes receivable, discounted or sold.....			
2. Liability on accounts receivable, pledged, assigned or sold			
3. Liability as bondsman.....			
4. Liability as guarantor on contracts or on accounts of others...			
5. Other contingent liabilities.....			
Total Contingent Liabilities.....			

FINANCIAL STATEMENT—Continued

DETAILS RELATIVE TO ASSETS

1	Cash:	(a) On hand	\$
		(b) Deposited in banks named below	\$
		(c) Elsewhere—(state where)	\$

Name of Bank	Location	Deposit in Name of	Amount

2	Notes receivable:	(a) Due within 90 days.....	\$
		(b) Due after 90 days.....	\$
		(c) Past due	\$

Receivable from, Name and Address	For What	Date of Maturity	How Secured	Amount

Have any of the above been discounted or sold?..... If so, state amount, to whom, and reason.....

3	Accounts receivable from completed contracts exclusive of claims not approved for payment	\$
----------	--	-----------------

Name and Address of Owner	Nature of Contract	Amount of Contract	Amount Receivable

Have any of the above been assigned, sold or pledged?..... If so, state amount, to whom, and reason.....

4	Sums earned on incomplete contracts, as shown by Engineer's estimate:		
	(a) Amount receivable after deducting amounts retained.....		\$
	(b) Amounts retained to date, due upon completion of contract.....		\$

Designation of Contract and for Whom Performed	Amount of Contract	Amount Earned	Amount Received	Amount Retained		Amount Exclusive of Amount Retained
				When Due	Amount	

Have any of the above been assigned, sold, or pledged?..... If so, state amount, to whom, and reason.....

FINANCIAL STATEMENT—Continued

5 | Accounts receivable not from construction contracts \$.....

Receivable from: Name and Address	For What	When Due	Amount
.....			
.....			

What amount, if any, is past due..... \$.....

Assigned, sold, or pledged.....

6 | Deposits with bids or otherwise as guarantees \$.....

Deposited With: Name and Address	For What	When Recoverable	Amount
.....			
.....			

What amount, if any, has been assigned, sold, or pledged \$.....

7 | Interest accrued on loans, securities, etc..... \$.....

On What Accrued	To Be Paid When	Amount
.....		
.....		

What amount, if any, has been assigned, sold, or pledged \$.....

8 | Stocks and bonds: (a) Listed — Present market value..... \$.....
 (b) Unlisted — Present value.....

Description	Issuing Company	Last Int. or Div. Paid		Par Value	Present Market Value	Quantity	Amt.
		Date	%				
1							
2							
3							

Who Has Possession	If any are Pledged or in Escrow, State for Whom and Reason	Amount Pledged or in Escrow
1		
2		
3		

FINANCIAL STATEMENT—Continued

9	Materials in stock and not included in Item 4, assets:	
	(a) For use on incomplete contracts (inventory value).....	\$.....
	(b) Other materials (inventory value).....	.....

Description of Material	Quantity	Present Value	
		For incom- pleted Contracts	Other Materials

10	Real estate (a) Used for business purposes.....	\$.....
	Book value (b) Not used for business purposes..	.....

Description of Property	Improvements		Total Book Value
	Nature of Improvements	Book Value	
1			
2			
3			

Location	Held in Whose Name	Assessed Value	Amount of Encumbrances
1			
2			
3			

11	Construction equipment at book value	\$.....
	List separately each item or similar class of items, <i>e. g.</i> , 1 power shovel, 7 1½-ton trucks, etc. <i>Do not</i> list equipment as "tractors, trucks, shovels, etc.," with no segregation. If more space than is provided is needed affix a separate sheet hereto.	
	(List separately all items of quarries, gravel pits, warehouses and similar plants which are not included under Detail "10"—Real Estate)	

Quan- tity	Description, Name and Capacity of Items	Age of Items	Purchase Price	Depreciation Charged Off	Book Value

Are there any liens against above?..... If so, state
total amount..... \$.....

12	Furniture and fixtures at book value	\$.....
-----------	---	---------

13 Other assets \$.....

Description	Amount
TOTAL ASSETS	\$

14	Total value of other contracts awarded or pending award and not included in above statements	\$
----	--	----------

Description of Contract	For Whom Performed	Date for Completion	Amount
TOTAL (not to be included in assets)			\$

15 Bonds supplied during last five years:

[illegible]

1	Notes payable:	(a) To banks, regular.....	\$.....
		(b) To banks for certified checks	
		(c) To others exclusive of equip- ment obligations	

To Whom: Name and Address	What Security	When Due	Amount

2	Accounts payable:	(a) Not past due	\$.....
		(b) Past due .....	.....

To Whom: Name and Address	For What	Date Payable	Amount

FINANCIAL STATEMENT—Continued

3	Real estate encumbrances (See Item 10, Assets).....	\$.....
----------	---	---------

4	Equipment obligations secured by equipment.....	\$.....
----------	---	---------

To Whom: Name and Address	Monthly Payments Required	Amount
.....		
.....		

5	Other liabilities	\$.....
----------	-------------------------	---------

Description	Amount
.....	
.....	

6	Reserves.....	\$.....
----------	---------------	---------

Interest	Insurance	Bldgs. & Fixt.	Plant Depr.
\$.....	\$.....	\$.....	\$.....
Taxes	Bad Debts	Maintenance	
\$.....	\$.....	\$.....	\$.....

7	Capital stock paid up:	(a) Common	\$.....
		(b) Preferred .....	.....

8	Surplus.....	\$.....
----------	--------------	---------

TOTAL LIABILITIES	\$.....
--------------------------------	---------

GENERAL INFORMATION AND AFFIDAVITS

IF A CORPORATION, ANSWER THIS	IF A COPARTNERSHIP ANSWER THIS	
Capital paid in cash, \$.....	Date of organization.....	
When incorporated.....	State whether partnership is	
In what State.....	general, limited or associa-	
President's name.....	tion.....	
Vice President's name.....	Name and address of partners	Age
Secretary's name.....	.....	.....
Treasurer's name.....	.....	.....

AFFIDAVIT FOR INDIVIDUAL

....., being duly sworn,
deposes and says: That the foregoing statement of experience and
financial condition and all statements therein contained are true
and correct as of.....19.....; that the statement is for the
purpose of inducing the Department of Highways to supply the
submitter with plans and specifications and that any depository,
vendor or other agency therein named is hereby authorized to supply
said Department of Highways with any information necessary to
verify the statement; furthermore, should the foregoing statement
at any time cease to properly and truly represent his financial con-
dition, he will refrain from further bidding on State work until he
shall have submitted a revised and corrected statement.

Sworn to before me this.....day
of 19..... Applicant must sign here
Notary Public

....., being duly sworn,
deposes and says: That he is a member of the firm of.....
and that the foregoing statement of experience and financial condition and all statements therein contained are true and correct as of....., 19.....; that the statement is for the purpose of inducing the Department of Highways to supply the submitter with plans and specifications, and that any depository, vendor, or other agency therein named is hereby authorized to supply said Department of Highways with any information necessary to verify the statement; furthermore, should the foregoing statement at any time cease to properly and truly represent the financial condition of said firm, they will refrain from further bidding on State work until they shall have submitted a revised and corrected statement.

Sworn to before me this.....day
of 19.....
.....
Notary Public

.....
Member of firm must sign here
.....
Name of firm

The foregoing statement and affidavit are hereby approved.

.....
 Remaining members of firm must sign here

....., being duly sworn,
deposes and says: That he is of the
the corporation described in the foregoing statement of experience

and financial condition, and all statements therein contained are true and correct as of..... 19.....; that the statement is for the purpose of inducing the Department of Highways to supply the submitter with plans and specifications, and that any depository, vendor, or other agency therein named is hereby authorized to supply said Department of Highways with any information necessary to verify the statement; furthermore, should the foregoing statement at any time cease to properly and truly represent the financial condition of said corporation, they will refrain from further bidding on State work until they shall have submitted a revised and corrected statement.

Sworn to before me this.....day
of 19..... Officer must sign here

.....
Notary Public

NOTE—Use full corporate name and attach corporate seal.

AFFIDAVIT OF CERTIFIED PUBLIC ACCOUNTANT

STATE OF }
COUNTY OF } ss.

....., being duly sworn, deposes and says: That he is a Certified Public Accountant of the State of that he has examined the books of; and that the foregoing financial statement has been accurately prepared from the books of the said individual/copartnership/corporation, and that in his opinion it is a true and fair statement of the financial condition of said individual/copartnership/corporation as of.....
.....19.....

Sworn to before me this.....day
of 19..... *Certified Public Accountant*

.....
Notary Public

The above affidavit of Accountant may not be made by any individual who is a member of or in the regular employ of the firm or corporation submitting this statement.

SECTION 120—PROPOSAL
STATE OF NEVADA
DEPARTMENT OF HIGHWAYS
PROPOSAL

PROPOSAL OF.....

(Name)

OF.....
to furnish and deliver all materials except those specified to be furnished by the State of Nevada and to do and perform all work in accordance with the plans, specifications and contract marked "Nevada Project No....., County of....., Route....., Section....., of the Department of Highways of the State of Nevada, for constructing a portion of a highway between..... and..... and more particularly described as extending from Station..... to Station....., a distance of approximately..... miles, as indicated on the plans."

TO THE DEPARTMENT OF HIGHWAYS, CARSON CITY, NEVADA.

The undersigned, as bidder, declares that the only person or parties interested in this proposal as principals are those named herein, that this proposal is made without collusion with any other person, firm, or corporation, that he has carefully examined the proposed form of contract and the plans and specifications therein referred to and made a part thereof, and he proposes and agrees, if this proposal is accepted, that he will contract with the State of Nevada, in the form of the contract prescribed, to provide all necessary machinery, tools, apparatus and other means of construction, and to do all the work and furnish all the materials specified in the contract and annexed plans and specifications, in the manner and time prescribed and according to the requirements of the Engineer as therein set forth, it being understood and agreed that the quantities shown herein are approximate only and are subject to increase or decrease, and that he will take in full payment therefor the following sums:

SCHEDULE OF PRICES

Item No.	Approximate Quantities	Items and Unit Prices Bid	Unit Prices		Amounts	
			Dols.	Cts.	Dols.	Cts.
		at.....				
		at.....				
Aggregate Amount of Unit Prices.....						

Contractor.

By.....

Address.....

Date....., 19.....

SECTION 121—CONTRACT

CONTRACT

THIS AGREEMENT, Made and entered into this.....day of....., One Thousand Nine Hundred and Thirty....., in..... between the State of Nevada, by the Department of Highways thereof, party of the first part, and..... of....., party of the second part, hereinafter called the Contractor:

WITNESSETH, That the said party of the second part agrees with the said party of the first part, for the consideration and agreements hereinafter mentioned and contained to be made and performed by the said party of the first part, and under the conditions expressed in a bond bearing even date with these presents, and hereunto annexed, that he, the said party of the second part, shall and will at his own proper cost and expense, do all the work and furnish all the materials necessary for the substantial construction and completion, and to the satisfaction of the said party of the first part, of a portion of the system of highways of the State of Nevada, being in the County of....., between....., and....., Route..... Section....., in strict conformity, in every part and particular, with the annexed special provisions and specifications, and the plans entitled "State of Nevada, Department of Highways; Plan and Profile of Proposed State Highway in the County of....., between....., and....., Route..... Section....." approved by the State Highway Engineer and the Board of Directors of the Department of Highways on....., 19....., which special provisions, specifications and plans are made a part hereof, and in full compliance with the terms of this agreement.

And the Contractor hereby further agrees to receive and accept the prices set forth in the Proposal Schedule, hereto annexed and hereby made a part of this agreement, as full compensation for furnishing all materials and labor, and the doing of all work, in strict accordance with the plans, special provisions and specifications hereinbefore mentioned, to the satisfaction of the Engineer and in the manner and under the conditions hereinbefore specified.

The said party of the first part hereby promises and agrees with the said Contractor, to employ, and does hereby employ, the said Contractor to provide the materials and to do the work according to the terms and conditions herein contained and referred to, for the prices aforesaid, and hereby contracts to pay the same at the time, in the manner, and upon the conditions above set forth; and the said parties themselves, their heirs, executors, administrators, successors, and assigns, do hereby agree to the full performance of the covenants herein contained.

The Contractor further agrees that no moneys payable under this contract shall be assigned by power of attorney, or otherwise, except upon the written consent of the Department.

It is further expressly agreed, by and between the parties hereto, that should there be any conflict between the terms of this instrument and the bid or proposal of said Contractor, then this instrument shall control, and nothing herein shall be considered an acceptance of the said terms of said proposal conflicting therewith.

And the said Contractor hereby further agrees that the payment of the final amount due under this contract shall release the State of Nevada and the Department of Highways from any and all claims or liability on account of work performed under this contract other than such claims, if any, as may be specifically excepted by the Contractor in writing at the time final payment is made.

IN WITNESS WHEREOF, The parties to these presents have hereunto set their hands and seals the year and date first above written.

STATE OF NEVADA

Through the Department of Highways

Dated....., 19.....

.....
Chairman, Board of Directors.

Attested :.....

State Highway Engineer.

.....
Contractor.

By.....
.....

Contractor's Acknowledgment (If an Individual or Partnership)

STATE OF }
COUNTY OF } ss.

On this.....day of....., A. D....., personally
appeared before me, a....., in and for
(Notary Public, Judge, or other officer.)

.....County, State of.....,
known (or proved) to me to be the persons described in and who
executed the foregoing instrument, who acknowledged to me that
he (they) executed the same freely and voluntarily and for the uses
and purposes therein mentioned.

Contractor's Acknowledgment (If a Corporation)

STATE OF }
COUNTY OF } ss.

On this.....day of....., A. D....., personally
appeared before me, a....., in and for
(Notary Public, Judge, or other officer.)

.....County, State of.....,
known (or proved) to me to be the
(President, Vice President, or Secretary.)

of the corporation that executed the foregoing instrument, and,
upon oath, did depose that he is the officer of said corporation as
above designated; that he is acquainted with the seal of said cor-
poration and that the seal affixed to said instrument is the corporate

seal of said corporation; that the signatures to said instrument were made by officers of said corporation as indicated after said signatures; and that the said corporation executed the said instrument freely and voluntarily and for the uses and purposes therein mentioned.

SECTION 122—CONTRACTOR'S BOND**CONTRACTOR'S BOND**

KNOW ALL MEN BY THESE PRESENTS, THAT WE.....

as Principal, and.....

as surety are held and firmly bound unto the State of Nevada in the sum of.....

(\$.....) dollars, to be paid to the said State of Nevada; for which payment, well and truly to be made, we bind ourselves, our heirs, executors and administrators, successors or assigns, jointly and severally, firmly by these presents: That, of the total amount of said bond, two-thirds is conditioned that such work under the contract shall be performed in accordance with the plans and specifications and the terms of the contract, and one-third is conditioned to provide and secure payment for all material, provisions, provender, and supplies, teams, trucks, and other means of transportation used in, or upon, or about, or for the performance of the work contracted to be done, and for any work or labor done thereon.

THE CONDITION OF THIS OBLIGATION IS SUCH, That Whereas, the above principal did, on the.....day of....., 19....., enter into a contract with the Department of Highways of the State of Nevada, for the performance of the following specific work:.....

Now, if the said..... heirs, executors, administrators, successors and assigns, shall well and truly perform.....part of said contract, and if such work under the contract shall be performed in accordance with the plans and specifications and in strict conformity with the terms of said contract, and every covenant and agreement therein contained, and further, if the said.....

shall indemnify and save harmless the State of Nevada from and against all damages which it may sustain by reason of liens for labor and materials furnished for said work, and if the said.....

shall pay all laborers, mechanics and material men and persons who may have supplied provisions, provender and supplies, teams, trucks, and other means of transportation used in, or about, or upon the said work, all just debts due to such persons, or to any person to whom any part of such work was given, and in addition all bills for labor, materials, team hire, sustenance, provisions, provender or supplies used or consumed by subcontractors or otherwise in the performance of the work contracted to be done, together with interest at the rate of eight percent per annum, then this obligation shall be void; otherwise to remain in full force and effect.

And the said surety hereby stipulates and agrees that no change,

extension, alteration or addition to the terms of the contract or specifications shall in any wise affect its obligation on this Bond.

Contractor.

By.....

Attorney in Fact.

Agent, in and for the State of Nevada.

ACKNOWLEDGMENTS FOR SIGNERS OF BOND

Contractor's Acknowledgment (If an Individual or Partnership)

STATE OF }
COUNTY OF } SS.

On this.....day of....., A. D....., personally appeared before me, a....., in and
(Notary Public, Judge, or other officer.)
for..... County, State of....., known (or proved) to me to be the persons described in and who executed the foregoing instrument, who acknowledged to me that he (they) executed the same freely and voluntarily and for the uses and purposes therein mentioned.

Contractor's Acknowledgment (If a Corporation)

STATE OF }
COUNTY OF } SS.

On this.....day of....., A. D....., personally appeared before me, a....., in and
(Notary Public, Judge, or other officer.)
for..... County, State of..... known (or proved) to me to be the.....
(President, Vice President, or Secretary.)
of the corporation that executed the foregoing instrument, and, upon oath, did depose that he is the officer of said corporation as above designated; that he is acquainted with the seal of said corporation and that the seal affixed to said instrument is the corporate seal of said corporation; that the signatures to said instrument were made by officers of said corporation as indicated after said signatures; and that the said corporation executed the said instrument freely and voluntarily and for the uses and purposes therein mentioned.

Acknowledgment for Bonding Company

STATE OF }
COUNTY OF } SS.

On this.....day of....., A. D....., personally appeared before me, a....., in and
(Notary Public, Judge, or other officer.)
for..... County, State of..... known (or proved) to me to be the.....
of the corporation that executed the foregoing instrument, and,

upon oath, did depose that he is the officer of said corporation as above designated; that he is acquainted with the seal of said corporation and that the seal affixed to said instrument is the corporate seal of said corporation; that the signatures to said instrument were made by officers of said corporation as indicated after said signatures; and that the said corporation executed the said instrument freely and voluntarily and for the uses and purposes therein mentioned.

Approved....., 19.....

.....
Attorney-General of the State of Nevada.

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