

STATE OF MAINE
STATE HIGHWAY COMMISSION



Standard Specifications
Highways and Bridges

Revision of June 1968

STATE OF MAINE



State Highway Commission

Standard Specifications Highways and Bridges

Revision of June 1968

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DIVISION 100 — GENERAL PROVISIONS

SECTION 101 — DEFINITIONS AND TERMS

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

101.01 Abbreviations. Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

A.A.N.	American Association of Nurserymen
A.A.R.	Association of American Railroads
A.A.S.H.O.	American Association of State Highway Officials
A.G.C.	Associated General Contractors of America
A.I.A.	American Institute of Architects
A.R.A.	American Railway Association
A.R.E.A.	American Railway Engineering Association
A.S.A.	American Standards Association
A.S.C.E.	American Society of Civil Engineers
A.S.L.A.	American Society of Landscape Architects
A.S.T.M.	American Society for Testing and Materials
A.W.W.A.	American Water Works Association
A.W.S.	American Welding Society
B.P.R.	Bureau of Public Roads, U. S. Department of Transport
F.S.S.	Federal Specifications and Standards, General Services Administration
I.T.E.	Institute of Traffic Engineers
S.A.E.	Society of Automotive Engineers
U.S.A.S.I.	United States of America Standards Institute

101.02 Advertisement. The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

101.03 Aggregate. Inert material such as sand, gravel, broken stone or crushed stone or a combination thereof.

101.04 Award. The acceptance by the Commission of a bid.

101.05 Base Course. The layer or layers of specified or selected material of designated thickness placed on a subbase or a subgrade to support a surface course.

101.06 Bidder. An individual, firm or corporation submitting a bid for the advertised work.

101.07 Bridge. A structure having a clear span of 10 feet or more measured at the elevation of the bridge seats along the centerline of the road, or in case of multiple spans when the combined clear spans equals or exceeds 10 feet.

Length. The length of a bridge structure is the over-all length measured along the construction centerline back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor; but in no case less than the total clear opening of the structure.

Roadway width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in the case of multiple height of curbs, between the bottoms of the lower risers.

101.08 Calendar Day. Every day shown on the calendar, Sundays and Holidays included.

101.09 Change Order. A written order issued by the Engineer to the Contractor, covering changes in the plans or quantities or both, within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the changes.

101.10 Commission. The State Highway Commission of the State of Maine as authorized by the Revised Statutes of Maine, for the administration of highway work.

101.11 Conduit. A pipe used for receiving and protecting wires or cable.

101.12 Construction Limit Line. A line outside of the established right-of-way indicating the limits within which the work will be performed and within which the Contractor may legally work.

101.13 Construction Easement (Right-of-Way). A right acquired by public authority to use or control property, outside of the established right-of-way limits for a designated highway purpose.

101.14 Contract. The written agreement between the Commission and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the proposal, contract form and contract bonds, specifications, supplemental specifications, special provisions, general and detailed plans, and notice to proceed, also any change orders and agreements that are required to

complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

A contract may include any part of a project or one or more projects.

101.15 Contract Bonds. The approved form of security, executed by the Contractor and his Surety or Sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

101.16 Contract Item (Pay Item). A specifically described unit of work for which a price is provided in the Contract.

101.17 Contract Payment Bond. The security furnished by the Contractor and his surety to guarantee payment of the debts covered by the bond.

101.18 Contract Performance Bond. A security furnished by the Contractor and his surety to guarantee performance of the work in accordance with the contract.

101.19 Contract Time. The number of working days or calendar days allowed for completion of the contract, including authorized time extensions.

In case a calendar date of completion is shown in the proposal in lieu of the number of working or calendar days, the contract shall be completed by that date.

101.20 Contractor. The individual, firm or corporation contracting with the Commission for performance of prescribed work.

101.21 Control Test. Control tests are those tests that determine the quality of the material at time of incorporation in the work, and include tests, certified tests and certificates of compliance.

101.22 County. A political subdivision of the State.

101.23 Culvert. Any structure not classified as a bridge which provides a drainage opening under the roadway, or approaches to the roadway.

101.24 Drainage. The system of pipes, drainage ways, ditches and structures by which surface or subsurface waters are collected and conducted from the highway area.

101.25 Engineer. The Chief Engineer of the State Highway Commission, acting directly or through his duly author-

ized representatives, who is responsible for engineering supervision of the construction.

101.26 Equipment. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

101.27 Extra Work. An item of work or labor and materials to be furnished by the Contractor not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

101.28 Extra Work Order. A change order concerning the performance of work or furnishing of materials involving extra work. Such extra work may be performed at agreed prices or on a force account basis as provided elsewhere in these specifications.

101.29 Haul Road. A private way leading to a public way, such private way being used by the Contractor to provide materials to be incorporated in the work or to remove surplus material not required for the work.

101.30 Highway. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.31 Inspector. The Resident Engineer's authorized representative assigned to make detailed inspections of contract performance.

101.32 Invitation for Bids. The advertisement for proposals for all work or materials on which bids are required. Such advertisement will indicate with reasonable accuracy the quantity and location of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of proposals.

101.33 Laboratory. The testing laboratory of the Commission or any other testing laboratory which may be designated by the Engineer.

101.34 Lane. A strip of traveled way intended to accommodate the forward movement of a single line of vehicles.

101.35 Legal Holidays. In the State of Maine legal holidays shall be construed to occur on the following days: New Year's Day, Washington's Birthday, Patriot's Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, and Christmas Day. If any holiday listed above

falls on a Sunday the following Monday shall be considered a holiday.

101.36 Lines of Improvement. Irregular lines, left and right of the roadway centerline, within which construction will be performed.

101.37 Liquidated Damages. The charge assessed against the Contractor to cover additional costs incurred by the State because of failure of the Contractor to complete the contract within the contract time. Assessment of liquidated damages will be by deductions from payments otherwise due, of an amount at a specified rate per day for each day of overrun in contract time in accordance with the contract terms.

101.38 Supplemental Liquidated Damages. The charges assessed against the Contractor for his failure to complete specific work within a specified date or time. These charges are in addition to and separate and distinct from Liquidated Damages. Whenever Supplemental Liquidated Damages are applied a Special Provision will set forth their provisions. Assessment of damages will be the same as specified in subsection 101.37.

101.39 Lump Sum. The single price bid by a Contractor as a single amount for a complete contract item as defined by the Specifications.

101.40 Materials. Any substances specified for use in the construction of the project and its appurtenances.

101.41 Notice of Award. A written notice to the successful bidder stating that his bid has been accepted and that, in accordance with the Notice to Contractors and the specifications, he is required to execute the Contract Agreement and furnish the satisfactory Contract Bonds.

101.42 Notice to Contractors. The official notice stating the time and place for the submission of bids.

101.43 Notice to Proceed. Written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

101.44 Owner. The legal owner of the buildings or premises on which the contract work is to be performed.

101.45 Pavement Structure. The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.46 Plans. The approved plans, profiles, typical cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be done.

101.47 Preliminary Tests. Tests performed by the Engineer at the source of supply prior to delivery to determine the acceptability of the material.

101.48 Premises. Land of the owner on which the building or buildings now stand or to which they are to be moved.

101.49 Profile Grade. The trace of a vertical plane intersecting the top of the wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

101.50 Project. The specific section of the highway or bridge or both, together with all appurtenances and construction to be performed thereon under the contract.

101.51 Proposal. The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

101.52 Proposal Form. The approved form on which the Commission requires bids to be prepared and submitted for the work.

101.53 Proposal Guaranty. The security designated in the proposal and furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

101.54 Questionnaire. The specified forms on which the Contractor shall furnish required information as to his ability to perform and finance the work.

101.55 Reference Stakes. Wooden stakes, set beyond the lines of improvement for use as control for the new construction.

101.56 Resident Engineer. A Registered Professional Engineer project representative of the Chief Engineer acting within the scope of the particular duties assigned to him or the authority given him.

101.561 Resident Inspector. A person, other than a Registered Professional Engineer, who is assigned as a project representative of the Chief Engineer in the same capacity and with the same duties and authority as a Resident Engineer.

101.57 Right-of-Way. A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a highway.

101.58 Road. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.59 Roadbed. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

101.60 Roadside. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.61 Roadside Development. Those items necessary to the complete highway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

101.62 Roadway. The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

101.63 Schedule of Work. The approved work schedule, submitted by the Contractor, stating the dates within which he contemplates the completion of various work items within the contract time.

101.64 Section. (When referring to the Specifications.) A numbered article or group of related articles forming a part of the specifications and applying to or controlling the procedure of an operation or regulation.

101.65 Shoulder. The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

101.66 Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

101.67 Skew or Skew Angle. The acute angle formed by the intersection of the line normal to the centerline of the

roadway with a line parallel to the face of the abutments, or, in the case of culverts, with the centerline of the culverts.

101.68 Specialty Item. Specialty Items shall be construed to be limited to work that requires highly specialized knowledge, craftsmanship or equipment not ordinarily available in contracting organizations qualified to bid on the contract as a whole and in general are to be limited to minor components of the overall contract.

101.69 Special Provisions. Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.70 Specified Completion Date. The date on which the contract work is specified to be completed.

101.71 Specifications. A general term applied to all directions, provisions and requirements pertaining to material and performance of the work.

101.72 State. The State of Maine acting through its authorized representative.

101.73 Street. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.74 Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

101.75 Subbase course. The layer or layers of specified or selected material of designated thickness placed on the subgrade to support the base course.

101.76 Subcontractor. An individual, firm or corporation to whom the Contractor sublets part of the contract.

101.77 Subgrade. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

101.78 Substructure. All of that part of the structure below the bearings of simple and continuous spans, skew-backs of arches and tops of footings of rigid frames, together with the backwalls, parapets, and wing walls of abutments.

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

101.80 Superstructure. The entire structure except the substructure.

101.81 Supplemental Specifications. Additions and revisions to the standard specifications that are adopted subsequent to issuance of the printed book of Standard Specifications.

101.82 Supplementary Agreement. ^{Department} A written agreement executed by the Contractor and the Commission covering the furnishing of materials, also for the performance of work not included in the original contract which is necessary for the proper completion of the work.

101.83 Surety. The corporation, company, partnership or individual, other than the Contractor, executing a bond furnished by the Contractor.

101.84 Surface Course. One or more layers of pavement designed to accommodate the traffic load. The top layer may be called the Wearing Course.

101.85 Titles (Or Headings). The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

101.86 Town, City, Township, Plantation. A subdivision of the county used to designate or identify the location of the proposed work.

101.87 Traveled Way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.88 Unit Price. The price bid by the Contractor for one unit of work, as defined by the specifications.

101.89 Utility. An organization serving the public by the transmission of services. For the purposes of this definition railways are considered utilities unless otherwise clearly indicated by context.

101.90 Work. Work shall mean the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

101.91 Working Day. A calendar day, exclusive of Saturdays, Sundays, and State recognized legal holidays, as set

~~forth in subsection 101.35, Legal Holidays and the period from November 15 to May 15 inclusive as set forth in subsection 108.06, on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for 70 percent of the hours of the usual working day with the normal working force.~~

Saturday shall be considered one half of a working day if the Contractor's normal working force works 2 or more hours during the forenoon. If work by the Contractor's normal working force is carried on after 12 o'clock noon, it shall be considered as one working day. If, because an extreme emergency exists, and after approval, work is performed on a Sunday or a Legal Holiday, then the day shall be considered a working day. Necessary maintenance work or that necessary for the safety of the traveling public performed on Sundays or Legal Holidays is not to be considered in working day computations.

~~Reference is made to subsection 108.04 and subsection 108.06.~~

101.92 Working Drawings. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

101.93 Work Order. A written order, signed by the Engineer, of a contractual status requiring performance by the Contractor without negotiation of any sort.

101.94. In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned, it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer".

SECTION 102 — BIDDING REQUIREMENTS AND CONDITIONS

102.01 Qualification of Bidders. The form "Questionnaire and Financial Statement for Bidders", included in the pro-

posal, shall be submitted by bidders who have not been awarded a contract by the Commission within the 5 years preceding the date of the opening of proposals, or upon request of the Commission at any time. The questionnaire shall include a complete report of the bidder's financial resources and liabilities, equipment, past record and personnel.

When a bidder who has not been awarded a contract by the Commission within the 5 years previous to the date of opening of proposals, wishes to submit proposals on more than one project on the same day, he may submit his Questionnaire and Financial Statement for Bidders under separate cover for consideration in conjunction with all of the proposals submitted on that day. The instructions on the form must be followed in detail. The proposal of any bidder not complying with the above requirement in regard to Questionnaire and Financial Statement for Bidders shall be considered informal.

102.02 Notice to Contractors. The notice will contain a description of the proposed work, instructions to the bidder regarding proposal forms, proposal guaranty, plans, specifications, and the reservation of the right of the Commission to reject any or all bids.

102.03 Method of Obtaining Plans, Specifications and Proposal Forms. Plans, specifications and proposal forms may be seen and obtained at the office of the State Highway Commission, Augusta, Maine, upon payment as specified in the published Notice to Contractors.

102.04 Contents of Proposal Forms. The proposal form will state the location and description of the contemplated construction and will show the approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished, and will have a schedule of items for which unit or lump sum bid prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty, and the date, time and place of the opening of proposals. The proposal form will also include special provisions or requirements which vary from or are not contained in the standard specifications.

All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered when the proposal is submitted.

The plans, specifications and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

The prospective bidder will be required to pay the Commission the sum stated in the Notice to Contractors for each copy of the proposal form and each set of plans.

When there is more than one item for payment, specified under the same contract pay item, another digit or digits will be added to the end of the decimal of the pay item number in order to differentiate between the various pay items. The item number shown in these specifications for this particular case will not be used directly but will be revised as shown in the following illustration:

Item number shown in specifications = 900.06

Pay item number to be used in proposal = 900.061, 900.062, — etc.

102.05 Issuance of Proposals. The Commission reserves the right to disqualify or refuse to issue a proposal if a bidder is in default for any of the following reasons:

(a) Lack of competency and adequate machinery, plant and other equipment, as revealed by the financial statement and experience questionnaires required under subsection 102.01.

(b) Uncompleted work which, in the judgment of the Commission, might hinder or prevent the prompt completion of additional work if awarded.

(c) Failure to pay, or satisfactorily settle, all bills due for labor and material on former contracts in force at the time of issuance of proposals.

(d) Failure to comply with any regulations of the Commission.

(e) Default under previous contracts.

102.06 Interpretation of Quantities in Bid Schedule. The quantities appearing in the bid schedule are approximate only and are prepared for the comparison of bids, they are not guaranteed to be accurate and are furnished without liability on the part of the Commission. The Commission reserves the right to increase or decrease the quantities shown or to omit any items, as it deems necessary. Payment to the Contractor will be made only for the actual quantities of work performed and accepted or materials furnished in accordance with the contract. The scheduled quantities of work to be done and materials to be furnished may each be increased, decreased, or omitted as hereinafter provided.

102.07 Examination of Plans, Specifications, Special Provisions, and Site of Work. The Commission will prepare full, complete, and accurate plans and specifications giving such directions as will enable any competent mechanic or Contractor to carry them out. The bidder is expected to examine carefully the site of the proposed work, the proposal, plans, specifications, supplemental specifications, special provisions, and contract forms, before submitting a proposal. He is expected to fully inform himself as to the quantity and quality of materials required and the character of the work, and he is expected to further investigate the location and make a careful examination of the source of supply for materials and labor. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination, and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, supplementary specifications, special provisions, and contract. The bidder will be held responsible for his failure or neglect to observe or comply with these instructions.

The bidder shall have access to and may examine, at the office of the Commission, the record of all borings, test excavations, other subsurface investigations and soil analyses, if any, made for design purposes prior to the construction of the project, the records of which may or may not be shown on the plans. The subsurface information furnished is based on the interpretation by the Commission of investigations made at the specified locations indicated, and no assurance is given that these conditions are necessarily typical or that they have remained unchanged since the field data were obtained. Such information is subject to inaccuracies inherent in drilling methods and to variations in the driller's classification and interpretation of soil layers. No assurance is given that the presence or absence of water in subsurface explorations at the time of these explorations will be representative of actual conditions at the time of construction. It is the obligation of the bidder to draw his own conclusions of subsurface conditions from his own investigations prior to submitting a proposal. The Contractor agrees, in signing his contract, that he will make no claim against the Commission, if in carrying out the work he finds that the actual conditions encountered do not conform to those conditions shown by said borings, test excavations and subsurface investigations.

102.08 Preparation of Proposal. The bidder shall submit his proposal upon the forms furnished by the Commission. The bidder shall specify a unit price or lump sum price, whichever the case may be as required in the proposal, in

words and figures, for each pay item for which a quantity is given and shall also show the products of the respective unit prices and quantities written in figures in the column provided for that purpose and the total amount of the proposal obtained by adding the amounts of the several items. All the words and figures shall be in ink. In case of a discrepancy between the prices written in words and those written in figures the prices written in words shall govern.

When an item in the proposal contains a choice to be made by the bidder, the bidder shall indicate his choice in accordance with the specifications for that particular item and thereafter no further choice will be permitted.

If a unit price or lump sum bid already entered by the bidder in the proposal is to be altered it shall be crossed out with ink, the new price or lump sum entered above or below it and initialed by the bidder, also in ink.

The bidder's proposal must be correctly signed with ink by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture, or by one or more officers of a corporation, or by an agent of the Contractor legally qualified and acceptable to the Commission. If the proposal is made by an individual, his name and post office address must be shown; by a partnership, the name and post office address of each partnership member must be shown; as a joint venture, the name and post office address of each member or officer of the firms represented by the joint venture must be shown; by a corporation, the name of the corporation and the business address of its corporate officials must be shown.

The corporation seal must be affixed to all proposals submitted by a corporation, and the signature of the signer must be notarized. In addition, an affidavit executed and sworn to must accompany each proposal submitted by a corporation indicating the authority of the designated official to sign each document on behalf of the corporation.

102.09 Irregular Proposals. Proposals will be considered irregular and may be rejected for the following reasons:

(a) If the proposal is on a form other than that furnished by the Commission or if the form is altered or any part thereof is detached.

(b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.

(c) If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

(d) If the proposal does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.

(e) If the proposal lacks any of the requirements of subsection 102.08.

102.10 Proposal Guaranty. No proposal will be considered unless accompanied by a guaranty in an amount not less than the amount indicated in the proposal form and made payable to the Treasurer of the State of Maine. Acceptable forms of guaranty are an official bank check, a cashier's check, a certified check, or a United States postal money order.

102.11 Delivery of Proposals. Each proposal should be submitted in a sealed, special envelope furnished by the Commission. The blank spaces on the envelope shall be filled in correctly to clearly indicate its contents. When an envelope other than the special one furnished by the Commission is used, it shall be of the same general size and shape and be similarly marked to clearly indicate its contents. When sent by mail, the sealed proposal shall be addressed to the State Highway Commission, Augusta, Maine; if forwarded otherwise than by mail it shall be delivered to the office of the Chief Engineer or at an alternate place if so designated. All proposals shall be filed prior to the time and at the place specified in the Notice to Contractors. Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.12 Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been deposited with the Commission, provided the request for such withdrawal or revision is received by the Commission or Chief Engineer, in writing or in person, before the time set for opening proposals.

In addition to the above, any bidder who has submitted proposals on more than one project, may, by a request in writing or in person, withdraw any or all of his additional proposals after the Commission, or its representative, has announced that such bidder has submitted the lowest proposal on the project for which bids have last been read. When this option is exercised, the proposal for any other project will be returned to the bidder unopened, provided that the request for the withdrawal of the other proposal is made

before the total amount of the first bid for any other project for which he has submitted a bid is read. No returned proposals will be considered after the bidder has exercised his privilege to withdraw the same. Any bidder exercising the privilege of withdrawing his bid or bids, waives all claims that may arise should it be found that his opened proposal is not in proper form or for any other reason is unacceptable to the Commission.

102.13 Combination Proposals. If the Commission so elects, proposals may be issued for projects in combination or separately, so that bids may be submitted either on the combination or on separate units of the combination. The Commission reserves the right to make awards on combination bids or separate bids to the best advantage of the Commission. No combination bids, other than those specifically set up in the proposals by the Commission will be considered.

102.14 Public Opening of Proposals. Proposals will be opened by the Commission in the order in which they are drawn and read publicly at the time and place indicated in the Notice to Contractors. Bidders, their authorized agents, and other interested parties are invited to be present.

102.15 Disqualification of Bidders. Any of the following reasons may be considered as being sufficient for the disqualification of a bidder and the rejection of his proposal or proposals:

(a) More than one proposal for the same work from an individual, firm, or corporation under the same or different name.

(b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Commission until any such participant shall have been reinstated as a qualified bidder.

Title 23, United States Code requires as a condition precedent to approval by the Bureau of Public Roads of the contract for this work that there be filed a sworn statement executed by, or on behalf of the person, firm, association, or corporation to whom such contract is to be awarded, certifying that such person, firm, association, or corporation has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with such contract. The Contractor shall comply with this requirement. This sworn statement shall be in the form of an affidavit executed and sworn to by the successful bidder

before a person who is authorized by the laws of this State to administer oaths. The original of such sworn statement shall be filed with the Commission prior to the award of the contract.

(c) Lack of competency, as determined by the Commission, after analysis of the Questionnaire and Financial Statement for Bidders.

(d) Lack of responsibility as shown by past work judged by the Commission from the standpoint of workmanship and progress.

(e) Incomplete work which, in the judgment of the Commission, might hinder or prevent the prompt completion of additional work if awarded.

(f) For being in arrears on existing or previous contracts, in litigation with the Commission, or having defaulted on a previous contract.

102.16 Material Guaranty. Before a contract is awarded the successful 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 contract.

102.17 Non-resident Contractors. The successful bidder, if a foreign corporation, shall file, at the time of the execution of the contract, with the Commission, notice of the name of its resident attorney, appointed as required by Statute.

The successful bidder, if a resident of another state and not a corporation, shall file with the Commission, at the time of the execution of the contract, a written appointment of a resident of this State, having an office or place of business herein, to be his true and lawful attorney upon whom all lawful processes in any actions or proceedings against him may be served; and in such writing, which shall set forth said attorney's place of residence, shall agree that any lawful process against him which is served on said attorney shall be of the same legal force and validity as if served on him, and that such authority shall continue in force so long as any liability remain outstanding against him in this State. The Power of Attorney shall be filed in the office of the Secretary of State and copies certified by him shall be sufficient evidence thereof. Service of such process shall be made by leaving a copy of the process in the hands or in the office of the said attorney, and such service shall be sufficient service upon

the successful bidder. Such appointment shall continue in force until revoked by an instrument in writing, designating in a like manner some other person upon whom such process may be served, which instrument shall be filed in the manner provided herein for the original appointment.

A Non-resident Contractor shall be deemed to be:

(a) Any person who is not a resident of the State of Maine.

(b) Any firm that has no member thereof resident of the State of Maine.

(c) Any corporation established under laws other than those of the State of Maine.

SECTION 103 — AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals. After the proposals are opened and read, they will be compared by the Commission on the basis of the summation of the products of the approximate quantities shown in the Schedule of Prices multiplied by the unit bid prices. The results of such comparisons will be available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid price shall govern.

When unit bid prices indicate a credit to the State, the net result will be that result obtained by subtraction of the totals of the credit (or minus) item or items from the total of the plus item or items in the Schedule of Prices. Double spaces are provided in the Schedule of Prices for those items for which it is anticipated that a credit (or minus) unit price might be entered. This does not prohibit credit (or minus) bidding on items for which no double spaces are provided in the schedule. However, care must be exercised to write the word CREDIT in conjunction with the written amount shown under the column headed Items and Unit Prices Bid, otherwise a plus unit price will prevail. The possibility of the withdrawal, by the Commission, at some future date of a credit (or minus) item from the contract will not be a factor in the determination of the low bidder.

The right is reserved to reject any or all proposals, to waive technicalities or to advertise for new proposals, if in the judgment of the Commission the best interests of the Commission will be promoted thereby.

103.02 Award of Contract. The award of contract, if it be awarded, will be made within 30 calendar days after the opening of proposals to the lowest responsible and qualified bidder whose proposal complies with all the requirements prescribed. The successful bidder will be notified by registered or certified letter mailed to the address shown on his proposal, that his bid has been accepted and that he has been awarded the contract.

103.03 Cancellation of Award. The Commission reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the Commission.

103.04 Return of Proposal Guaranty. All proposal guaranties, except those of the 2 lowest bidders, will be returned within 3 days following the opening and checking of proposals. The proposal guaranty of the unsuccessful of the 2 lowest bidders will be held until the contract is executed by the successful bidder, at which time this proposal guaranty will be returned. The proposal guaranty of the successful bidder will be retained until after the contract has been properly executed, after which it will be returned.

In case all proposals are rejected all guaranties will be returned within 3 days of the date of rejection. Unopened and informal proposals will be returned immediately.

103.05 Requirements of the Contract Bonds. The successful bidder must furnish the following bonds at the time of the execution of the contract:

(a) A Contract Performance Bond in a sum equal to the full amount of the contract for the prompt and faithful performance and completion of the work to be done under the contract.

(b) A Contract Payment Bond in a sum equal to the full amount of the contract for the payment in full of all labor and material used or required in connection with the work set forth by the contract.

The two bonds shall be payable to the Treasurer of the State of Maine, or his successors in office. The form of the bonds shall be those provided by the Commission and the surety shall be acceptable to the Commission. A bond shall be procured from insurance or bonding companies licensed to do a surety bond business in the State of Maine and be executed or countersigned on the part of such a company by a licensed resident agent in the State of Maine. The licensed resident agent, when executing or countersigning contract

bonds, must indicate the name of the local bonding agency whom he represents or by whom he is employed, as well as the name of the surety company furnishing the bonds.

If surety company bonds are not provided, certified checks payable to the Treasurer of the State of Maine or other negotiable security acceptable to the Commission shall be deposited with the Treasurer of the State of Maine in lieu of a surety company bond and shall be subject to all conditions of such bonds and to such agreements as may be required by the Commission.

103.06 Execution and Approval of Contract. The contract shall be signed by the successful bidder and returned, together with the contract bonds, to the office of the Commission at Augusta, Maine, within 12 calendar days after the date of the Notice of Award of contract, except if the 12th day falls on a holiday, a Saturday or a Sunday, then the conditions will be fulfilled if the contracts are received before 12 o'clock noon, on the day following the holiday or the Monday following the Saturday or Sunday. If the contract is not executed by the Commission within 24 calendar days after the date of the Notice of Award of contract, the successful bidder shall have the right to withdraw his proposal without loss of his proposal guaranty. No contract shall be considered effective until it has been fully executed by all of the parties thereto. Three copies of the contract agreement shall be executed. One shall be kept by the Commission, one shall be delivered by the Commission to the State Controller, and one returned to the Contractor.

103.07 Failure to Execute Contract. Failure of the successful bidder to execute the contract and file acceptable bonds within the time stated in the proposal shall be just cause for the cancellation of the award and the forfeiture of the proposal guaranty which shall become the property of the State. Award may then be made to the next lowest responsible bidder, or the work may be readvertised and constructed under contract or otherwise, as the Commission may decide. If the successful bidder refuses to accept an award, the Commission may refuse to consider any proposal of the bidder for a period of not more than 3 years from the date of such refusal.

103.08 Insurance. Before work is started under the contract the Contractor will be required to file with the Commission a Certificate of Insurance, executed by an insurance company or companies satisfactory to the Commission and licensed by the State of Maine Insurance Department to do business in the State of Maine, stating that the Contractor

carries insurance in accordance with the following requirements and stipulations:

(a) *Workmen's Compensation Insurance.* With respect to all the operations the Contractor performs and all those performed for him by subcontractors, the Contractor or the subcontractor shall carry Workmen's Compensation Insurance or shall qualify as a self-insurer with the State of Maine Industrial Accident Commission, all in accordance with the requirements of the laws of the State of Maine.

(b) *Contractor's Public Liability and Property Damage Insurance.* With respect to the operations he performs and also those performed for him by subcontractors, the Contractor shall carry regular Contractor's Public Liability Insurance and Contractor's Protective Public Liability Insurance, each covering bodily injury liability of not less than 100,000 dollars for damages arising out of bodily injuries to or death of one person, and, subject to that limit for each person, a total limit of 300,000 dollars for damages arising out of bodily injuries to or death of two or more persons in any one accident or occurrence, and covering property damage liability of not less than 50,000 dollars for all damages arising out of injury to or destruction of property in one accident or occurrence, and, subject to that limit per accident, a total (or aggregate) limit of 100,000 dollars for all damages arising out of injury to or destruction of property during the policy period.

(c) *Automobile Liability Insurance.* The Contractor shall carry automobile Liability Insurance covering the operation of all motor vehicles, including those hired or borrowed, used in connection with the contract, covering bodily injury liability of not less than 100,000 dollars for all damages arising out of bodily injuries to or death of one person, and, subject to that limit for each person, a total of 300,000 dollars for all damages arising out of bodily injuries to or death of two or more persons in any one accident or occurrence, and covering property damage liability for a limit of not less than 50,000 dollars for all damages arising out of injury to or destruction of property in one accident or occurrence.

(d) *Contractual Liability Insurance.* The Contractor shall carry Contractual Liability Insurance covering the liability he has assumed under the contract to indemnify and save harmless the Commission, its officers and employees with respect to bodily injuries to or death of any person or persons or injury to or destruction of property. The limits for such insurance shall be not less than those specified for Contractor's Public Liability Insurance in paragraph (b) above.

(e) *Blasting.* When explosives are to be used in the prosecution of the work, the insurance required under paragraphs (b), (c), and (d) above shall also contain provisions for protection, in the amounts stated, against damage claims due to such use of explosives.

(f) *Each policy* shall be signed by the President and Secretary of the insurance company and shall be countersigned by a licensed resident agent in the State of Maine as an authorized representative of the company.

(g) *Termination or Change of Insurance.* Each insurance policy shall be endorsed to provide that the insurance company shall notify the Commission by certified mail at least 30 days in advance of cancellation of or any change in the policy. No change shall be made without prior written approval of the Commission.

The Contractor shall keep all the required insurances in continuous effect until 31 days after the date of final acceptance of the project or until such time as may be established by the Commission.

(h) *Claims.* Each insurance policy shall state that the insurance company shall agree to investigate and defend the insured against all claims for damages, even if groundless.

(i) *Compliance with the requirements* of this subsection may be met by procurement of insurance covering all work under contract with the State or may be met by procurement of separate insurance for each individual contract. In either case a Certificate of Insurance must be filed for each contract to show evidence that all required insurance has been obtained.

SECTION 104—SCOPE OF WORK

104.01 Intent of Contract. The intent of the contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the contract.

104.02 Alteration of Plans or Character of Work. The Commission reserves the right to make, at any time during the progress of the work, such increases or decreases in quantities and such alterations in the details of construction, including alterations in the grade or alignment of the road or structure or both, as may be found to be necessary or desirable. Such increases or decreases and alterations shall not

invalidate the contract nor release the surety, and the contractor agrees to accept the work as altered, the same it had been a part of the original contract.

Under no circumstances shall alterations of plans or on the nature of the work involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.

Unless such alterations and increases or decreases substantially change the character of the work to be performed or the cost thereof, the altered work shall be paid for at the same unit prices as other parts of the work. If, however, the character of the work or the unit costs thereof are materially changed, an allowance shall be made on such basis as may have been agreed to in advance of the performance of the work, or in case no such basis has been previously agreed upon, then an allowance shall be made, either for or against the Contractor, in such amount as the Engineer may determine to be fair and equitable.

No claim shall be made by the Contractor for any loss of anticipated profits because of any such alteration, or by reason of any variation between the approximate quantities and the quantities of work as done.

Payment for work occasioned by changes or alterations will be made in accordance with the provisions set forth under subsection 109.03. If the altered or added work increases the total cost of the work actually performed, an increase in contract time will be computed in accordance with the provisions of subsection 108.06.

104.03 Extra Work. The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable in order to complete fully the work as contemplated. Before any extra work is started, a written supplemental agreement shall be entered into which, when executed, shall become a part of the original contract and the work paid for in the same manner as any other contract item. In lieu of such an agreement the Commission may require the Contractor to do extra work on a force account basis. Such work shall be performed in accordance with the specifications and as directed, and will be paid for as provided under subsection 109.04.

104.04 Maintenance of Traffic. The roadway, while undergoing improvement, shall be kept open to traffic unless otherwise provided. The Contractor may bypass traffic over an approved detour route when so provided for on the plans or authorized by the Commission during progress of the work.

The Contractor shall keep the portion of the project being used by public travel, whether it be used by through or local traffic and whether it is on new or old locations of the road between project termini, in such condition that traffic will be adequately accommodated over a satisfactory surface at all times with a minimum of delay and obstructions. Portions of the project open to public traffic shall have a minimum width suitable for 2 lanes of traffic unless otherwise provided. When installing drainage systems the Contractor shall provide a minimum width of 14 feet over or around the installation and shall have in effect the protection as specified in subsection 107.11. The Contractor shall also provide and maintain in a safe condition temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages and farms. The Contractor shall bear all expenses in maintaining traffic over the section of road undergoing improvement whether it is on new or old location of the road between project termini and of constructing and maintaining such approaches, crossings, intersections and other features as may be necessary, without direct compensation, except as provided in (a) and (c) below.

(a) *Special Detours.* When the proposal contains the item, Special Detours, the payment of such item shall cover all costs for constructing, repairing, maintaining and removing the detour or detours, including any and all temporary bridges and accessory features, and obliteration of the detour road. Right-of-way for temporary detours or bridges, or both, called for under this paragraph, will be furnished by the Commission unless otherwise indicated on the plans or stated in the Special Provisions.

(b) *Detours.* When provided for on the plans, or approved by the Commission during progress of the work, the Contractor may bypass traffic over an approved detour route. The Contractor will not be liable for the maintenance of such a detour but he shall construct and maintain adequate barriers, watchman, or lights at both ends of the portion of the project closed to traffic. Whenever a road is so closed, the Contractor must carry on his work in such a manner that local travel and abutters will be inconvenienced as little as possible.

(c) *Maintenance of Traffic During Construction of the Project.* Except as otherwise specified and when the work is suspended, all work required under this article shall be incidental to other contract items and shall be performed without direct compensation. However, if conditions require, granular borrow, gravel borrow, aggregate subbase or suit-

able roadway excavation shall be added as directed by the Engineer. Payment will be made at the contract price for the material so used.

The Engineer may authorize a suspension of the work in accordance with the provisions of subsection 108.07 when unfavorable weather or other conditions, not the fault of the Contractor, makes such suspension advisable. Prior to such suspension the Contractor shall make passable and shall open to traffic such portions of the project under improvement as may be agreed upon by the Contractor and the Engineer for the temporary accommodation of traffic for the anticipated period of suspension. All portions of the project to be used by traffic during periods of suspension shall have a minimum width suitable for two lanes of traffic. To provide space for snow removal, this width shall be a minimum of 36 feet in cuts.

Portions of the existing highway to be used by traffic, between the termini of the project, on which the existing pavement has not been disturbed and on which the Contractor does not carry on work, exclusive of cross culvert installations, clearing and cutting trees and on which the Contractor does not haul excavation, or other materials, may be approved for suspension if so requested in writing by the Contractor. The pavement on such suspended portions will be maintained by the State until such time as the Contractor commences or resumes work thereon.

The portions of the roadway to be used by traffic during periods of winter suspension, which have not been treated with bituminous material or otherwise surfaced, shall be shaped to a cross sectional slope of at least $\frac{3}{4}$ of an inch per foot and not greater than $\frac{1}{4}$ of an inch per foot and graded smooth. All costs of grading and regrading upon resumption of work including addition and/or removal of materials, placed by the Contractor or placed by others for ice control, shall be considered incidental to the cost of the various bid items and no separate payment shall be made. This shall be done regardless of the designated cross sectional slope required for final completion of the pavement structure.

During periods of approved suspension of work, the Contractor will not be responsible for plowing snow, sanding ice, maintaining the road, patching, and retreating the surface, repairing or replacing damaged guard rail and barricades. The Contractor will be responsible for the correction of settlement.

When the Contractor's operations are being carried out during periods subject to winter weather conditions, the Con-

tractor shall be responsible for plowing snow from the traffic lanes of portions of the project on which the Contractor is actually carrying on operations. This responsibility for plowing by the Contractor shall extend over 24 hours each day, 7 days each week. Sanding of such portions will be done by the agency responsible for the regular winter maintenance operation.

On portions of a project carrying traffic where no construction operations have taken place, and on portions of a project where the Contractor has completed his operations, leaving the roadway carrying traffic in a suitable condition as is required for approved suspension of work, the State or other agency responsible for winter maintenance will be responsible for plowing snow and sanding.

Upon resuming work, following winter suspension, the Contractor will be required to clean up all evidence of snow and ice control including removing excess sand and debris from the roadway. No payment will be made for such work as it will be considered incidental to the related contract items.

(d) The Contractor shall, at his own expense, furnish flagmen at locations where equipment or construction activities or both interfere with the movement and safety of the traveling public. This includes locations where equipment enters, leaves, or crosses, normal traffic lanes being used or set aside for the use of the traveling public, and locations where heavy equipment is operating adjacent to or within areas where traffic is moving. Flagmen shall be used primarily in areas of localized construction for directing traffic around hazards created by construction equipment.

Hand signaling devices shall conform to, and flagmen shall conduct themselves, in accordance with the following:

(1) Flags used for signaling purposes shall be a minimum of 24 by 24 inches in size and made of bright red material securely fastened to a staff approximately 3 feet long.

(2) Sign paddles shall be at least 15 inches wide, with bold lettering at least 5 inches high. The STOP face shall be red background with white letters. The GO face shall be dark green background with white letters. If SLOW is used instead of STOP the face shall be highway yellow background with black letters.

(3) The flagman should possess the following minimum qualifications:

1. Average intelligence.
2. Good physical condition, including sight and hearing.

3. Mental alertness.
4. Courteous but firm manner.
5. Neat appearance.
6. Pleasing personality.
7. Sense of responsibility for safety of public and crew.

(4) Only signals, conforming to the illustrations shown in the "Manual on Uniform Traffic Control Devices for Streets and Highways," Part V, prepared by the National Joint Committee on Uniform Traffic Control Devices, may be used.

104.05 Rights in and Use of Materials Found on the Work. The Contractor with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. He shall replace at his own expense, with other acceptable material, all of that portion of the excavation material so removed and used which was needed for use in the embankments, backfills, approaches, or otherwise. No charge for the materials so used will be made against the Contractor. The Contractor shall not excavate nor remove any material from within the right-of-way which is not within the limits of improvement without authorization from the Engineer.

104.06 Repair of Roads Damaged by Contractor. Damage to any road or structure caused by equipment, including trucks, used in the prosecution of this work, shall be repaired by the Contractor to the satisfaction of the Engineer and the interested municipality. Payments for such work shall be considered as incidental to the several items of the contract. An exception shall be that when such damage has been done by trucks carrying legal loads and operating in full accordance with the laws of the State on roads having a surface width of 20 feet and over maintained by the Commission, and structures maintained by the Commission, the Contractor shall not then be held liable for the damage caused. On such roads, having a bituminous surface width of less than 20 feet, and providing an alternate route is available for the return trip, the Contractor may haul in one direction only. If no alternate route is available the Contractor shall be responsible for maintaining the surface, in an acceptable manner, for a minimum width equal to the original pavement width.

In the event it is necessary for the Contractor to transport gravel, borrow, or other construction material in legally registered vehicles carrying legal loads over town ways, a Contractor's Bond of not more than 5,000 dollars per mile of

traveled length may be required by the town or other agency, the exact amount of said bond to be determined prior to use of any town way. The town may also require the Contractor to use dust control measures. The Contractor will not be paid directly for any necessary bond, maintenance or dust control on town ways. Such costs shall be incidental to other items in the contract.

On haul roads, should the Contractor's operations create a dust nuisance to private property, the Commission will be responsible for the abatement of such nuisance. The Contractor will be compensated for dust control measures in accordance with contract items but the maintenance of such roads will be the responsibility of the Contractor who will not be paid directly, but such costs will be incidental to other items in the contract.

104.07 Removal and Disposal of Structures and Obstruction. Unless otherwise provided, all guard rail, drainage pipe, culverts, curbing, bridges or other manufactured highway material, except utility property, traffic control devices, lights and their supporting structures, found within the limits of the work, shall become the property of the Contractor. The material shall be removed as indicated by the excavation limits and disposed of by the Contractor at no additional expense to the State except as hereinafter provided.

Removal and disposal of highway material found above ground, such as guard rail, curbing, and bridge steel, shall, unless otherwise provided, be considered incidental to the various contract items and no separate payment will be made.

104.08 Final Cleaning Up. Before final acceptance, the highway, bridges, streams, structures, lawns, property adjacent to the project and all grounds occupied by the Contractor in connection with the work shall be cleaned of all rubbish, excess material, temporary structures and equipment and the ground graded to match the surrounding terrain. All borrow pits and haul roads in sight of any public way shall be treated as specified in Section 203, Excavation and Embankments. All parts of the work shall be left in an acceptable condition.

SECTION 105 — CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work, all questions which may arise as to the interpretation of the plans and specifica-

tions and all questions as to the acceptable fulfillment of the Contract on the part of the Contractor. The Engineer shall have such additional authority as may be designated in writing by the Chief Engineer.

The Engineer will have the authority to suspend the work wholly or in part in accordance with subsection 108.07.

105.02 Plans and Working Drawings. Plans, consisting of general drawings showing details necessary to give a comprehensive idea of the construction contemplated, will be furnished by the Commission. Roadway plans will show alignment, profile grade, typical cross sections of improvements, right-of-way and general cross sections. Structure plans will, in general, show in detail all dimensions of the work contemplated. When the structure plans do not show all dimensions in detail, they will show general features and such details as are necessary to give a comprehensive idea of the structure. The Contractor shall keep one complete set of plans available on the work site at all times.

The Contractor shall furnish, on the size sheets required by the Engineer, such working and detail drawings, not furnished by the Commission, as may be required for any part of the finished construction.

Working drawings for steel structures shall consist of shop detail, erection, and other working plans showing details, dimensions, material, sizes and types of material, and other information necessary for the complete fabrication and erection of the metal work.

Working drawings for concrete structures shall consist of such detailed plans as may reasonably be required for the successful prosecution of the work and which are not included in the plans furnished by the Commission. These may include plans for falsework, bracing, centering, form work, steel reinforcement and masonry lay-out diagrams.

The Contractor shall submit to the Engineer for approval two sets of any required preliminary detailed shop or working drawings. These plans shall be submitted in sufficient time to allow discussion and correction prior to beginning the work they cover. Prior to the approval of the drawings, any work done or materials ordered for the structures involved shall be at the Contractor's risk. One set of these drawings shall be returned to the Contractor approved or marked with corrections to be made; the other set will be retained by the Engineer. After approval has been given, the Contractor shall supply the Engineer with three sets of the revised detailed shop or working drawings.

The Engineer's approval of the Contractor's working drawings relates to the requirements for strength and detail and such approval will not relieve the Contractor from responsibility for errors in dimensions, for successful completion of the project or for responsibility for damage claims as defined in subsection 107.15.

The Contractor shall furnish the Commission with copies of the working drawings as may be required for approval and construction purposes. All final tracings on linen or equivalent shall be filed with the Commission.

The contract price shall include the cost of furnishing all working drawings and final tracings and the Contractor will be allowed no extra compensation for such drawings.

105.03 Conformity with Plans and Specifications. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions and material requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgment.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

105.04 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions. These specifications, the supplemental specifications, the plans, special provisions, and other 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 complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; plans will govern over specifications; sup-

plemental specifications will govern over specifications; special provisions will govern over both specifications and plans. When the plans provide that new work is to connect with existing structures the Contractor must verify all dimensions with the Engineer before proceeding with the work.

The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

105.05 Cooperation by Contractor. The Contractor will be supplied with a maximum of four sets of approved plans and contract assemblies, including special provisions, free of charge; one set of which the Contractor shall keep available on the work site at all times.

The Contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer and his inspectors, with utilities and with other Contractors in every way possible.

The Contractor shall have on the work at all times, as his agent, a competent English speaking superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or his authorized representatives. The superintendent shall have full authority to execute orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet.

The Contractor shall furnish the Engineer with a list of addresses and telephone numbers of his personnel who may be reached in case of emergency during hours when no work is being performed. On week-ends and during storms the Contractor shall alert certain of his personnel to stand by and shall inform the Engineer of arrangements so made.

The Contractor shall provide all required facilities and furnish the Commission the information, assistance and samples required by the Engineer and Inspector for proper inspecting or testing of materials and workmanship.

An acceptable Schedule of Work shall be submitted, on forms furnished by the Commission, indicating the order in which the Contractor proposes to carry out the work includ-

ing the dates he will start and complete work on the various items. Submission of the first progress estimate by the Engineer shall be contingent on acceptance of the Schedule of Work by the Commission.

In order that proper coordination may be obtained between the work of the Contractor and the work of various utilities a preconstruction utility meeting will be required when called for by the Engineer. A representative of each affected utility, the Contractor or his representative authorized to make decisions for him in regard to the scheduling of the proposed work, is required to attend the meeting. A report of the preconstruction utility meeting will be prepared and distributed by the Engineer to all represented at the meeting.

When the preconstruction utility meeting is called the Contractor shall submit an acceptable Schedule of Work not later than 10 days after the meeting. In preparing the Schedule of Work, due consideration shall be given to the complexity of the work to be done by the utilities. The Schedule of Work shall include a detailed schedule of the priorities of all operations involving the utilities. The agreements reached at the meeting shall be incorporated into the Schedule of Work. If a preconstruction utility meeting is not required the Contractor shall submit the Schedule of Work to the Commission within 10 days after the Notification of Award of the contract.

Revisions in the Contractor's Schedule of Work shall be set forth in a letter of notification to the Engineer, and if such changes affect the operations of a utility, a minimum of 10 days notice shall be given for such revisions unless previous arrangements have been made with the utility company involved.

105.06 Cooperation with Utilities. Pipe lines, gas lines, wire and cable lines, sewer lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, manholes and all other utility fixtures and appurtenances within the limits of the proposed construction will be relocated or adjusted by the owners without expense to the Contractor except as otherwise provided.

The Commission will notify all utility companies and other parties affected, and will endeavor to have all necessary adjustments of the public or private utility fixtures and appurtenances within the limits of construction made as soon as practicable. All necessary adjustments will include relocations, temporary or permanent, within the right of way or within the construction limit lines which are required to permit reasonably convenient and safe construction of the proj-

ect. All necessary adjustments will also include unforeseen conditions which would clearly be the responsibility of the Commission as provided above.

Where adjustments have not been completed, are not provided for in the Special Provisions nor are noted on the plans they may be agreed upon at the preconstruction utility meeting or at a special meeting called for this purpose. Adjustments due to unforeseen conditions may be made on order of the Engineer or may be agreed upon at a special meeting. The decision of the Engineer in ordering adjustments by utilities at their expense or at the expense of the Commission shall be final.

If the Contractor desires, for his convenience, temporary changes of location of utility fixtures and appurtenances, which are not the responsibility of the Commission as provided above, may be made. He shall satisfy the Commission that the proposed relocation does not interfere with his or other Contractor's operations or the requirements of the work and does not cause an obstruction or a hazard to traffic. The Contractor shall make his own request to the utility or other parties affected by such relocation work. Such relocation work shall be made solely at the Contractor's expense.

Any work done upon or within the right-of-way of a railroad shall be under the supervision and control of the Chief Engineer of the railroad or other designated officer of said railroad to the extent necessary, in the judgment of said Chief Engineer or other designated officer, to insure safe and uninterrupted operation of its trains and the convenient conduct of its business. Any additional conditions or requirements for doing work within the railroad right-of-way will be set forth in the Special Provisions.

It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility fixtures and appurtenances in their present or relocated positions as mentioned in the special provisions or as shown on the plans and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility fixtures and appurtenances or the operation of adjusting them.

105.07 Cooperation Between Contractors. The Commission reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

The Contractor shall arrange his work and shall place and dispose of the material being used so as not to interfere with

the operations of the other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others. In case of dispute the Engineer shall be the referee and his decision shall be final and binding.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the State from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operations of other Contractors working within the limits of the same project. He shall assume all responsibility for work not completed or accepted because of the presence and operation of the other Contractors.

105.08 Construction Stakes, Lines and Grades. The Engineer, unless otherwise specified by special provisions, will set reference stakes establishing lines, slopes, profile grade in road work, centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as he may deem necessary; and will furnish the Contractor with all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control from which the Contractor shall establish other necessary controls and perform the work.

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

The Commission, unless other provisions are made, will be responsible for the accuracy of lines, slopes, grades, and other engineering work set forth under this section.

105.09 Authority and Duties of Resident Engineer or Resident Inspector. The Resident Engineer or Resident Inspector has immediate charge of the details of each construction project. He is responsible for the administration and satisfactory completion of the project and has been delegated commensurate authority. The Resident Engineer or Resident Inspector has the authority to reject defective material and to suspend work that is being improperly performed.

105.10 Duties of the Inspector. Inspectors employed by the Commission will be authorized to inspect all work done and

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 will not be authorized to alter or waive the provisions of the contract. The inspector is not authorized to issue instructions contrary to the plans and specifications nor to act as foreman for the Contractor.

105.11 Inspection of Work. All materials and every detail of the work will be subject to inspection by the Engineer. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall 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 standards required by the specifications. Should the work thus exposed or examined prove to be acceptable, the uncovering, or removing, and the replacing of the covering or making good the parts removed will be paid for as extra work. Should the work so exposed or examined prove to be unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed, will be at the Contractor's expense.

Any work done or materials used without supervision or inspection by an authorized Commission representative may be ordered removed and replaced at the Contractor's expense unless the Commission representative failed to inspect after having been given reasonable notice that the work was to be performed.

When any unit of government or political subdivision or any railroad is to pay a portion of the cost of the work covered by this contract, its respective representative shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad a party to this contract, and shall in no way interfere with the rights of either party hereunder.

105.12 Removal of Unacceptable and Unauthorized Work. Except as provided in subsection 105.03 all work which does not conform to the requirements of the contract will be considered as unacceptable work.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness

or any other cause, found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner at the Contractor's expense.

No work shall be done without lines and grades having been given by the Engineer unless otherwise authorized. Work done contrary to the instructions of the Engineer, work done before preliminary measurements are made, work done without proper inspection, work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work done without authority and a prior agreement in writing as to price, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

When the material is fabricated or treated with another material, or where any combination of materials is assembled to form a product, any or all of which are covered by specifications, the failure of any of the components of the product to comply with the designated specification may be sufficient cause for the rejection of the whole.

Materials shipped from approved deposits or sources of supply which are found to be defective upon arrival at destination shall not be used.

105.13 Load Restrictions. The Contractor shall comply with all legal load restrictions in hauling on public roads beyond the limits of the project. A special permit will not relieve the Contractor of liability for damage which may result from the moving of equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or the roadway or to any other type of construction will not be permitted. Hauling of materials over the base courses or surface course under construction shall be limited to legal loads. No loads will be permitted on a portland cement concrete pavement, or structure before the expiration of the curing period. In no case shall legal load limits be exceeded unless permitted in writing, with the exception of equipment used in grading operations, which operation includes the preparation of the subgrade prior to the placing of the subbase course. The Contractor shall be responsible and pay for all repairs for damage done by his hauling equipment.

105.14 Approaches and Access. Any approaches, accesses, or median crossovers, other than public ways, contemplated by the Contractor shall be approved by the Engineer prior to their construction. All such approaches, accesses, or cross-

overs shall be removed, the ground restored to its original contour and the area loamed, seeded and mulched. This work will not be paid for directly but shall be considered incidental to the related items.

105.15 Maintenance During Construction. The Contractor shall maintain the work during construction and until the project is accepted. This maintenance shall consist of continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway or structures are kept in satisfactory condition at all times.

The Contractor shall provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and the safety of the public for all items not provided for in Section 630—Traffic Officers. This work will not be paid for directly but will be considered incidental to the related items.

In the case of a contract for placing a course upon a course or upon subgrade previously constructed, the Contractor shall maintain the previously constructed course or subgrade during all construction operations.

Costs of maintenance work during construction, and before the project is accepted shall be included in the unit prices bid on the various work items. Such work will not be paid for directly but shall be considered incidental to the related items.

105.16 Failure to Maintain Roadway or Structure. If the Contractor fails to comply with the provisions of subsection 105.15, the Engineer will notify the Contractor of such non-compliance. If the Contractor fails to provide satisfactory maintenance immediately after receipt of such notice, the Engineer may proceed to maintain the project, and the entire cost of this maintenance will be deducted from monies due or to become due the Contractor.

105.17 Acceptance.

(a) Partial Acceptance. If at any time during the prosecution of the project the Contractor completes a unit or portion of the project, such as a structure, an interchange, or a section of road or pavement, he may request the Engineer to make final inspection of that unit. If the Engineer finds upon inspection that the unit has been completed in compliance with the contract he may accept that unit as being completed and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance shall in no way void or alter any of the terms of the contract.

(b) *Final Acceptance.* Upon due notice from the Contractor of completion of the entire project, the Engineer will make an inspection. If all construction provided for and contemplated by the contract is found completed to his satisfaction, that inspection shall constitute the final inspection and the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction of same, and the Contractor shall immediately comply with and execute such instructions. Upon correction of the work, another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

105.18 Claims for Adjustment and Disputes. If the Contractor deems that additional compensation is due him for work or material not clearly covered in the contract or not ordered by the Engineer as extra work, as defined herein, the Contractor shall notify the Engineer in writing of his intention to make claim for such additional compensation before he begins the work on which he bases the claim. If such notification is not given, and the Engineer is not afforded proper facilities by the Contractor for keeping accurate account of actual costs, the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost shall not in any way be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the Engineer, is found to be just it will be paid as extra work as provided herein for force account work. Nothing in this subsection shall be construed as establishing any claim contrary to the terms of subsection 104.02.

105.19 Access to Contractor's Records. The Contractor and his subcontractors shall make foreman's daily time reports, records of force account work, employment records, payrolls, and other documents substantiating payment, available for inspection by authorized representatives of the Commission and shall permit such representatives to interview his employees during working hours. These records shall be retained for a period of at least 3 years after acceptance of the project.

SECTION 106 — CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. The materials used on the work shall meet the quality requirements of the contract at the time they are incorporated into the work. In order to expedite inspection and testing of materials, the Contractor shall notify the Engineer of his proposed sources of materials sufficiently prior to delivery to allow time for testing. Representative samples of materials may be taken at the source of supply by the Engineer for approval before delivery is started. If, after trial it is found that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources. All material will be tested and accepted as specified elsewhere in these specifications or as otherwise specified in the contract.

Samples of all materials for tests, upon which is to be based the acceptance or rejection, shall be taken by the Engineer either prior to shipment or after being received at the place of construction. Sampling, inspection, and testing shall be done in accordance with the methods hereinafter prescribed. The Contractor shall provide such facilities as the Engineer may require for conducting field tests and for collecting and forwarding samples. The Contractor shall not use or incorporate into the work any materials represented by samples until tests have been made and the material found to be acceptable unless otherwise authorized. Only materials conforming to the requirements of these specifications and which have been approved shall be incorporated in the work. It is the Contractor's responsibility to perform the work and supply materials using methods and equipment that will not cause materials to change in character, quality or gradation to the extent that they might be outside of the specification for the particular material during or after placing on the roadway. Any material which, after prior approval has been obtained, has for any reason become unfit for use or outside of its specification limits shall not be incorporated in the work.

106.02 Local Material Sources.

(a) *Designated Sources.* Possible sources of local materials may be designated on the plans and described in the special provisions. The quality of material in such source may be acceptable but the Contractor shall determine for himself the amount of equipment and work required to produce material meeting the specifications. It shall be understood that it is not feasible to ascertain from samples the limits for an entire source, and that variations shall be con-

sidered as usual and are to be expected. The Engineer may order procurement of material from any portion of a deposit and may reject portions of the source as unacceptable.

The Commission may acquire and make available to the Contractor the right to take materials from the sources designated on the plans and described under special provisions, together with the right to use such property as may be specified.

(b) *Contractor Furnished Sources.* If the Contractor desires to use material from sources other than those designated, he shall acquire the necessary right to take materials from the sources and shall pay all costs related thereto, including any which may result from an increase in length of haul. All costs of exploring and developing such other sources shall be borne by the Contractor. The use of material from other than designated sources will not be permitted until representative samples taken by the Engineer have been approved and written authority is issued for the use thereof.

When material sources are not designated the Contractor shall provide sources of material acceptable to the Engineer. When sources of material or material deposits are provided by the Contractor the Commission will assume the cost of processing a sufficient number of samples to determine the suitability of the material.

Sites from which material has been removed shall, upon completion of the work, be left in a neat and presentable condition. Where practicable, borrow pits, gravel pits, and quarry sites shall be located so that they will not be visible from the highway. Unless otherwise permitted, pits and quarries shall be so excavated that water will not collect and stand therein.

106.03 Samples, Tests, Cited Specifications. Materials will be inspected, tested and accepted as specified in subsection 106.01 by the Engineer before incorporation in the work. Any work in which untested and unaccepted materials are used without approval or written permission of the Engineer shall be performed at the Contractor's risk and may be considered as unacceptable and unauthorized and may not be paid for. Unless otherwise designated, tests in accordance with the most recent cited standard methods of AASHTO, ASTM, AWS or ASA, which are current on the date of advertisement for bids, will be made at the expense of the Commission. Samples will be taken by a qualified representative of the Commission. Materials being used are sub-

ject to inspection, test or rejection at any time prior to incorporation into the work. Copies of all tests will be furnished to the Contractor's representative at his request.

Designated tests and methods of sampling for Liquid and Cement Bituminous Materials, Bituminous Mixes, and Aggregates for Bituminous Mixes shall be those listed in the SPECIFIED TESTING PROCEDURES of the Bituminous Section, Maine State Highway Commission. The test procedure current on the date of advertisement for bids shall be used for control of the work for the project, unless otherwise specified. Copies of the SPECIFIED TESTING PROCEDURES and individual procedures are available at the office of the Commission.

106.04 Plant Inspection. The Engineer may inspect the materials at the plant.

In the event plant inspection is undertaken the following conditions shall be met:

(a) The Engineer shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has arranged for materials.

(b) The Engineer shall have full access at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.

(c) If required by the Engineer, the Contractor shall arrange for an approved testing laboratory building for the use of the inspector. The building shall be located near the plant and conform to the requirements of Section 639 — Engineering Facilities.

(d) Adequate safety measures shall be provided and maintained.

The Commission reserves the right, after material has been delivered and before the material is incorporated into the work, to retest the materials accepted at the source of supply and to reject all retested material which does not meet the requirements of these specifications or those established for the specific project.

106.05 Field Office. The Contractor shall supply, for the Engineer's use, a building located on an approved site. This building, including furnishings, shall be the type as specified in Section 639 — Engineering Facilities and constructed as shown on the plans.

If approved by the Engineer, the Contractor may substitute office facilities, which have at least equivalent furnish-

ings and floor space as the type of office called for in the proposal and on the plans. Payment of the first progress estimate may be contingent upon the availability of the field office.

106.06 Storage of Materials. Materials shall be stored to assure the preservation of their quality and fitness for the work. The method of storage shall be subject to the approval of the Engineer. Stored materials even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located to facilitate their prompt inspection. Portions of the right-of-way may be approved for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required shall be provided by the Contractor at his expense. Private property shall not be used for storage purposes without written permission of the owner or lessee; copies of such written permission shall be furnished to the Engineer upon his request. All storage sites, either on the right of way or on private property, shall be restored to their original condition at the completion of the project by the Contractor at his expense. The provisions of this subsection shall not apply to the stripping and storing of topsoil, or to other materials salvaged from the work.

106.07 Handling Materials. All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles constructed to avoid loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities and quality of materials intended for incorporation in the work and the quantities and quality of such material actually received at the construction site.

106.08 Unacceptable Materials. Materials not conforming to the requirements of the specifications, at the time they are used, shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the work site unless otherwise instructed by the Engineer. No rejected material, the defects of which have been corrected, shall be used until approval has been given by the Engineer.

106.09 Commission Furnished Material. The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Commission. Material furnished by the Commission will be delivered or made available to the Contractor at the points specified in the

special provisions. The cost of handling and placing all materials after they are delivered to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor will be held responsible for all Commission furnished material delivered to him and deductions will be made from any monies due to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges.

SECTION 107 — LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01 Laws to be Observed. The Contractor shall keep fully informed of all Federal and State Laws, all local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by himself, his employees or his subcontractors.

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

107.03 Patented Devices, Materials, and Processes. If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the State for any costs, expenses, and damages which it may be obliged to pay by reason of any infringement, at any time during the prosecution or after the completion of the work.

107.04 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the

highway or street or to grant permits to construct or reconstruct is, at any time during construction, hereby expressly reserved by the Commission and the Contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.

Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit from the Commission. The Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the Engineer, the Contractor shall make, in an acceptable manner, all necessary repairs due to such openings and such necessary work will be paid for as extra work or as provided for in the special provisions, and will be subject to the same contract conditions as the original work performed.

107.05 Federal Aid Provisions. When the United States Government pays all or any portion of the cost of a project, the Federal laws and the rules and regulations made pursuant to such laws must be observed by the Contractor. The reports, and the records enumerated in subsection 105.19 and the work shall be subject to the inspection by the appropriate Federal agency.

Such inspection shall 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.

107.06 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 of the State and Local Boards of Health, or of other bodies or agencies having jurisdiction. No source of inconvenience, complaint or nuisance shall result to the public or to residents or others in the vicinity of the work.

107.07 Public Convenience and Safety. The Contractor shall at all times conduct his work as to assure the least possible obstruction to traffic. The safety and convenience of the general public and the residents along the highway and the protection of persons and property shall be provided for by the Contractor as specified under subsection 105.15. Materials stored upon the highway shall be placed so as to cause no undue obstructions to traffic or to snow removal.

When not in use, construction equipment shall be parked off the highway whenever practical. In the event removal of equipment is not practical, barricades and warning lights

shall be used to clearly indicate the presence of a hazard to traffic.

Fire hydrants on or adjacent to the highway shall be kept accessible to fire apparatus at all times. Footways, gutters, sewers, inlets, and portions of the highway, adjacent to the work under construction, shall not be obstructed more than is necessary.

107.08 Railway-Highway Provisions. If the plans require that materials be hauled across the tracks of any railroad, the Commission will make preliminary arrangements with the railroad to permit any new crossings required or to permit the use of any existing private crossings. The Contractor shall negotiate and enter into any necessary agreements with the railroad pertaining to construction, maintenance and protection of the crossing and shall pay, as an expense incidental to the contract, all costs applicable thereto. If the Contractor elects to use crossings other than those shown on the plans or as described in the special provisions he shall make his own arrangements for the use of such crossings.

Work to be performed by the Contractor in construction on a railroad right-of-way shall be performed at such times and in such manner as not to unnecessarily interfere with the movement of trains or traffic upon the track of the railway company. The Contractor shall use care and precaution to avoid accidents, damage, or unnecessary delay or interference with the railway company's trains or other property. Work on a railroad right-of-way shall conform to provisions of subsection 105.06.

107.09 Bridges Over Navigable Waters. Work on navigable waters shall not interfere with free navigation of the waterways and shall not impair existing navigable depths and widths except as allowed by permit issued by the U.S. Army Corps of Engineers.

107.10 Water Traffic and Stream Discharge. The Contractor shall not unduly interrupt nor obstruct log driving on the river, stream or other waters affected by the work. He shall also provide for such other water traffic as may pass under or through the bridge. Whenever a movable span is included in the work he shall provide a clear and unobstructed opening having a width conforming to the lesser dimensions secured by either the old or the new structure, and shall provide and maintain such sights, signals, and other warnings as may be required for public safety and convenience or to conform with Federal regulations.

Expenses connected with the maintenance of water traffic and losses arising from unforeseen obstruction or difficulty encountered in connection therewith or from delay or hindrance from any cause resulting therefrom shall be borne by the Contractor and shall not constitute a claim for extra compensation or for an extension of time for the completion of the contract.

During construction and until completion of the work the Contractor shall provide a waterway ample and efficient for stream discharge. Any debris dropped into the stream bed, as the result of his operations, shall be removed by him and he will be held responsible for all damage which may be caused or may result from such water backing up or flowing over, through, from, or along any part of the work, or which any of his operations may cause to flow elsewhere. Furthermore he will be held responsible for all damage caused by or resulting from lowering the elevation of the water in the stream by reason of his operations.

107.11 Barricades and Warning Signs. The Contractor shall provide, erect and maintain necessary barricades, suitable and sufficient lights, signs and other traffic control devices, and shall take necessary precautions for the protection of the work and safety of the public. Obstructions shall be lighted during hours of darkness. Highways closed to traffic shall be blocked off by approved barricades and lights.

The Contractor shall provide, erect and maintain adequate warning signs as specified herein or as directed by the Engineer. Warning signs, barricades, lights, temporary signals, and other protective devices shall be constructed and erected in accordance with the plans furnished. In the absence of specific plans or instructions such devices shall conform to those outlined in the latest edition of the "Manual on Uniform Traffic Control Devices for Streets and Highways" — Part V, prepared by the National Joint Committee on Uniform Control Devices.

Warning signs "State Highway Under Construction" or "Bridge Under Construction" will be furnished by the Commission and shall be obtained by the Contractor from the nearest Commission Division Office. All other signs shall be furnished by the Contractor. The signs shall be placed as follows:

(a) "State Highway Under Construction" or "Bridge Under Construction" signs shall be conspicuously placed at least 200 feet but not more than 500 feet from each end of the project. Additional "State Highway Under Construc-

tion" or "Bridge Under Construction" signs shall be placed on intersecting side roads or streets at a distance of at least 200 feet from the intersection, or as directed by the Engineer.

(b) "Construction Ahead" signs shall be placed at a distance of 500 to 1,500 feet in advance of the "State Highway under Construction" or "Bridge under Construction" signs. Additional "Construction Ahead" signs shall be erected on intersecting side roads or streets at a distance of at least 200 feet from the intersection, or as directed by the Engineer.

(c) "Work Area" signs shall be erected, moved and re-erected and maintained at each location where designated by the Engineer and placed to provide maximum visibility and effectiveness during working hours.

When all work is completed on the project all signs furnished by the Commission shall be returned by the Contractor to the nearest Commission Division Office.

107.12 Use of Explosives. When the use of explosives is necessary the Contractor shall exercise the utmost care not to endanger life or property, including new work. The Contractor shall be responsible for all damage imposed by law resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with the latest approved rules and regulations for the keeping of explosives as set forth by the Insurance Department, State of Maine, and local laws and ordinances. All such storage places shall be clearly marked.

The Contractor shall notify each utility having structures close to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the utilities to take such steps as they may deem necessary to protect their property from injury. Such notice shall not relieve the Contractor of responsibility for any damage imposed by law resulting from his blasting operations.

Any site where electric blasting caps are located or where explosive charges are being placed or have been placed shall be designated as a Blasting Area. A Blasting Area shall be marked by approved signs with information similar to the following:

**BLASTING AREA
NO RADIO TRANSMISSION**

and on reverse side:

END OF BLASTING AREA

These signs shall be conspicuously placed at a distance of 500 to 700 feet from each end of the Blasting Area and shall remain in place only while these conditions are in effect and shall be removed after the blast or after all caps have been removed from the area.

All persons and adjacent property owners within the danger zone of blasting operations shall be warned by the Contractor, and no blasting shall be done until the zone is cleared. Sufficient flagmen, furnished by the Contractor, shall be stationed outside the danger zone to stop all approaching traffic during blasting operations.

The Contractor shall have adequate equipment available, immediately after blasting, to remove debris from the traveled way so that a normal flow of traffic may be restored with a minimum of delay.

Watchmen shall be provided by the Contractor during the loading period and until the charges have been exploded.

107.13 Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation of all public and private property and shall carefully protect from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall not enter upon private property for any purpose without first obtaining permission.

The Contractor shall be responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in his manner or method of executing the work, or at any time due to defective work or materials and said responsibility will not be released until the project shall have been completed and accepted.

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 by the Contractor, he shall restore, at his own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner.

In case of failure on the part of the Contractor to restore such property, or make good such damage or injury, the

Engineer may, upon 48 hours notice, excluding holidays and Sundays, proceed to repair, rebuild or otherwise restore such property as may be deemed necessary and the cost thereof will be deducted from any monies due or which may become due the Contractor under the contract.

107.14 Forest Protection. In carrying out work within or adjacent to State or National Forests, the Contractor shall comply with all regulations of the State Fire Marshal, Conservation Commission, Forestry Department, or other authority having jurisdiction, governing the protection of forests and the carrying out of work within forests and shall observe all sanitary laws and regulations with respect to the performance of work in forest areas. He shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures in accordance with the requirements of the forest supervisor.

The Contractor shall take all reasonable precaution to prevent and suppress forest fires and shall require his employees and subcontractors, both independently and at the request of forest officials, to do anything reasonable within their power to prevent and suppress and to assist in preventing and suppressing forest fires and to make every possible effort to notify a forest official at the earliest possible moment of the location and extent of any fire seen by them.

107.15 Responsibility for Damage Claims. The Contractor shall indemnify and save harmless the Commission, its officers and employees, from all suits, actions or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the said Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any omission, neglect, or misconduct of said Contractor; or because of any claims or amounts recovered from any infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act", or any other law, ordinance, order, or decree; and so much of the money due the said Contractor under and by virtue of his contract as may be considered necessary by the Commission for such purpose may be retained for the use of the State; or, in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims for injuries or dam-

ages as aforesaid shall have been settled and suitable evidence to that effect furnished the Commission.

The Contractor shall promptly pay all bills for labor, materials, machinery, water, tools, equipment, teams, trucks, automobiles, freight, fuel, light and power and for all other things, contracted for or used by him on account of the work herein contemplated. If at any time during the progress of the work or before final payment of any money due the Contractor under the terms of this contract, any claim for labor, materials, water, tools, equipment, teams, trucks, automobiles, freight, fuel, light and power, or for any other things specified as aforesaid, or for damages by reason of any acts, omissions or neglect of the Contractor in the prosecution of the work, shall be presented to the Commission, the Commission may retain such sum or sums from the monies due the Contractor under this contract as would be necessary to discharge all such claims whether for labor or materials or for damages as aforesaid when the validity of such claims shall be established and finally determined, all such claims may be paid from the amount so retained if it be sufficient for that purpose. If such claims are invalid and groundless, any amount so retained shall be paid to said Contractor or in case of default of contract to the Contractor's surety. Neither the Commission nor any member thereof shall be liable to any individual, firm or corporation making such claims for failure or refusal to hold and retain any money due under this contract for the purpose of payment of such claim. If the monies so retained under this contract are insufficient to pay all such claims presented to the Commission and adjudged by any court of competent jurisdiction to be valid obligations of said Contractor, the Commission may at its discretion pay the claim and the Contractor shall repay the Commission all sums so paid. The Commission, at its option, may also on the written consent of the Contractor use any monies due or to become due under this contract for the purpose of paying any claims presented to said Commission. Should the Contractor neglect to pay any undisputed claim made in writing to the Commission within 30 days after the date of final acceptance as specified in subsection 109.10, but continuing unsatisfied for a period of 90 days, the Commission may pay such claim and deduct the amount thereof from the balance due the Contractor.

Should the Contractor neglect to discharge any claim made in writing to the Commission within 30 days after the date of final acceptance of the project and continuing unsettled for a period of 6 months after the date of final acceptance,

the Commission may, after due notification to the surety, make the final payment.

107.16 Opening Sections of Project to Traffic. At the option of the Engineer, certain sections of the work may be opened for traffic. Such opening shall not constitute acceptance of the work, or any part thereof, or a waiver of any provisions of the contract; provided, however, that on such portions of the project as are completed and accepted for use of traffic, the Contractor shall not be required to assume any expense entailed in maintaining the roadway for traffic. Such expense shall be borne by the Commission or shall be compensated for in the manner provided for in subsection 104.03.

Any damage to the highway not attributable to traffic which might occur on uncompleted sections, except slides, shall be repaired by the Contractor at his expense. The removal of slides shall be done by the Contractor on a basis agreed to prior to the removal of such slides.

If the Contractor is dilatory in completing shoulders, drainage structures, or other features of the work, the Engineer may order all or a portion of the project open to traffic, but in such event the Contractor shall not be relieved of his liability and responsibility during the period the work is so opened prior to final acceptance. The Contractor shall conduct the remainder of his construction operations so as to cause the least obstruction to traffic, and in accordance with subsection 104.04.

107.17 Contractor's Responsibility for Work. Until final written acceptance of the project by the Engineer, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof. Damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God, of the public enemy or governmental authorities shall be repaired by the Contractor with the approval and under the direction of the Engineer and paid for at the respective contract unit prices for the quantities and items of work involved. In case of a contract for the placing of a base course or surface course or courses upon previously constructed and completed work, the Contractor

shall be required to maintain such previously constructed work concurrently with his other operations for the entire length of his project.

In case of suspension of work from any cause whatever, the Contractor shall be responsible for the project and shall take such precautions as may be necessary to prevent damage to the project, provide for normal drainage and shall erect any necessary temporary structures, signs, or other facilities at his expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under his contract, and shall take adequate precautions to protect new tree growth and other important vegetation growth against injury.

107.18 Contractor's Responsibility for Utility Property and Services. At the point where the Contractor's operations are adjacent to properties of railway, telegraph, telephone, and power companies, or are adjacent to other property, damage to which might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication of work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

The Contractor shall use suitable precaution to prevent damage to pipes, conduits and other underground structures; to poles, wires, cables, and other overhead structures, whether or not shown on the plans. Arrangements for special protection of utility plant, when needed, shall be made by the Contractor with the utility in advance of construction operations.

In the event of interruption to utility services as a result of accidental breakage or as a result of utility plant being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with the authority in the restoration of service. If service is interrupted repair work will be continuous until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued services have been approved by the local fire authority.

Telephone cables having plastic components are in common use. These components have a softening point of 176° F.

and a melting point of 230° F. The Contractor shall ascertain to his own satisfaction the extent to which such cables may affect his operations.

The Contractor shall not build fires near telephone cable lines which will produce temperatures around the cable in excess of 150° F. Fires will not be allowed when the wind direction is from the fire towards the cable line. Protection of the cable line from damage shall be the responsibility of the Contractor.

107.19 Furnishing Right-of-Way. The Commission will be responsible for securing all necessary right-of-way in advance of construction. Any exceptions will be indicated in the contract.

107.20 Personal Liability of Public Officials. In carrying out any of the provisions of these specifications, or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Commission, Engineer, or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.21 No Waiver of Legal Rights. The Commission shall not be precluded or estopped by any measurement, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefor from showing the true amount and character of the work performed and materials furnished by the Contractor, nor from showing that any such measurement, estimate or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Commission shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate and payment in accordance therewith, from recovering from the Contractor or his sureties, or both, such damage as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the Commission, or any representative of the Commission, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Commission, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

107.22 Minimum Wages. The wages for an hour's work paid to employees in the various classifications, as designated

in the proposal, shall not be less than the wage rates set forth in the contract. In those contracts containing wage determinations made by the U.S. Department of Labor as well as minimum wages established by statute or by a state agency, the larger of the amounts shall be the minimum wage for that classification. This provision, pertaining to wages, shall apply to all work performed on the contract by the Contractor with his own organization and to all work performed by a subcontractor.

107.23 Safety and Accident Prevention. The Contractor shall fully comply with all applicable Federal, State and local laws governing safety, health and sanitation. The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions, on his own responsibility or as the Engineer may determine, reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

107.24 Archaeological Deposits. All activities that would cause a disturbance to any object of archaeological interest shall immediately cease, and shall not be resumed until an investigation of the deposit has been completed and the removal of articles of interest has been accomplished. Should such a deposit be uncovered, the Contractor or Engineer shall notify the Commission immediately.

The first indication of Indian burial grounds or campsites may be the bones of the dead and their implements such as arrowheads, spear points and axes.

Delay of the Contractor's operations in the event of the above shall not be compensated for directly, but shall be considered to be incidental to general items in the contract, and may be subject to adjustment in working days or calendar days allowed, if delay involves one or more working days or calendar days.

SECTION 108 — PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of his right, title or interest therein, without written request to and written consent of the Commission.

Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing accom-

panied by a showing that the organization which will perform the work is particularly experienced and equipped for such work. The Contractor shall give assurance that the minimum wage for labor, as stated in his proposal, shall apply to labor performed on all work sublet, assigned or otherwise disposed of in any way. In case such consent is given, the Contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work amounting to not less than 50 percent of the total contract cost, except that any items designated in the contract by the Commission as Specialty Items may be performed by subcontract and the cost of any such Specialty Items so performed by subcontract may be deducted from the total cost before computing the amount of work required to be performed by the Contractor with his own organization.

Upon receipt of suitable evidence that the subcontractor is not performing in a satisfactory manner the Commission may, by a letter to the Contractor, withdraw its approval of a subcontractor. The Contractor upon receipt of such notice shall discharge the subcontractor from all further work on the contract, as a subcontractor. It is agreed between the parties to the contract that such action shall not constitute a breach of contract.

The Contractor shall file with the Commission copies of all assignments and shall, if requested by the Commission, furnish copies of sublet agreements. No subcontracts, nor transfer of contract, shall in any case relieve the Contractor of his liability under the contract and bonds.

In addition to the above it is agreed and understood that all subcontracts will contain, by inclusion or reference, all the pertinent provisions of the contract and will be subject to the terms and requirements thereof.

Contractors may, for purposes of this requirement, omit, remove or obscure the prices shown in the copy of the subcontract submitted to the Commission.

A subcontracting arrangement shall be considered to exist when a person or firm assumes obligation for performing part of the contract work, using their own equipment and workmen; procuring their own materials and supplies (exclusive of contract pay items such as Structural Steel, Delivered); and furnishing their own supervision with only general overall supervision being exercised by the prime contractor or approved subcontractor, then this person or firm must have prior approval as a subcontractor or lower tier subcontractor before performing work on any contract item.

The simple expedient of carrying the workmen of another recognized contractor on the prime contractor's or approved subcontractor's payroll, to avoid obtaining subcontract or lower tier subcontract approval, will not be permitted.

108.02 Notice to Proceed. The notice to commence work will stipulate the date on which it is expected the Contractor will begin the construction and from which date contract time will be charged. Commencement of work by the Contractor may be deemed and taken as a waiver on his part of this notice. In no case, however, shall the Contractor begin work prior to the date of execution of the contract agreement by the Commission.

108.03 Prosecution of Work. The Contractor shall begin work at such points and proceed in such order as set forth in the Schedule of Work as specified in subsection 105.05.

If, at any time during the construction of the project satisfactory progress is not being made to complete the project within the time specified in the contract the Engineer shall order, in writing, the Contractor to increase his forces, machinery and equipment. The Contractor shall comply with this order or he shall reply, in writing, to the Engineer why it would not be necessary for him to do so in order to complete the project within the time specified. The Commission reserves the right to request a revised Schedule of Work at any time. The failure of the Engineer to make such demand shall not relieve the Contractor of his obligation to complete the work within the time specified. The Contractor shall not suspend the work without a written order by the Engineer. Should the prosecution of the work for any reason be discontinued by the Contractor, with the written consent or order of the Engineer, he shall notify the Engineer at least 24 hours before again resuming operations; the Engineer may require the Contractor to resume operations by giving him a written 24-hour notice.

108.04 Limitation of Operations. The Contractor shall conduct the work at all times in such a manner and in such sequence as will assure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started. The Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional sections if finishing such section is essential to public convenience.

The Contractor shall not carry on construction operations on Sundays or Legal Holidays, unless of an emergency nature. Permission to work on Sundays and Legal Holidays must be obtained from the Engineer prior to the Sunday or Legal Holiday. In addition, if so directed by the Engineer, the Contractor shall suspend all work, other than maintaining the roadway for traffic, on all portions of the project open to traffic, at such other times as he deems necessary. When such suspensions are ordered, working days or calendar days will not be charged against the Contractor during the suspension period.

108.05 Character of Workmen, Methods and Equipment. The Contractor shall at all times employ sufficient superintendents, foremen, labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications and contract.

All workmen shall have sufficient skill and experience to perform properly the work assigned to them.

Any person employed by the Contractor or by any subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until such orders are complied with.

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work and to meet all safety requirements. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highways will result from its use.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that will accomplish the contract work in conformity with the requirements of the contract. On projects which are paid for in whole or in part from Federal funds the Contractor shall not use any equipment for which rental is

paid either directly or indirectly to the State or any County or Municipality.

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used, an explanation of the reasons for making the change and an estimate of savings or added cost, if any, to the Commission. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing construction work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall at his own expense remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in the basis of payment for construction items involved nor in contract time as result of authorizing a change in methods or equipment under these provisions.

108.06 Determination and Extension of Contract Time. The number of working days or calendar days allowed for the completion of the work will be stated in the proposal and contract, and will be known as the contract time.

When the contract time is on a working day basis, the Engineer will furnish the Contractor a written weekly statement showing the number of working days charged to the contract for the preceding week, the number of working days specified for completion of the contract, and the number of working days remaining to complete the contract. The Contractor will be allowed one week in which to file a written protest setting forth in what respects said weekly statement is incorrect, otherwise the statement shall be deemed to have been accepted by the Contractor as correct.

When the contract time is on a calendar day basis it shall consist of the number of calendar days stated in the contract counting from the effective date of the Engineer's order to proceed, including all Sundays, holidays and non-work days.

All calendar days elapsed between the effective dates of any orders of the Engineer to suspend work and to resume work for suspensions not the fault of the Contractor shall be excluded.

The number of working days or calendar days allowed to complete the contract is based on the original contract amount. If satisfactory fulfillment of the contract, with extension and increases authorized under subsection 104.02, shall require the performance of work in greater quantities than those set forth in the proposal, the contract time allowed for performance shall be increased in the same ratio that the total cost of the work actually performed shall bear to the total cost in the proposal. The increase in contract time shall be computed to the nearest one-half day.

When the contract is on a working day basis, the time charge shall start on whichever of the following dates occur first; the date that any work is performed on a pay item or the date specified in the Notice to Proceed as described in subsection 108.02. When the time charge is on a calendar day basis the computations shall start when any work is performed on a pay item. In any event the computations shall start no later than the date specified in the proposal.

Unless otherwise specified in the proposal the period from November 15th to May 15th, inclusive, all days not defined as working days as specified in subsection 101.91, all State of Maine holidays as specified in subsection 101.35 and all authorized suspensions as specified in subsection 108.04, shall be allowed the Contractor and shall be excluded from the number of working days.

When the contract is on a working day basis and work has been suspended during the winter months the time charge will start on the first working day after May 15th. If because of ground or weather conditions the Contractor is unable to work then a working day will not be charged.

If the Contractor finds it impossible for reasons beyond his control to complete the work within the contract time, he may make a written request to the Commission for an extension of time, setting forth therein the reasons which he believes will justify the granting of his request. The Contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the Commission finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, it may extend the time for completion in such amount as the conditions justify. The extended time for completion shall then be in full force

and effect the same as though it were the original time for completion.

When final acceptance has been duly made by the Engineer as prescribed in subsection 105.17 the daily time charge will cease.

108.07 Temporary Suspension of Work. The Engineer shall have the authority to suspend the work wholly or in part by written order, for such period as he may deem necessary due to unsuitable weather, to conditions considered unfavorable for the suitable prosecution of the work, or to failure on the part of the Contractor to correct conditions unsafe for workmen or the general public, or to carry out written orders given, or to perform any provisions of the contract, or for any other reasons or conditions deemed to be in the public interest.

If it should become necessary to stop work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public, nor become damaged in any way. He shall take every precaution to prevent damage or deterioration of the work performed, provide suitable drainage of the roadway by opening ditches, shoulder drains, and erect temporary structures where necessary.

108.08 Failure to Complete on Time. For each work day or calendar day that any work shall remain uncompleted after the contract time specified for the completion of the work, the amount per working day or calendar day, as specified in the proposal, shall be deducted from any money due the Contractor, not as a penalty but as liquidated damages; provided, however, that due account shall be taken of any adjustment of the contract time for completion of the work granted under the provisions of subsection 108.06. If such charges exceed the sum which would have been payable under the contract the Contractor and the Surety shall be liable and shall pay the Commission the amount of such excess.

108.09 Schedule of Liquidated Damages. The specific rates for liquidated damages shall be set forth in the following schedule:

Original Contract Amount		Amount of Liquidated	
From	To and	Damages Per Day	
More Than	Including	Calendar Day	Working Day
\$ 0	\$ 25,000	\$ 30	\$ 42
25,000	50,000	50	70
50,000	100,000	75	105

100,000	500,000	100	140
500,000	1,000,000	150	210
1,000,000	2,000,000	200	280
2,000,000	—	300	420

108.10 Default and Termination of Contract. If the Contractor:

- (a) Fails to begin the work under the contract within the time specified in the Notice to Proceed, or
- (b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work, or
- (c) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or
- (d) Discontinues the prosecution of the work, or
- (e) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
- (f) Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or
- (g) Allows any final judgment to stand against him unsatisfied for a period of 10 days, or
- (h) Makes an assignment for the benefit of creditors without authorization by the Commission, or
- (i) For any other cause whatsoever, fails to carry on the work in an acceptable manner, the Engineer will give notice in writing to the Contractor and his Surety of such delay, neglect, or default.

If the Contractor or Surety, within a period of 10 days after such notice, shall not proceed in accordance therewith, then the Commission will, upon written notification from the Engineer of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Commission may appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the Engineer will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Commission, together with the cost of completing the work under the contract, will

be deducted from any monies due or which may become due said Contractor. If such expense exceeds the sum which would have been payable under the contract, then the Contractor and the Surety shall be liable and shall pay to the Commission the amount of such excess.

SECTION 109 — MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. All work acceptably completed under the contract will be measured by the Engineer according to United States standard measure.

For all items other than those to be paid for by lump sum, after the work is completed and before final payment is made therefor, the Engineer shall determine the quantities of various items of work accepted as the basis for final payment. The Contractor, in case of unit price items, will be paid for the actual amount of work accepted and for the actual amount of materials placed. The quantities of work performed shall be computed in accordance with the method of measurements described herein under the item involved.

The distance between stations when used as a definition or term of measurement will be 100 linear feet measured horizontally.

The method of measurement and computations to be used in determination of quantities of materials furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for surface area computations will be made horizontally, and no deductions will be made for individual fixtures having a surface area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered by the Engineer.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions in accordance with the method of measurement stated in the specifications.

All items which are measured by the linear foot will be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans or in the special provisions.

In computing volumes of excavation the average end area method or other acceptable methods will be used.

The term "gage", when used in connection with the measurement of plates, will mean the U. S. Standard Gage, except

that when reference is made to the measurements of galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, then the term "gage" will mean that specified in AASHO M 36 or M 167.

Except for electrical application, when the term "gage" refers to the measurement of wire, it will mean the wire gage specified in AASHO M 32. When used in electrical applications the term "gage" will mean the American Wire Gage (Awg.).

The term "Ton" will mean the short ton consisting of 2,000 pounds avoirdupois. All materials which are measured or proportioned by weight shall be weighed on accurate approved scales. When a delivery slip is required for payment of materials measured by weight, weighing shall be performed by a Licensed Public Weighmaster furnished by the Contractor, on approved platform truck scales in accordance with the following requirements:

(a) *Licensed Public Weighmaster.* A Licensed Public Weighmaster shall be any person satisfying the requirements of the State Sealer of Weights and Measures, and granted a license as a Public Weighmaster. Each Licensed Public Weighmaster shall provide himself with an impression seal as required by the State Sealer, and shall impress this seal upon all delivery slips issued by him. Delivery slips shall, when completed by a Licensed Public Weighmaster, be considered as the Weight Certificates required by the Maine Weights and Measures Law. The Weighmaster shall perform all other duties required of him by the law and the specifications.

(b) *Weighing Trucks.* Tare weights of trucks hauling stone, bituminous mixes and similar items shall be determined twice daily, once during the forenoon and once during the afternoon. The tare weight thus found shall be used to determine the net load until the next tare weighing of the empty truck. Tare weights of trucks hauling liquid and bituminous cement materials, or other items not generally on a repeat basis shall be determined immediately before being loaded, and the weight thus found shall be used for that load only. The tare weight of a truck shall be defined as the weight of the empty vehicle including the driver, but with no passengers.

(c) *Platform Truck Scales.* An approved platform truck scale meeting the following requirements shall be provided, installed and maintained by the Contractor, or be available to him at an approved nearby location:

(1) The scale shall conform to the specifications, tolerances, and regulations for commercial weighing devices of the National Bureau of Standards, and shall be accurate within a maximum tolerance of plus or minus 2 pounds per 1,000 pounds of load.

(2) No auxiliary indicators, in combination with the beams or dial of the scale, shall increase the scale capacity above the manufacturer's rated capacity, which capacity shall be at least 10 percent in excess of the maximum gross load weighed.

(3) The platform of the scale shall be of sufficient size to accommodate the entire vehicle or combination of vehicles. If a combination of vehicles must be divided into separate units in order to be weighed as prescribed, each such separate unit shall be entirely disconnected before weighing, and a separate weight certificate, delivery slip, or ticket shall be issued for each such separate unit.

(4) The value of the minimum graduation on the indicator of the scale shall not be greater than 20 pounds. All weighing shall be read and recorded to the nearest 20 pounds or one-hundredth ton.

(5) The scale shall be set on concrete or other approved foundation. The recording mechanism of the scale shall be suitably housed or protected from the elements.

(6) The Contractor shall have the scale checked, inspected, and approved by the State Sealer of Weights and Measures within a period of 12 months preceding the date of any weighing and after each change of location.

(d) *Check Weighing.* Checks may be made on the weights and on the weighing on scales during production in the following manner:

(1) At least once each day, in the presence of a State inspector, a loaded truck which has been weighed and the weight slip issued, may be turned and a new weighing made of the truck and load with the truck heading in reverse of the direction and at the opposite end of the scale platform from the first weighing. The new weight will be recorded. If the variation from the first weight is 0.2 of 1 percent or less, the fact will be so noted in the project records. However, if the variation exceeds 0.2 of 1 percent the scales may not be used until rechecked and resealed by the State Sealer of Weights and Measures.

(2) At least once each day, a loaded truck which has moved off the scales will be intercepted, directed back to

the scales and reweighed under the supervision of a State inspector.

(3) At least once each day, in the presence of a State inspector, a truck which has been emptied will be directed to the scales before being loaded, at a time other than the normal tare weighing, and weighed again for a check on the tare weight.

(4) Check weighing will be on a plant basis and although a plant may produce material for more than one project or contract, check weighing will not be required for each project or contract.

(5) Although a minimum of one check weighing a day is specified, additional checks will be made occasionally at the discretion of the Engineer. Claims by the Contractor for delays or inconvenience due to check weighing will not be considered.

(e) *Reciprocal Agreements.* Weighing of materials on scales located outside the State of Maine will be permitted for materials produced or stored outside the state, when requested by the Contractor and approved by the Engineer.

Out of state weighing, in order to be approved, must be performed by a Licensed Public Weighmaster or a person of equal authority in the state concerned, on scales accepted in the state concerned and meeting the requirements given in subparagraph 109.01 (c) Platform Truck Scales.

(f) *Delivery Slips.* Serially pre-numbered delivery slips of acceptable size and format for stating the following minimum information shall be furnished by the Contractor, in as many copies as may be necessary. One copy shall be signed and retained by the Engineer or his inspector upon accepting delivery of the material.

(1) Vehicle identification

(2) Date

(3) Project

(4) Identification of material

(5) Quantity information as necessary:

Gross, Tare and Net Weights

Volume of Load, if not material requiring weighing

Net Gallons at 60° F. (Bituminous Liquids)

(6) Signatures (legible initials acceptable) of:

Weighmaster (if weight measured material)

Contractor's representative (if volume measured material)

State representative

Material included in the delivery slips, and not used in the work, or subsequently rejected, shall be deducted from the amount being measured for payment.

All quantities of materials delivered, as shown on the above required delivery slips, shall be reconciled between the Contractor and the Engineer before the end of the following working day.

If material is shipped by rail, the car weight may be accepted provided that only the actual weight of material be paid for. However, car weights will not be acceptable for materials to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the Engineer directs, and each truck shall bear a plainly legible identification mark.

Rail shipments of liquid bituminous materials shall be measured directly by volume. Correction shall be made when liquid bituminous material has been lost from the car, wasted, or otherwise not incorporated in the work.

Bituminous materials will be measured by the gallon or ton. Volumes will be measured at 60° F. or will be corrected to the volume at 60° F. using ASTM D1250 for asphalts or ASTM D633 for tars. The Table in subsection 702.04 contains the multipliers from these ASTM specifications and the multipliers to be used for emulsified asphalts and will be used for all Temperature - Volume corrections.

When bituminous materials are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming, may be used for computing quantities. Net certified weight shall be determined upon loading for all bituminous liquids when shipped by truck or transport. The net weight of each load shall be converted to net gallons at 60° F. by a conversion factor expressed in pounds per gallon.

109.011 Determination of Conversion Factor: The method, frequency of determination, and exactness of the conversion factor shall be as follows:

(a) The Bituminous Materials Inspector assigned to the Contractor's plant shall determine the specific gravity of the material according to AASHTO Method T 43, and corrected to 60° F. The specific gravity thus obtained shall be converted to the conversion factor by multiplying by 8.32823, the standard weight of 1 gallon of water at 60° F. and rounding the result to the nearest one-hundredth pound per gallon.

(b) A conversion factor shall be determined for each type and grade of bituminous material in storage. This conversion

factor shall serve for similar grades of materials in separate storage tanks at one plant location if the factors differ no more than 0.04 pound per gallon. The factor representing the greatest quantity of each material shall be used.

(c) A "Conversion Factor Determination Report" will be prepared by the Bituminous Materials Inspector for all types and grades of materials when available for shipment. This report shall bear the signature of the representative of the producer or supplier, signifying agreement on the conversion factor or factors as stated, and will be filed with the Commission.

Subsequent reports shall be prepared and filed according to the following schedule:

(1) Whenever new material, received or manufactured into storage, is found to have a conversion factor differing by more than 0.04 pound per gallon from the factor previously used for a similar grade of material.

(2) At the end of the week following the first and fifteenth day of each calendar month during production, the conversion factors for all types and grades of bituminous materials in storage shall be redetermined and reported, regardless of whether the materials have been altered by blending or by any other means.

(3) Whenever a request for a new determination of the conversion factor is made by either the Contractor or the Commission.

(d) The conversion factor, stated in pounds per gallon, as determined by the method stated above, for the particular type and grade of bituminous material loaded and weighed, shall be entered upon all loading invoices and delivery slips.

Upon delivery, the net gallons measured when loaded shall be subject to correction when liquid bituminous material has been lost from the vehicle, wasted, or otherwise not incorporated in the work. Correction when required at a location other than the point of loading and weighing, will be determined by volume measurement, using a calibrated tank gauge, measuring stick, or other measurement acceptable to the Engineer. Measurement shall be reconciled with the Contractor when performed and shall be final.

109.02 Scope of Payment. The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials and for performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage, or expense of whatever char-

acter arising out of the nature of the work or the prosecution thereof, subject to the provisions of subsection 107.21.

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

109.03 Compensation for Altered Quantities. When the accepted quantities of work vary from the quantities in the bid schedule, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the accepted quantities of work, unless an appeal has been filed under the dispute clause of subsection 105.18. No allowance, except as provided in subsection 104.02, will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursements therefor or from any other cause.

109.04 Extra and Force Account Work. Extra work performed in accordance with the requirements and provisions of subsection 104.03 will be paid for at the unit prices or lump sum stipulated in the order authorizing the work, or the Commission may require the Contractor to do such work on a force account basis to be compensated in the following manner:

(a) *Labor.* When the item "Hand Labor" is not called for in the proposal the following shall apply. For all labor and foremen in direct charge of the specific operations, the Contractor shall receive the rate of wage (or scale) agreed upon by the Engineer before beginning work, for each and every hour that said labor and foremen are actually engaged in such work. To such labor costs shall be added an amount equal to 30 percent of the sum thereof; which added amount shall constitute payment for all bond and insurance premiums and taxes paid by the Contractor for property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions, social security taxes and other overhead and profit on the force account work.

When the item "Hand Labor" is called for in the proposal, labor shall be paid for at the contract unit price per hour to which no percentage will be added. Specialized skilled labor

will be provided on an agreed price basis in accordance with the preceding paragraph. The Engineer reserves the right to determine the number and type of labor employed under this subsection.

(b) *Materials.* For all materials used, and incorporated in the permanent work, the Contractor shall receive the actual cost of such materials, and freight and delivery charges, as shown by the original receipted bills, plus 15 percent of such costs. For all materials not incorporated in the permanent work, the Contractor shall receive the actual value of such material at the time of its use less the fair salvage value of the material when released. Upon the sum thus determined an allowance of 15 percent will be made to the Contractor.

(c) *Equipment.* When the item "Equipment Rental" is not called for in the proposal the following shall apply:

For any power operated machines or other equipment, including trucks, the use of which has been authorized by the Engineer, the Contractor shall receive the rental rates approved by the Engineer for the actual time that such equipment is in operation on the work, to which rental sum no percentage shall be added.

When the item "Equipment Rental" is called for in the proposal the desired items shall be used in accordance with their specifications.

(d) *Superintendence.* No part of the salary or expenses of anyone connected with the Contractor's forces above the grade of foreman and having general supervision of the work, will be included in the labor items as specified above, except when the Contractor's organization is entirely occupied with force account work, in which case, the salaries of the superintendent and the timekeeper may be included in the labor item specified above when the nature of the work is such that, in the opinion of the Engineer, their services are required. The allowable rate of pay of such employees shall be as agreed upon before starting the work.

(e) *Compensation.* The compensation as set forth above shall be received by the Contractor as payment in full for extra work done on a force account basis.

(f) *Statements.* All statements shall be accompanied and supported by receipted invoices for all materials used and transportation charges, provided that, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then in

lieu of the invoices the statements shall contain or be accompanied by an affidavit of the Contractor certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor. No payment will be made for work performed on a force account basis until the Contractor has furnished to the Engineer duplicate itemized statements of the cost of such force account work detailed as to the following:

(1) Name, classification, date, daily hours, total hours, rate, and amount for each foreman and laborer.

(2) Designation, dates, daily hours, total hours, rental rate, and amount for each unit of equipment.

(3) Quantities of materials, prices and amounts.

(4) Transportation charges on materials.

(g) *Specialty Work.* When specialty work is considered necessary for the satisfactory completion of the project for which there is no contract price and the type of work involved requires specially trained men and special equipment, the Contractor may engage an approved concern or personnel to do this work.

Payment for acceptably completed specialty work will be made on the basis of the total cost of the work, as supported by an invoice in duplicate, made out to the Contractor, from the concern actually performing the work.

Total cost of the work shall mean the cost of all labor, materials, equipment, tools, insurances, taxes and any other authorized costs necessary to complete the work.

To the sum thus determined an amount of 15 percent will be allowed the Contractor.

109.05 Eliminated Items. Should any items contained in the proposal be found unnecessary for the proper completion of the work, the Engineer may, upon written order to the Contractor, eliminate such items from the contract, and such action shall in no way invalidate the contract, and no allowance will be made for anticipated profits for items so eliminated in making final payment to the Contractor. When a Contractor is notified of the elimination of items, he will be reimbursed for actual work done and costs incurred in partial performance of the eliminated items, as shown on bills submitted by the Contractor, including mobilization of materials prior to said notification.

109.06 Adjustments for Changes in Common Carrier Rates. It is understood and agreed that the accepted proposal for this project is based on common carrier rates on file with the Interstate Commerce Commission or with a corresponding intra-state commission or body and in effect as of the date of opening bids. Payments to the Contractor will be adjusted to compensate for increases and decreases in cost due to changes in common carrier rates becoming effective after the date of opening of bids and before the date stipulated for completion of the work, as adjusted because of authorized extensions of time. The adjustment shall be limited to an amount determined as follows:

The adjustment shall be the product of the net increases or decreases in the said common carrier rates, multiplied by the net quantity of material shipped at the new rates to the work and incorporated therein, all as shown by the receipted common carrier bills.

109.07 Partial Payments. Partial payments will be made at least once each month as the work progresses. Estimates may be paid twice each month if in the judgment of the Engineer the amount of work performed is sufficient to warrant such payment. Said payment will be based upon estimates prepared by the Engineer of the value of the work acceptably performed and materials complete in place in accordance with the contract and for materials delivered in accordance with subsections 109.08 and 109.09. All partial estimates and payments shall be subject to correction in subsequent partial estimates and payments and on the final estimate and payment. No such estimate or payment shall be required to be made when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the contract or when the total value of the work done since the last estimate amounts to less than \$1,000.

From the amount for payment shown on the progress estimate will be deducted 10 percent, until the amount so deducted equals 5 percent of the amount of the contract; and the balance, less all previous payments, shall be certified for payment. Thereafter, no additional deduction will be made, except as provided in subsection 107.15 of these specifications.

Upon completion of the work under this contract the Engineer may release 60 percent of the amount then retained. The balance of the amount retained will be held until all reports required of the Contractor are received and final payment is authorized by the Commission. The Commission may, at its option, retain temporarily or permanently a smaller amount

and may cause the Contractor to be paid temporarily or permanently, from time to time, such portion of the amount retained as it deems equitable.

109.08 Payment for Material Delivered on the Project.

At the discretion of the Engineer, acting upon the request of the Contractor, an estimate, accompanied by receipted bills, may be made for payment of all or part of the value of acceptable, non-perishable materials which are to be incorporated in the work, such as stone masonry, curbing, timber and lumber, metal culverts, stone, sand, gravel and other materials delivered on the work or in the vicinity of the work at acceptable storage places, and not used at the time of such estimate. Materials, when so paid for by the Commission, shall become the property of the Commission, and in the event of default on the part of the Contractor, the Commission may use, or cause to be used, these materials in the construction of the work provided for in the contract. The Contractor shall be responsible for any damage to, or loss of, these materials.

The payment for certain materials shall be determined as follows:

(a) Borrow and unprocessed aggregates: 50 percent of the unit price.

(b) Processed aggregates, except stone; stockpiled in the pit, 30 percent of the unit price; when stockpiled on the project, 60 percent of the unit price.

(c) Processed stone; stockpiled in the quarry, 45 percent of the unit price; when stockpiled on the project, 55 percent of the unit price.

(d) Loam stockpiled; 25 percent of the unit price.

(e) Payment for all other materials shall be made as previously specified.

The amount thus paid by the Commission shall go to reduce estimated amounts due the Contractor as the material is used in the work.

Partial payments for materials stockpiled will not constitute acceptance and any faulty material will be rejected even though previous payment may have been made.

No allowance for partial payment shall be made upon fuels, supplies, form lumber, false work, or other materials, or on temporary structures of any kind which are not in the contract as a pay item or covered by the provisions of subsection 109.04.

No payment will be made on living or perishable plant materials unless acceptably planted in their final location.

109.09 Payment for Materials Not Delivered on the Project.

At the discretion of the Engineer, acting upon the request of the Contractor, an estimate accompanied by receipted bills, may be made for payment for all or part of the value of acceptable non-perishable material not delivered on the project but stored in acceptable storage, and not used at the time of such estimate. Payment for such materials shall be in accordance with subsection 109.08. In addition, the Contractor will provide a material bond in the amount of payment contemplated. The form of bond shall be that provided by the Commission and the surety shall be one which is acceptable to the Commission. A certified and duly executed copy of the bond shall be filed with and approved by the Commission before any payment is made. Payment will be made in the amount indicated by receipted bills filed with the Commission. Total payments made to the Contractor shall not exceed the amount specified in the bond.

109.10 Acceptance and Final Payments. When the project has been accepted as provided in subsection 105.17 the Engineer will prepare a final quantity estimate of the various classes of work performed. After approval of such final quantity estimate by the Contractor, and after all supporting information necessary to substantiate pay quantities such as statements itemizing force account work have been furnished by the Contractor, he will be paid the sum found to be due after deducting all previous payments and all remaining amounts to be retained or deducted under the provisions of the contract.

Upon submission by the Contractor of all required reports, completed forms and certifications and a written statement that all bills for labor and material used under this contract have been paid the payment of final estimate for the remaining amount retained may be paid. A written request for payment of the final estimate should accompany this statement but the failure of the Contractor to make a request for payment of the final estimate shall not prohibit the Commission from authorizing final payment. The acceptance by the Contractor of the final payment under the contract shall constitute a release to the Commission from all claims and liability under the contract. Upon termination of work and acceptance of the payment by the Contractor, the Contractor shall then be released from further obligation, except as set forth in the contract bond.

All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

DIVISION 200 — EARTHWORK

SECTION 201 — CLEARING RIGHT-OF-WAY

201.01 Description. This work shall consist of clearing, selective clearing and thinning, tree removal, including dead, blown down or uprooted trees, removing and disposing of all stumps, stumps and debris within the limits of the right-of-way and easement areas except such objects as are designated to remain or are to be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain and the treatment of stumps and stumps with herbicides.

(a) *Clearing.* Clearing shall consist of cutting and disposing of all trees, down timber, stubs, brush, bushes and debris within designated limits.

(b) *Selective Clearing and Thinning.* Selective clearing and thinning shall consist of cutting and disposing of designated trees, down timber, stubs, brush, bushes and debris within designated limits.

(c) *Tree Removal.* Tree removal shall consist of cutting and disposing of single trees, stubs, stumps and roots, located outside the limits of clearing or selective clearing and thinning limits, as indicated on the plans or as authorized.

1. A single tree is defined as any tree, or remains of a tree, still standing, 9 inches or more in its largest cross-sectional dimensions measured as specified in subsection 201.09 and taller than 10 feet measured from the ground at the base of the tree.

2. A stub is defined as the remains of a single tree as stated in 1 above, still standing, from which the topping has been removed, which is not more than 10 feet nor less than 3 feet in height measured from the ground at the base of the stub.

3. A stump is defined as the remains of a single tree from which the toppings have been removed and which is less than 3 feet in height measured from the ground at the base of the stump.

MATERIALS

201.02 Materials. Materials shall conform to the requirements specified in the following subsections of Section 700 — Materials:

Herbicide	712.31
Tree Paint	708.04

CONSTRUCTION REQUIREMENTS

201.03 General. The Engineer will establish right-of-way lines and construction lines and designate the trees, shrubs, plants and other things to remain. All things designated to remain shall be preserved.

Alignment stakes, grade stakes, witness stakes, boundary markers, bench marks and tie points shall be preserved until such time as their usefulness has ceased and permission for their destruction is given by the Engineer.

201.04 Clearing. In areas indicated on the plans, all trees, down timber, stubs, brush, bushes, shrubs, plants, and debris not designated to remain shall be removed and disposed of. Grubbing, as defined in subsection 203.01 (a), will not be required under this item.

In areas where the proposed embankment is not designated to be grubbed, as provided in subsection 203.09, all stumps shall be cut off as close to the ground as is practicable, but not to exceed 4 inches above the ground surface at the base of the stumps. When stumps are to remain in the backslope rounding of cut sections, they shall be cut flush with or below the final slope line.

All merchantable timber and wood in the clearing area, except trees designated to remain, which has not been removed from the right-of-way prior to the beginning of construction, shall become the property of the Contractor, unless otherwise provided.

Unsound or unsightly branches of trees and shrubs designated to remain, and not specified to be removed under another item, shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to provide a clear height of 20 feet above the road and shoulder surface. Trimming shall be done by skilled workmen and in accordance with good tree surgery practices. All such removing and trimming, painting with tree paint and the disposal of debris, shall be a part of and incidental to other contract items, whether or not the contract provides for clearing, selective thinning or tree removal.

Because of the disease-carrying characteristics of elm trees, the Contractor shall take special care to completely dispose of all elm trees removed, either by burning or by burying under soil in approved areas. These elm trees shall be disposed of within 10 days after cutting. Longer periods may be authorized during the period between November 15 and April 15.

All live stumps or stubs, except evergreens, 1 inch or more in diameter located between the lines of improvement and the outermost clearing or selective clearing lines shall be treated with an herbicide as provided under subsection 201.06.

In areas where stumps and shrubs are to remain, the surface of the ground shall not be unduly disturbed or compacted. Existing ground cover shall be preserved insofar as possible and the area shall be left neat and clean and in a condition which is reasonably consistent with the surroundings.

201.05 Selective Clearing and Thinning. The Contractor shall substantially complete all grading, including drainage-ways and slopes, before beginning selective clearing operations, unless directed otherwise by the Engineer. In order that the trees may be properly marked in advance of thinning operations, the Contractor shall give the Engineer at least 2 weeks notice prior to starting work and prior to resuming work after suspending operations. Only those trees or bushes designated to be removed shall be cut. In no event shall selective clearing and thinning operations begin until the Engineer has given his approval.

All dead or diseased trees or shrubs, junk, trash, litter or foreign matter of any kind shall be removed from the areas to be enhanced. This shall include uprooted stumps and all branches, tops, trunks and dead wood, resulting from wood-cutting operations or from any other causes.

Trees and shrubs to be preserved shall be carefully pruned to remove all dead, diseased and injured wood. In addition, in certain areas, the Engineer may require the branches of designated trees to be removed to a height above ground as directed in order to improve sight distance, provide head clearance, open vistas or improve appearance of the tree. Complete clearing may be required in certain areas for the purpose of removing drainage obstructions, shade hazards, improving sight distance, and improving appearance. Such clearing shall be included under this subsection. Storing logs and pulpwood in thinned areas shall be avoided.

The Contractor shall avoid disturbing or compacting the existing ground surfaces as well as avoiding damage to plant growth. Use of tractors, cranes, winches, or any other heavy equipment, operating anywhere within the area to be selectively thinned, will not be allowed unless exceptions are specifically authorized. The use of horses will be allowed only if they are used in such a manner as not to damage plant growth to be preserved and not to unduly disturb or compact the ground surface.

Any injury to trees and shrubs which are to be preserved shall be carefully repaired. Disturbed ground surface shall be restored as nearly as possible to natural conditions.

Pruning and repairs to live trees and shrubs shall be done by skilled workmen or tree surgeons according to approved arboricultural practice. Pruning scars and cuts and wounds 1 inch in diameter or over shall be painted with an approved asphaltic base tree paint prepared and customarily used for tree surgery purposes. The Engineer may permit such cuts on evergreen trees to remain unpainted. Stumps, new or old, shall be cut to a maximum height of 4 inches above the surrounding ground or as approved by the Engineer.

Trees falling outside the specified limits of the thinning areas shall be removed and disposed of in a satisfactory manner. Undesirable trees leaning or falling over the highway right-of-way from outside shall be cut at the property line.

All wood, branches, junk, trash, debris, or foreign matter shall be cleared away and disposed of in accordance with the provisions of subsection 201.07.

201.06 Herbicides. All stumps and stubs, new or old, shall be cut to a maximum height of 4 inches above the level of the surrounding ground or as approved by the Engineer. With the exception of coniferous (softwood) trees, the stumps and stubs above 1 inch in diameter resulting from the cutting of live trees and shrubs shall be treated with the herbicide spray mixture. The spray mixture may be applied at any time until regrowth from the stumps has reached a height of approximately 24 inches except that it shall not be applied when the stumps are wet or frozen. The herbicide spray mixture shall be sprayed or brushed on all exposed surfaces of stumps, stubs, and the stems only, of regrowth, until there is complete saturation and run-off. Particular attention shall be given to the bark and all exposed roots.

All stumps and stubs shall receive at least one treatment with the herbicide spray mixture. Following the initial treatment any regrowth from stumps and stubs and any new seedling growth of undesirable trees shall be retreated as many times as necessary to control such growth. During the life of the contract, treatments shall be given as often as necessary to keep regrowth from reaching a height of more than 24 inches. At the time of Final Acceptance, live regrowth or hardwood tree seedlings shall have been substantially eliminated.

Particular care must be taken that the spray does not get on or too near live trees and shrubs that are to be saved. Unless otherwise directed by the Engineer none of the spray mixture shall be applied closer than two feet from the trunk of a tree that is to be saved, even if this means not treating certain stumps close by.

The Contractor shall be responsible for maintaining the treated area until final acceptance of the work. Any damage or die-back due to wind, fire, exposure or any other cause, shall be repaired at the Contractor's expense as directed. At the time of final acceptance the area shall be free of all dead, dying, or damaged trees and shrubs and litter of any kind as well as free from regrowth.

201.07 Disposal. Except as otherwise provided all unburned wood, trash, debris, stumps and other foreign matter shall be removed and disposed of by the Contractor. Disposal may be by depositing in approved waste areas, by burning, by chipping when authorized or under certain conditions by the lop and scatter method. Materials and debris which cannot be burned shall be disposed of at approved waste areas in accordance with the applicable provisions of subsection 203.06.

All burning on the project shall be done in accordance with applicable laws and ordinances. Burning shall be under the direction of competent watchmen with extreme care taken to control the fires. Fires will not be allowed where there is any possibility of burning, scorching, overheating or otherwise jeopardizing trees, shrubs, surrounding forest cover or adjacent property or buildings nor where there is a possibility of damaging overhead wires and cables. Fires will not be allowed where undisturbed ground is to remain exposed nor on areas which have been seeded to grass or other plants.

Wood chipping shall be done with approved wood chipping machines capable of reducing woody material to chips not over ¼ inch in thickness nor over 8 inches long. Chips shall be distributed in a thin layer over the ground surface. Ground cover plants shall not be smothered and drainageways shall not be blocked. If the wood chipper and any auxiliary machines damage existing plants or ground surface, the Engineer may prohibit its further use.

Any debris remaining after burning is completed shall be removed in a satisfactory manner. Any damage to base, slopes or other accepted areas will be the responsibility of the Contractor and shall be repaired without compensation.

Where the outer line of Selective Clearing and Thinning is more than 115 feet from the edge of pavement, the Engineer

may allow slash or other woody material, originating outside the 115 foot line, to be disposed of in the thinned area where it originates, provided that it is disposed of carefully at such location and in such manner as approved by the Engineer. Disposal may be by the lop and scatter method or by burning, as directed by the Engineer. Approval by the Engineer of this system of disposal will be contingent on handling of the woody material in such a manner as to create nothing of an unsightly nature conspicuous from the roadway.

The Contractor will be held responsible for any damage caused by fires built in the process of constructing the project. Such responsibility shall include removing and disposing of burned material, replacing trees, shrubs, fences or any other material or object which has been designated to remain, and seeding, fertilizing and mulching the burned areas. At the option of the Engineer, a cash settlement, instead of replacing damaged trees and plants, may be assessed or a combination of replacement and cash settlement. When directed by the Engineer, the Contractor may be required to perform such work beyond the right-of-way lines.

201.08 Removing Single Trees, Stumps and Stubs. When called for on the plans or designated by the Engineer, complete removal and disposal of single trees, stumps and stubs shall be required and shall include the backfilling of stump holes. In congested areas and areas where traffic is flowing, special care shall be taken to prevent falling branches and trunks from causing damage or becoming a hazard. Special equipment shall be provided for the prompt removal of obstructions from the roadway.

Dead trees which are standing erect shall be removed by cutting as close to the ground as possible. The stump may remain.

Trees which have been uprooted shall be removed by cutting the tree and removing the stump from the ground or where approved by the Engineer, the stumps may be placed back in the hole to present a natural appearance. The area shall be graded to conform to the surrounding terrain.

The trees and stumps which are removed shall be disposed of by the Contractor in accordance with the applicable requirements for wasted material.

201.09 Method of Measurement. Clearing, and selective clearing and thinning will be measured by the acre, determined from horizontal dimensions, acceptably cleared or thinned within the limits shown on the plans or additional

areas staked by the Engineer. Areas not shown on the plans or not staked for clearing or thinning will not be measured for payment.

Single trees, stubs and stumps will be measured by the unit. The classified size of the tree trunk or stub shall be the greatest horizontal cross-sectional dimension determined at a height of 4½ feet above the ground. When the removal of trees or stumps is performed under this contract and the removal of the stump is also required, the stump classified size shall be the same size as that determined for the tree or stub. The classified size of all other stumps shall be the greatest horizontal cross-sectional dimension determined at the top of the stump. Trees, stubs, or stumps which have multiple trunks protruding from a single base trunk shall be measured for payment as a single tree or stub. The classified size shall be determined as the diameter of a circular cross-sectional area which shall be equal to the combined cross-sectional areas of the several trunks forming the tree, stub or stump. Individual trunks of multiple trunk trees, stubs or stumps having a diameter of less than 9 inches will not be included in the summation of trunk areas to determine the size of a tree, stub or stump.

201.10 Basis of Payment. The accepted quantities of clearing, selective clearing and thinning, will be paid for at the contract unit price per acre.

The accepted quantity of single trees, stubs and stumps removed will be paid for at the contract unit price for each. Payment for trees and stubs shall include removal and disposal of the entire tree or stub except the stump. Payment for stumps shall include removal and disposal of the stump and roots. Stumps removed from grubbing areas and excavation areas which are also within clearing areas will not be paid for directly but their removal shall be considered incidental to the various contract bid items. Stumps removed from within grubbing areas and excavation areas located outside of clearing areas will not be paid for directly unless they result from the removal of the single tree tops, or stubs under this contract, or unless they are shown on the plans as single trees or stubs. All other stumps designated to be removed will be paid for at the contract unit bid price.

The accepted quantity of removal of dead, blown down, or uprooted trees over 6 inches in diameter will be paid for at the contract unit price each. No reduction in payment will be made for removal of such tree trunks when the stump is left in place. Trees which are less than 6 inches in diam-

eter will not be paid for but shall be removed as directed and the costs considered incidental to the various bid items.

When the bid schedule does not contain an estimated quantity for clearing, the work will not be paid for directly but shall be considered incidental to the other contract items.

Whenever the use of herbicide or tree paint is required to complete the work outlined under this section, it will not be paid for directly, but will be considered as incidental to the other contract items.

Grubbing, when required will be measured and paid for as provided in Section 203 — Excavation and Embankment. Payment for removal of trees, stumps and stubs, not classified as pay items under this Section, shall be considered incidental to the various contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
201.11 Clearing	Acre
201.12 Selective Clearing and Thinning	Acre
201.13 Removing Single Trees, 9 inches to 24 inches, Tops only	Each
201.14 Removing Single Trees, over 24 inches to 48 inches, Tops only	Each
201.15 Removing Single Trees, over 48 inches, Tops only	Each
201.16 Removing Stubs, 9 inches to 24 inches, Tops only	Each
201.17 Removing Stubs, over 24 inches to 48 inches, Tops only	Each
201.18 Removing Stubs, over 48 inches, Tops only	Each
201.19 Removing Stumps, 9 inches to 24 inches	Each
201.20 Removing Stumps, over 24 inches to 48 inches	Each
201.21 Removing Stumps, over 48 inches	Each
201.22 Removing Dead, Blown Down or Uprooted Trees, over 6 inches	Each

SECTION 202 — REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.01 Description. This work shall consist of the removal wholly or in part, and satisfactory disposal of all designated buildings, structures, old pavement, and other obstructions which are required to be removed, except for

the obstructions to be removed and disposed of under other contract items. It shall also include the salvaging of designated materials.

CONSTRUCTION REQUIREMENTS

202.02 Removal of Buildings. The Contractor shall remove and dispose of all buildings and foundations indicated.

Cavities remaining as a result of foundation or structure removal shall be filled to the level of the surrounding ground and, if within the limits of embankment or below the subgrade in excavation areas, shall be compacted in accordance with applicable embankment construction requirements.

Details of the ownership of the building and all the equipment, fixtures and materials therein, except equipment belonging to a public utility, or equipment or fixtures specifically excepted, and details relative to the date of availability of the property, will be stated in the Special Provision.

Written notice will be given the Contractor when any building becomes available prior to the date specified. On the above specified date, or upon notice of availability, ownership of the buildings shall transfer from the State to the Contractor who then shall proceed with the work required under this section. The buildings shall not be used or occupied for any purpose while in the right-of-way and the buildings shall be removed as soon as possible after date available, unless otherwise authorized.

If, during the negotiations between the State and the owners of the building specified under this section, agreements are made with the owners to move, remove or raze the buildings, the State reserves the right to remove any or all items from the contract upon written notice to the Contractor and no payment will be made for the items. Removal of debris, when necessary under such conditions, will be accomplished under Section 629 — Hand Labor and Section 631 — Equipment Rental.

All debris and unusable materials shall be removed to an approved dump, or a waste area. No material shall be disposed of on the premises by burning unless written permission of the Engineer is obtained as well as a permit from the local Fire Department.

202.03 Removal of Existing Superstructure.

(a) *General.* Removal of existing superstructures shall consist of the removal and disposal of existing superstruc-

tures and pile or trestle bents at sites where new structures are located and/or at other sites shown on the plans. Where pile or trestle bents are involved, the piles shall be removed to at least one foot below existing ground or stream bed elevation or to such other elevations as called for on the plans or in the special provisions. Removal of concrete shall be accomplished without damage to the portion of the structure which is to remain.

(b) *Material Retained by Commission.* When the material from an existing structure is to be retained by the Commission, it shall be carefully dismantled by the Contractor, and all materials except those which may be specified to be re-used in the new structure, shall be loaded on trucks supplied by the Commission or carefully stored within the right-of-way. The use of any portion of the salvaged material in connection with new or temporary construction shall not be anticipated by the Contractor. The dismantling of metal structures shall, when especially provided, include the removal of all bolts and rivets necessary to disconnect the members, and the match-marking of these members for future reassembling.

(c) *Material to Become Property of Contractor.* When the material from an existing structure is designated to become the property of the Contractor, it shall be entirely removed and disposed of out of sight of the highway and beyond the limits of the right-of-way. Such material shall not be deposited in rivers, streams or other bodies of water. If the material is to be wasted then it shall be disposed of at a public dump or other approved location.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which might damage new construction, shall be completed prior to placing the new work or, if this is not feasible, done only if approved by the Engineer and entirely at the Contractor's risk.

202.04 Removal of Pavement. All portland cement concrete pavement and portland cement concrete base course designated for removal shall be broken into pieces suitable for use in construction of embankment or disposed of as directed. When used in the construction of embankments, the maximum size of any fragment shall not exceed the thickness of the layer being placed. The Contractor may, at his option and with the approval of the Engineer, dispose of material in approved waste areas and replace with an equivalent volume of granular borrow at no cost to the State.

202.05 Salvageable Material. All material designated to be salvaged shall be carefully removed and stored on the right-of-way. All other material shall be removed and disposed of.

202.06 Method of Measurement. Removal of Buildings and Removal of Existing Superstructure will each be measured by the unit. Removal of Pavement will be measured by the square yard with no deductions made for areas occupied by existing drop inlets, catch basins and manholes. Removal of existing structural concrete will be measured by the cubic yard in place before work starts on the particular portion of the structure to be removed. Removal of existing railings will be measured by the linear foot in place along the grade and line of the railing from outside to outside of end posts or rail projections, whichever is greater.

202.07 Basis of Payment. The quantity of Removal of Buildings and Removal of Existing Superstructure will be paid for at the contract lump sum price which price shall be full compensation for removing and disposing of the obstructions. Removal of Pavement will be paid for at the contract unit price per square yard which price shall be full compensation for removal and disposal of pavement and pavement reinforcement. Material for backfilling holes resulting from removal of obstructions will be measured and paid for as provided in Section 203 — Excavation and Embankments. The quantity of structural concrete removed will be paid for at the contract unit price per cubic yard, which price shall include disposal of the concrete. The quantity of railing removed will be paid for at the respective contract unit price per linear foot of railing removed and disposed of.

When the payment item calls for material to be retained by the Commission, payment shall include salvage of these materials, custody, preservation and storage on the right-of-way and disposal as provided herein. When the proposal does not include pay items for removal of structures and obstructions as set out in this section, such work shall be considered incidental to the various contract items and no direct payment will be made except that removal of foundations will be paid as provided in Section 203 — Excavation and Embankment.

Payment will be made under:

Pay Item	Pay Unit
202.08 Removal of Building No. _____	Lump Sum
202.09 Removal of Existing Superstructure (Retained by Commission)	Lump Sum

202.10 Removal of Existing Superstructure (Property of Contractor)	Lump Sum
202.11 Removing Portland Cement Concrete Pavement	Square Yard
202.12 Removal of Existing Structural Concrete	Cubic Yard
202.13 Removal of Existing Railings (Retained by Commission)	Linear Foot
202.14 Removal of Existing Railings (Property of Contractor)	Linear Foot

SECTION 203 — EXCAVATION AND EMBANKMENT

203.01 Description. This work shall consist of the removal, haul and disposal and compaction, if required, of all material not being removed under some other item, which is encountered and is necessary for the construction of the project in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer. All excavation except structural excavation will be classified as "common excavation", "rock excavation", "unclassified excavation", "muck excavation", as hereafter described. Material not classified as excavation which is required to construct embankments and backfill trenches and holes shall be classified as "borrow".

(a) *Common Excavation.* Common excavation shall consist of the removal of all material encountered in grading the project within the limits of construction and in drive-ways which is not otherwise classified and paid for. Common excavation shall include the removal and disposal of boulders, solid mortared stone masonry, and concrete masonry when each is less than one cubic yard in volume and all soft and disintegrated rock which can be removed with ordinary excavating machinery. It shall include grubbing which consists of the removal and disposal of all stumps, roots, bushes, grass, turf or other objectionable material not exceeding a depth of 2 feet below the original ground surface.

(b) *Rock Excavation.* Rock excavation shall consist of the removal of hard igneous, metamorphic and sedimentary rock which cannot be excavated without blasting or the use of ripping equipment and all boulders, solid mortared stone masonry, concrete masonry, each having a volume of one cubic yard or more.

(c) *Unclassified Excavation.* Unclassified excavation shall consist of the removal of common excavation and rock excavation as classified above and not measured separately.

When identical unit prices are bid for Common Excavation and for Rock Excavation, such bids shall be considered as a bid for Unclassified Excavation of the combined items and shall be so classified.

(d) *Muck Excavation.* Muck Excavation shall consist of the removal and disposal of saturated or unsaturated mixtures of soils and organic matter not suitable for embankment foundation material regardless of moisture content.

MATERIALS

203.02 *Materials.* Borrow shall consist of approved material required for the construction of embankments or for other portions of the work as designated and shall be obtained from beyond the limits of the required cut slopes. Unless otherwise designated in the contract, the Contractor shall make his own arrangements for obtaining borrow and shall pay all costs involved. No material shall be removed from an approved borrow pit except for use under this contract.

Material shall meet the requirements of the following subsections of Division 700 — Materials:

Common Borrow	703.18
Granular Borrow	703.19
Gravel Borrow	703.20
Rock Borrow	703.21
Tree Paint	708.04

Slope blanket backfill material shall meet the requirements of aggregate base or subbase specified in subsection 703.06 as directed.

203.03 *Unauthorized Use of Materials.* No earth excavation, rock excavation, unclassified excavation or borrow which is designated for use in embankments or backfill may be diverted for the Contractor's own use such as in haul roads and parking areas. Any unauthorized use of such material will be adjusted by deducting quantities, measured by the most appropriate method as determined by the Engineer and 115 percent of that quantity deducted from the total amount.

CONSTRUCTION REQUIREMENTS

203.04 *General.* Prior to beginning of excavation, grading, and embankment operations in any area, all necessary clearing in that area shall have been performed in accordance with Section 201 — Clearing Right of Way.

Unsuitable material shall be disposed of as directed and no material shall be wasted without permission of the Engineer. Excavating operations shall be conducted so that material outside of the limits of slopes will not be disturbed.

Suitable material taken from excavation shall be used in the formation of embankment, subgrade, and for backfilling as indicated on the plans, or as directed by the Engineer, except that if the volume of suitable excavated material exceeds that required to construct the embankments to the grades indicated, the excess shall be used to grade the areas of ultimate development, or wasted as directed.

The Contractor shall give the Engineer sufficient time before beginning excavation to take necessary cross section elevations and measurements. The Contractor shall not excavate beyond the dimensions, slopes and elevations established, and no material shall be removed prior to the staking out and cross-sectioning of the site. Unless otherwise authorized by the Engineer, borrow material shall not be placed until after all suitable excavation has been placed in the embankment unless the use of granular borrow is called for on the plans or required by the Engineer for use under embankments or in conjunction with the use of excavated material. If the Contractor places more borrow than is required and thereby causes a waste of suitable excavation material, the amount of such waste will be measured by the method deemed most appropriate by the Engineer and 115 percent of the amount deducted from the borrow volume.

When different unit prices are bid for Common Excavation and Rock Excavation, the Contractor will be required to strip earth from the ledge to provide an opportunity for the Engineer to take the necessary measurements. When identical prices are bid for Common Excavation and Rock Excavation, the Contractor will not be required to strip the earth from the ledge.

When it is necessary to temporarily remove fencing designated to remain, the fencing shall be replaced by the Contractor at his expense in as good a condition as it was originally. The Contractor shall be responsible for the confinement of livestock when a portion of the fence is removed. When

new fencing for confinement of livestock is required, it shall be erected before existing fencing is disturbed. Where the new fencing cannot be erected in its final location, any temporary fencing shall be at the Contractor's expense.

Excavation for obliteration of old roadways shall include all grading operations necessary to incorporate the old roadway into the new roadway and surroundings in order to provide a pleasing appearance from the new roadway.

The Engineer may designate as unsuitable those soils that cannot be properly compacted in embankments and all such unsuitable material shall be disposed of in approved waste areas.

Unstable slopes subject to sliding and slumping, shall be excavated to the lines and grades shown or as directed. Immediately after each location is excavated, approved granular slope blanket backfill material shall be placed and shaped to match the adjacent slopes.

203.05 Roadway Excavation. When excavating, the roadway shall be maintained in such condition that the excavation will be well drained. Temporary drains, drainage ditches and culverts shall be constructed to intercept and divert water which may adversely affect the condition of the excavation and the prosecution of the work.

Excavation shall, in general, proceed in a direction up-grade. Subgrades shall be promptly graded and rolled to minimize absorption of water. Adjacent ditches shall be graded to the extent that puddles will not form. Grubbing areas which cannot be drained shall be promptly filled with approved excavation or borrow to such an elevation that surface drainage will be effective. If, due to unusual circumstances, drainage by gravity cannot be accomplished, the Engineer may require the Contractor to provide adequate means of pumping the area. Pumping may be required on a 24 hour a day continuous basis and no direct compensation for cost of pumping will be made.

Muck shall be removed in such a manner to insure its complete removal with no areas remaining pocketed or trapped below the embankment. Excavated muck shall be deposited, if feasible, adjacent to the area from which it is excavated, outside of the embankment slope and inside the right-of-way or construction limit line, all as shown on the plans or as directed. Muck storage areas may also include an area 100 feet longitudinally ahead and back of the muck excavation areas. After the embankment has been completed, the muck stored at the designated storage areas shall be used to flatten

slopes to the line and grade shown on the plans or flatter or graded over adjacent areas. Surplus muck which cannot be stored in designated muck storage areas shall be loaded and hauled to an approved waste area. When muck is encountered that was not contemplated on the plans, it shall be disposed of as indicated above.

Excavation adjacent to the roots of trees or shrubs which are to remain shall be removed by hand. Live roots to be removed shall be cut cleanly and approved tree paint applied within 24 hours to the cut surfaces remaining.

When excavating results in a subgrade of unsuitable soil, the Engineer may require the Contractor to remove unsuitable material and backfill with approved material. The Contractor shall conduct his operations in such a way that the Engineer can take the necessary measurements before the backfill is placed.

Material classified as rock, whether paid for as rock excavation or unclassified excavation, shall be excavated to the required depth. Care shall be taken that undrained pockets will not be left in the surface of the rock remaining. The space between the rock remaining and the normal subgrade shown on the plans shall be backfilled with the designated Aggregate Subbase or Aggregate Base, or with pulverized rock or other material approved by the Engineer. The Contractor should conduct his excavating and hauling work in a manner that will cause as little contamination as possible. Any excavated areas which become contaminated with clay, silt, organic matter or other impervious type materials shall be cleaned of such material before starting construction of the base courses. Fine grading at the normal subgrade line will not be required if Aggregate Subbase or Aggregate Base material is used as backfill and this material may be placed in depths limited only by the requirements of subsection 304.03. If pulverized rock or other approved material is used as backfill, fine grading will be required at the subgrade.

Ditches in rock cuts shall be constructed with no protrusions of rock above the designated rock cut lines greater than 3 inches. The space between the rock remaining and the finished surface of the ditch shall be backfilled with approved earth material obtained from excavation or borrow sources.

For rock backslopes designated to be constructed on a 2 to 1 slope or flatter, the slope shall be uniformly finished to within 6 inches above or 6 inches below the lines designated, but in no case shall projections of rock extend over 6 inches above the actual finished surface of the slope as constructed.

Materials which have been displaced or loosened beyond the finished work as shown on the plans shall be removed and disposed of by the Contractor. The Engineer shall determine if the displacement of such material was unavoidable and his decision shall be final. In all cuts, loose rocks on the back slopes shall be removed to the finished grade of the slope.

Buried structures and obstructions, as specified in subsection 104.07, located within the designated limits of the work, shall be removed as part of the applicable excavation item for the type of work being performed. Buried structures and obstructions located below or outside the required excavation, whose removal is ordered by the Engineer, shall be removed and such removal paid for as Common Excavation, or Unclassified Excavation, whichever is applicable.

203.06 Waste Areas. The location of all waste areas outside of the right-of-way or construction limit lines shall be approved by the Engineer and the written permission of the property owner shall be obtained by the Contractor. A copy of the agreement shall be supplied to the Engineer, if requested, before any use is made of the waste area. When waste areas are located within wooded areas, a screen of trees shall be maintained between the waste area and the right-of-way. Waste areas adjacent to and in sight of any public way shall be uniformly graded to drain; loamed, seeded, and hay mulched. When the Engineer determines that loam, seed, and hay mulch are necessary, the requirements shall be incorporated into an agreement between the waste area land owner and the Contractor. The Engineer shall be furnished with a copy of the agreement if requested. Seeding of waste areas shall be in accordance with Section 618 — Seeding, Method Number 2.

All trees which are damaged, uprooted or otherwise moved as a result of the waste material and trees which have had waste material placed around them to the extent that they may die, shall be cut and removed at the expense of the Contractor.

Waste areas may be established by the Commission. When such waste areas are established, the location and other conditions relating to them will be described in the Special Provisions.

203.07 Haul Roads. In wooded areas, haul roads shall be kept to a minimum width and placed at approximately right angles to the road or angled away from view of oncoming traffic. Particular care shall be taken to save large or well shaped trees.

203.08 Borrow. The location of all borrow pits and ledge borrow quarries adjacent to or visible from any Public Way shall be approved by the Engineer in writing. In wooded areas, all pit haul roads shall be kept to a minimum width and placed at approximately right angles to the road or angled away from the view of oncoming traffic. Prior to the completion of the project all borrow pits in view of any Public Way and any portion of any haul road visible from any Public Way shall be graded to blend with adjacent ground, loamed if necessary, seeded and hay mulched. When the Engineer determines that loam, seed and hay mulch is necessary in the case of privately owned pits, these requirements shall be incorporated into an agreement between the pit owner and the Contractor. The Engineer shall be furnished a copy of the agreement if requested.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross-section elevations and measurements of the ground surface after stripping may be taken and the borrow material can be tested before being used. Existing pits shall, when directed by the Engineer, be graded and shaped by the Contractor prior to being cross-sectioned for original measurements.

Borrow pits shall be excavated to neat lines and all slopes shall be dressed uniformly and left in a neat condition. When practicable, the bottom of all pits shall be graded to drain the pit. Where not practical to do so, the side slopes below any anticipated water level shall not be steeper than 4 to 1.

203.09 Preparation of the Embankment Area. When the depth of the embankment measured vertically below subgrade does not exceed 5 feet the area on which the embankment is to be placed shall be grubbed as defined in subsection 203.01 (a). When the embankment is more than 5 feet, as measured above, all vegetation in the embankment area shall be cut as specified in Section 201 — Clearing Right-of-Way.

When embankment is to be placed and compacted on hill-sides, or where new embankment is to be compacted against existing embankment, slopes steeper than 2 to 1 shall be continuously benched by excavating steps into the existing material of sufficient width to permit operations of placing and compacting the additional material. Material removed shall be placed and compacted along with the new embankment material. When such benching is required, it shall be indicated on the plans, called for in the special provisions or directed by the Engineer.

203.10 Embankment Construction — General. Layers shall start at the deepest portion of the fill and as placement progresses, layers shall be constructed approximately horizontal. Except for the first layer of fills over swampy ground and cleared areas, roadway embankment of earth material shall be placed in layers not exceeding 8 inches, loose measurement, and shall be compacted as specified before the next layer is placed. When it is impractical to construct layers over the full width of the cross-section, partial width layers may be authorized.

Effective spreading equipment shall be used on each layer to obtain uniform thickness and specified crown prior to compacting. Each layer shall be crowned not less than $\frac{1}{2}$ inch per foot and maintained free of ruts and ridges to provide direct drainage of water from the embankment. As the compaction of each layer progresses, grading and manipulating will be required to assure uniform density. Construction equipment shall be routed uniformly over the entire surface of each layer.

Embankments within 50 feet of a bridge abutment, structural plate or box culvert type structure shall be compacted by the moisture and density control method as specified in subsection 203.12 except that rock embankments may be constructed over culverts as specified in subsection 203.15.

Water shall be added or removed, if necessary, in order to obtain required compaction. Aeration of excavated materials to reduce the moisture content to within specified limits shall be as specified under subsection 631.04.

When placing layers of specified thickness is not feasible, such as filling in water or over swampy ground, the initial layer of embankment may be constructed in one layer to an elevation where bridging will be accomplished. In embankment areas where no grubbing is required, the material placed in the first layer shall be of sufficient depth to cover all stumps.

When the excavation or borrow consists predominantly of fragments of such size that the material cannot be placed in embankments in layers of thickness prescribed without breaking down the pieces, such material may be placed in layers in thicknesses not exceeding the approximate average size of the larger rocks but in no case shall exceed 2 feet. Rocks exceeding this thickness shall be separated and collectively placed in accordance with the requirements for rock embankments. Each layer shall be leveled and smoothed with suitable leveling equipment and by even distribution of rock spalls

and finer rock fragments or earth. The Engineer may direct the Contractor to proof roll any or all layers which are constructed in depths exceeding 8 inches. The layers so constructed shall not be placed above an elevation 2 feet below the finished subgrade. The remainder of the embankment shall be composed of suitable material smoothed and placed in layers not exceeding 8 inches loose thickness and compacted as specified for earth embankments.

Where guard rail is to be installed, rock shall not be placed in the embankment under the location of the guard rail to a depth of 4 feet below the finished grade of the shoulder. Rocks, broken concrete, or other solid materials shall not be placed in any portions of embankments where piling is to be placed or driven or where utility conduits are to be placed.

Excess or unsuitable excavated material, including rock and boulders, which cannot be used in embankments may be placed in the slopes of the nearest available fill area. The distinct shoulder line and slope shall be maintained by keeping all such waste material below the finished slope surface. When it is impossible to dispose of all such material in the manner described, the remainder shall be disposed of in approved waste areas.

When material obtained from roadway excavation is, by itself, unsatisfactory for use in the formation of embankments due to excessive moisture content and when it can be rendered satisfactory for such use by combination with granular material, granular borrow shall be used in combination with such unsatisfactory material for embankment formation when and only as directed by the Engineer.

If the embankment is required to be deposited on only one side of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. When embankment is to be placed on both sides of a concrete wall, structural plate or box type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.

At the close of each day's work, the embankment surface shall be graded to not less than $\frac{1}{2}$ inch per foot crown, smoothed and sealed against infiltration of water by rolling with a pneumatic-tired or smooth wheel steel roller.

203.11 Construction of Embankment — Layer Method. This method will be required unless otherwise specified. The material shall be deposited and spread in full width layers not

more than 8 inches in depth, loose measure, upon compacted material. Clay or loam soils shall be compacted by use of sheepsfoot or tamping-type roller having a minimum weight on each tamper, under working conditions, of 250 pounds per square inch of cross-sectional bearing area. Sand or gravel soils shall be compacted by vibratory-type compaction equipment or by pneumatic-tired equipment and, if necessary, by the addition of water. A combination of the above or other methods capable of producing equivalent results may be used. The compacting operations shall be continued until each layer is compacted to its full depth and width.

Proof rolling will not be required under this subsection.

203.12 Construction of Embankment with Moisture and Density Control. The contract will designate the areas to be constructed with moisture and density control, and the distance below subgrade to which such methods shall be applied. The moisture content at the time of compaction shall be suitable to obtain the required density. The maximum density shall be determined in accordance with AASHTO T 180, Method C or D, corrected by the Soils Laboratory Adjustment Chart available at the Soils Laboratory, Bangor, Maine. Field density tests will be made in accordance with AASHTO T 191 or AASHTO T 205 adjusted to include only the material passing a $\frac{3}{4}$ -inch sieve, or by an approved method using a calibrated nuclear device.

All material in embankments above the elevation designated on the plans for moisture density control shall be placed at a moisture content suitable to obtain the required density. Each layer placed with controlled moisture shall be compacted to not less than 90 percent of the maximum density.

Density requirements will not apply to the portions of embankments constructed of material which cannot be tested in accordance with AASHTO T 191 or when the material contains more than 30 percent material retained on a 2 inch square mesh sieve.

203.13 Construction of Embankments with Proof Rolling Control. The contract will designate the areas to be constructed with proof rolling control. Compaction shall be accomplished by rolling with pneumatic-tired roller, tamping type roller or vibratory methods as best suited for the characteristics of the soil being placed.

The pneumatic-tired type roller shall have a gross weight of not less than 2,500 pounds per foot of rolling width and a minimum rolling width of 40 inches. The tires shall produce

a ground contact pressure of 65 pounds per square inch, determined from the gross tire contact area on a solid, non-flexible, flat surface. The tire pressure may be reduced at the direction of the Engineer if soil conditions so warrant. Information as to tire sizes, ply rating, air pressure, and loading shall be furnished for each type of pneumatic-tired roller.

Tamping type rollers shall be of heavy duty type and shall have a load of not less than 250 pounds per square inch on the footprint, which shall have a length of foot not less than 6 inches. Tamping type rollers shall consist of one or more cylindrical drums of not less than 48 inches in diameter at the drum surface, not including the length of the studs of tamping feet and not less than 60 inches total rolling width.

A minimum of six complete coverages over the entire area of each layer will be required. Compaction shall be thorough and satisfactory to the Engineer and shall be subject to proof rolling tests as specified in subsection 203.14. When satisfactory density cannot be obtained with six coverages, rolling shall continue until satisfactory density is obtained. The necessary number of coverages for satisfactory density shall be required for all embankment layers of the particular type material.

Hauling equipment shall not be considered as rolling in lieu of compaction equipment as specified above, but the traffic of such hauling equipment shall be in addition to compaction with the equipment specified.

At any time the Engineer may take density tests in accordance with subsection 203.12. If passing density tests cannot be obtained, the Contractor shall take corrective measures by aerating or sprinkling the embankment material, recompact-ing and the embankment retested. The embankment may be accepted on the basis of passing density without retesting by proof rolling.

203.14 Proof Rolling. After placing and compacting each 5 feet of embankment as specified and after placing the final layer in each embankment, the entire surface of the embankment shall be proof rolled with one complete coverage of a rubber tired roller or construction equipment having a load of 20,000 pounds or greater per tire, each tire having a tire inflation pressure of not less than 100 pounds per square inch. Any deficiency in stability as indicated by excess vertical movement accompanied by cracking of the surface shall be rectified and the test repeated until satisfactory stability is obtained.

203.15 Construction of Embankments — Rock. The material for rock embankment shall be placed in compacted layers not exceeding 3 feet in depth. Depositing the rock directly over the end of the fill from the hauling equipment will not be permitted; it shall be deposited on the fill and pushed into place by means of bulldozers or other equipment. The top of the rock embankment shall be so choked with small rock fragments, earth excavation or borrow that there will be no infiltration of the earth embankment placed on the surface of the rock embankment.

The method shall be used only in fills in excess of 4 feet in depth. In no case shall the rock embankment be placed within 1 foot of the subgrade.

When structures are located under rock embankment, they shall be covered with not less than 2 feet of earth excavation or borrow before the rock embankment is placed over the structures.

203.16 Winter Construction of Embankments. Frozen material shall not be placed in the embankment. The construction of embankments may continue during cold weather only when all frozen material in the top of the embankment or the existing ground is moved to the outside of the slope before placing additional material. Frozen material may be deposited between a 1 to 1 slope and the designed slope or designated slope.

Should an amount of frozen material be deposited which causes slopes to be flatter than the designed or designated slope, resulting in the use of additional borrow, the amount of wasted material will be measured by the method deemed most appropriate by the Engineer and 115 percent of the amount deducted from the borrow volume.

Compaction shall be in accordance with the specified method of embankment construction. When the prevailing temperatures are below 30°F., all material used in embankment construction shall have a moisture content at the time of compaction equal to or less than the optimum moisture content.

The embankment shall not be constructed upon frozen material except that such construction of embankments may be allowed providing the total depth of the added fill, including gravel bases, plus the depth of the frozen material beneath does not exceed 5 feet. Frozen material may be left in the embankment only if it has been compacted as specified prior to freezing. The Contractor shall not resume construction of any embankments built in this manner until all

frozen material has thawed. If test holes are required to make this determination they shall be dug and backfilled with satisfactory compaction at the Contractor's expense. Before additional material is added, uncompacted material on the surface of such embankments shall be either recompact in accordance with the specified method of embankment construction or removed.

203.17 Preparation and Protection of the Subgrade. Unless otherwise provided, the subgrade shall be brought to a condition of uniform stability and compaction for the full width of the roadbed by grading and rolling operations, and shall be maintained to a tolerance of 1 inch above or 1 inch below the required grade and cross-section for a distance of at least 500 feet ahead of the base course placing operation unless otherwise authorized by the Engineer.

The required compaction shall be the same as specified for embankments. When the subgrade occurs in cuts, the required compaction shall apply to a depth of 6 inches below subgrade unless otherwise specified.

The Contractor shall protect the subgrade from damage. Ditches and drains along the roadway shall be maintained to effectively drain the subgrade. In no case shall vehicles be allowed to travel in a single track and form ruts. If ruts are formed exceeding 1 inch in depth the subgrade shall be reshaped. No material shall be deposited on a subgrade until the subgrade has been approved.

203.18 Method of Measurement. The quantities of excavation and borrow for which payment will be made will be the number of cubic yards measured in its original position by cross-sectioning the area excavated, which measurements will include overbreakage or slides in common excavation and unclassified excavation, not attributable to carelessness of the Contractor, and authorized excavation of rock, shale, muck or other unsuitable material. Volumes will be computed by the average end area method or by other methods generally recognized as conforming to good engineering practice.

For Muck Excavation, the quantity to be measured for payment shall be the number of cubic yards of material acceptably excavated from or adjacent to areas shown on the plans, stored adjacent to the area or hauled to an approved waste area, measured in its original position by the method of cross-sectional elevations and the volume computed by the method of average end areas. In the event that muck is stored in excess of the maximum slope flattening requirements of the muck storage area, the amount requiring re-

loading, hauling and disposing of in approved waste areas shall again be measured for payment by the most appropriate method in accordance with engineering procedures.

When it is impractical to measure excavation, including grubbing, by the cross-sectional method due to the erratic location of isolated deposits, acceptable methods involving three-dimensional measurements may be used. When small quantities of borrow are involved and it is impractical to measure in its original position, a quantity not exceeding 1,000 cubic yards per item for a single project may be measured in vehicles at the point of delivery, and a quantity not exceeding 5,000 cubic yards per item for a single project may be measured in place. When measured in vehicles, the quantity for payment shall be 90 percent of the quantity determined for earth and 75 percent of the quantity determined for rock, as shown on delivery slips. When measured in place, the amount for payment shall be 115 percent of the quantity so measured for earth material and 75 percent of the quantity so measured for rock.

For rock slopes designated to be constructed on a $\frac{1}{4}$ to 1 slope, the measurements for rock excavation will allow overbreakage to a distance of 12 inches horizontally from the neat line of the rock cut back slope shown on the plans or as otherwise authorized and extending to a slope not flatter than $\frac{1}{2}$ to 1. For rock slopes designated to be constructed on a 2 to 1 slope or flatter, there will be no allowance for material removed beyond the designated slopes lines.

Unless otherwise authorized, measurement allowance for excavation will not exceed 6 inches beyond the lines indicated on the plans measured perpendicular to the slope. Material placed in embankments outside a surface parallel to and 6 inches beyond the neat lines of embankment slopes as shown on the plans, unless otherwise authorized, will not be included in the quantity for payment and will be deducted from the borrow at 100 percent of the material so measured.

Measurements will be made for unsuitable materials actually excavated and removed to obtain proper compaction in cut sections and in foundations for fill sections.

Aeration of excavated materials to reduce moisture content to specified limits will be measured as specified under Section 631 — Equipment Rental.

203.19 Basis of Payment. The accepted quantities of excavation and borrow will be paid for at the contract unit price per cubic yard of measurement for each of the pay items

included in the proposal. Payment shall be full compensation for obtaining borrow when required and for excavating, loading, hauling, placing, grading and compacting all material necessary for the formation of embankments. It shall also include full compensation for disposal of unsuitable and surplus material when necessary.

Payment for removal of unstable material below subgrade in cuts will be paid at the contract unit price per cubic yard for Common Excavation or Unclassified Excavation, whichever is appropriate.

Payment for placing and compacting any backfill, except Special Backfill, placed in accordance with Section 206 — Structural Excavation, will not be paid for separately but will be included in the payment for any one of the related excavation items, provided however, there is suitable excavation material available in its original position at the time of backfilling. When there is no suitable material available for backfilling, the material authorized will be paid for under the contract item for the class of material used.

When rock is encountered and no item is included in the contract for its removal, the excavation of the rock will be paid for at 6 times the contract unit price bid for common excavation.

The furnishing and placing of backfill material between the rock remaining and the normal subgrade line of rock cuts will not be paid for directly but shall be considered incidental to the work. The quantity of Aggregate Subbase or Aggregate Base for payment in rock cuts shall include only the material placed above the normal subgrade line.

Earth material removed from beyond the 6 inch limit on earth cut slopes and rock removed from beyond the $\frac{1}{2}$ to 1 backslope overbreakage line, both as specified in subsection 203.18, may be paid for when used to construct the embankments at the contract unit bid price for excavation or borrow, whichever is less. Costs for furnishing and placing material necessary to backfill and to grade rock cut slopes designated to be constructed on a 2 to 1 slope or flatter will be considered to be included under the payment for the material used; excavation or borrow.

When muck is encountered and no item is included in the contract for its removal, the excavation of the muck will be paid for at the contract unit price bid for Common Excavation or Unclassified Excavation.

Excavation which requires more than one handling prior to final placement in the embankments including material placed

as backfill and loamy top soil to be stockpiled and reserved for later use on the slopes, will be paid for at the contract unit price for Common Excavation, Unclassified Excavation, or Rock Excavation, as the case may be, for each handling approved by the Engineer. It may be paid for under another contract item for the second handling when so authorized. Each handling shall be considered to include each loading, transporting, unloading and disposing of earth or rock material.

Excavation for slope blanket, as defined in subsection 203.04, will be paid for at twice the contract unit price bid for common excavation. Backfill material will be paid for as specified in subsection 304.07.

Excavation for benching of sidehills to receive embankments will be paid for as Common Excavation, Rock Excavation or Unclassified Excavation.

Water added to embankment material to aid in compaction will not be paid for directly but shall be considered incidental to the contract.

Machine aerating, for aerating excavated material only, will be paid for as specified under Section 631 — Equipment Rental.

Removal of portland cement concrete pavement and portland cement concrete base course, when not included in the contract as a separate pay item, will be paid for under Item 203.21. Excavation done in connection with roadway obliteration will be paid for under the appropriate excavation item. Scarifying for obliteration of old roadways, when no excavation is required, will be paid for under the appropriate item of Section 631 — Equipment Rental. Payment for excavation or filling and compacting material in building or other foundation holes, whether existing or created by the removal of structures and obstructions, will be made under the appropriate item for excavation or borrow and no additional allowances will be made.

Overhaul, when shown in the schedule of prices, will be paid for under Items 205.04 or 205.05, whichever is appropriate, for Granular Borrow and Gravel Borrow.

All work and materials required to grade, loam, seed, and hay mulch waste areas, borrow pits, and haul roads thereto and therefrom, as specified to eliminate unsightly conditions, will not be paid for directly but will be considered incidental to the various classifications of excavation and borrow.

Whenever the use of tree paint is required to complete the work outlined under this section, it will not be paid for directly but will be considered incidental to related excavation items.

Stripping pits to obtain necessary borrow will not be paid for separately but will be considered incidental to the various bid items.

When Common Excavation and Rock Excavation are reclassified as Unclassified Excavation, because of identical unit bid prices, payment will be made for the reclassified items under Pay Item 203.22, Unclassified Excavation at the identical unit bid price.

Payment will be made under:

Pay Item	Pay Unit
203.20 Common Excavation	Cubic Yard
203.21 Rock Excavation	Cubic Yard
203.22 Unclassified Excavation	Cubic Yard
203.23 Muck Excavation	Cubic Yard
203.24 Common Borrow	Cubic Yard
203.25 Granular Borrow	Cubic Yard
203.26 Gravel Borrow	Cubic Yard
203.27 Rock Borrow	Cubic Yard

SECTION 204 — HAUL

204.01 Description. No payment will be made for haul of any material used under Division 200 — Earthwork. All haul, except that which is included under Section 205 — Overhaul, for specified materials will be considered a necessary and incidental part of the work and the cost thereof shall be considered by the Contractor and included in the contract unit prices bid for the pay items involved.

Haul, connected with the disposal of waste and/or surplus material shall be limited to a maximum distance of 2,000 feet beyond the limits of the project for disposal in flattening slopes or other roadway work. If no disposal areas are designated by the Engineer, the haul shall be made to an approved waste area supplied by the Contractor.

SECTION 205 — OVERHAUL

205.01 Description. Overhaul, when provided for in the schedule of prices, shall consist of transporting specified

material, as designated in the specifications under the appropriate item, from the pit for a distance in excess of a free haul limit of 2 miles from that part of the project nearest the pit.

When acceptable material cannot be obtained within the free haul limit, overhaul will be allowed on the amount of material hauled beyond the free haul limit for items in which overhaul is specified for payment.

If 2 or more projects or non-continuous sections of projects are combined in one contract, they shall be considered as 1 continuous project for the purpose of computing overhaul.

205.02 Method of Measurement. The quantity of overhaul to be measured for payment shall be the number of yard miles of acceptable material specified for overhaul, transported more than the free haul limit of 2 miles, via the shortest practicable truck route. This quantity shall be obtained by multiplying the cubic yards of the pay quantities of the respective items by the distance in excess of 2 miles (measured to the nearest 1/10 mile) the material is transported.

If the Contractor elects to obtain material from another source, other than the nearest source acceptable to the Commission, the overhaul distance will be measured, as specified above, from the nearest acceptable source.

Overhaul computed for material used for stabilizing Aggregate Subbase Course — Sand, shall be measured as stated above except that overhaul distance allowed shall not exceed that used for computing overhaul for the Aggregate Subbase Course — Sand.

Measurement of overhaul over alternate return routes as specified in subsection 104.06 will be made over both routes and payment based on the average of the two distances.

205.03 Basis of Payment. All work done under this item will be paid for at the contract unit price of 10 cents per yard mile for in place measured material, and 8 cents per yard mile for pit measured material. When no overhaul is included in the proposal, any overhaul encountered during the construction of the project shall be considered incidental to the contract items involved.

Payment will be made under:

Pay Item	Pay Unit
205.04 Overhaul (In Place Measure)	10¢ per cu. yd. mile
205.05 Overhaul (Pit Measure)	8¢ per cu. yd. mile

SECTION 206 — STRUCTURAL EXCAVATION

206.01 Description. This work shall consist of the excavation, haul, and backfill or disposal of all material excavated for the construction of bridges, masonry retaining walls, box culverts, pipe culverts, storm drain culverts, under-drain culverts, berm ditches, cut slope downspout ditches, and other structures in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical cross-sections shown on the plans or established by the Engineer. Ditches at inlets and outlets of culverts, special ditches and outlet ditches therefrom, all as shown on the plans, shall be constructed and paid for under Section 203 — Excavation and Embankments. All excavation for structures below the designed slope or roadway excavation limits as shown on the plans will be included under this section. Material which is required to be excavated under another item shall not be included under this item. Rock shall be as defined in paragraph 203.01 (b).

(a) Structural Earth and Structural Rock Excavation for Drainage and Minor Structures. Structural excavation for drainage and minor structures shall include the excavation and disposal of all material encountered in excavating for pipe culverts, structural plate culverts, box culverts, under-drains, berm ditches, cut slope downspout ditches, culvert end walls, concrete steps and other minor structures.

(b) Structural Earth and Structural Rock Excavation for Abutments and Retaining Walls and Piers. Structural excavation for abutments and retaining walls and piers shall include the excavation and disposal of all material, including existing wood or masonry piers or abutments, encountered in preparing foundation pits for abutments and masonry retaining walls, and piers. When called for on the plans, existing approach fills, abutments or piers (not included within the limits specified above) shall be removed and disposed of under this classification.

(c) Structural Earth and Structural Rock Excavation for Channels. Structural excavation for channels shall include the excavation and disposal of all material encountered in excavating for stream channel diversion, channel widening or straightening, when designated on the plans, outside the limits of structural excavation of other classifications.

(d) Special Backfill. Special backfill shall consist of obtaining, hauling, and placing selected material consisting of a mixture of rock and coarse gravel suitable for the location where it is to be used.

Special Backfill as a contract item will be called for on the plans or in the proposal.

CONSTRUCTION REQUIREMENTS

206.02 Construction Methods. The Contractor shall notify the Engineer a sufficient length of time in advance of the beginning of structural excavation so that necessary elevations and measurements may be taken of the undisturbed ground. When ledge rock is encountered which is to be removed, the Contractor shall uncover the ledge and provide ample opportunity for the Engineer to take the necessary measurements of the undisturbed rock.

When the foundation material is soft or otherwise unsatisfactory, the excavation shall be carried to a depth designated by the Engineer, and the material removed below the elevation shown on the plan shall be replaced with approved granular material, thoroughly compacted, or a lower elevation for the bottom of the structure shall be established. This soft or otherwise unsatisfactory material shall be classed as Structural Excavation.

Any suitable material removed from the excavation area including that material removed from beyond the specified excavation pay limits shall be used for backfilling or for the formation of embankments and no additional allowances for payment will be made. Unsuitable or surplus material shall be disposed of in an approved waste area.

When the foundation is to be placed on solid rock, the rock shall be excavated to a firm surface, either level, stepped or serrated. In trenches for pipe culverts, underdrains, structural plate pipes and structural plate pipe arches, when solid or disintegrated rock or boulders are encountered, the rock shall be excavated to a minimum depth of 12 inches below the bottom of the proposed pipe. Except for installations of underdrain, the material so removed shall be replaced with selected fine compressible material such as silty clay or sand and uniformly compacted and shaped in accordance with subsection 603.04.

When the structure is to rest on an excavated surface, other than rock, special care shall be taken not to disturb the bottom of the excavation. Final removal of the material to grade shall not be made until immediately preceding the placing of the culvert pipe, concrete or masonry.

After each excavation is completed, the Contractor shall notify the Engineer and no culverts or masonry shall be placed, foundation piles driven or other installations made,

until the Engineer has approved the depth of the excavation and the character of the foundation material.

Before drainage or underdrainage pipe is installed in cut areas where common excavation, unclassified excavation or muck excavation is removed below the subgrade elevation shown on the plans, the undercut roadbed shall be filled with approved granular material to a depth sufficient to support construction equipment. All fill material shall be compacted as required.

206.03 Backfilling. Backfilling shall consist of placing suitable material in all spaces excavated and not occupied by drainage structures, bridge structures and other permanent structures up to the elevation of the existing ground or other elevations shown on the plans or designated. Backfill material shall be fine readily compressible soil or granular material, at or near optimum moisture content, and shall not contain stones larger than 3 inches, frozen lumps, chunks of clay, mineral matter or any other objectionable material. The material shall be uniformly distributed in layers of not more than 8 inches, loose measure, and each layer thoroughly compacted by use of approved compactors before successive layers are placed. When backfill is being placed around a pipe or structure, operations shall be so conducted that the fill is always at approximately the same elevation on both sides of the structure. Water shall be added when necessary to increase the moisture content of the backfill material to obtain compaction. Puddling or jetting of backfill will not be allowed unless specifically provided in the contract.

Backfill shall not be placed against gravity sections of masonry abutments, wing walls, box culverts or other structures requiring forms, until the masonry has been placed at least 7 days. For reinforced sections, no backfill shall be placed until the masonry has been in place at least 14 days. Backfilling around pipes, catch basins and manholes, the joints of which are made with portland cement mortar, shall not be done until the mortar has been in place at least 12 hours unless methods approved by the Engineer are used to protect the mortar from being disturbed.

Unless otherwise indicated on the plans or directed by the Engineer, all sheeting and bracing used during structural excavation shall be removed by the Contractor following the completion of the work, and all voids resulting from use of the sheeting and bracing backfilled where necessary.

206.04 Method of Measurement. The quantity of structural excavation for which payment will be made will be the

number of cubic yards of material measured in its original position acceptably excavated in conformity with the plans or as directed.

For masonry culverts, headwalls, steps, structural plate pipes and arches and drainage structures, other than pipe culverts, storm drains and underdrains, the quantity to be measured for payment will be the amount actually excavated to the required elevation, provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 18 inches outside the lines of the base as shown on the plans.

For pipe culverts and storm drains, the quantity to be measured for payment will be the amount actually excavated to the required elevation, provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 15 inches from the pipe.

For underdrains, the quantity to be measured for payment shall be the amount actually excavated to the neat lines of the trench as shown on the plans.

For abutments, masonry retaining walls, piers, box culverts and substructure units for structural plate arches, the quantity to be measured for payment will be the amount actually excavated to the required elevation, provided, however, that the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 18 inches outside the neat lines of the base as shown on the plans. For structures constructed on grillages, the maximum allowable horizontal dimensions shall be those bounded by vertical planes 6 inches outside the grillage and the depth to the required elevation.

When rock is required to be excavated for the construction of structural concrete substructure units to; (1) definite elevations as shown on the plans or (2) elevations designated by the Engineer after the rock has been exposed, the maximum depth of measurement for payment will be to a horizontal plane or planes located 12 inches below the elevation shown or designated. When rock is required to be excavated for installation of pipe culverts, underdrains, conduits, or precast units, the depth for measurement will be the actual depth required in accordance with the specifications or as otherwise designated by the Engineer. The quantity of rock to be measured will be the number of cubic yards actually removed determined from these depths and from vertical surfaces located as defined elsewhere in this subsection. Any removal of hard rock, for the purpose of leveling, stepping

or serrating, as required for a satisfactory foundation, as shown on the plans or determined by the Engineer, shall be measured within the aforementioned limits and paid for as structural rock excavation. When earth is required to be removed to uncover existing ledge, it will mean to excavate to undisturbed hard rock and will be so measured for payment.

When structures are in areas where roadway excavation is to be removed, only the excavation below the limits of those items will be classed as structural excavation. Measurement of Structural Excavation for drainage and underdrainage in undercut areas will include excavation of the compacted granular material used to replace the unsuitable material to an elevation authorized by the Engineer.

The quantity of "Special Backfill" to be measured for payment as a contract item will be the number of cubic yards of material acceptably placed and measured in place, but will not include replacement of material excavated beyond the specified pay limits for structural excavation.

206.05 Basis of Payment. The accepted quantities of structural excavation will be paid for at the contract unit price per cubic yard. The unit price per cubic yard shall include the placing and compacting of all backfill, the formation of any embankments made with material from structural excavation and the disposal of all surplus or unsuitable material, unless otherwise specified.

Structural excavation material which cannot be placed in its final position in one operation and must be stockpiled for future use will, when rehandled and placed as backfill or embankment, be measured and paid for as "Common Borrow" or as "Special Backfill" in accordance with the classification under which it is placed. The work will be considered as performed in one operation if at the time the excavation is made there exists, within the limits of the work, a location where fill material can be placed in its final position.

When rock is encountered and no structural rock excavation item is included in the contract, the excavation of the rock will be paid for at 6 times the contract unit price for structural earth excavation of the corresponding classification.

When it is necessary to excavate for abutments, masonry retaining walls, or substructure for structural plate arches, piers or box culverts below the elevation shown on the plans, payment for such excavation will be made at 1½ times the contract unit price for the item classification applying where the extra depth is required.

When no bid item appears in the contract for clearing drainage ways, maintenance of traffic, special detours or cofferdams, any necessary work under these items will not be paid for directly but will be considered incidental to the various structural excavation items. Unless otherwise specified, payment for structural excavation shall include costs of all pumping, bailing, draining, sheeting, bracing and incidentals required for proper execution of the work.

Any backfill or bedding material, except for material used to backfill underdrain whose source is other than structural excavation, will be paid for under the class of material designated. Material used to backfill underdrain will not be paid for but shall be considered incidental to the cost of the underdrain.

Special Backfill will be paid for at the contract unit price per cubic yard.

When no other classification of structural excavation other than Structural Excavation — Drainage and Minor Structures appears in the proposal all excavation required for necessary structure installation will be paid for under Items 206.06 or 206.07.

Payment will be made under:

Pay Item	Pay Unit
206.06 Structural Earth Excavation — Drainage and Minor Structures	Cubic Yard
206.07 Structural Rock Excavation — Drainage and Minor Structures	Cubic Yard
206.08 Structural Earth Excavation — Abutments and Retaining Walls	Cubic Yard
206.09 Structural Rock Excavation — Abutments and Retaining Walls	Cubic Yard
206.10 Structural Earth Excavation — Piers	Cubic Yard
206.11 Structural Rock Excavation — Piers	Cubic Yard
206.12 Structural Earth Excavation — Channel	Cubic Yard
206.13 Structural Rock Excavation — Channel	Cubic Yard
206.14 Special Backfill	Cubic Yard

SECTION 207 — BRUSH MATTING

This section is reserved. Specifications will be provided and inserted in the proposal book when required.

DIVISION 300 — BASES

SECTION 301 — PLANT MIX BITUMINOUS BASE COURSE

301.01 Description. This work shall consist of one or more courses of bituminous mixture constructed on approved base or sub-base in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

301.02 Composition of Mixture. The bituminous base shall be composed of a mixture of aggregate, filler (if required) and bituminous material, combined as required in subsection 401.02 of Section 401, Plant Mix Pavements — General.

301.03 Materials. Aggregates shall meet the applicable requirements of Section 703 — Aggregates.

Additives, if required, shall meet the applicable requirements of Section 650 — Hot Bituminous Mixture Additives.

Bituminous material shall be of the type and grade specified in the contract. The grade may be changed one step by the Engineer at no change in unit price. The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Material, and may be conditionally accepted at the source.

CONSTRUCTION REQUIREMENTS

301.04 General. The construction requirements shall be as prescribed in subsections 401.07 through 401.19 inclusive of Section 401 — Plant Mix Pavements — General.

301.05 Surface Tolerance. The surface will be tested with a 10-foot straight-edge by the Engineer at selected locations. The variation of the surface from the testing edge of the straight-edge between two contacts with the surface shall at no point exceed $\frac{1}{4}$ inch. All humps or depressions exceeding the specified tolerances shall be corrected.

301.06 Method of Measurement. Plant mix bituminous base course will be measured as prescribed in subsection 401.21.

301.07 Basis of Payment. The accepted quantities of Plant Mix Bituminous Base Course will be paid for at the contract unit price per ton for the bituminous mixtures and the bituminous material, when specified, complete and in place.

Payment will be made under:

Pay Item	Pay Unit
301.08 Plant Mix Bituminous Base Course, Grading A	Ton
301.09 Plant Mix Bituminous Base Course, Grading B	Ton
301.10 Plant Mix Bituminous Base Course, No. 1 Binder	Ton
301.11 Plant Mix Bituminous Base Course, No. 2 Binder	Ton
301.12 Asphalt Cement, Base Course	Ton

SECTION 302—ROAD MIX BITUMINOUS BASE COURSE

302.01 Description. This work shall consist of aggregate and bituminous material mixed in place on an approved base or subbase in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

302.02 Bituminous Material. The bituminous material furnished shall meet the applicable requirements of Section 702—Bituminous Materials. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer at no change in unit price. Bituminous material may be conditionally accepted at the source.

302.03 Aggregate. Aggregates shall meet the requirements of subsection 703.04 immediately preceding addition of bituminous material to the mix. This acceptance will be based on tests of samples of the stockpiles after all aggregates have been blended.

CONSTRUCTION REQUIREMENTS

302.04 Construction Requirements. The construction of road mix bituminous base shall meet the requirements of

subsections 405.04 through 405.10 inclusive of Section 405—Road Mix Bituminous Pavement.

302.05 Surface Requirements. The surface will be tested by the Engineer using a 10 foot straight edge at selected locations. The variation of the surface from the testing edge of the straight edge between any 2 contacts with the surface shall at no point exceed $\frac{1}{4}$ inch. All humps or depressions exceeding the specified tolerance shall be corrected.

302.06 Method of Measurement. Aggregate for road mix bituminous base will be measured by the cubic yard in place measure in accordance with Section 109—Measurement and Payment. Bituminous material will be measured by the gallon in accordance with Section 109—Measurement and Payment.

302.07 Basis of Payment. The accepted quantities of Road Mix Bituminous Base Course will be paid for at the contract unit price per cubic yard for the aggregates and the bituminous material per gallon for road mix bituminous base of the type specified complete in place.

Payment will be made under:

Pay Item	Pay Unit
302.08 Aggregate for Road Mix Bituminous Base	Cubic Yard
302.09 Bituminous Material for Road Mix Bituminous Base	Gallon

SECTION 303—PENETRATION MACADAM BASE COURSE

303.01 Description. This work shall consist of furnishing and placing one or more courses of graded aggregate and one or more applications of bituminous binder, with chip covering, constructed on an approved subbase, by the penetration method, in accordance with these specifications, in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

303.02 Bituminous Materials. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Materials.

Bituminous material may be conditionally accepted at the source.

303.03 Aggregates. Aggregates shall meet the requirements of subsection 703.05 in the stockpiles.

CONSTRUCTION REQUIREMENTS

303.04 Weather Limitations. Bituminous material shall not be placed on any wet surface; when the air temperature is below 50° F. or when weather conditions otherwise would prevent the proper construction of the pavement.

303.05 Equipment. The equipment used shall conform to subsection 406.05.

303.06 Placing and Compacting Coarse Aggregate. Placing and compacting coarse aggregate shall conform to the requirements of subsection 406.06.

303.07 Application of Bituminous Material. Bituminous material shall be uniformly applied at the rate specified.

During the application of bituminous material care shall be taken to prevent spattering adjacent pavements, structures and trees. Such objects so discolored shall be cleaned. The distributor shall not be cleaned or discharged into ditches, borrow pits, onto shoulders or along the right of way.

303.08 Application of Key Aggregate. Immediately following the first application of bituminous material, key or choke aggregate shall be spread and worked into the voids of the coarse aggregate by broom dragging and rolling. Additional key aggregate shall be spread as required, broom dragged and rolled until the course is uniformly filled and compacted.

303.09 Method of Measurement. Aggregate for penetration macadam base will be measured by the ton and by the gallon for bituminous material in accordance with Section 109 — Measurement and Payment. When weighed, the stone shall be clean and drained of all free water.

Due to possible variations in the specific gravity of the aggregates, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

303.10 Basis of Payment. The accepted quantities of penetration macadam base will be paid for at the contract price per ton for the aggregates and per gallon for the bituminous material complete in place.

Payment will be made under:

Pay Item	Pay Unit
303.11 Coarse Aggregate for Penetration Macadam Base	Ton
303.12 Key Aggregate for Penetration Macadam	Ton
303.13 Bituminous Materials for Penetration Macadam Base	Gallon

SECTION 304 — AGGREGATE BASE AND SUBBASE COURSE

304.01 Description. This work shall consist of furnishing and placing one or more courses of aggregates on a prepared surface in accordance with the specifications in reasonably close conformity with the lines, grades, thicknesses and typical cross sections, as shown on the plans or established by the Engineer.

MATERIAL

304.02 Aggregate. Aggregates shall conform to the requirements specified in the following subsections of Section 700 — Materials.

Aggregate Base	703.06(a)
Aggregate Subbase	703.06(b)

CONSTRUCTION REQUIREMENTS

304.03 Placing. If the required compacted depth of base course called for on the plans exceeds 6 inches or subbase course exceeds 9 inches the courses shall be constructed in 2 or more layers of approximately equal thicknesses. The maximum completed thickness of any base layer shall not exceed 6 inches and any subbase layer shall not exceed 9 inches.

Each layer of aggregate shall be placed over the full width of the section. When existing traffic or other conditions restrict operations over the full width, the Engineer may authorize the Contractor to place less than full width layers. When the Contractor places material to complete the full width, the exposed edge of the previously placed aggregate

shall be cleaned of all contamination before additional base or subbase aggregate is placed adjacent thereto.

Aggregate base and subbase courses may be placed upon frozen surfaces when such surfaces have been properly constructed.

The material as spread shall be well mixed with no pockets of either fine or coarse material. Segregation of large or fine particles will not be allowed.

304.04 Shaping and Compacting. Compaction of each layer shall continue until a density of not less than 95 percent of the maximum density has been achieved for the full width and depth of the layer. The maximum density shall be determined in accordance with AASHTO T-180, Method C or D, corrected by the Soils Laboratory Adjustment Chart available at the Soils Laboratory, Bangor, Maine. Field density tests will be made by the sand cone method or at the option of the Commission, by the use of nuclear devices or by the water balloon test methods. The surface and compaction shall be satisfactorily maintained until the pavement course has been placed. If required, additional water shall be applied to prevent checking or raveling.

The surface of each layer shall be maintained during compaction operations in such manner that a uniform texture is produced and the aggregate firmly keyed. The moisture content of the material shall be maintained at the proper percent to attain the required compaction.

304.05 Surface Tolerance. The completed surface of the designated course shall be shaped and maintained to a tolerance, above or below the required cross sectional shape, of $\frac{1}{2}$ inch for subbase and $\frac{3}{8}$ inch for base material.

304.06 Method of Measurement. Aggregate base course and aggregate subbase course will be measured in cubic yards completed in place. The width and thickness for measurement will be the width and thickness of aggregate base as shown on the plans or as modified by the Engineer. The length will be along the centerline. All measurements will be in accordance with Section 109 — Measurement and Payment.

The quantity of aggregate base or subbase course used for driveways and other locations difficult to accurately measure in place may be measured for payment as 80 percent of the number of cubic yards accepted and used, measured in vehicles at point of delivery as shown by "Delivery Slips" in accordance with subsection 109.01. The quantity so measured per project shall not exceed 500 cubic yards after shrinkage.

304.07 Basis of Payment. The accepted quantities of aggregate base course and aggregate subbase course of the type specified will be paid for at the respective contract unit prices per cubic yard.

When aggregate is required for slope blanket protection, bedding underdrainage structures and other foundations, it shall be paid for at twice the contract unit price for the respective aggregate base or subbase course item used.

Payment for aggregate base and subbase courses shall include, purchasing material, stripping pits, excavating, crushing, screening, hauling, placing, compacting, and other necessary processes which are required to furnish acceptable material under this item.

Water added to material to assist compaction and to prevent raveling is incidental to the work and is an expense assumed by the Contractor.

Overhaul, when shown in the Schedule of Prices, will be paid under Section 205 — Overhaul, for all items in this Section.

The quantity of Aggregate Subbase or Aggregate Base placed on rock subgrade shall include only that material placed above the normal subgrade line. The furnishing and placing of backfill material between the ledge and the normal subgrade line will not be paid for directly but shall be considered incidental to the work.

Payment will be made under:

Pay Item	Pay Unit
304.08 Aggregate Base Course — Screened	Cubic Yard
304.09 Aggregate Base Course — Crushed	Cubic Yard
304.10 Aggregate Subbase Course — Gravel	Cubic Yard
304.11 Aggregate Subbase Course — Granular	Cubic Yard
304.12 Aggregate Subbase Course — Sand	Cubic Yard

SECTION 305 — VACANT

SECTION 306 — VACANT

SECTION 307 — VACANT

SECTION 308 — VACANT

SECTION 309 — VACANT

SECTION 310 — BITUMINOUS STABILIZED BASE

310.01 Description. This work shall consist of aggregate and bituminous material mixed and placed on an approved surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

310.02 Mixtures. Bituminous stabilized base shall be composed of a mixture of aggregate and bituminous material. The mixture of aggregates and residual bitumen shall have a Hveem stability of at least 25 when tested according to ASTM D 1560. Test specimens will be prepared according to ASTM D 1561. Compaction temperature for all mixtures containing emulsified asphalt shall be 60° C. (140° F.) as specified in Procedure 4.1.1.

310.03 Bituminous Materials. Either asphalt cement or a mixing grade emulsion shall be used. The method of mixing shall determine the type of bituminous material. The grade shall be determined by the Bituminous Materials Engineer. The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Materials. Bituminous materials may be conditionally accepted at the source.

310.04 Aggregates. Aggregates shall meet the requirements of subsection 703.17 preceding the addition of the bituminous materials.

CONSTRUCTION REQUIREMENTS

310.05 General. This material may be mixed and placed according to the applicable Construction Requirements of Section 301 — Plant Mixed Bituminous Base Course or Section 302 — Road Mixed Bituminous Base Course, depending upon the construction method selected by the Contractor.

The following exceptions will apply:

(a) When the road mix option is selected, no tack coat will be required and the pneumatic tired roller will not be limited to a maximum of 350 pounds per inch of compaction width.

(b) When the plant mix option is selected the aggregates need not be separated after drying. Any type spreader which will produce the required grade and controls and which is approved by the Engineer may be used. Hot hand tampers will not be required.

The bitumen content will be determined by the Engineer.

When this base course is placed in 2 or more layers each layer shall be tacked by the application of approximately .05 gallons of emulsified asphalt. The maximum thickness of a single layer shall not exceed 3 inches when compacted.

310.06 Weather Limitations. When cold mixes are being produced the weather limitations shall conform to Section 405.04. Hot mix operations shall conform to the weather limitations as specified in 401.07. Mixing operations from a stabilization plant may be permitted after September 15 providing the air temperature is 40° F. and a heated mixture (130-220° F.) is discharged from the mixing plant.

310.07 Compaction. Whether a heated or cold mix method is used the minimum dry compaction requirement for the Bituminous Stabilized Base Course will be 92 percent of the laboratory specimen compacted as specified in subsection 310.02. The residual bitumen will be included as part of the unit dry weight.

310.08 Surface Tolerance. The surface will be tested with a 10 foot straightedge by the Engineer at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed ¼ inch. All humps or depressions exceeding the specified tolerances shall be corrected.

310.09 Method of Measurement. Bituminous Stabilized Base will be measured by the square yard complete, accepted, and in place. The width for measurement will be the width of the pavement as shown on the plans and additional widening when called for or otherwise directed. Prior to acceptance, the thickness shall be determined by measuring the thickness of cores cut in the following manner: Each lane will be divided into increments of 2,000 feet. One core will be cut from each increment and measured for thickness. The exact location from which the core will be cut will be determined on a random basis within this increment or section. Sections in which the measured thickness is less than the specified thickness by more than ¾ of an inch shall be further checked by cutting additional cores in the section under question. After determining the extent of the deficient area, the Contractor shall, if directed, either add additional material to correct this deficiency and correct the grade, or remove the existing base and replace it to the proper thickness. Any section so corrected shall be done at the expense of the Contractor. The length will be the horizontal distance as deter-

mined along the center of the roadway. No deductions for areas occupied by drop inlets, catchbasins, and manholes will be made.

310.10 Basis of Payment. Bituminous Stabilized Base will be paid for at the contract unit price per square yard, which will be full compensation for furnishing, processing, mixing, hauling, placing, and compacting; for furnishing all labor, equipment, all granular materials and all bituminous materials, tools, and other incidentals necessary to complete the work. No payment for "Overhaul" will be made.

Payment will be made under:

Pay Item	Pay Unit
310.11 Bituminous Stabilized Base (____inches)	Sq. Yd.
310.12 Bituminous Stabilized _____ (____inches)	Sq. Yd.

DIVISION 400 — PAVEMENTS

SECTION 401 — PLANT MIX PAVEMENTS — GENERAL

401.01 Description. This work shall consist of one or more courses of bituminous mixture constructed on approved foundation in accordance with these specifications and the specific requirements of the type under contract, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

401.02 Composition of Mixtures. The bituminous plant mix shall be composed of a mixture of aggregate, filler, if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula.

The Contractor shall submit, for the Engineer's approval, a job-mix formula for each mixture to be supplied to the project. The job-mix formula shall establish a single percentage of aggregate passing each required sieve size, and, with the allowable tolerances, given below, shall be within the master gradation range specified for the particular type of mixture. The job-mix formula shall state the source, gradation and percentage of each fraction of the aggregate, and filler, if required. It shall state the name of the refiner and the supplier of the particular bituminous material to be used, and shall state the viscosity in centistokes at 275° F. and at temperatures above and below the viscosity limits specified in subsection 401.15.

At the time the job-mix formula is submitted, the Contractor shall indicate, and make available for sampling and testing, stockpiles of all aggregates proposed for use. A minimum of 10 days shall then be allowed for testing, prior to approval of the job-mix formula.

Upon approval of the mix, the Engineer will establish, as a part of the job-mix formula, a percentage of residual bituminous material for the mixture, and temperatures for the mixture at the two points of discharge.

After the job-mix formula is established, the components and temperatures of the mixture furnished shall conform thereto within the following tolerances:

Aggregate portion of mix:

Passing No. 4 and larger sieves	± 7 percent
Passing No. 8 to No. 100 sieves (incl.)	± 4 percent
Passing No. 200 sieve	± 2 percent

Bituminous Material:

Percent of mixtures	± 0.4 percent
Viscosity @ 275° F.	± 50 centistokes

Mix Temperature at discharge from:

Mixing plant	± 20° F.
Truck at project	± 20° F.

Should a change in sources of materials be made, a new job-mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job-mix formula.

401.03 Aggregates. Aggregates shall meet the applicable requirements of Section 703 — Aggregates, in the stockpiles at the plant site.

401.04 Additives. Additives shall meet the requirements of Section 650 — Hot Bituminous Mixture Additives.

401.05 Vacant.

401.06 Bituminous Materials. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction.

The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Materials and may be conditionally accepted at the source.

CONSTRUCTION REQUIREMENTS

401.07 Weather Limitations. Unless otherwise specified bituminous plant mix shall not be placed on a wet surface. Plant mixed bituminous pavements shall be constructed between the dates of May 1st and October 1st, and then only when the air temperature in the shade at the paving location is 40° F. or above.

Weather conditions shall be otherwise satisfactory for proper handling and finishing of the mixture.

When it is in the public interest for service to traffic, the Commission may authorize construction of bituminous pavements at lower atmospheric temperatures than those specified or extend the dates of the paving season.

401.08 Bituminous Mixing Plant.

401.081 General Requirements. Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

(a) Aggregate Storage.

1. Sufficient storage space shall be provided for uniform stockpiles of various sized or blended aggregates which shall be kept separated until they have been introduced into the cold bins that feed the drier.

2. The storage yard shall be maintained in a neat and orderly manner and the separate stockpiles shall be readily accessible for sampling.

(b) Bitumen Storage.

1. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperature.

2. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank.

3. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period.

4. Provisions shall be made for measuring and sampling storage tanks.

5. A valve for sampling this material shall be provided. The valve shall be located in a circulating feed line connecting the storage tank with the mixing plant, or in a line of the storage circulating system. The valve shall be placed in a readily accessible location offering protection from danger, and shall be maintained in a workable condition. A drainage receptacle shall be provided.

(c) Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

(d) Drier. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process.

(e) Screens.

1. Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capaci-

ties in excess of the full capacity of the mixer, shall be provided.

2. The screen deck shall have a tailing pipe of sufficient size to prevent any oversize material from entering the bins.

(f) Hot Bins.

1. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity.

2. The bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates.

3. Separate dry storage shall be provided for filler or hydrated lime when used, and the plant shall be equipped to feed such material into the mixer.

4. Each bin shall be provided with overflow pipes of such size and at such location the outlets of which shall be open at all times during plant operation so as to prevent backing up of material into other compartments or bins.

5. Each compartment shall be provided with its individual outlet gate, constructed so that when closed there shall be no leakage. The gates shall cut off quickly and completely.

6. The bins shall be so constructed that samples can be readily obtained.

7. The bins shall be equipped with adequate tell-tale devices to automatically indicate the position of the aggregates in the bins at the lower quarter points.

(g) Bituminous Control Unit.

1. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amounts of bituminous material in the mix within the tolerance specified.

2. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

(h) Thermometric Equipment.

1. An armored thermometer of adequate range in temperature reading shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

2. The plant shall also be equipped with either an approved dial scale, mercury-actuated thermometer, electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregates.

3. The fine aggregate hot bin shall be equipped with a thermometer or other approved thermometric instrument to indicate the temperature of the heated aggregate immediately before it enters the mixer. The dial or other indicator shall be plainly visible and readable from the mixing platform.

4. The Engineer may require replacement of any thermometer by an approved temperature-recording apparatus for better regulation of the temperature of aggregates.

(i) Dust Collector. The plant shall be equipped with a dust collector constructed to waste or return uniformly to the hot elevator all or any part of the material collected.

(j) Truck Scales.

1. The bituminous mixture shall be weighed on scales meeting the requirements of Section 109.

2. Such scales shall be inspected and sealed by the State Sealer as often as the Engineer deems necessary to assure their accuracy.

(k) Safety Requirements.

1. Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required.

2. Accessibility to top of truck bodies shall be provided by a platform or other suitable device, placed in an acceptable location near the testing laboratory, to enable the Engineer to obtain sampling and mixture temperature data.

3. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

4. Ample and unobstructed space shall be provided on the mixing platform.

5. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

401.082 Requirements for Batch Plants.

(a) Weigh Box or Hopper.

1. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over.

2. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

(b) Bituminous Control.

1. When an asphalt metering system is used to measure the bituminous material it shall be accurate to plus or minus 0.1 percent of nominal batch size. In the event of malfunction of the system, the Contractor may provide a calibration chart for the indicator of the metering device which will show the quantity of material delivered at each setting. Production using such a chart may be continued for a period not to exceed the next 48 hours.
2. The bituminous material bucket shall be a non-tilting type.
3. The length of the discharge opening or spray bar shall be not less than $\frac{3}{4}$ of the length of the mixer, and it shall discharge directly into the mix.
4. The bituminous material bucket, its discharge valve or valves and spray bar shall be adequately heated. Steam jackets if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales.
5. The capacity of the bituminous material bucket shall be at least 15 percent in excess of the weight of bituminous material required in any batch.
6. The plant shall have an adequately heated quick-acting, non-drip charging valve located above and as close to the bucket as practical.
7. The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used in a batch.
8. The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after addition of bituminous material to each batch.
9. All dials shall be in full view of the mixer operator.
10. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over and all of the bituminous material required for one batch will be discharged in not more than 20 seconds after the flow has started.
11. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer.
12. The section of the bituminous line between charging valve and the spray bar shall be provided with a valve and

outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

(c) Mixer.

1. The batch mixer shall be an approved type capable of producing a uniform mixture within the job-mix tolerances.
2. The clearance of the blades from all fixed and moving parts shall not exceed 1 inch unless the maximum diameter of the aggregate in the mix exceeds $1\frac{1}{4}$ inches, in which case the clearance shall not exceed $1\frac{1}{2}$ inches.

(d) Control of Mixing Time.

1. The mixer shall be equipped with an automatic accurate time lock to control the operations of a complete mixing cycle.
2. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle.
3. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods.
4. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material.
5. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.
6. The control of the timing shall be flexible and capable of being set at intervals of 5 seconds or less throughout a total cycle of up to 3 minutes.
7. A mechanical batch counter shall be installed as a part of the timing device, and shall be so designed as to register only completely mixed batches.
8. The setting of the time intervals shall be performed in the presence and at the direction of the Engineer who shall then lock the case covering the timing device until such time as a change is to be made in the timing period.

(e) Plant Scales.

1. Plant scales shall meet the following requirements:

Aggregate Scales:

Minimum Graduations	= (Batch Size) $\times$.0025
Sensitivity	= (Batch Size) $\times$.00125
Accuracy	= (Batch Size) $\times$.005

Asphalt Scales:

Minimum Graduations	= (Batch Size) $\times$.0005
Sensitivity	= (Batch Size) $\times$.00025
Accuracy	= (Batch Size) $\times$.001

2. Poles shall be designed to be locked in any position to prevent unauthorized change of position.
3. In lieu of plant and truck scales, the contractor may provide an approved automatic printer system which will print the weights of the material delivered.
4. The above system must be used in conjunction with an approved automatic batching and mixing control system.
5. Weights shall be evidenced by a weigh ticket for each load.
6. Each weigh ticket shall be signed by a representative of the contractor.
7. In the event of a malfunction of the automatic printer system, production may be continued for a period not to exceed the next 48 hours, providing total weights of each batch are recorded on weigh tickets and certified by a Licensed Weighmaster.
8. Plant scales shall be inspected as often as the Engineer may deem necessary to assure their continued accuracy.
9. The Contractor shall have on hand not less than 10 fifty-pound weights for testing of the scales.

401.083 Requirements for Continuous Mixing Plants

(a) Aggregate Proportioning.

1. The plant shall include means for accurately proportioning each size aggregate.
2. The plant shall have a feeder mounted under each compartment bin.
3. Each compartment bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each compartment.
4. The feeding orifice shall be rectangular with one dimension adjustable for positive mechanical means provided with a lock.
5. Indicators shall be provided for each gate to show the respective gate openings in inches.

(b) Weight Calibration of Aggregate Feed.

1. The plant shall include a means for calibration of gate openings by weighing test samples.

2. Provision shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes.

3. The plant shall be equipped to conveniently handle individual test samples weighing not less than 200 pounds and accurate scales shall be provided by the contractor to weigh such test samples.

(c) Synchronization of Aggregate and Bituminous Material Feed.

1. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bin and the flow of bituminous material from meter or other proportioning device.

2. This control shall be accomplished by interlocking mechanical means or by any other positive method satisfactory to the Engineer.

(d) Mixer.

1. The plant shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job mix tolerances.

2. It shall be equipped with a discharge hopper with dump gates which will permit rapid and complete discharge of the mixture.

3. Continual mixing will not be allowed with the discharge gates in the open position.

4. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix.

5. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge.

6. Charts shall be provided showing the rate of feed of aggregate per hour for the aggregate being used.

401.09 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of fuel oil, lime solution or other approved material to prevent the mixture from adhering to the beds. Such trucks shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

401.10 Bituminous Pavers. Bituminous pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thicknesses shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly and without segregation in front of the screed.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

The paver shall be capable of being operated, when laying mixtures, at forward speeds consistent with satisfactory laying of the mixture.

401.11 Rollers. Rollers shall be of the steel wheel and/or pneumatic tire type and shall be in good condition, capable of reversing without backlash and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted.

401.12 Conditioning of Existing Surface. The surface upon which bituminous mixture is to be placed shall be thoroughly cleaned of all objectionable material.

When the surface of the existing base or pavement is irregular, it shall be brought to uniform grade and cross section as directed.

Contact surfaces of curbing, gutters, manholes, and other structures shall be coated with a thin, uniform coating of bituminous material prior to the bituminous mixture being placed against them.

401.13 Preparation of Bituminous Material. The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

The Contractor shall cooperate with the Engineer to the extent that the amount of bituminous material used each day on a particular project can be determined.

401.14 Preparation of Aggregates. The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot on the aggregate.

The aggregates, immediately after heating and drying, shall be screened into two or more fractions and conveyed into separate compartments ready for batching and mixing with bituminous material.

401.15 Mixing. The dried aggregates shall be combined in the mixer in the amount of each fraction of aggregate required to meet the job-mix formula. The bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula.

For hot mix bituminous pavement, the mixture shall be produced at the temperature established by the job-mix formula. This temperature will be determined by the Engineer, and will be a temperature at which the viscosity of the bituminous material is between 150 and 300 centistokes (75 and 150 SFS).

The aggregate shall be sufficiently dried so that the mixture will not flush, foam excessively, or displace excessively under the action of the rollers. It shall be introduced into the mixer at a temperature of not more than 25° F. above the temperature at which the viscosity of the bituminous material being used is 150 centistokes.

The bituminous material shall be stored and introduced into the mixer at a uniformly maintained temperature which shall be within the limits at which the viscosity of the material is between 150 and 300 centistokes.

After the required amounts of aggregate and bituminous material have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained. Wet mixing time will be determined by the Engineer for each plant and for each type of aggregate used.

401.16 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Bituminous pavers shall be

used to distribute the mixture either over the entire width or over such partial width as may be practicable. During placing operations, pavers shall be operated at a speed so as to provide as continuous as possible placement of the mixture as normally produced by the plant, regardless of haul distance.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked and luted by hand tools. For such areas the mixture shall be dumped, spread and screeded to give the required compacted thickness. On such areas the mixture shall be placed on dump boards or on unfinished surfaces and this material must be completely rehandled and spread.

When production of the mixture can be maintained and when practical, pavers shall be used in echelon to place the surface course in adjacent lanes.

401.17 Compaction. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, or shoving.

The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density.

Unless otherwise directed, rolling shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping one half the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. On super-elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline.

Rollers shall move at a slow but uniform speed with the drive roll wheels nearest the paver. Rolling shall be continued until all roller markings are eliminated.

After compaction the minimum percentage of the TMD obtained shall be 90 percent for all machine placed courses, except the wearing course, which shall be 93 percent. The

test for theoretical maximum density (TMD) shall be performed in accordance with ASTM D 2041 on laboratory specimens of mixture combined in the proportions of the job-mix formula.

Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes or lutes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.

To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical vibrating compactors. Hand tamping will be permitted only for areas inaccessible to other compaction equipment. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

401.18 Joints. Placing of the bituminous mixture shall be as continuous as possible. The edge of the layer shall be constructed vertical and rollers shall not pass over the unprotected end of freshly laid mixture unless authorized by the Engineer.

Transverse joints of the wearing course shall be at right angles with the longitudinal edge and shall be straight and neatly trimmed; a vertical face exposing the full depth of the course may be formed by inserting a header, by breaking the bond with the underlying course, or by cutting back with hand tools. Feathered or "lap" joints may be permitted on lower courses or when matching existing low type pavements.

Edges that are to form longitudinal joints shall be maintained in a vertical position. A brush coat of emulsified asphalt shall be applied to all joints except those formed by pavers operating in echelon.

Two coats of emulsified asphalt applied by approved spraying equipment may be substituted for the brushcoat. The bituminous material shall be applied immediately before additional mixture is placed against the previously rolled material.

401.19 Pavement Samples. On the morning of the following working day the Contractor shall cut samples from the compacted pavement for testing by the Engineer. Samples of the mixture shall be taken for the full depth of the course at the locations directed. Samples shall be presented for measurement and forwarded to the plant inspector prior to 10:00 A. M.

All holes in the pavement left as a result of sampling by the Engineer or by the Contractor shall be refilled with acceptable mixture at the earliest possible time. Before filling, the holes shall be carefully cleaned and coated with emulsified asphalt.

401.20 Surface Tolerances. The surface will be tested by the Engineer using a 10 foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed $\frac{3}{16}$ inch. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as directed. A 10 foot straightedge, acceptable to the Engineer, shall be supplied by the Contractor, and shall at all times be available at the paving operation.

401.21 Method of Measurement. Plant mix bituminous pavement will be measured by the ton in accordance with Section 109—Measurement and Payment. Batch weights will not be permitted as a method of measurement, unless the alternate provisions of Section 401.082(e)1 are met, in which case the cumulative weight of all the batches will be used for payment. The tonnage shall be the weight used in the accepted pavement and no deduction will be made for the weight of bituminous material or additives in the mixture.

When specified in the contract as a pay item, the quantity of bituminous material will be the number of tons used in the accepted work and shall be computed by multiplying the total tonnage of mixture accepted in place by the percent bitumen content stated in the applicable job-mix formula.

Due to possible variation in the specific gravity of the aggregate, and field changes in areas to be paved, the quantity of mixture used may vary from the estimated quantities and no adjustment in contract unit price will be made because of the variations.

401.22 Basis of Payment. All work performed and measured as prescribed above will be paid for as provided in respective sections for each type specified.

Work prescribed in subsection 401.12 will be paid for at the contract unit prices for the material used except that furnishing and applying bituminous material to joints and contact surfaces will be incidental.

SECTION 402 — SHEET ASPHALT PAVEMENT

402.01 Description. This work shall consist of constructing a binder course and a surface course on an approved base in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

The binder course shall be composed of a mixture of aggregate and bituminous material. The surface course mixture shall be composed of fine aggregate, filler and bituminous material.

MATERIALS

402.02 General. The materials and their use shall conform to the requirements of subsections 401.02 through 401.06 and to the designated gradation requirements of subsection 703.08.

CONSTRUCTION REQUIREMENTS

402.03 General. The construction requirements shall be as prescribed in subsections 401.07 through 401.20.

402.04 Method of Measurement. Sheet asphalt surface and binder courses of pavement will be measured as prescribed in subsection 401.21.

402.05 Basis of Payment. The accepted quantities of sheet asphalt pavement will be paid for at the contract price per ton for the bituminous paving mixtures, including bituminous material, complete in place.

Payment will be made under:

Pay Item	Pay Unit
402.06 Sheet Asphalt Binder Course, No. 1 Binder	Ton
402.07 Sheet Asphalt Binder Course, No. 2 Binder	Ton
402.08 Sheet Asphalt Surface Course	Ton

SECTION 403 — HOT BITUMINOUS PAVEMENT

403.01 Description. This work shall consist of constructing one or more courses of bituminous pavement on an approved base in accordance with these specifications, and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

The bituminous pavement shall be composed of a mixture of aggregate, filler if required, and bituminous material.

MATERIALS

403.02 General. The materials and their use shall conform to the requirements of subsections 401.02 through 401.06 and to the designated gradation requirements of subsection 703.09.

CONSTRUCTION REQUIREMENTS

403.03 General. The construction requirements shall be as prescribed in subsections 401.07 through 401.20 except as follows:

Pavement placed with a paving machine after Labor Day shall be rolled and kneaded with an approved pneumatic roller in addition to the steel rollers.

Wearing course mixtures shall be placed only when the atmospheric temperature is 50° F. and rising, and the temperature of the existing pavement is 40° F. or higher. All temperatures are to be measured in the shade.

403.04 Method of Measurement. Hot bituminous pavement will be measured as prescribed in subsection 401.21.

403.05 Basis of Payment. The accepted quantities of hot bituminous pavement will be paid for at the contract unit price per ton for the bituminous mixtures, including bituminous material, complete in place.

Payment will be made under:

Pay Item	Pay Unit
403.06 Hot Bituminous Pavement, Grading A	Ton
403.07 Hot Bituminous Pavement, Grading B	Ton
403.08 Hot Bituminous Pavement, Grading C	Ton
403.09 Hot Bituminous Pavement, Grading C (Crushed Ledge)	Ton
403.10 Hot Bituminous Pavement, Grading D	Ton

403.11 Hot Bituminous Pavement, Grading D (Crushed Ledge)	Ton
403.12 Hot Bituminous Pavement, Grading E (Sidewalks, Drives, Etc.)	Ton
403.121 Hot Bituminous Pavement, Grading E (Shimming)	Ton
403.13 Vacant	
403.14 Asphalt Cement, Hot Bituminous Surface Pavements	Ton

SECTION 404 — VACANT

SECTION 405 — ROAD MIX BITUMINOUS PAVEMENT

405.01 Description. This work shall consist of constructing one or more courses of road mix bituminous pavement on an approved base or road surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

405.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Materials.

Bituminous material may be conditionally accepted at the source.

405.03 Aggregate. Aggregates in stockpiles shall meet the requirements of subsection 703.11 for the grading size and type specified.

CONSTRUCTION REQUIREMENTS

405.04 Weather Limitations. The construction of road mix bituminous pavement shall be carried on only when the surface on which the material is to be placed is dry and when the atmospheric temperature is above 50° F. and has not been below 40° F. during the preceding 24 hours.

No material shall be mixed or placed between September 15 and May 1 except with written approval.

405.05 Equipment. The equipment used by the Contractor shall include scarifying, mixing, spreading, finishing

and compacting equipment, a bituminous distributor, and equipment for heating bituminous material.

The aggregate spreader shall be of such a type that a uniform and accurately controlled amount of aggregate will be distributed regardless of the speed of the spreader or the towing vehicle.

The distributor shall be designed, equipped, maintained and operated so that bituminous material at constant temperature may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically.

All liquid and cement bituminous material bulk delivery vehicles and distributors shall be equipped with an acceptable sampling valve.

On bulk delivery vehicles the valve shall be located in an accessible area in the lower half of the front or rear bulkhead. The valve shall be similarly located on distributors, except that it may be installed in a circulating line having a rising flow.

Traveling or stationary mixing plants or other equipment of proven performance may be used by the Contractor in lieu of the specified equipment if approved.

Rollers shall be self-propelled steel wheel tandem or 3-wheel rollers weighing not less than 8 tons each, and pneumatic-tire rollers having a total compacting width of not less than 60 inches and the gross weight adjustable within the range of 200 to 350 pounds per inch of compaction width. The operating weight shall be as directed. Tire pressure or contact pressure may be specified for pneumatic tire rollers.

405.06 Preparation of Base. Before spreading materials for road mixing, the surface of the base or road surface on which the road mix is to be placed shall be conditioned as specified in subsection 401.12.

After a prime coat is applied, it shall be left undisturbed not less than 24 hours. The Contractor shall maintain a primed surface until the road mix material has been placed. This maintenance shall include the spreading of sand or other

approved material, if necessary to prevent adherence of the prime coat to the tires of vehicles using the primed surface, and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become damaged shall be repaired before the road mix material is placed.

After a tack coat is applied, it shall be allowed to dry until it is in the proper condition of tackiness to receive the road mix material. This coat shall be applied only as far in advance of the placing of road mix material as is necessary to obtain a proper bond. Any breaks in this coat shall be repaired.

405.07 Placing Aggregates. Aggregates shall be uniformly spread on the road by the use of spreader boxes, or other approved mechanical spreading devices. When two or more sizes of aggregates are used, each size of aggregate shall be placed in the proper amount such that the combined total of the aggregates will provide sufficient material for the surfacing of the required width and thickness. Each size of aggregate shall be windrowed to a uniform section, and left undisturbed until measuring and sampling are completed, after which they shall be mixed until they are uniformly blended and then spread over the road surface.

If the surface moisture of the aggregate is more than 2 percent of the dry weight of the aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be turned by blades or otherwise aerated until the moisture content is reduced to 2 percent or less.

In place of aerating and drying the aggregate, the Contractor may use an anti-stripping additive, conforming to the requirements of subsection 702.11. The additive shall permit suitable coating of the wet aggregate and shall prevent the bituminous coating from stripping in the presence of water.

The aggregate shall then be spread smoothly in successive passes, each pass spreading a portion of the previously mixed aggregates in a uniform layer over half the road width being surfaced. The material may be spread over more or less of the road width if convenient or necessary. Each spread of aggregate shall receive in turn an application of bituminous material. When a traveling mixing plant is used the aggregate shall, after mixing, be placed to provide the required cross section after compaction.

405.08 Application of Bituminous Material. The bituminous material shall be uniformly distributed in successive applications, with the first application being on the portion of

the existing surface to be covered, and on each portion of the aggregate spread, as directed above, in such amounts and at such intervals as directed. The mixing equipment shall follow immediately behind the distributor after each application of bituminous material to partially mix the aggregate and the bituminous material.

405.09 Mixing. Spreading and mixing of the several successive portions of the aggregate shall continue until all of the aggregate has been treated. The bitumen applied in the several treatments shall amount to the total required in the Contract or specified by the Engineer.

After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the road surface and then mixed, by blading the mixture from side to side of the road, or by manipulations producing equivalent results, until all aggregate particles are coated with bituminous material and the whole mass has a uniform color and the mixture is free from fat or lean spots, balls or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When directed, the mixing process shall be confined to part of the width or area of the road so as to allow traffic to pass.

Should the mixture show an excess, deficiency or uneven distribution of bituminous material, the condition shall be corrected by the addition of aggregate or bituminous material as required and re-mixing. If the mixture contains excessive amounts of moisture or volatile matter, it shall be bladed, aerated, or otherwise manipulated until the moisture and volatile content are satisfactory. The spreading of the mix shall not be done when the surface to be covered is in an unsatisfactory condition.

At the end of each day's work, or when the work is interrupted by weather conditions or otherwise, all loose material shall be bladed into a windrow, whether mixing is completed or not, and shall be retained in a windrow until operations are resumed.

When the mixing operations have been satisfactorily completed, the mixture shall be formed into a windrow of uniform cross section.

If the Contractor elects to use traveling or stationary mixing plants in lieu of the specified equipment, the same requirements regarding residual moisture and evaporation of volatiles given above shall apply.

405.10 Spreading, Compacting and Finishing. The material shall be spread by a self-propelled, pneumatic-tire blade grader or a mechanical spreader of approved type. In spreading from the windrow, care shall be taken to avoid cutting into the underlying base.

After the material is spread, the surface shall be rolled. Rolling shall be parallel to the road center line and shall commence at the outer edges of the road, overlapping the shoulders and progress toward the center, overlapping on successive passes by at least one-half the width of the roller, except that on superelevated curves rolling shall progress from the lower to the upper edge. Each pass shall terminate at least 3 feet in advance or to the rear of the end of the preceding pass. During the compaction the surface shall be dragged or bladed as necessary to fill ruts and to remove incipient corrugations or other irregularities. Rolling shall continue until the surfacing is of uniform texture and satisfactory compaction obtained. Initial rolling shall be performed with a pneumatic tire roller and final rolling with a 3-wheel or tandem-type steel wheel roller. Rolling shall be discontinued whenever it begins to produce excessive pulverizing of the aggregate or displacement of the mixture.

This course shall be placed in a minimum of two layers except when the course is 2 inches or less in thickness. The maximum thickness of a single layer shall not exceed 2 inches when compacted.

While the surface is being compacted and finished the Contractor shall trim the edges neatly to line.

405.11 Surface Requirements. The surface will be tested by the Engineer using a 10-foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed $\frac{3}{16}$ -inch. All humps or depressions exceeding the specified tolerance shall be corrected.

405.12 Method of Measurement. The quantity of material to be measured for payment will be the number of cubic yards of material forming this course, completed and accepted in accordance with the typical cross sections. Measurement will be determined as shown on the plans for in-place measure according to average end area computations. Additional work authorized by the Engineer will also be measured according to the end area method. The length will be determined horizontally along the center line of the roadway.

Bituminous material will be measured by the gallon according to Section 109.

405.13 Basis of Payment. The accepted quantities of road mix bituminous pavement will be paid for at the contract unit price per cubic yard for the aggregates and per gallon for the bituminous material, including additives if required, complete in place.

Payment will be made under:

Pay Item	Pay Unit
405.14 Aggregate for Road Mix Bituminous Pavement	Cubic Yard
405.15 Bituminous Material for Road Mix Bituminous Pavement, Applied	Gallon

SECTION 406 — PENETRATION MACADAM PAVEMENT

406.01 Description. This work shall consist of furnishing and placing one or more courses of graded coarse aggregate and one or more applications of bituminous binder, with a bituminous seal coat and chip covering, constructed on an approved base course by the penetration method in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross section shown on the plans or established by the Engineer.

MATERIALS

406.02 Bituminous Materials. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Materials.

Bituminous material may be conditionally accepted at the source.

406.03 Aggregates. Aggregates shall meet the requirements of subsection 703.12, in the stockpiles at the source.

CONSTRUCTION REQUIREMENTS

406.04 Weather Limitations. Penetration macadam surface course shall be constructed only between May 15th and September 15th, and the application of bituminous material shall be made only when the atmospheric temperature at the location of paving is above 50° F., and weather conditions otherwise are favorable for proper construction of the pavement.

406.05 Equipment. The equipment to be used shall include a power broom, approved broom dragging equipment, rollers, a self-propelled mechanical spreader for spreading coarse aggregate, a mechanical revolving cylinder-type aggregate spreader or mechanical roller-type hopper spreader for spreading fine aggregate that can be so adjusted as to spread accurately the required amount of material per square yard, a bituminous distributor meeting the requirements of subsection 405.05, and equipment for heating bituminous material. Other types of aggregate spreaders may be used provided they accomplish results equal to those obtained by the types described herein, and are approved.

Rollers shall be self-propelled steel wheel, vibratory or pneumatic type. The number and weight of rollers shall be sufficient to compact the mixture to the required density.

406.06 Placing and Compacting Coarse Aggregate. Immediately before placing coarse aggregate, the surface upon which the pavement is to be constructed shall be properly conditioned by a thorough cleaning of all objectionable material.

Coarse aggregate shall be placed in the required amount by approved stone spreaders, or by other approved mechanical methods. All areas of non-uniformly graded aggregate shall be removed and replaced with suitable material before the rolling begins. These corrections shall be made by hand picking whenever necessary and shall be continued after initial rolling until the appearance and texture of the aggregate are uniform and all irregularities are corrected.

The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed. Rolling shall be parallel to the road center line and shall start at the outer edges of the road, overlap equal portions of aggregate and shoulder and progress toward the center, overlapping on successive passes by at least one-half the width of the roller, except that on super-elevated curves rolling shall progress from the lower to the upper edge.

Material which crushes excessively under the roller or becomes segregated in such manner as to prevent free and uniform penetration of the bituminous material shall be removed and replaced with suitable aggregate. The compacted coarse aggregate shall have a firm, even surface.

Along curbs, headers and walls, and at all places not accessible to the roller, the aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand

tamper shall weigh not less than 50 pounds and have a face area of not more than 100 square inches.

Aggregate in any course that becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed and replaced with clean aggregate, and the area shall be re-rolled.

Dry rolling shall be stopped when the surface of the coarse aggregate will support the distributor and before the voids are closed sufficiently to prevent the free uniform penetration of the bituminous material.

Prior to application of the bituminous material, the surface of the aggregate will be tested by the Engineer using a 10-foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed $\frac{1}{4}$ inch. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

406.07 Application of Bituminous Material. Bituminous material shall be uniformly applied at the rate specified. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper so used shall be removed and disposed of in a satisfactory manner. During the application of bituminous material care shall be taken to prevent spattering adjacent pavements, structures and trees. The distributor shall not be cleaned or discharged into ditches, borrow pits, onto shoulders or along the right of way.

406.08 Application of Key Aggregate. Immediately following the first application of bituminous material, key or choke aggregate shall be spread and worked into the voids of the coarse aggregate by broom dragging and rolling. Additional key aggregate shall be spread as required, broom dragged and rolled until the course is uniformly filled and compacted.

406.09 Second Application of Bituminous Material. After the first application has been completed for at least 3 hours, a second application shall be applied. This application shall be followed by a second application of key aggregate as specified in subsection 406.08.

406.10 Traffic Protection. The completed penetrated course shall be protected from traffic for a period of 3 hours or until the bituminous material has set. Traffic will be allowed on

the course within 24 hours after completion only when controlled to a speed of not over 20 miles per hour by means of a pilot car. The pilot car, if used, shall be furnished by the Contractor with operator as an alternate to barricading the work.

406.11 Finishing. After completion of the key aggregate application, 2 courses of seal coat shall be applied. Before the first seal coat is applied the surface shall be swept clean. Each seal coat shall consist of approximately 0.4 gallon of bituminous material per square yard. The bituminous material shall be immediately covered with a uniform covering of chips (AASHO size No. 7) in an amount sufficient to take up excess bitumen. This course shall be broom dragged and rolled thoroughly.

A second seal consisting of approximately 0.4 gallon of bituminous material per square yard shall be applied. This shall be immediately covered by an application of stone chips (AASHO size No. 8). They shall be thoroughly broomed, dragged and rolled.

Final rolling shall continue until thorough compaction has been obtained. The variation of the surface from the testing edge of a 10 foot straightedge between any two contacts with the surface shall at no point exceed $\frac{3}{8}$ inch longitudinally.

406.12 Method of Measurement. Aggregate for penetration macadam pavement will be measured by the ton and by the gallon for bituminous material in accordance with Section 109 — Measurement and Payment. When weighed, the stone shall be clean and drained of all free water.

Due to possible variations in the specific gravity of the aggregates, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

406.13 Basis of Payment. The accepted quantities of penetration macadam pavement will be paid for at the contract price per ton for the aggregates and per gallon for bituminous material complete in place.

Payment will be made under:

Pay Item	Pay Unit
406.14 Coarse Aggregate for Penetration Macadam Pavement	Ton
406.15 Key Aggregate for Penetration Macadam	Ton
406.16 Cover Aggregate for Penetration Macadam Pavement	Ton

SECTION 407 — VACANT

SECTION 408 — VACANT

SECTION 409 — VACANT

SECTION 410 — BITUMINOUS SURFACE TREATMENT

410.01 Description. This work consists of furnishing and applying one or more courses of bituminous treatment and aggregate cover material when required on an approved surface in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

The types of bituminous surface treatments are designated as follows:

Tack Coat shall consist of an application of bituminous material to provide bond with a superimposed course. A cover coat will not be required.

Prime Coat shall consist of an application of low viscosity liquid bituminous material to coat and bind mineral particles preparatory to placing a base or surface course. A light coat of cover material may be required.

Seal Coat shall consist of an application of bituminous material and cover material. A double Seal Coat shall consist of a second application of bituminous material and may require a second application of cover material.

When the payment item for Bituminous Surface Treatment is by the square yard the type or combinations of types of treatments will be specified.

MATERIALS

410.02 Bituminous Material. The types and grades of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Materials. The bituminous material may be conditionally accepted at the source.

410.03 Aggregates. The type of cover coat material will be specified in the contract.

Cover material for prime coat shall meet the requirements of subsection 703.13, Sand Cover or subsection 703.14.

Cover material for Seal Coat shall meet the requirements of subsection 703.13, Stone Chips or Sand Cover.

The cover material will be accepted in stockpile at the source.

CONSTRUCTION REQUIREMENTS

410.04 Weather Limitations. Bituminous material shall not be applied on a wet surface, after sunset or before sunrise, or when the atmospheric temperature is below 50° F. in the shade or when weather conditions are otherwise unfavorable to proper construction procedures.

410.05 Equipment. The following equipment or its equivalent shall be furnished:

A power broom.

Equipment for heating and applying bituminous material meeting the requirements of subsection 405.05.

Rolling equipment for seal coat meeting the requirements of subsection 405.05. A minimum of one steel wheel roller and one pneumatic tire roller will be required.

Equipment for applying aggregate cover coat material for seal coat shall consist of: One self-propelled aggregate spreader of approved design supported by at least four wheels equipped with pneumatic tires on two axles. The aggregate spreader shall be equipped with a means of applying the larger cover coat material to the surface ahead of the smaller cover coat material and with positive controls so that the required amount of material will be deposited uniformly over the full width of the bituminous material. Other types of aggregate spreaders may be used provided they accomplish equivalent results and are approved.

410.06 Preparation of Surface. The surface to be treated shall be smooth, stable, uniformly compacted, free of ruts, corrugations or other irregularities. Prior to placing tack coat or seal coat the surface shall be thoroughly cleaned of all loose or objectionable material.

Unless otherwise authorized by the Engineer, a 5 day curing period shall be required between successive applications of bituminous material, and cover material when specified, for construction of a multiple course surface treatment.

If the surface treatment is to consist of successive applications of bituminous material, and cover material when

specified, a 5 day curing period shall be required between the applications.

The cover material shall be evenly distributed and all excess material removed prior to the second application of bituminous material for a double seal coat.

410.07 Application of Bituminous Material. Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated and within the temperature range specified in subsection 702.05.

The width of treatment and quantity of bituminous materials to be used per square yard shall be as directed.

When the item for payment for Bituminous Surface Treatments is by the square yard, the type, grade and approximate quantity of bituminous material per square yard will be specified.

Junctions of spreads shall be carefully made. For seal coats the spray bars of the distributor shall be started on building paper. Skipped areas and deficiencies in distribution for all types of surface treatments shall be corrected.

When traffic is maintained, one way traffic will be permitted on the untreated portion of the roadbed. Following satisfactory penetration and covering of prime coat, traffic may be transferred to the treated portion of the roadway.

When the rolling operation is finished, traffic may be transferred to the newly completed seal coat. Protection from fast moving vehicles shall be furnished as provided for in the contract or as directed by the Engineer.

The length of spread of bituminous material shall not be in excess of that which trucks loaded with aggregate can immediately cover. Under no circumstances shall bituminous material be allowed to chill or set up, dry or otherwise impair retention of the cover coat.

410.08 Application of Aggregate Cover. If after the application of the prime coat, the bituminous material fails to penetrate satisfactorily and the roadway must be used by traffic, the specified cover material shall be spread in the amounts required to absorb any excess bituminous material. The primed surface shall be maintained by subsequent spreading of additional cover material.

When the item for payment for Bituminous Surface Treatment is by the square yard, the type and approximate quan-

tity of aggregate cover per square yard for prime coat and seal coat will be specified.

Immediately following the application of the bituminous material, the specified cover material for seal coat shall be spread in quantities as designated. Cover material for seal coat shall be spread with a self-propelled aggregate spreader unless otherwise specified or directed by the Engineer. Spreading shall be accomplished in such a manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material.

When the aggregate cover material specified for seal coat is stone chips, the Engineer may require drag brooming before rolling. If deemed necessary sand cover shall be uniformly distributed with a wire fabric drag.

Following completion of the rolling operation the seal coat shall be maintained by distributing aggregate cover over the surface to absorb any free bituminous material, and to cover any areas deficient in cover material. Light brooming may be required.

Maintenance shall continue until the treated surface has become stable. When directed by the Engineer all excess aggregate cover material shall be removed by rotary brooms.

410.09 Rolling. Initial rolling of cover material for seal coat shall begin immediately after brooming and shall consist of one complete coverage with a steel wheel roller. Rolling with a pneumatic roller shall follow the initial rolling. The amount of pneumatic-tire rolling shall be sufficient to seal the aggregate cover material and shall not be less than 2 complete coverages. At all times rollers shall move at a slow speed that will prevent any loosening of embedded aggregate cover.

410.10 Method of Measurement. Unless otherwise specified bituminous material will be measured by the gallon, aggregate cover material and blotter material by the ton or cubic yard, measured in the truck.

When specified in the contract as a pay item, Bituminous Surface Treatment will be measured by the square yard.

All quantity determinations will be made in accordance with Section 109 — Measurement and Payment.

410.11 Basis of Payment. The accepted quantity of bituminous material will be paid for at the contract unit price per gallon for the designated type of material complete in place.

The accepted quantity of aggregate cover material will be paid for at the contract unit price per ton or per cubic yard in accordance with the contract pay item for the type of material complete in place.

The accepted quantity of Bituminous Surface Treatment will be paid for at the contract unit price per square yard complete in place which price shall include furnishing and applying bituminous materials, aggregates, and additives, when required.

Payment will be made under:

Pay Item	Pay Unit
410.12 Asphalt Cement, Applied	Gallon
410.13 Tar, Applied	Gallon
410.14 Cut-back Asphalt, Applied	Gallon
410.15 Emulsified Asphalt, Applied	Gallon
410.16 Cover Coat Material, Sand	Cubic Yard
410.17 Cover Coat Material, Stone Chips	Cubic Yard
410.18 Cover Coat Material, Stone Chips	Ton
410.19 Blotter Material	Cubic Yard
410.20 Bituminous Surface Treatment	Square Yard

SECTION 411 — UNTREATED AGGREGATE SURFACE COURSE

411.01 Description. This work shall consist of constructing a surface course or levelling course of untreated aggregate on an approved base in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

411.02 Aggregate. Aggregates shall conform to the requirements specified in the following subsection of Section 700 — Materials.

Aggregate for Untreated Surface Course and Levelling Course 703.10.

CONSTRUCTION REQUIREMENTS

411.03 Placing. The surface course material shall be spread evenly in one layer upon the prepared base course to a depth that will insure the required depth after being com-

pacted. The aggregate as spread shall be well graded with no pockets of fine or coarse material and shall be bladed and shaped with a power grader.

411.04 Compaction. Compacting shall be done with rollers, heavy construction equipment or any combination capable of satisfactorily compacting the course. The Contractor shall maintain the moisture content of the material at the proper degree to attain the required compaction.

When the aggregate surface material lacks sufficient fines to secure compaction, binder material of an approved quality shall be added. The amount added shall not increase the total fines in the mixture to exceed the limits specified. The binder material shall be uniformly incorporated into the surface material by means of harrowing or by other methods capable of obtaining satisfactory results.

411.05 Surface Tolerance. The entire surface shall be shaped and maintained to a tolerance of $\frac{3}{8}$ inch above or $\frac{3}{8}$ inch below the required cross sectional shape.

411.06 Levelling Course. When Aggregate Levelling Course for fine grading aggregate base and subbase course is called for, it shall be placed, measured, and paid for under the bid item for Untreated Aggregate Surface Course.

411.07 Method of Measurement. Untreated Aggregate Surface Course will be measured by the cubic yard in place. The width and thickness for measurement will be the width and thickness of aggregate surface as shown on the plans or as modified by the Engineer. The length will be along the centerline. All measurements will be in accordance with Section 109 — Measurement and Payment.

The quantity of aggregate surface course used for drive-ways and other locations difficult to accurately measure in place may be measured for payment as 80 percent of the number of cubic yards accepted and used, measured in vehicles at the point of delivery as shown by "Delivery Slips" in accordance with subsection 109.01. The quantity so measured shall not exceed 300 cubic yards per contract.

411.08 Basis of Payment. The accepted quantities of Untreated Aggregate Surface Course of the type specified will be paid for at the respective contract price per cubic yard. Payment shall include purchasing material, stripping pits, excavating, crushing, and screening when necessary, hauling, placing, compacting and other necessary processes which are required to furnish acceptable material under this item.

Water added to the material to assist compaction and to prevent ravelling will be incidental and at the Contractor's expense.

Overhaul, when shown in the schedule of prices, will be paid for under Section 205 — Overhaul, for items in this Section.

Payment will be made under:

Pay Item	Pay Unit
411.09 Untreated Aggregate Surface Course	Cubic Yard

SECTION 412 — BITUMINOUS MULCH SURFACE COURSE

412.01 Description. This work shall consist of preparing and mixing an untreated aggregate with bituminous material on an approved base or road surface, in accordance with these specifications and in reasonably close conformity with the lines and thickness shown on the plans or established by the Engineer.

MATERIALS

412.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 702 — Bituminous Materials.

Bituminous materials may be conditionally accepted at the source.

412.03 Aggregate. Aggregate for bituminous mulch surface course shall meet the requirements of subsection 703.13 Sand Cover. The aggregate will be accepted immediately preceding addition of bituminous material. The acceptance will be based on periodic testing of samples of the windrow.

412.04 Weather Limitations. The construction of bituminous mulch surface course shall be carried on only when the surface on which the material is to be placed is dry, the atmospheric temperature is above 50° F., and weather conditions are otherwise suitable for proper handling of the materials or mixture.

EQUIPMENT

412.05 Equipment. Equipment used by the Contractor shall include sweeping, mixing, spreading, finishing, and com-

packing equipment, a bituminous distributor and equipment for heating the bituminous material.

The following equipment or its equivalent shall be required:

A power broom.

A power grader (conforming to the requirements of subsection 631.02).

An aggregate spreader and bituminous distributor conforming to the requirements of subsection 405.05.

Unless otherwise authorized rolling equipment shall conform to the requirements of subsection 409.05.

CONSTRUCTION REQUIREMENTS

412.06 Placing Aggregate. The aggregate shall be placed uniformly on the previously prepared course by the use of the aggregate spreader. The material shall be placed on one side of the pavement centerline, in order to provide for two way traffic, and not more than 24 hours in advance of mixing.

The amount of aggregate required for mulching shall be approximately 300 cubic yards per mile of project, per 22 foot width with proportional increases or decreases corresponding to variable widths of pavement.

412.07 Application of Bituminous Material and Mixing. Immediately preceding the application of the bituminous material, about $\frac{1}{2}$ of the width of the surface to be treated shall be broomed clean. To this broomed area shall be applied bituminous material at the rate of approximately 0.10 gallon per square yard. A power grader shall closely follow the distributor and blade the windrowed aggregate onto the treated surface. A power broom shall follow the grader and cleanly broom the remaining aggregate onto the treated surface. The remainder of the prepared surface shall then be broomed clean and approximately 0.10 gallon per square yard of bituminous material shall be applied to the other side of the remaining travelway. The aggregate shall then be bladed by a power grader to cover the newly treated surface. To this aggregate shall be applied bituminous material at the rate of approximately 0.15 - 0.20 gallon per square yard, as determined by the Engineer. The aggregate shall then be mixed by the grader until all aggregate is coated and no bare or sandy streaks appear and no lumps containing excess bituminous material remain.

Care should be taken during the mixing process not to blade the aggregate nearer than one foot from the edge of the treated surface.

Bituminous material shall be applied at the temperature specified in subsection 702.05. The mixture shall require mixing and curing until the volatiles are reduced.

412.08 Spreading and Finishing. The completely mixed material shall be spread the full width of the course by means of the power grader. This course shall be sealed with a seal coat as specified in Section 410 — Bituminous Surface Treatment, if required by the Engineer.

Bituminous Mulch Surface Course shall be rolled in accordance with the requirements of subsection 405.10 unless otherwise directed.

The Engineer may permit rolling in accordance with subsection 411.04.

412.09 Method of Measurement. Bituminous material will be measured by the gallon and aggregate will be measured by the cubic yard (100 percent of the volume measured in the hauling vehicles) in accordance with Section 109 — Measurement and Payment.

412.10 Basis of Payment. The accepted quantity of bituminous mulch surface course will be paid for at the contract unit price per gallon for bituminous material and per cubic yard for aggregate complete in place.

Payment will be made under:

Pay Item	Per Unit
412.11 Bituminous Material for Mulch Surface Course	Gallon
412.12 Aggregate for Mulch Surface Course	Cubic Yard

SECTION 413 — VACANT

SECTION 414 — VACANT

SECTION 415 — VACANT

SECTION 416 — VACANT

SECTION 417 — VACANT

SECTION 418 — VACANT

SECTION 419 — VACANT

SECTION 420 — PORTLAND CEMENT CONCRETE PAVEMENT

420.01 Description. This work shall consist of the construction of a pavement composed of air-entrained portland

cement concrete, plain or with reinforcement as specified; constructed on an approved foundation in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, typical cross sections, and details shown on the plans or as modified by the Engineer.

MATERIALS

420.02 Materials. Materials shall meet the requirements of the following subsections of Section 700, Materials, except as modified herein.

Portland Cement	701.01
Cut-back Asphalts	702.03
Emulsified Asphalts	702.04
Fine Aggregates for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Preformed Expansion Joint Filler	705.01
Joint Sealing Compound	705.05
Graphite Lubricant	708.08
Reinforcing Steel	709.01
Curing Materials	711.01
Air Entraining Admixtures	711.03
Water	712.01
Calcium Chloride	712.02

420.03 Concrete. The materials used and the production of the concrete for cement concrete pavement shall conform to the requirements for air-entrained Class A cement concrete given in Section 502 — Structural Concrete; except as modified or supplemented by the following:

(a) Portland cement used in all portland cement concrete pavements shall be Type II cement unless otherwise specified.

(b) The concrete shall contain 6 percent, plus or minus 1½ percent, entrained air obtained by the use of an air entraining admixture added to the concrete at the mixing site.

(c) The concrete shall have a slump of between 1½ and 3 inches if not vibrated, or between 1 and 2 inches if vibrated throughout. Slump will be measured in accordance with AASHTO T 119.

(d) After the materials provided by the Contractor have been accepted for the project; the exact proportions of cement, fine and coarse aggregates, the amount of air-entraining agent, and the desired slump necessary to produce concrete of the required plasticity, durability, and air content will be designated by the Engineer throughout the progress of the work.

(e) Test specimens will be made, cured and tested in accordance with subsection 420.18.

420.04 Steel Reinforcement. When steel reinforcement is called for, it shall consist, at the Contractor's option, of either prefabricated steel bar mats or welded steel wire fabric sheets as shown on the plans.

Lane-width bar mats or welded steel wire fabric sheets shall be shipped and handled without bending, or folding devices of approved design shall be incorporated into the bar mats or welded steel wire fabric sheets so they may be shipped and handled without bending. These devices shall be so constructed as to allow a minimum amount of free movement and shall conform in all other respects to the standard requirements specified herein for strength and design.

Reinforcing bars shall be rolled from new billet steel or axle steel, of intermediate grade; or rail steel. They shall conform to the AASHTO Specifications for the kind of steel used. Bars rolled from rail steel or axle steel will not be allowed for any reinforcement which will require bending in the field. Rust that has produced scale or has pitted the steel will be considered an imperfection. Surface rust will not be considered an imperfection but rusty surfaces shall be brushed to remove loose material.

(a) Steel Bar Mats shall be of deformed, round, steel bars as required on the plans. Clipped or welded mats may be furnished at the option of the Contractor.

(b) Welded Steel Wire Fabric shall be furnished in flat sheets, either lane width or folding. The size and spacing of wires shall be as shown on the plans.

(c) Tie Bars and Tie Bolts shall conform to AASHTO Designation M 31 or M 42. Ties across longitudinal joints shall be deformed bars of new billet steel, rail steel (AASHTO M 31 or M 42) or tie bolts as shown on the plans or otherwise approved.

Bending and re-straightening of tie bars conforming to AASHTO Designation M 42 will not be permitted, but will be permitted for those conforming to M 31.

Either tie bars or tie bolts may be used across longitudinal joints formed by weakened plane construction. Only tie bolts may be used across longitudinal construction joints unless the slipform method of construction is used; in which case, tie bars may be employed — subject to the above and to the provisions of subsection 420.28 (g).

420.05 Load Transfer Assembly. Load transfer assemblies for transverse joints shall consist of dowels of plain round steel bar stock, or other approved shape, and a metal device designed to hold the bars exactly and firmly in correct position during concrete placing.

The bars shall be from new billet steel; structural, intermediate, or hard grade, free from burring or other deformation restricting slippage in the concrete.

The entire assembly shall be a complete structure, rigid enough to be lifted as a unit and installed in the work, and shall have sufficient bearing area to prevent sinking into the base. Any member crossing the joint shall permit unrestrained movement of the joint.

The lubricated unbonded ends of dowels for expansion joints shall be fitted with an approved metal combination sleeve and cap meeting the requirements specified in subsection 709.01.

The entire load transfer assembly shall be left in the pavement.

420.06 Preformed Joint Filler. Preformed joint fillers shall be cut or cast in strips of the thickness shown on the plans and lengths equal to not less than the width of 1 lane. The height of the filler strip shall be as shown on the plans. The filler shall be punched to admit the dowels where called for on the plans.

Where 2 or more traffic lanes are being placed in a single operation, the filler may be furnished in sections, provided the length of each section is equal to the width of 1 lane. When more than 1 section is used in a joint, the abutting ends shall be fastened securely and held accurately to shape by lacing, stapling, or other positive fastening satisfactory to the Engineer.

Butted ends and dowel holes shall be so fabricated that no concrete will be admitted into the space designed to be occupied by the filler.

The top of the preformed filler shall be fitted with an approved metal cap to facilitate installing the joint and to provide adequate rigidity while the concrete is being placed.

After the longitudinal floating and transverse scraping have been completed, the metal cap shall be carefully removed and replaced with a spring steel bar of the following description:

The bar shall be rectangular in cross section. Its depth shall be equal to the distance from the top of the preformed filler to the top of the concrete slab; its width shall be equal to the thickness of the filler and its length shall be at least equal to the width of the slab.

420.07 Joint Sealing Compound. The joint sealing compound for all joints shall be a rubberized joint sealing material conforming to Federal Specification SS-S-164 for Sealing compound; hot-poured type for joints in concrete.

At locations where portland cement concrete pavement abuts curb or edging, expansion material shall be provided as shown on the plans or as specified. The space above the expansion material and between the portland cement concrete pavement and the curb or edging shall be filled with rubberized joint sealing compound. This work will be considered incidental to the pay item.

420.08 Asphaltic Paint. Asphaltic material for painting the side of slabs, where additional slabs are to be placed; shall, at the Contractor's option, be either cut-back asphalt RC-70 or asphaltic emulsion RS-1.

Prior to application of the asphaltic paint, all holes and honeycomb areas shall be patched in accordance with subsection 420.24.

420.09 Curing Materials. Curing materials shall be one of the following types:

(a) *Burlap Cloth Made from Jute or Kenaf.* The burlap shall be of one type only — either jute or kenaf and Class 3 or 5, weight based on 40-in. width. It shall be furnished in strips not less than 3 ft. nor more than 6 ft. in width and 2½ ft. longer than the width of the pavement slab.

The burlap shall not have been used for any purpose other than concrete curing.

(b) *Cotton Mats for Curing Concrete.*

(c) *Waterproof Paper for Curing Concrete.* The name of the manufacturer shall be marked or imprinted clearly on the paper for proper identification. Each paper cover shall be not less than 20 nor more than 75 ft. in length, and shall be of such a width that, when in place, it will extend at least 18 in. beyond each edge of the slab to be covered. Paper covers may be furnished in widths corresponding to that of the slab provided supplemental stringer sheets, at least 18 in. wide, are placed along the edges of the slab under the paper covers. Paper covers, not manufactured in sizes which will

provide the proper width, shall be securely sewed or cemented together with minimum laps of 4 in. so as to produce an air-tight, waterproof joint which will not open or separate during the curing period.

(d) *Polyethylene Sheets for Curing Concrete.* Additional general requirements for polyethylene sheets shall be those given for waterproof paper in (c) preceding.

(e) *Liquid Membrane-forming Compounds for Curing Concrete.* Membrane curing compound shall be Type 2. The use of any membrane material which would impart a slippery surface to the pavement or permanently alter its natural color will not be permitted.

The impervious membrane shall retain, for a period of 3 days, a minimum of 95% of the water content of the concrete at the time of application of curing compound, when tested in accordance with AASHTO Designation T 155.

CONSTRUCTION REQUIREMENTS

420.10 Equipment and Tools. Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. Any equipment or tools which are not maintained in full working order or which, as used by the Contractor, prove inadequate to obtain the results prescribed, shall be improved or new equipment or tools shall be substituted or added as directed.

(a) *Scales.* Scales will be inspected and sealed by the State Sealer of Weights and Measures as often as the Engineer may deem necessary to assure their continued accuracy.

(b) *Laboratory.* A testing laboratory shall be provided for the use of the plant inspector. It shall be located in view of the batching plant operations, at a location satisfactory to the Engineer.

(c) *Curing Box.* An approved thermostatically-controlled curing box for concrete test cylinders shall be provided. The curing box shall meet the requirements of Section 514, Curing Box for Concrete Cylinders, except that the size and capacity shall be adequate to store 1 week's production of test cylinders. The number of cylinders to be stored will be determined as provided in subsection 420.18.

(d) *Batching Plant and Equipment.* The batching plant and equipment shall conform to the applicable requirements

of subsection 502.06 supplemented by the provisions of subsection 420.14.

(e) *Mixing and Delivery Equipment.* Mixers shall conform to the applicable requirements of subsection 502.07 supplemented by the following and also by the provisions of subsection 420.15. Concrete may be mixed at the site of construction or at a central point.

1. Mixers at Site of Construction — Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period. Paving mixers shall be equipped with a boom and bucket, fully power controlled, and operated in such a manner that the concrete batches will be discharged and uniformly distributed over the entire grade without segregation. The mixer shall be equipped with a water measuring device not affected by variation in pressure of the water supply line, and capable of accurate measurement to within 1 percent. There shall be no leakage. If water measurement equipment ceases to deliver the proper quantity of water, use of the mixer shall immediately stop and shall not be resumed until repairs have been made. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The timing device shall also control the transfer in pavers having more than 1 drum. The device shall be equipped with a bell or other suitable warning device which gives a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day, providing that each batch is mixed 2 minutes. The timing device shall be repaired before another day's use of the mixer.

2. Truck Mixers and Truck Agitators. Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central-mixed concrete, shall conform to the applicable requirements in subsection 502.07 and to the Standard Specifications for Ready-Mixed Concrete, AASHTO Designation M 157.

3. Non-Agitating Hauling Equipment. Non-Agitating trucks used for transporting concrete shall conform to the requirements of subsection 502.07 (e), subparagraph 4.

(f) *Spreading and Finishing Equipment.*

1. The spreading machine shall be an approved self-propelled machine capable of spreading the concrete evenly between the side forms, without segregation, and without

introducing thrust on the side form. It shall be equipped with a spreading device, adjustable in height, for distributing the concrete longitudinally and transversely and a blade, adjustable in height, to strike-off the concrete at the required elevation above or below the top of the side forms.

2. The transverse finishing machine shall be an approved self-propelled machine equipped with at least 2 oscillating screeds. It shall have independent screed and traction speeds to permit the operator to choose a combination of speeds that will produce the required finish with the consistency of concrete being used. The screed drive shall be arranged to minimize lateral thrust on the side forms. It shall be so coordinated in weight, number of wheels, and power of motor as to prevent slippage on the side forms. It shall not cause displacement of the side forms nor cause undue delay due to mechanical difficulties.

3. The longitudinal float shall be an approved power float. The float in contact with the pavement shall be at least 12 inches in transverse width and at least 12 feet in length.

4. A long wheel-base combination float-finishing machine may be used in lieu of the transverse finishing machine and longitudinal float providing the combination machine can be adjusted to produce satisfactory results and final finishing is properly timed. The drag float shall have a transverse width equal to the width of pavement being placed and a surface contact length of approximately 2 feet.

5. Vibrators for full width vibration of concrete paving slabs may be either the surface pan-type or the internal type with either immersed tube or multiple spuds. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with expansion material, load transfer devices, base, or side forms. The frequency shall not be less than 3,500 impulses per minute for surface vibrators, nor less than 5,000 impulses per minute for internal tube vibrators, nor less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute. Vibrators shall not cause displacement of the side forms nor cause undue delay due to mechanical difficulties.

(g) *Concrete Saw* — The Contractor shall provide sawing equipment with water-cooled, diamond-edge blades or abrasive wheels of the required dimensions; adequate to complete

the sawing at the required rate. He shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing, if necessary. All of this equipment shall be on the job both before and continuously during concrete placement.

(h) *Forms* — Straight side forms shall be metal and shall be furnished in sections not less than 10 feet in length. They shall have a depth equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width at least equal to the depth of the forms but not less than 8 inches. Flange braces shall extend outward on the base not less than $\frac{3}{4}$ the height of the form. Flexible or curved forms of proper radius shall be used for curves of 200 foot radius or less and be of a design acceptable to the Engineer. Satisfactory wooden forms, approved by the Engineer, may be used for curves of 200 foot radius or less or where the design of the pavement is such that metal forms cannot be used.

Forms shall be provided with devices for secure setting and for locking abutting form sections together, so that when in place; they will withstand the impact and vibration of the consolidating and finishing equipment without visible spring or settlement. Forms to be used for concrete which is to be finished by hand shall have a base not less than 6 inches in width.

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

Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved by the Engineer.

420.11 Preparation of Grade. After the base course immediately under the pavement has been brought to line and grade, and immediately prior to placing the forms, the base shall be conditioned and trimmed to the exact shape, grade, and cross section required by the plans with a tolerance as specified in subsection 420.13. Such conditioning and shaping shall extend at least 2 feet beyond each edge of the proposed paving.

The use of a subgrade machine of approved type will be permitted. If a subgrade machine is used, the forms may be placed in advance of the exact conditioning and trimming.

420.12 Setting Forms.

(a) *Base Support.* The foundation under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which, at the form line, is found below the established grade shall be filled to grade with base material placed in lifts of $\frac{1}{2}$ inch or less for a distance of 18 inches on each side of the base of the form, and the material thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

(b) *Form Setting.* After the forms have been set to correct grade, the grade shall be thoroughly tamped at both the inside and outside edges of the base of the forms. Forms shall be joined neatly and tightly and staked securely with not less than 3 pins for each 10 foot section. If necessary, a pin shall be placed at each side of every joint to hold the forms. Form sections shall be tightly locked and free from play or movement in any direction. If any play or movement of the forms occurs, additional pins will be required by the Engineer. The entire base of forms shall be directly in contact with the base. If a form does not have satisfactory bearing area for its full length, it shall be removed and the bearing area of the base reshaped and compacted and the form replaced. Building of pedestals of earth or other materials upon which to reset the forms to bring them to the required grade will not be permitted. Forms shall be set in advance of the point of placing concrete as provided in subsection 420.16. They shall be thoroughly cleaned and greased before concrete is placed against them. No settlement or springing of forms under the finishing machine will be tolerated.

(c) *Grade and Alignment.* The forms shall be set to correct line and grade. Smooth alignment and grade shall be checked by sighting, string lining, and with an approved 10 foot straight edge. The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor well in advance of placing the concrete as provided in subsection 420.16. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked. A mechanical tamper of approved type and design will be permitted for use in the preparation of a firm, even base for form installation.

420.13 Conditioning of Base. When side forms have been securely set to grade, the base between shall be brought to proper cross section. The fine grading shall be compacted to

the density specified by means of approved equipment. A base check template shall be used as a final check. The surface of the base shall not be above nor more than $\frac{3}{4}$ inch below the plan base elevation. Any deviation from the required base surface exceeding this tolerance shall be corrected.

The template shall span the width being paved and be supported on the side forms. It may be power or hand operated, with scratch teeth or pins which can be adjusted readily to the required cross section and which are supported in a frame of sufficient strength to withstand the loads imposed. The points of the teeth or pins shall be adjusted to be at the designated base elevation. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade except that areas which are not more than $\frac{3}{4}$ inch below base elevation may, at the contractor's option, be filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

Conditioning of the base, shall precede concrete placement operations as provided in subsection 420.16.

The base shall be uniformly moist when the concrete is placed. When the base is dry, it shall be sprinkled immediately in advance of placing concrete with as much water as can be absorbed readily. It shall also have been similarly sprinkled not less than 8 hours nor more than 24 hours before concrete is placed.

420.14 Handling, Measuring and Batching Materials. The batch plant site, layout, equipment, and provisions for transporting material shall be adequate to assure a continuous supply of material to the work. Stockpiles shall be built up in layers not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next and shall not fall down over the layer beneath. Aggregates from different sources and of different gradings shall be stockpiled separately with positive separation of piles provided.

Aggregates shall be hauled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. Aggregates shall be completely free of wood, rags, paper, and other organic debris regardless of source. The use of a slurry separator is recommended and will be required if other means of control prove unsatisfactory. All aggregates produced or handled by hydraulic methods and all

washed aggregates shall be stockpiled or binned for draining for at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. When the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours will be required by the Engineer.

The fine aggregate and each size of coarse aggregate shall be separately weighed in the respective amounts set by the Engineer in the job mix. Cement shall be measured by the sack or by weight. Separate scales and hoppers shall be used for weighing the cement with a device to positively indicate the complete discharge of the cement into the batch box or container. Ninety-four pounds of bulk cement shall be considered one sack. Batches involving fractional sacks will not be allowed, except when bulk cement is used.

When required by the contract, or when otherwise permitted, batching plants shall be equipped to proportion aggregates and bulk cement, by weight, by means of automatic and interlocked proportioning devices of approved type.

When mixing at the site of the work, the aggregate shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers of adequate capacity to properly carry the volume required. Partitions separating batches shall effectively prevent spilling from one compartment to another while in transit or while being dumped. When bulk cement is used, the Contractor shall use a method of handling the cement from the weighing hopper to the container for transportation to the mixer employing a chute, boot, or other approved device which will prevent loss of cement and provide positive assurance of the actual presence in each batch of the entire cement content specified. Vibrators may be required to insure flow of cement through handling devices.

Bulk cement shall be transported to the mixer in tight compartments, separate from the aggregate, and carrying the full amount of cement required for each batch. Provision shall be made for the cement to be discharged into the skip after the aggregate has been discharged. Any batch in which the cement has been in contact with the aggregate more than $1\frac{1}{2}$ hours previous to completion of discharge from the mixer shall be rejected. Cement, in original shipping packages, may be transported on top of the aggregates; each batch containing the number of sacks required by the job mix.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped into the mixer without loss of cement or aggregate, and when more than one batch is carried on the truck, without spilling of material from one batch compartment into another. Batching shall be so conducted as to result in batches having the required weights of each material within a tolerance of 1 percent for cement and 2 percent for aggregates.

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over 1 percent. Unless the water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve, provided for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank. The Contractor shall cooperate with the Engineer in checking the accuracy of water measuring apparatus by furnishing a suitable tank and scales, and by making such plumbing connections as may be required.

Methods and equipment for adding air-entraining agent or, when required, other admixtures to the batch, shall be approved by the Engineer. Admixtures shall be measured into the mixer with an accuracy of plus or minus 3 percent.

420.15 Mixing Concrete. The concrete may be mixed at the site of the work or, if approved by the Engineer, in a central mix plant. Approval for the use of central mixed concrete will depend on the Contractor's proposal to use satisfactory mixing, hauling, and spreading equipment. All mixers shall be of an approved type and capacity.

(a) *Mixing in Pavers at the Site.* Concrete shall be mixed for at least 60 seconds, including transfer time, but not less than 50 seconds, exclusive of transfer time, after all materials, except water, are in the drum. The mixer shall be operated at the drum speed shown on the manufacturer's name plate. The manufacturer's guaranteed capacity of the mixer shall be not less than 27 cubic feet. Except by written permission of the Engineer, the mixer shall not be operated in excess of its guaranteed capacity nor by more than 10 percent above the rated capacity shown on the standard rating plate of the machine.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and

aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 20 seconds of the mixing period. The entire contents shall be emptied from the drum before the succeeding batch is introduced. The inside of the drum shall be kept free from hardened concrete. The skip and throat of the drum of the mixer shall be kept clean and free of accumulations or encrustations of inert materials. Admission of these materials to the mixer shall be cause for rejection of any batch in which they are included. The concrete, as discharged from the mixer, shall be uniform in composition and consistency. If this condition is not produced with the maximum allowable size of batch, the size of the batch shall be reduced or the mixing time increased, or both, until an acceptable mixture is obtained.

All materials, except water, shall be admitted to the mixer simultaneously. Thereafter, no additional amount of any ingredient shall be admitted to the mixer, except on specific instructions issued by the Engineer or his representative, and covering each individual batch. Such instructions shall not be given for more than 3 consecutive batches after which the proportions of the mix shall be corrected prior to the initial charging of the mixer. Such instructions shall not relax the following restrictions concerning retempering:

Retempering concrete by the addition of water will not be permitted. The addition of water to the batch in the mixer more than 10 minutes after the initial charging, or the addition of water to the concrete after removal from the mixer, shall be construed as retempering. Batches of concrete prepared contrary to these restrictions will be rejected and shall be immediately removed from the site. The concrete shall be mixed only in the quantity required for immediate use. Concrete not in place 30 minutes after the ingredients were charged into the mixing drum, or that has developed initial set, will be rejected.

(b) *Central-Mixed Concrete.* Central-mixed concrete shall conform to all the requirements for materials, proportioning, air entrainment, mixing, placing, and finishing specified herein, and to the requirements of Section 502 — Structural Concrete and those of AASHTO Designation M 157, except as hereby modified or supplemented.

Central-mixed concrete for use in pavement shall be proportioned and mixed at a central plant and transported to the project in truck-agitators or in truck-mixers constantly rotating at the agitating speed designated by the manufacturer of the equipment, or it may be transported in non-

agitating equipment if approved by the Engineer. When central-mixed concrete is used, it shall be placed with an approved spreader, except as otherwise authorized by the Engineer.

After introduction of the cement to the aggregate, discharge of central-mixed concrete shall be completed within 1½ hours or before 250 revolutions of the drum or blades, whichever comes first. In hot weather or under conditions contributing to quick stiffening of the concrete, delivery and discharge shall be completed within 1 hour.

If additional mixing water is required to be added to maintain the specified slump, a minimum of 20 revolutions of the mixer drum at mixing speed will be required before discharge of the concrete.

All truck-mixers shall be equipped with separate wash-water tanks. After discharge of the concrete from truck-mixers or agitators, sufficient wash water shall be introduced to thoroughly cleanse the drum and the drum shall be slowly rotated during return to the batch plant. Wash water used in truck-agitators and truck-mixers used as agitators shall not be used as part of the mixing water but shall be discharged from the drum prior to charging with concrete. Water lines of all truck-mixers and truck-agitators shall be kept clean. Drums, charging doors, and discharging doors shall not leak.

Truck-mixers and truck-agitators shall be of types approved by the Engineer and shall be maintained in good mechanical condition. The Engineer may require inspection of any unit before use and he shall be advised at least 24 hours in advance of the contemplated use of any truck-mixer or truck-agitator.

Discharge of central-mixed concrete from non-agitating hauling equipment shall be completed within 1½ hours after introduction of the cement to the aggregates. Truck bodies shall be thoroughly cleaned with water following each load.

Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85° F. or above, discharge from any hauling equipment shall be completed within 1 hour.

(c) Central Batching Plant. When a central batching plant is used and dry ingredients are transported in truck-mixers and mixed at the site of the work, the truck-mixers shall be charged at the batching plant with reasonably dry aggregates and cement but no mixing water. The required

amount of mixing water shall be carefully introduced into the mixer at the job site and the batch of concrete shall be mixed as outlined below. Under these conditions 1 hour will be allowed for the discharge of the load, computed from the time the mixing water has been added to the batch and mixing has begun as outlined above. The total time allowed for transporting, mixing, and discharging shall be as provided in subsection 502.07 (e), subparagraph 1.

When truck-mixers are used for complete mixing, each batch of concrete shall be mixed for not less than 50 nor more than 100 revolutions of the drum or blades — at the mixing speed designated by the manufacturer of the equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the counter for determining the number of revolutions of mixing.

(d) General. Batches shall be discharged in a manner to facilitate placing the concrete in its final position with a minimum of handling and without damage to forms, concrete previously placed, or other parts of the work.

The interval between loads shall be controlled in order that concrete in place will not become partially hardened prior to placing succeeding batches. In no case shall the interval exceed 30 minutes. Plant capacity and transportation facilities shall be sufficient to insure delivery of concrete at the required rate.

420.16 Limitations of Mixing and Placing. No concrete shall be mixed, placed, finished or prepared for curing when the natural light is insufficient.

The Engineer will be the sole judge of the sufficiency of the natural light. To insure compliance with the intent of this specification he may, by written order, establish time limitations governing specific operations. He may, by written order, permit specific operations after the period of sufficient natural light when such operations are occasioned by unforeseeable equipment breakdown or inclement weather and provided the Contractor provides adequate artificial lighting. This provision shall in no way waive the requirements that moist curing, joint sawing and incidental joint curing be performed at appropriate times, day or night.

At least 1,500 feet of fully adjusted forms and acceptably prepared grade shall exist in advance of the point where concrete placement is to start each day. Concrete placement shall stop at any time that less than 500 feet of acceptable

forms, grade, and dowel assemblies exist in advance of the point where concrete is being placed.

Unless otherwise authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a dropping air temperature in the shade and away from artificial heat reaches 40° F. and the work shall not resume until a rising air temperature in the shade and away from artificial heat reaches 35° F.

When concreting is authorized during cold weather, the aggregates may be heated prior to being placed in the mixer by either steam or by dry heat. The apparatus used shall heat the mass uniformly and shall prevent the possibility of overheated areas which might injure the materials. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50° F. and not more than 70° F. at the time it is placed in the forms.

If, due to special authorization for cold weather work, the air temperature is 35° F. or less at the time of placing concrete; the Engineer may require the water, the aggregate, or both, to be heated to not less than 70° F. nor more than 150° F. Frozen aggregates shall not be used in the concrete.

420.17 Placing Concrete. Concrete shall be placed only on an approved base course.

The Contractor shall notify the Engineer at least 24 hours in advance of placing concrete.

The depositing of concrete on excessively wet or on frozen bases will not be permitted. Concrete shall not be placed around manholes or other structures until they have been constructed to the required grade and at the correct location.

During dry weather, when traffic on the base or adjacent roadways would deposit wind-blown dust and dirt on unprotected freshly-placed concrete, the Contractor shall apply satisfactory treatment to keep down the dust.

Unless otherwise permitted by the Engineer, all equipment used for mixing, hauling, and placing concrete shall be operated outside the forms. Should operation of such equipment be permitted on the prepared base, suitable runway devices shall be provided and used for the equipment to travel on so that the base will be maintained in an approved condition.

The concrete shall be deposited on the grade in a manner requiring as little handling as possible and shall be distributed so that, when consolidated and finished, the slab thickness and surface grade required by the plans will be obtained at all

points. Unless truck-mixers, truck agitators, or nonagitating hauling equipment are especially equipped for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and shall be mechanically spread on the grade in a manner which will act to prevent segregation of the materials. Placing shall be continuous between transverse joints, without the use of intermediate bulkheads, except as specified under subsection 420.20, paragraph (d). Necessary hand spreading shall be done with shovels. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or other foreign substances.

The concrete shall be deposited carefully at and around contraction and expansion joints. It shall be placed against both sides simultaneously. Care shall be taken that the concrete is worked under all metal parts of the load transfer assemblies. The concrete shall not be dumped directly upon or against the joints in any manner which displaces the load transfer assemblies or joint materials from their true positions.

Immediately after the concrete has been struck off, it shall be thoroughly consolidated against the faces of all forms and around all parts of joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in direct contact with joint assemblies, the grade or side forms. In no case should vibrators be operated longer than 5 seconds in any one location.

Surface vibrating equipment shall be used only on the top course of the pavement and must be completely out of use when spreading the bottom course of concrete in two-course construction.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

When concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment is to be operated upon the existing lane of pavement, that lane shall not be opened to such traffic until the 7 day curing period has been completed, the transverse joints have been sealed, and the concrete has attained a compressive strength of 3,500 pounds per square inch as determined by test cylinders made when the concrete was placed. Only rubber-tired equipment will be permitted to operate upon the concrete pavement.

420.18 Test Specimens. The Contractor shall furnish the concrete necessary for casting test cylinders. All equipment, materials, facilities, and incidentals required to conform to

the specified procedures for field curing shall be supplied by the Contractor. One set of three cylinders will be made for each 2,000 square yards or fraction thereof of pavement placed each day. Test specimens shall be made, cured, and tested in accordance with AASHTO T 22 and AASHTO T 23.

Samples of concrete for test and test specimens may be taken from transportation units at the point of discharge or from the concrete in place as determined by the Engineer.

420.19 Strike-off of Concrete and Placement of Reinforcement. As soon as concrete has been placed on the base, it shall immediately be struck-off by means of an approved mechanical spreading device, leaving a surface of uniform texture, true to grade, elevation, and contour. The strike-off shall be so adjusted for elevation that, when the concrete is consolidated, sufficient material remains above grade to form the final finished surface of the pavement.

All reinforcing metal must be kept clean and free from dirt, oil, paint, grease, mill scale, loose or thick rust or any foreign material which could impair bond of the steel with the concrete except that, if the design requires more than one size of mat, a small area of color-coding paint will be permitted. Welded sheet fabric and clipped bar mats shall be furnished in flat sheets, kept straight until installed and they shall be handled carefully during placing.

The reinforcement shall be accurately placed as shown on the plans. Adjacent sheets of welded fabric and clipped bar mats shall be lapped as shown on the plans and shall be securely fastened to maintain their design position in the slab. Except at transverse joints, the rear edge at each mat shall be placed under the leading edge of the previously placed mat.

When reinforced concrete pavement is placed in 2 layers, the entire width of the bottom layer shall be struck-off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final design position. The reinforcement shall be placed directly upon the concrete after which the top layer of the concrete shall be placed, struck-off, and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When concrete is placed in 1 layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by approved

mechanical or vibratory means immediately after the concrete has been spread and struck-off.

420.20 Joints. Joints shall be constructed of the types and dimensions and at the locations required by the plans or specifications or as directed by the Engineer. They shall be placed to a true alignment as shown on the plans or as directed. The sides of joints shall be protected during the curing period as specified in subsection 420.23, paragraph (c). Joint spaces shall be protected against infiltration of foreign material before the time of sealing. All joints shall be sealed before the pavement is opened to any kind of traffic. Dowels, tie-bars, and tie-bolts shall be prepared and placed across joints where indicated on the plans.

If sealed joints become contaminated with dirt, sand, gravel, or other foreign material during the construction period, they shall be reopened, cleaned, and resealed prior to acceptance of the project.

(a) Longitudinal Joints — General. Longitudinal joints shall consist of construction joints between adjacent lanes and surface groove joints used when the paving is placed more than 1 lane at a time. They shall be located as shown on the plans or as directed.

Deformed steel bars or tie-bolts of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints. They shall be placed by approved hand or mechanical methods or rigidly secured by chairs or other approved supports to prevent displacement. Tie-bars and tie-bolts shall not be painted or coated with asphalt or other material nor enclosed in tubes or sleeves.

When fixed forms are used, tie-bolts shall be placed across longitudinal construction joints as shown on the plans or as directed. Tie-bolts shall be installed in 2 major parts to form an integral tie-bolt unit. These shall be attached to the form rail in such a manner that the internally threaded unit together with the temporary bolt will serve to hold the keyway forms to the form rails.

Tie-bars in multi-lane paving shall be of the size and length shown on the plans and shall be placed at right angles to the longitudinal joints. The mid-point of tie-bars shall be at the longitudinal joints. Tie-bars may be supported above the fine grade ahead of the placement of concrete or tie-bars may be placed in the plastic concrete of the first layer, by approved hand or mechanical methods, before the top layer of concrete is placed. The method employed shall insure placement within 1 inch of the designed elevation.

1. Longitudinal construction joints shall extend for the full depth of the pavement and be perpendicular to the pavement surface. The slab edges shall be keyed and tied as shown on the plans. The upper edges of the slab shall be rounded as shown on the plans. The slab placed second shall be edged with a tool having a vertical leg $\frac{1}{4}$ inch thick and of the depth shown on the plans. The joint shall be filled with sealing material.

Immediately after removal of the forms, all honeycombed areas on the vertical faces of longitudinal joints shall be cleaned with a wire brush, be thoroughly wetted, and be patched with mortar of the same composition as that used in the pavement.

After any necessary cleaning or patching and before the adjacent slabs are placed, the edges of the concrete slabs along the longitudinal joints shall be painted with asphaltic material as specified in subsection 420.07.

2. When paving more than 1 lane at a time, longitudinal surface groove joints shall be constructed by sawing with approved concrete saws to the depth, width, and alignment shown on the plans. Suitable guide lines or devices shall be used to assure cutting the joints on the true alignment. If sawing is done before the end of the curing period, the faces of the joints shall be cured as provided for transverse sawed joints in subsection 420.23, paragraph (e). The joints shall be filled with joint sealing compound as specified under subsection 420.07.

(b) *Transverse Expansion Joints* — Transverse expansion joints shall be constructed where shown on the plans or directed by the Engineer. They shall consist of a pre-formed filler, a top sealing cap of poured joint filler compound, and an approved load transfer assembly as specified in subsections 420.06, 420.07, and 420.05 respectively.

The expansion joint filler shall be continuous from form to form and be shaped to the grade and to the keyway along the form. It shall extend from the grade to the distance below the pavement surface shown on the plans.

Preformed joint filler shall be furnished in lengths equal either to the paving width or to the width of one lane. Where more than one section is used in a joint, the sections shall be securely laced or clipped together. Damaged or repaired joint filler shall not be used unless repaired to the satisfaction of the Engineer.

During the concreting operations, a removable metal cap shall be placed over the top of the preformed joint during the

concreting operations to maintain proper grade and alignment. Concrete shall be placed as specified and shall be carefully consolidated against the joint filler. The metal cap shall be removed immediately after the final pass of the finishing machine. A suitable strip of the exact thickness and width of the filler shall then be inserted in the joint as a guide and the concrete edged. The strip shall then be removed and any rough or torn places in the concrete shall be corrected.

Particular care shall be taken to keep the concrete in exactly the same plane on both sides of the joint. No concrete shall extend across the joint. No plugs of concrete will be permitted anywhere within the expansion space.

(c) *Transverse Contraction Joints* — These joints shall consist of planes of weakness created by sawing grooves in the surface of the pavement at the locations and to the depth and width indicated on the plans.

Approved load transfer assemblies shall be installed at each contraction joint as shown on the plans and in accordance with the Specifications.

The Contractor's sawing equipment and method of sawing shall be subject to the approval of the Engineer. The timing of sawing and the order in which joints are sawed shall be subject to such control by the Engineer as in his judgment is necessary to protect the pavement from ravelling, spalling, random cracking, or other damage. Normally, contraction joints will be sawed progressively with approved circular saws not less than 6 nor more than 24 hours after finishing. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions.

To control random cracking the Engineer may require that initial curing (for the first 24 hours) be done with wet burlap.

The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. Cracks occurring before sawing or ahead of the saw kerf shall be routed to a minimum of $\frac{1}{2}$ inch in depth, thoroughly cleaned and filled with joint sealing compound. In general, all joints should be sawed in sequence. All contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs.

When approved by the Engineer, a vibrating bar may be used to move coarse aggregate off the line of the saw cut.

The vibrating bar shall be used only in plastic concrete so as not to produce areas of segregated mortar.

(d) *Transverse Construction Joints* — Transverse construction joints shall be placed at the end of each day's work and when placement of concrete will be interrupted for more than 30 minutes. No transverse construction joint shall be placed closer than 15 feet from a regular transverse expansion or contraction joint.

Substantial temporary wood or metal bulkheads shall be used to form construction joints.

Deformed bars, as shown on the plans, shall be used to create a bonded tie across construction joints.

When steel bar mats or welded steel wire fabric sheets are specified, the longitudinal members of the mats or mesh shall project through the bulkhead not less than the design length of lap. Load transfer across transverse construction joints shall be accomplished by means of a keyway such as is detailed for longitudinal construction joints. At the Contractor's option, the keyway may be omitted provided that additional tie-bars or uncoated dowels of approved length are placed across the joint at approved locations in such number that the total cross-sectional area of all steel across the joint, exclusive of mesh, is equal to that provided by the dowels at a regular contraction joint.

(e) *Load Transfer Devices* — Dowels shall be held in design position parallel to the surface and center line of the slab by metal devices meeting the requirements of subsection 420.05.

The complete joint assembly shall be lifted carefully into place. If the base is trimmed too low or if there are any open spaces beneath the preformed joint filler, the joint assembly shall be removed, the base correctly graded, tamped, and the joint assembly reset.

One-half the length of each slip-dowel bar of load transfer units shall be rendered bondless with a coat of graphite lubricant. The lubricant shall be applied to the free end of each dowel by daubing, mopping, or with a gloved hand to produce a thorough coating approximately $\frac{1}{8}$ inch thick. Brushes shall not be used for application of the lubricant. The lubricant shall be mixed and applied as specified at least one hour before the concrete is placed around dowel assemblies.

The assemblies shall be held in the required position at line and grade by metal stakes or pins which shall remain in the completed pavement. No concrete shall be placed un-

less the methods and devices used by the Contractor for installing and securing joint assemblies, including any joint filler required, and methods for finishing the joints meet with the approval of the Engineer. Immediately prior to depositing the concrete, the position of the dowels shall be checked and the assemblies tightened if necessary. The installation of dowel assemblies and the placement of the surrounding concrete shall result in dowels being tightly encased in concrete exactly parallel to both the pavement surface and the center line of the pavement, and at plan locations.

420.21 Final Strike-off, Consolidation and Finishing

(a) *Sequence* — Immediately after placement, concrete shall be properly finished. The sequence of operations shall be as follows: strike-off, consolidation, transverse screeding, longitudinal floating, straightedging, texturing and edging of formed joints. The machine method of finishing shall be employed, except that odd widths or shapes of slabs may be finished by the hand method.

The addition of superficial water to the surface of the concrete, to assist in finishing operations will not be permitted.

(b) *Finishing at Formed Joints* — Concrete adjacent to joints shall be deposited and mechanically vibrated as required in subsection 420.17. After the concrete has been placed and vibrated adjacent to a joint, the finishing machine shall be brought forward operating in a manner to avoid damage or displacement of the joint. If uninterrupted operation of the finishing machine to, over, and beyond the joint causes segregation of concrete, damage to, or misalignment of the joint; the finishing machine shall be stopped when the front screed is approximately 8 inches from the joint. Segregated concrete shall be removed from in front of and off the joint; the front screed shall then be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

The finishing of the concrete at joints shall be done from a bridge which shall not rest on the concrete at any point. The edges of slabs on both sides of all formed transverse joints shall be carefully finished to the correct grade. All stages of the work shall be checked with straightedges not less than 4 feet in length.

The top edges of expansion joints shall be rounded with an edging tool having the radius shown on the plans and a vertical leg of sufficient length to contact the vertical side of the preformed filler.

The top edges of formed transverse construction joints and formed longitudinal joints shall be rounded to the radius shown on the plans. The edges of slabs adjacent to pavement already in place shall be rounded with an edging tool having a vertical leg $\frac{1}{4}$ inch thick and of the depth shown on the plans.

Tool marks shall be eliminated by use of small burlap drags.

(c) Machine Finishing.

1. Non-vibratory Method. The concrete shall be distributed or spread as soon as placed. As soon as the concrete has been placed it shall be struck-off and screeded by an approved finishing machine. The tops of the forms shall be kept clean by effective devices attached to the machine. Travel of the machine on the forms shall be maintained without lift, wobble, or other variation tending to affect the precision finish.

The transverse finishing machine shall consolidate and screed the concrete with no more than 2 passages over the slab, except with the special permission of the Engineer. The operation of the machine shall be so controlled as to prevent excess mortar and water from being worked to the top of the slab or the formation of a watery mortar in the roll of concrete in front of the screeds.

If excess mortar does form, it shall be removed from the site and wasted. It shall not, under any circumstances, be placed on the base or ahead on top of the slab. Segregated particles of coarse aggregate, which may collect in front of the screed, shall be wasted outside the forms.

In order to secure uniform consolidation and to prevent lifting of the screed by irregular amount or overload of concrete, a uniform depth roll of concrete shall be maintained in front of the screeds at all times.

2. Vibratory Method — Unless otherwise specified, the vibratory method shall be employed. Vibrators for full width vibration of concrete paving slabs shall meet the requirements of subsection 420.10 (f), subparagraph 5. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement; the Contractor shall furnish equipment and employ methods which will produce pavement conforming to the Specifications. All the provisions in the

Non-vibratory Method, preceding, which are not in conflict with the provisions for the vibratory method shall govern.

(d) Hand Finishing — Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

1. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited or in transit when the breakdown occurs.

2. Finishing of narrow widths or areas of irregular dimensions where operation of the mechanical equipment is impractical.

The surface of the concrete shall be struck-off immediately after it is placed and leveled by means of an adjustable steel template 10 inches wide and 2 feet longer than the width of the pavement being placed. A second adjustable steel template 8 inches wide and of the same length shall be used directly behind the first. Both templates shall be constructed to produce pavement of the required cross section and shall have sufficient strength to retain their shape under all working conditions. The templates shall be moved forward with a combined longitudinal and transverse motion while fully resting on the forms at all times. During the strike-off operation, the distance between the 2 templates shall at no time exceed 10 feet. The templates shall be used until a true surface is obtained. While the concrete is being struck-off with the first template, workmen shall level, spade, and tamp the concrete in front of the template.

Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

After the concrete has been struck-off with the hand templates described previously, other finishing operations described as following screeding by finishing machines shall be carried out.

Straightedging operations following the screeding shall be sufficient to remove surface irregularities and produce a riding surface equivalent to that produced by machine operations.

(e) Floating.

1. Mechanical Method — As soon as possible after the concrete has been struck-off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal power float. The float in contact with the pavement shall be at least 12 feet long and at least 12 inches wide. The type of float and details of its construction shall

be approved by the Engineer. It shall be in good working condition.

The float and tracks from which the float operates shall be accurately adjusted to the required cross section and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap half the previously floated area yet pass over each area of pavement no more than twice except with the special permission of the Engineer. Any excess water or soupy material shall be wasted over the side forms at each pass.

2. Hand Method — When strike-off and consolidation are done by hand methods and longitudinal floating by hand is required, the float shall be not less than 16 feet in length, not less than 10 inches in width, suitably stiffened against flexibility and warping, and equipped with suitable handles. It shall be operated from bridges spanning the pavement and be operated with a sawing motion parallel to the centerline while passing gradually from one side of the pavement to the other. Movement ahead shall be in successive advances of not more than one-half the length of the float. Excess water or soupy material shall be wasted over the side forms at each pass.

(f) *Alternate Finishing and Floating.* As an alternative to the machine finishing and floating method in (c) and (e) of this subsection, the Contractor may use a long wheel base combination float-finishing machine in place of the transverse finishing machine and longitudinal float, providing the combination machine can be adjusted to produce satisfactory results and final finishing is properly timed. Any combination of screeding, floating, and finishing machines shall include at least two transverse oscillating screeds.

(g) *Straightedge Testing and Surface Correction.* Immediately following the longitudinal finishing operations all remaining irregularities shall be eliminated by use of scraping straightedges 10 feet in length, equipped with handles at least 2 feet longer than the width of pavement being placed. Straightedges shall be made of redwood or aluminum. Wood straightedges shall be 2 inches thick and shall taper from 7 inches deep at the center to 4 inches deep at the ends. The preferred shape for aluminum straightedges is a "T" section with bearing width of not more than 3 inches. Both metal and wood straightedges shall weigh approximately 30 to 35 pounds exclusive of the weight of the handle. Handles shall

be attached to form an angle of about 10 degrees with the blade face so as to present a cutting edge when in operation.

Each straightedge shall be placed on the form or edge of of the pavement nearest the operator. The handle shall be lowered to knee height and the straightedge shall be pushed transversely over the pavement surface. When it reaches the opposite form or pavement edge the handle shall be raised to shoulder height and the straightedge shall be drawn back across the pavement in the same path. Additional passes shall be made if all irregularities are not removed by these two passes. Each pass shall be lapped one-half the length of the straightedge as the work progresses. Any depressions found shall immediately be filled with freshly mixed concrete, struck-off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness.

Straightedge testing and surface corrections shall continue until the entire surface is free from observable departures from the straightedge and the slab conforms to the required grade and cross section.

The Contractor shall maintain a master straightedge on the job. Straightedges shall be checked against the master straightedge in the morning before use and again at noon. Any variation from a true plane shall be corrected before further use.

(h) *Final Finish.* Following the scraping straightedges, the final surface texture shall be developed by use of wet burlap strips dragged longitudinally over the pavement. Each burlap strip shall be not less than 3 feet nor more than 6 feet wide, shall be without seams, and shall be a minimum of 2 feet longer than the pavement width being dragged. The leading edge shall be fastened to a pole to keep the burlap in proper position. At least 2 feet of the burlap drag shall be in contact with the surface when dragging the pavement. Two such drags shall be used so that the complete operation may be in a forward direction without backing up.

The drags shall be cleaned of mortar when necessary to maintain uniform and satisfactory surface texture. Drags that cannot be cleaned shall be discarded and new drags substituted. When not in use, the drags shall be removed or raised above the pavement surface.

The surface of the concrete, after use of the burlap drags, shall be uniform in appearance with a gritty texture; shall have the required grade and contour; and shall be free from

surplus water, rough and porous spots, irregularities, depressions, and other objectionable surface features. The entire operation shall be executed to the satisfaction of the Engineer.

(i) *Edging at Forms and Joints.* After the final finish has been completed, but before the concrete has taken its initial set, the edges of slabs along forms and at formed joints shall be carefully finished and tooled to form a smooth rounded surface of the radius required on the plans. Corners or edges of slabs which have slumped and any areas which lack sufficient mortar for proper finishing shall be cleaned by removing all soupy mortar and loose fragments and shall be solidly filled and finished with a mixture of correct proportions and appropriate consistency. Tool marks shall be eliminated by the use of small burlap drags. Edges shall be smooth and true to line and the surface of the slab shall not be unduly disturbed by tilting of the tool during use.

All concrete on top of joint fillers shall be completely removed.

420.22 Surface Test. The entire surface shall be checked with an approved 10 foot metal straightedge while the concrete is still plastic. Any deviation from the general surface shall immediately be corrected.

The surface shall be checked again immediately after the removal of the burlap where an initial burlap covering is used, or at the end of 24 hours where membrane curing is used. The straightedge shall be placed at several points across the pavement parallel to the centerline and shall be advanced in 5 foot intervals. Areas showing high spots of more than $\frac{1}{8}$ inch but not exceeding $\frac{1}{2}$ inch in 10 feet shall be marked and immediately ground or rubbed down with an approved tool to an elevation such that the area or spot will not shown surface deviations in excess of $\frac{1}{8}$ inch when tested with the 10 foot straightedge. This grinding or rubbing shall be done carefully to avoid loosening coarse aggregate or otherwise damaging the slab. Following grinding, curing of the affected area shall be immediately resumed as provided in subsection 420.23.

Where the departure from correct cross section exceeds $\frac{1}{2}$ inch, the unsatisfactory pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be not less than 15 ft. in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the

newly formed joints that is less than 15 feet in length, shall also be removed and replaced. Newly formed joints shall be sawed to a depth which will permit removal without damage to the adjacent slab.

When a section of pavement requiring replacement does not extend on both ends to the regular transverse joints, the newly created joint or joints shall be provided with dowels by drilling holes and grouting the dowels into the adjacent pavement. Graphite grease and sleeves shall not be used on the dowels in these joints. Dowels shall be of the size and transverse spacing called for on the plans for transverse expansion or contraction joints. Tooled joint edges shall be formed as specified in the portion of subsection 420.21, paragraph (b), relating to tooling of edges of longitudinal joints adjacent to previously placed pavement, and the joints shall be sealed.

When a removed section extends to a regular expansion or contraction joint, care shall be exercised to avoid damaging the existing dowels or expansion materials. All nicks, burrs, and portions of dowel assembly frames shall be completely removed from the dowels and all dowels projecting into the replacement slab shall be coated as provided in subsection 420.20 paragraph (e)

420.23. Curing. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods. In all cases in which curing requires the use of water, the curing shall have prior rights to all water supplies. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use or a lack of water adequately to take care of both curing and other requirements shall be cause for immediate suspension of concreting operations. The concrete shall never be left exposed for more than $\frac{1}{2}$ hour between stages of curing or when removing forms and, except when membrane curing compound has been applied, shall never be permitted to become surface dry at any time during the curing period.

Not more than $\frac{1}{2}$ hour after removal of side forms, the type of curing in effect at the time the forms are removed shall be fully applied to the slab edges. Thereafter, slab edges shall be cured as provided for the slab surface.

Burlap, cotton mats, waterproof paper, and polyethylene sheeting, shall all be placed and so weighted down as to cause them to be in intimate contact with the pavement and so as

to prevent wind lift or other disturbance which will cause non-uniform moisture retention.

(a) Burlap Curing

1. Initial Curing: Strips of burlap saturated with water shall be carefully placed on the fresh concrete surface so as to avoid marring. The strips shall overlap not less than 3 inches. This burlap shall be kept thoroughly and continuously wet by sprinkling it with a fine spray of water until it is removed. Initial curing with wet burlap shall be for a period of not less than 24 hours. Burlap which has been used for any purpose other than curing concrete shall not be used.

2. Final Curing: Following completion of initial curing, the curing shall be continued using an additional layer of saturated burlap. This double layer shall remain in place and shall be kept thoroughly and continuously saturated with water for a period of not less than 6 days.

(b) Cotton Mat Curing

1. Initial Curing: Initial curing shall be with wet burlap as specified in paragraph (a), 1, above.

2. Final Curing: When cotton mats are used for final curing the burlap shall be removed in such manner that not more than 60 linear feet of pavement is exposed at one time, followed at once by application of saturated cotton mats. The surface of the concrete shall not become dry at any time. The cotton mats shall remain in place and shall be kept thoroughly and continuously saturated with water for a period of not less than 6 days.

(c) Waterproof Paper Curing.

1. Initial Curing: Initial curing shall be with wet burlap as specified in paragraph (a), 1, above.

2. Final Curing: The burlap shall be removed in such a manner that not more than 75 linear feet of pavement is exposed at one time, followed at once by application of the waterproof paper. The surface of the concrete shall not become dry at any time. The surface of the pavement shall be moist when the paper is placed. The top surface and sides of the pavement shall be entirely covered with waterproof paper. Paper covers shall be not less than 20 nor more than 75 feet in length. They shall be of such width that, when in place, they will extend at least 18 inches beyond the edges of the slab to be covered. Paper covers may be furnished in widths corresponding to that of the slab, provided supple-

mental stringer sheets at least 18 inches wide are used. Such sheets shall be placed along the edges of the slab under the paper covers. When forms are removed, the paper shall be brought down over the slab side and held with a continuous bank of earth. The junctions between the paper covers shall be lapped approximately 12 inches and be held in place by being weighted with earth. All rips or holes developing in the paper covers shall be immediately repaired with a sealed patch to render them airtight. Covers which have become damaged or soiled to the extent that they will not provide satisfactory curing or will mar the concrete shall not be used. The paper shall be left in place for a period of not less than 6 days or longer if necessary to obtain the required strength.

(d) White Polyethylene Sheeting Curing.

1. Initial Curing: Initial curing shall be with wet burlap as specified in paragraph (a), 1, above.

2. Final Curing: The general requirements for the use of white polyethylene sheets shall be those for waterproof paper curing in paragraph (c) above.

(e) Impervious Membrane Curing. After finishing operations have been completed and immediately after any free water has left the surface, the surface of the slab shall be completely coated and sealed with a uniform coating of white pigmented curing compound. The compound shall be applied in a continuous operation and at a rate of not less than 1 gallon per 150 square feet of surface. The compound shall be applied by means of a pressure sprayer mounted on a self-propelled carriage. The compound shall form a uniform, continuous, coherent film that shall not check, crack, or peel and that shall be free from holes or other imperfections. If discontinuities, pin holes, or abrasions exist; an additional coat shall be applied to the affected areas within 30 minutes. The equipment shall provide adequate stirring of the compound during application. The spray fog shall be protected from wind by an adequate shield. The equipment for applying the compound shall be approved by the Engineer before work is started. Should the method of applying the compound not produce a uniform film an additional coating may be required. Unsatisfactory results from use of this method may require its discontinuance and the curing shall then be done by one of the other approved methods specified herein. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause

within the required curing period, the damaged portions shall be repaired immediately with additional compound.

The faces of all joints; formed expansion, contraction, and longitudinal joints; sawed contraction joints; and sawed longitudinal joints, if sawed before the end of the normal curing period, shall be protected and cured until the end of the specified curing period. Curing shall be by one of the following methods or by an approved combination of methods which will insure continuous moist curing of all joint areas:

1. Formed joints shall be protected from being coated with the membrane curing compound and shall be cured by method (a), (b), (c), or (d), hereinbefore described. Sawed joints shall be cured either by one of those methods or by means of jute or cotton ropes inserted in the saw kerfs. The jute or cotton ropes shall not be allowed to dry out during the curing period.

2. Polyethylene tape with gummed edges may be used on all types of joints.

3. Liquid membrane curing compound may be applied to formed joints and sawed joints provided the Contractor can satisfactorily and completely remove the compound from all joint areas designed to be in contact with the joint sealing compound. The methods and equipment to be employed in removing the coating from joint faces shall be demonstrated to the Engineer and shall be approved by him before such coating will be authorized. If this option is used for sawed joints, the faces of the saw kerfs shall be completely coated with curing compound immediately after sawing.

Immediately after the forms are removed the entire area of the sides of the slab shall be coated with the curing compound at the rate specified for the pavement surface. This spraying shall be a continuous process. Waiting until all forms have been removed before making the application will not be permitted. Hand-spray equipment will be permitted for the application of the curing compound to the sides of the slab. Care shall be used to prevent coating the ends of the kerf of sawed contraction joints unless option 3, above, is being used.

If hair checking develops before the curing compound can be applied, the concrete shall be moist-cured with burlap for at least 24 hours before applying any membrane curing compound. If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required

to apply a new coat of material to the affected areas, equal to that specified for the original coat. The treated surface shall be protected from injury for a period of at least 7 days. All traffic, foot or otherwise, will be considered injurious to the film of the applied compound. A minimum of foot traffic will be permitted on the dried film as necessary to carry on the work properly and the use of small machines directly involved in joint sawing will be permitted provided any damage to the film other than the saw kerf itself, is immediately repaired by the application of an additional coat of compound.

In order to provide timely and proper curing in the event of breakdown of the membrane application equipment, there shall be available on the job site; either auxiliary membrane application equipment or materials and equipment sufficient to employ one of the alternate curing methods to any concrete already placed or to be placed for the remainder of the day's work. Paving shall not resume on the subsequent day until the original state of preparedness is restored.

(f) *Cold Weather Curing.* When the air temperature may be expected to drop below 40° F. during the day or night; a sufficient supply of loose dry hay, straw, or other suitable approved blanketing material for covering all pavement which has been in place for 7 days or less, shall be provided along the line of the work. When the atmospheric temperature is below 40° F. in the shade and dropping, the material so provided shall immediately be spread to a sufficient depth to prevent the temperature at the surface of the slab from falling below 32° F. Such hay, straw, or other blanketing material shall not take the place of the other covering specified herein for curing but shall be placed in addition to it. The hay, straw, or other blanketing material shall be maintained at least until the end of the regular specified curing period. The Engineer may direct that the blanketing material remain for an additional period if weather conditions have delayed thorough hardening of the concrete. All concrete, which has been exposed to a surface temperature of less than 40° F. at any time during the regular curing period, shall be subject to such tests for quality as the Engineer may deem appropriate. Any pavement deemed defective shall either be removed and replaced at the Contractor's expense and in the manner hereinbefore specified, or it may be accepted at a reduced unit price as specified in subsection 105.03.

420.24 Removing Forms. Forms shall not be removed for 12 hours after the concrete has been placed or for a longer

period if so directed. Extreme care shall be taken in removing the forms so as not to damage the concrete. Under no condition shall any bar, pick, or other tool be used which depends upon leverage on the concrete for removal of the pins or forms.

As soon as side forms are removed and prior to sealing joints, the ends of all joints shall be opened. All mortar or foreign material shall be removed from the joint opening space provided for filler so that there will be complete freedom for required movement of the joint.

All holes or honeycomb shall be patched with mortar which is of the same composition as that used in the pavement and which has been allowed to set for about $\frac{1}{2}$ hour after mixing. Major honeycomb areas will be considered as defective work and the pavement shall be removed and replaced as provided in subsection 420.22. After the forms have been removed and holes and honeycomb have been patched, the side of the slab shall be cured by one of the methods specified in subsection 420.23.

420.25 Sealing Joints. After curing and before any kind of vehicular traffic is permitted on the pavement, joints shall be sealed with joint filler.

The sealing of joints shall be undertaken only when the atmospheric temperature is above 40° F. and when the weather is not foggy or rainy.

Just prior to sealing; each joint shall be thoroughly cleaned of all foreign material, including curing compound, by means of a mechanical power-operated concrete grooving machine or a power-operated wire brush. The grooving machine or wire brush shall be so operated that the vertical faces of the concrete in the joint opening will provide thoroughly clean concrete surfaces for application of the joint sealing compound. Following this operation each joint shall be further cleaned by a powerful jet of compressed air.

No joints shall be sealed when there is free water in or adjacent to the joints. Joint walls and all surfaces to which the sealing compound is to be applied shall be surface dry for at least 3 hours prior to sealing. No joints shall be sealed until the joints have been approved by the Engineer as being clean and dry.

Joints shall be filled with an approved hot-poured joint sealing compound. The melting devices used for heating the joint sealing material shall be of the double boiler, indirect heating type using high flash oil for heat transfer. Constant

mechanical agitation during the entire melting period shall be provided. No material shall be subjected to the high temperature, required for melting of the material, for more than 60 minutes. Positive thermostatic temperature control of the heating medium for the filler compound shall be provided at all times. The device shall be equipped with an accurate thermometer.

Hot-poured filler compound shall not be subjected to temperatures in excess of 450° F. at any stage of the melting operation. Filler material that has remained in the kettle in a molten state overnight will not be acceptable for use.

Hot-poured filler shall be applied under pressure, by means of a heavy duty air operated pump or other approved device. The material shall be discharged through a suitable nozzle in such a way as to fill the joint opening solidly and uniformly, in a neat and workmanlike manner.

When the atmospheric temperature at the time of sealing is below 50° F., the surface of the filler compound in the finished joint shall be approximately $\frac{3}{16}$ in. below the level of the pavement surface. Otherwise, the surface of the finished joint shall be approximately flush with the pavement surface.

The sealing shall be done in such a manner that the material will not be spilled on the surface of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

In the event paving must be suspended in the Fall because of cold weather, and the pavement cannot be completed until the following year, the Contractor shall clean and seal all joints in that part of the pavement completed at the time of the suspension.

420.26 Protection of Pavement. The Contractor shall erect and maintain suitable barricades and employ necessary watchmen to exclude all traffic from the newly constructed pavement for the period herein prescribed. Barricades shall be so arranged as not in any way to interfere with or impede public traffic on any lane intended to be kept open. Necessary signs shall be maintained by the Contractor, clearly indicating the lanes open to the public or open to construction traffic. When it is necessary to provide for traffic across the pavement, the Contractor shall construct the necessary bridges over the pavement at his own expense and immediately after finishing the concrete. The bridges shall be clear of the forms, at least 3 inches clear of the concrete,

and sufficiently strong to carry the traffic. He shall maintain these bridges until the concrete has attained the strength required in these specifications for opening to traffic.

For protection against sudden rain, the Contractor shall have on hand at the paving site sufficient approved cover material to cover at least $\frac{1}{8}$ day's normal production of pavement.

Any part of the pavement damaged by traffic, by the Contractor's shoulder construction work, or by other causes occurring prior to its final acceptance shall be repaired or replaced by and at the expense of the Contractor in a manner satisfactory to the Engineer. The Contractor shall protect the pavement against both public traffic and the traffic caused by his own employees and agents. The pavement shall be so protected until the test cylinders made at the time of the paving show a compressive strength of 3,500 pounds per square inch and until the end of the specified curing period.

420.27 Opening to Traffic. Upon the completion of the specified curing operations, the pavement may be opened to traffic provided the concrete shows a compressive strength of 3,500 pounds per square inch. Curing operations will not be considered completed unless a curing period of at least 7 days has elapsed since the concrete was placed.

Where high-early strength concrete is specified, the pavement may be opened to traffic after a shorter period of curing provided that the concrete shows a compressive strength of 3,500 pounds per square inch.

420.28 Slip-form Method. The cement concrete pavement may, at the Contractor's option, be placed by the Slip-form Method. When the pavement is constructed without the use of fixed forms the following provisions shall apply in addition to all other pertinent sections of the Specifications which are not changed or modified by the following:

(a) *Concrete.* Fine aggregate for use in concrete to be placed with a slip-form paver shall meet the gradation requirements specified for fine aggregate for concrete except that a maximum of 4 percent passing the number 200 sieve may be permitted in order to increase the cohesiveness of the cement concrete. The concrete when tested in accordance with AASHTO Designation T 119 shall have a slump of not more than 2 inches nor less than 1 inch.

(b) *Conditioning of Base.* The base shall be placed to a compacted depth approximately 1 inch higher than the grade called for on the plans to allow for planing to the proper

profile by approved mechanical means. It shall also be placed to a width at least 18 inches greater on each side than the required pavement slab width. After the base has been placed and compacted to the required density, and will adequately support the subgrade machinery and the slip-form paver, the entire width, including track areas, shall be cut to the proper elevation by the use of a mechanical subgrade machine or by other mechanical means approved by the Engineer. Behind the subgrade machinery the entire width, including track areas, shall be rolled to a smooth, firm, and uniform surface.

When concrete is placed, the surface of the base shall not be above nor more than $\frac{1}{4}$ inch below the plan elevation. If the density of the base is disturbed by the subgrade machine, it shall be corrected by additional compaction before concrete is placed. The base shall be conditioned and perfected not less than 1,500 feet in advance of the point where concrete placement is to start each day. Concrete placement shall stop at any time that less than 500 feet of accepted grade exists in advance of the point where concrete is being placed. If any traffic is allowed to use the prepared grade, the grade shall be checked and defects corrected immediately ahead of the placing of the concrete.

(c) *Stabilization of Slip-form Paver Track Area.* The base, after being conditioned, shall provide a firm unyielding support which will not be displaced by the movement of the paver. If the base is displaced by the movement of the paver to the extent that the finished pavement will be affected, the two areas that will support the slip-form paver tracks shall be stabilized as provided herein. The areas designated to be stabilized will be immediately outside the edge lines of the pavement slab on both sides and are each to be not less than 18 inches in width, measured from the exterior edges of the proposed pavement slab.

If cement is used for stabilization, the material to be stabilized shall be loosened and pulverized before any cement is added. Cement shall be uniformly spread on the loosened and pulverized material at the rate of approximately 4.5 pounds per square foot. The final depth of stabilization shall be not less than $3\frac{1}{2}$ inches in the completed track area. The exact amount of cement to be used to adequately harden the mixture of cement and base material will be determined by the Engineer.

The cement and base material shall be thoroughly mixed by means of a power driven mixer until the mixture is of a uniform color throughout the full required depth.

After the cement and base material have been mixed, water shall be added to the mixture and mixing continued until the water is uniformly distributed throughout the mixture. The amount of water to be added will be determined by the Engineer. The moist mixture, when ready for compaction, shall be near its optimum moisture content.

Within 2 hours after the addition of the water, the mixture shall be uniformly compacted for the full depth until it is firm and unyielding. Compaction shall be with a 10 ton, three-wheeled or tandem roller, approved rubber tired roller, or approved mechanical vibrator.

After compaction, the surface of the area that is to support the paver tracks shall be cut to true profile and elevation by approved mechanical equipment and then rolled to obtain a smooth, true surface.

The stabilization shall be protected from drying by the application of approximately 0.2 gallon per square yard of approved bituminous material or covered with straw, sand, or earth. If straw, sand, or earth is used for cover it must be broomed off before the area is used in further operations. The cover material shall be applied immediately after final rolling. It shall be maintained for at least 2 days unless, in the opinion of the Engineer, the stabilization has adequately hardened in a shorter time.

The cement content, mixing, and compaction shall be such that 24 hours after rolling the stabilization will be hard enough so that when struck with a hammer a "ringing" or "solid" tone will be produced and the surface will resist jabbing with an instrument such as a dull ice-pick. No traffic shall be permitted on the stabilization until curing is completed.

The Engineer may require samples of the base material, proposed for use in the areas to be stabilized, to be tested to determine the proper amount of cement to be used. In the event that the material requires more than 10 percent of cement by weight for satisfactory hardening, it may be rejected for use in the areas to be stabilized.

In lieu of the above method and procedure for stabilization of the track area, other proven methods and materials will be considered; subject to equivalent and acceptable performance.

Regardless of the method, materials, and procedures used; the burden or responsibility for the acceptability of work shall rest with the Contractor.

(d) *Placing Concrete.* The concrete shall be placed with an approved slip-form paver (or pavers) designed to spread,

consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine(s) and in such manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in conformance with the plans and specifications.

The slip-form paver(s) shall be of the self-propelled type, equipped with crawler type tracks. The machine (or second machine, if two are used) shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pad operating on the surface of the concrete. Trailing forms, if used, shall be rigidly held together to prevent spreading. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur.

The concrete shall be of such consistency that there will be no appreciable slumping at the edge of the pavement after the slip-forms have passed. Slump of the concrete shall not exceed $\frac{1}{4}$ inch at a crown line or within 6 inches of any pavement edge, exclusive of specified edge tooling. The edges along the longitudinal joint between two travel lanes of the same cross-slope shall be at true finished grade. Any deviation from these tolerances shall be corrected while the concrete is plastic.

The slip form paver(s) shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver(s) held to a minimum. If for any reason it is necessary to stop the forward movement of the paver(s), the vibratory and tamping elements shall also be stopped immediately.

The slip-form paver(s) shall be adjustable for crown and super-elevation and shall be capable of shaping and compacting the concrete to the cross sections shown on the plans. Adjustments shall be readily controllable for accuracy in transitions. No tractive force shall be applied to the machine(s) except that which is controlled from the machine(s).

(e) *Finishing.* The surface smoothness and texture shall meet the requirements of subsection 420.21 and subsection 420.22.

(f) *Curing.* Curing shall be done as specified in subsection 420.23. Exceptional care shall be taken in the use of

burlap to prevent any damage to the unsupported edges of the pavement.

(g) *Joints.* All joints shall be constructed in accordance with subsection 420.20.

The bending of rail-steel tie bars conforming to AASHO M 42 at right angles against the form of the first lane constructed, and later straightening into final position, will not be permitted but bending and straightening of new billet steel conforming to AASHO M 31 will be permissible.

(h) *Protection Against Rain.* The Contractor will be required to have material available at all times for the protection of the edges and surface of the unhardened concrete in order that the concrete may be properly protected against the effects of rain occurring before the concrete is sufficiently hardened. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 2 inches and a nominal width of not less than the thickness of the pavement at its edge and approved covering material for the protection of the surface of the pavement.

An adequate quantity of the materials described above shall be available, loaded on vehicles which can be promptly brought to the scene of paving operations, and located not more than $\frac{1}{2}$ mile from the place where the paving operations are in progress.

When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with protective coverings.

(i) *Defective Work.* In the event that slumping or sloughing occurs behind the machine resulting from placement of tie bars for adjacent pavement or for any other reason; or if any other defect occurs which, in the opinion of the Engineer, cannot be corrected to permissible tolerances; or if the reinforcing materials or load transfer units are displaced by action of the machine the Engineer may suspend paving operations until proper adjustment of the equipment or construction procedures has been made.

If satisfactory pavement does not result from slip-form paving operations, the Contractor shall, if directed by the Engineer, complete all remaining work using standard metal forms and standard methods of placement.

420.29 Tolerance in Pavement Thickness. It is the intent of these specifications that the pavement shall be constructed

in conformity to the thickness shown on the plans. Before final acceptance of the work or during the progress of the work, as may be advisable or necessary, the thickness or depth of the pavement in various units of work will be determined by cores taken by the Contractor under the direction of the Engineer or his designee.

(a) *Units of work defined.*

1. For the purpose of establishing an adjusted price for pavement, units to be considered separately are generally defined as 1,000 linear feet of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. A traffic lane is defined as being between longitudinal joints or between a longitudinal joint and a pavement edge. The last unit in each lane shall be 1,000 feet plus any fractional part of 1,000 feet remaining. The total area of each such unit may be modified as provided in (b) 4 herein.

2. Other areas such as intersections, entrances, cross-overs, and ramps; having an area of less than 1,400 square yards but more than 700 square yards, will each be considered as a unit. The Engineer will divide other areas such as intersections, entrances, cross-overs, and ramps; having an area of more than 1,400 square yards, into units of 1,400 square yards. Remaining fractional parts larger than 700 square yards will be considered as a unit and fractional parts smaller than 700 square yards will be considered as part of the adjacent unit.

3. Small irregular areas of less than 700 square yards may be included as part of the nearest other unit.

4. Portions of previously described units having a thickness less than the plan pavement thickness by more than 1.00 inch will be considered as separate units as hereinafter described.

(b) *Taking Cores.* The thickness of the pavement in the various units of work will be determined by average caliper measurement of cores obtained in accordance with AASHO Designation T 24 and tested in accordance with AASHO Designation T 148.

Initially, the Contractor shall take one core in each unit at a random location designated by the Engineer.

1. When the length of the core from a unit exactly equals or exceeds the plan pavement thickness, the pavement in the unit represented will be paid for at the full bid unit price and additional cores will not be required.

2. When the length of the core from a unit is less than the plan pavement thickness by not more than 0.20 of an inch, the pavement in the unit represented will be paid for at the full bid unit price and additional cores will not be required.

3. When the length of the core from a unit is less than the plan pavement thickness by more than 0.20 of an inch but by not more than 1.00 inch, the Engineer will designate two additional locations within the unit at which the Contractor shall take cores. Where the length of the unit permits, the three core locations shall be at least 300 feet apart. The thickness of the unit will be considered to be the average of the lengths of the three cores provided none is less than the plan pavement thickness by more than 1.00 inch. In calculating the average, cores having a length greater than the plan pavement thickness will be considered as being of the specified thickness. If the average length of the cores is less than the plan thickness by not more than 0.20 of an inch, the pavement in the unit represented will be paid for at the full bid unit price. If the average length of the cores is less than the plan pavement thickness by more than 0.20 of an inch, the pavement in the unit represented will be paid for at the adjusted unit price provided in subsection 420.31 (a).

4. When the length of any core is less than the plan pavement thickness by more than 1.00 inch, additional exploratory cores shall be taken at 25 foot intervals in each longitudinal direction until a core is found in each direction which is deficient by 1.00 inch or less. Each core less than the plan thickness by more than 1.00 inch will be considered as representing the thickness of 25 linear feet of pavement centered at the core location and the full width of the area unit at that location. The areas of pavement so represented will be deducted from the area of the unit of pavement originally being measured and each such 25 foot section will be treated as a separate unit as provided in paragraph 5 of this subsection. The thickness of the remainder of the original unit will be considered to be the average of the lengths of the exploratory cores which were found to be deficient by 1.00 inch or less and 2 other cores deficient by 1.00 inch or less taken in the remainder of the original unit as previously provided. The pavement in the remainder of the original unit so represented will be paid for as provided in subsection 420.31.

5. Areas represented by cores having a length less than the plan pavement thickness by more than 1.00 inch will be

evaluated by the Engineer and may be accepted by the Engineer at no payment to the Contractor. Should the Engineer order the Contractor to remove and replace such deficient areas or should the Contractor elect to remove and replace them, no payment will be made for the original deficient work or for the cost of removal. The new work will be cored and measured for payment as provided herein.

Holes in the pavement which result from core borings shall be repaired as follows:

Wire brush the hole and rinse with water.

While still wet, coat the sides with neat cement paste.

Fill the hole with Class Y concrete, having a very low water-cement ratio; firmly tamp in place in two inch layers.

Finish to match adjacent pavement.

Immediately treat patch with white pigmented curing compound.

Protect from traffic for at least 24 hours.

420.30 Method of Measurement. Cement concrete pavement will be measured by the square yard. The quantity paid for shall be the number of square yards as determined by the actual area of the finished pavement, complete, in place, and accepted but subject to adjusted proportional payment or non-payment as stated in subsection 420.31 for pavement areas found deficient in depth.

The widths for determination of pavement areas shall be those shown on the typical cross sections, including additional widenings where called for or otherwise directed in writing by the Engineer. The lengths will be measured horizontally along the center line of the concrete pavement of each roadway or ramp. Irregular areas will be measured by methods generally recognized as conforming to good engineering practice. No deduction will be made for drainage or other structures having a surface area of 1 square yard or less.

420.31 Basis of Payment. Cement Concrete pavement will be paid for at the contract unit price per square yard, complete in place, subject to price adjustments as set forth below, which price shall be full compensation for furnishing all water, aggregates, cement, and admixtures; for mixing, placing, screeding, finishing, curing, and protecting concrete; for furnishing and placing steel reinforcement, load transfer assemblies, tie bars, and tie bolts; for furnishing, placing, and removing forms if used; for furnishing all labor, material, and devices for forming and filling all joints; and for

all other labor, material, tools, supplies, equipment, and incidentals necessary to complete the work, including treating the roadway to keep down dust and providing necessary signs, barricades and temporary bridges specified in this section.

No direct payment will be made for the concrete used in performing slump or air tests or in making the required test cylinders hereinbefore specified or for the taking of cores to determine pavement thickness or for the repair of the resulting holes, but the cost of such work shall be considered included in the contract unit price per square yard for cement concrete pavement.

The Contractor shall have no claims for special allowances for extra cement or apparent shrinkage due to inaccurate proportioning or control, spilling, waste, or for other job conditions within his control.

If the pavement is constructed by the Slip-form method and stabilization of the track areas is required, no direct payment will be made for the stabilization. The cost of this work, including all labor, materials, tools, supplies, and incidentals necessary to complete the work shall be included in the contract unit price per square yard for Cement Concrete Pavement.

The testing laboratory will be paid for under Section 639 — Engineering Facilities, and furnishing the thermostatically controlled curing box shall be considered incidental to that item.

No additional payment over the unit contract price will be made for any pavement having an average thickness in excess of that shown on the plans. Where the average thickness of pavement is deficient in thickness by more than 0.20 inch but by not more than 1.00 inch, payment will be made as follows:

CONCRETE PAVEMENT PRICE ADJUSTMENTS

Deficiency in Thickness Determined from Cores (Inches)	Proportional Part of Contract Price to be Allowed (Percent)
0.00 to 0.20	100
0.21 to 0.30	80
0.31 to 0.40	72
0.41 to 0.50	66
0.51 to 0.75	57
0.76 to 1.00	50

When core measurements indicate that the pavement is deficient in thickness by more than 1.00 inch and, in the judgment of the Engineer, the area of such deficiency should not be removed; there will be no payment for the deficient area so retained. If the Contractor is directed to remove and replace or chooses to remove and replace pavement which is deficient in thickness by more than 1.00 inch, the removal and replacement work shall be in accordance with these specifications. No payment will be made for the original deficient work nor for the cost of removing it, but the replacement work will be included for payment as specified herein.

When high early strength concrete is specified by the Engineer in order to expedite the opening of pavement to traffic, the high early strength will be obtained by an increase in the cement factor and a reduction of the water-cement ratio. The extra cement will be paid for at the actual unit cost per barrel for the extra quantity of cement actually incorporated in the pavement, plus an allowance of 5 percent of the cost per barrel, which allowance shall be considered full compensation for all equipment, labor, storage, transportation, and work incidental to its inclusion in the concrete and incorporation in the finished pavement. The unit cost per barrel will be considered to be the cost to the Contractor at the normal point of bulk delivery.

Payment will be made under:

Pay Item	Pay Unit
420.32 Cement Concrete Pavement	Square Yard

DIVISION 500 — STRUCTURES

SECTION 501 — FOUNDATION PILES

501.01 Description. This work shall consist of furnishing and driving piles, of the size and type called for, in accordance with these specifications and in reasonably close conformity with the lines, grades and locations shown on the plans or authorized by the Engineer.

MATERIALS

501.02 Materials. Materials shall meet the requirements of the following section 502 — Structural Concrete and sub-sections of Division 700 — Materials.

Timber Preservative	708.05
Reinforcing Steel	709.01
Metal Shells for Cast-in-place Concrete Piles	712.17
Structural Steel	713.01
Untreated Timber Piles	714.01
Pressure Treated Timber Piles	714.02

H-Beam piles shall be of structural steel.

Structural concrete shall conform to the requirements of Section 502, Structural Concrete for the class specified.

CONSTRUCTION REQUIREMENTS

501.03 Length of Piles. The number and estimated lengths of piles required for a structure will be shown on the plans unless otherwise specified. Additional length required for reheading or for the Contractor's convenience shall be provided at the Contractor's expense.

501.04 Test Piles.

(a) When called for on the plans, in the special provisions, or when requested by the Engineer, test piles shall be driven.

(b) Test Piles shall be the same kind and size and shall be driven with the same equipment intended for the bearing piles. Lengths and locations will be designated by the Engineer. Test piles shall be driven in such locations that they will become part of the completed structure, unless otherwise approved by the Engineer.

(c) From information gained from the driving of test piles the Engineer will furnish the Contractor with a pile schedule.

501.05 Loading Tests.

(a) Loading tests are intended to serve one of two purposes. They are made to enable the Engineer to determine the number and size of piles required, or they are made to confirm that piles have attained the required load bearing capacity.

(b) A loading test consists of the application of a known load to the pile, or group of piles, and the accurate measurement of the resulting settlement.

(c) The load may be applied by weights, hydraulic jacks or any means by which it can be increased or decreased by known and variable amounts. The method of applying load to the test pile shall be submitted to the Engineer prior to starting the loading procedure.

(d) In the case of cast-in-place piles, no load shall be placed on the pile for at least 7 days after the concrete has been placed in the shell.

(e) Reference points for measuring pile settlement shall be so located as to preclude all possibility of disturbance.

(f) The entire apparatus shall have a working capacity of not less than three times the proposed design load.

(g) Tests shall be conducted under the direction of the Engineer but the Contractor shall furnish all labor and equipment.

501.06 Loading Formulas. When not driven to practical refusal and when the capacity of a pile is not determined by a loading test, the following formulas may be used to obtain an approximate value.

(a) For gravity hammers:

$$P = \frac{2 WhH}{Wd^*} \quad S = \frac{2 WhH}{P_1} - .4 \frac{Wd^*}{Wh}$$

(b) For single acting steam or air hammers or diesel hammers having unrestricted rebound of ram:

$$P = \frac{2 WhH}{Wd^*} \quad S = \frac{2 WhH}{P_1} - 0.1 \frac{Wd^*}{Wh}$$

(c) For double acting steam or air hammers or diesel hammers having enclosed rams:

$$P = \frac{2E}{\frac{Wd^*}{S + 0.1} + \frac{Wd^*}{Wh}} \quad S = \frac{2E}{P_1} - 0.1 \frac{Wd^*}{Wb}$$

*When $\frac{Wd}{Wh}$ is less than one, use one.

Where: P = Allowable pile load in pounds.

P₁ = Required working value of a pile, in pounds.

Wh = Weight of the striking part of the hammer, in pounds.

Wd = Weight driven (pile, driving head, etc.), in pounds.

H = Average height of fall in feet of the striking part of the hammer for the blows used to obtain the penetration, S.

S = Average penetration per blow, in inches, for the last 5 to 10 blows of a gravity hammer and the last 10 to 20 blows of a power hammer.

E = Effective output energy of the hammer, in foot pounds per blow. When a diesel hammer having an enclosed ram is used to drive friction piles, it shall be equipped with an instrument which measures the effective output energy of the hammer.

(d) Jets, if used, must be withdrawn before taking data for use in the above formulas.

(e) Any one or all of the above formulas are not applicable when:

1. The hammer or striking part does not have a free fall.
2. The head of the pile is broomed or crushed.
3. The penetration is not reasonably quick and uniform.
4. There is an appreciable bounce after a blow.
5. A follower is used.
6. The steam, air, or diesel hammer is operated at a speed less than that recommended by the manufacturer.

(f) When determining the bearing capacity of a pile by means other than a loading test, due consideration shall be

given to the character of the soil; size, length and weight of pile; type and weight of hammer and general driving conditions.

(g) Pile formulas may be modified by the Engineer on the basis of information obtained from a loading test.

(h) The load bearing capacity of a pile properly driven to refusal or practical refusal shall be computed as for a point bearing pile.

(i) Practical refusal will be considered attained when the following conditions are satisfied:

1. When a power hammer is used the weight of the striking part of the hammer is approximately equal to the weight of the pile being driven and the penetration does not exceed 1 inch in 10 successive blows.

2. When a gravity hammer is used the requirements for a power driven hammer shall apply. In addition, the Contractor may be required to demonstrate, at his expense and with the specific approval of the Engineer, that at least the design load as called for on the plans can be procured. The demonstration may be by a pile loading test or by comparison driving using a gravity hammer and a power hammer.

501.07 Ground Preparation.

(a) Before driving any piles, the ground surface shall be brought to the elevation called for.

(b) After the piles are properly driven, the ground surface shall be brought to the correct elevation either by excavation or by filling with granular material, thoroughly compacted.

(c) When making a fill through which piles are to be driven, no rocks larger than 6 inches in diameter shall be used and concentration of stones of any size shall be avoided.

501.08 Protection of Piles.

(a) Piles shall be handled and stored in such a way as to prevent injuring them.

Special care shall be taken to avoid breaking the surface of treated timber piles. Peaveys, cant-hooks, dogs, pike-poles and similar surface puncturing tools shall not be used. All surface cuts and breaks, and bolt holes, in treated timber piles shall be treated with hot creosote oil; surface cuts and breaks shall be given 3 brush coats and bolt holes shall have the creosote poured or swabbed into them.

(b) The use of hammers with excessively heavy striking parts, in comparison to the weight of the pile to be driven, will not be permitted.

(c) The heads of timber piles, when the nature of the driving is such as to injure them unduly, shall be protected by driving heads of approved design. When the area of the head of a timber pile is greater than that of the face of the hammer, a driving head shall be used which will distribute the blow of the hammer throughout the cross section of the pile. Collars, bands or other devices to protect timber piles against splitting and brooming shall be used when necessary.

(d) Timber piles shall be pointed where soil conditions so require. When necessary, the piles shall be shod with metal shoes of a design in accordance with the plans or, if not shown, by a method satisfactory to the Engineer. The tip end of the piles shall be carefully shaped to secure a uniform bearing on the shoes.

(e) Steel H-beam piles shall be cut squarely and fitted with a driving head which will hold the axis of the pile in line with the axis of the hammer. When driving conditions require, the points of steel H-beam piles shall be reinforced in accordance with the plans or, if not shown, by a method satisfactory to the Engineer. Welding, when required, shall be in accordance with the subsection 504.47 for shop welding and 504.63 for field welding.

(f) Shells for cast-in-place piles and other special sections shall be provided with driving heads, mandrels or other devices as recommended by the manufacturer. Each shell shall be furnished with an approved water tight heavy steel point.

501.09 Splicing Piles. Full length piles shall be used wherever practicable; however, under exceptional circumstances splicing may be permitted. The method of splicing shall be as specified hereinafter.

When a splice or a joint is to be made between sections of steel shells for cast-in-place piles it shall be made in accordance with the manufacturer's recommendations and shall be able to withstand any possible tension caused by heaving. Steel H-beam piles shall be spliced by Butt Joint Welds for the entire cross section of the piles. When the piles are to be spliced while in a vertical position the welds shall be either Single-Vee Groove or Single-Bevel Groove Welds. When the piles are to be spliced while in a horizontal position the welds shall be Single-Vee Groove Welds. Welding shall comply with the requirements of subsection 504.47 for shop welding and 504.63 for field welding.

When steel H-beam pile splices are made for the Contractor's convenience, they shall be made without compensation and only one splice per pile will be permitted for pile lengths up to 100 feet.

Splices in timber piles shall be made only under very unusual circumstances, shall require the approval of the Engineer and shall be made in accordance with details furnished by the Engineer.

501.10 Vacant.

501.11 Cutting off Piles and Pile Cut-offs.

(a) Each pile shall be cut off on a true plane perpendicular to the axis of the pile except that piles which support preformed structures shall be cut to conform to the plane of the bottom of the superimposed structure.

(b) The length of pile above cut-off elevation shall be sufficient to permit complete removal of all material injured by driving; however, should the damage to the pile extend below cut-off elevation, special corrective measures as specified in subsection 501.16 shall be taken.

(c) The pile cut-off is defined as the difference between the length of the pile authorized and the length of the pile remaining in place in the completed structure.

501.12 Hammers.

(a) The type of hammer, gravity, steam, air or diesel, will be the Contractor's choice, subject to the Engineer's approval. If a power hammer is to be used, the Contractor shall furnish to the Engineer a descriptive catalog of the hammer, containing all necessary information for the proper operation and for computing the load bearing capacity of driven piles.

(b) The size of hammer shall be dependent upon the size and type of pile, the type of hammer and the soil conditions involved.

(c) The following limitations are intended as guides and are to be applied only with sound engineering judgment.

1. A gravity hammer shall weigh no less than the combined weight of the pile and the driving head or 3,000 pounds, whichever is greater. The drop of the hammer shall be regulated to avoid injury to the piles. For timber piles and steel "H" piles the drop shall not exceed 15 feet and for the shells of cast-in-place piles it shall not exceed 8 feet.

2. A power hammer shall deliver at each full stroke of the piston, not less than 1 foot-pound of energy for each pound of weight driven or 6,000 foot-pounds, minimum.

3. If the value of "S" as determined by the appropriate formula in subsection 501.06 comes out less than 0.1 inch or negative, it is an indication that the hammer contemplated or being used is too small.

4. When the required penetration or bearing capacity cannot be obtained with a particular hammer, the Contractor shall provide a heavier hammer or a water jet and hammer combination.

501.13 Supplemental Equipment.

(a) *Leads.* Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer. They shall be held in position by guys or stiff braces to insure proper support of the pile during driving. Scale boards graduated in feet and inches shall be attached to the leads.

(b) *Followers.* Followers shall not be used except under unusual conditions, and then only with written permission of the Engineer. When a follower is used, one pile from every group of 10 shall be a long pile driven without the follower and shall be used to determine the average bearing power of the group. This determination may be made by means of the appropriate formula in subsection 501.06 or, when required by the Engineer, by a loading test as prescribed in subsection 501.05.

(c) *Water Jets.* Jetting shall be done only with the permission of the Engineer. When water jets are used the number of jets and the volume and pressure of the water at the nozzles shall be sufficient to erode freely the material adjacent to the piles. Two nozzles or other means shall be used in order to prevent piles from penetrating out of line. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven to final penetration with the hammer alone.

501.14 Driving Procedures.

(a) The sequence of driving piles in any unit shall be subject to the approval of the Engineer.

(b) When driving is interrupted before final penetration is reached, data for the bearing capacity of the pile shall not be taken until at least 12 inches penetration or refusal has been attained, after driving has been resumed.

(c) Piles which have heaved during the driving of other piles in a group shall be resealed to the required penetration or bearing capacity.

(d) A record will be kept of all pertinent facts concerning the pile and the driving and the Contractor shall furnish all assistance required to make the necessary observations and measurements.

501.15 Special Requirements for Cast-in-place Concrete Piles.

(a) Where the length of a tapered pile is such that the butt diameter would exceed the diameter called for, the butt end may be extended with a cylindrical casing of the diameter required for the butt.

(b) Piles with shells 0.12 of an inch or less in thickness shall be reinforced with 6 Number 6 longitudinal bars spaced uniformly around the pile and held securely at 2 inches clear from the inside of the shell. These bars shall extend from 1-foot above cut-off to 10 feet below the elevation at which the piles can be considered laterally supported. The requirements of Section 503 — Reinforcing Steel shall be met. Piles with shells over 0.12 of an inch thick need no reinforcing unless specifically called for on the plans or in the special provisions.

(c) Pile shells and reinforcing shall be inspected and approved by the Engineer immediately before concrete is placed. They shall be clean and the shells shall be free from water. Shells shall be free from rupture and undue deformation. Reinforcing, if required, shall be securely held in the proper place. The Contractor shall provide lights and other equipment necessary to inspect each shell for its full length.

(d) Portland cement concrete for filling the shells shall be class "Y", in accordance with Section 502 — Structural Concrete. It shall be placed in the shell in one continuous operation, care being taken to fill the shell completely. An internal type vibrator shall be used in the top 25 feet of the pile. Pile heads shall be protected and cured in accordance with subsection 502.15.

(e) The placing of concrete and the driving of piles shall be so scheduled that fresh and setting concrete will not be injured by the driving. Under no conditions shall any driving be carried on within 15 feet of concrete which is less than 7 days old unless this requirement is altered by the Engineer because soil conditions so warrant.

501.16 Defective Piles and Corrective Measures.

(a) Piles shall be driven with a variation of not more than $\frac{1}{4}$ inch per foot of length from the vertical or from the batter called for. Foundation piles shall not be out of position as shown on the plans more than 6 inches after driving.

(b) The procedure incident to the driving of piles shall not subject them to excessive and undue abuse causing injurious splitting, splintering or brooming of timber piles or deformation of steel piles.

(c) Any pile damaged by reason of internal defects or by improper driving, or driven below cut-off elevation or otherwise crippled, shall be considered defective and shall be corrected by and at the expense of the Contractor, as specified in the following paragraph (d).

(d) The method of correcting a defective pile shall be approved by the Engineer and may be one of the following:

1. The pile may be pulled and replaced by a new and, if necessary, longer pile.

2. A second pile may be driven adjacent to the defective pile. The position of the second pile shall be approved by the Engineer prior to driving.

3. The pile may be spliced or built up as provided in subsection 501.09 or a sufficient portion of the footing enlarged to properly embed the pile. Timber piles shall not be spliced without specific permission of the Engineer. All piles pushed up by the driving of adjacent piles or any other cause shall be driven down again.

(e) It is not the intent of this subsection to exclude deficiencies and corrective measures not listed.

501.17 Method of Measurement.

(a) Bearing piles will be measured for payment by the actual number of linear feet of piles satisfactorily driven and remaining in the finished structure.

(b) Test piles, when incorporated in the finished structure, will be measured for payment as in (a) above. When outside the finished structure, test piles will be measured for payment by the number of linear feet authorized for the test and driven, with no deduction for cut-offs.

(c) Loading tests will be measured for payment by the unit number of tests authorized and satisfactorily made.

(d) Shoes for timber piles and reinforcement for points of steel H-beam piles, when used in accordance with subsection 501.08 (d) and (e) will be measured for payment as 5 linear feet of the particular type and size of pile on which they are used.

(e) Splices in steel H-beam piles, when authorized, will be measured for payment as 5 additional linear feet of the pile spliced except that splices made for the Contractor's convenience, even though authorized, will not be measured for payment. Connections between the sections of shell for cast-in-place piles shall not be considered as splices and will not be measured for payment.

(f) Approved pile cut-offs having individual lengths of 3 feet or more will be measured as linear feet of piles driven under the appropriate contract item and the quantity for payment will be 60 percent of the approved cut-off lengths. These cut-offs shall become the property of the Contractor. Any cut-offs made because of damaged pile heads or any other reason, will not be measured for payment and will remain the property of the contractor. Cut-offs less than 3 feet in length and all cut-offs of shells for cast-in-place piles of whatever length will not be measured for payment and will remain the property of the Contractor.

(g) Piles ordered as authorized and not used may remain the property of the Contractor or at his option will be measured as linear feet of piles driven under the appropriate contract item and the quantity for payment will be 60 percent of the approved lengths and become the property of the Commission. Unused sections of shells for cast-in-place piles shall not be considered "authorized and not used" and will not be measured for payment.

501.18 Basis of Payment.

(a) Bearing piles, including test piles, as measured in subsection 501.17, will be paid for at the contract unit price per linear foot of piles for the respective items listed as follows, complete in place and accepted, including any necessary excavation or backfilling required after driving to bring the foundation area to the correct elevation.

(b) Cement and reinforcing steel for cast-in-place concrete piles will not be paid for separately but will be considered as incidental to item 501.22, Cast-in-place Concrete Piles.

(c) Loading tests will be paid for at the contract unit price each.

(d) Piles ordered as authorized and not used, will be paid for as piles driven under the appropriate contract item, measured as defined in subsection 501.17.

(e) Approved pile cut-offs will be paid under the appropriate contract item, measured as defined in subsection 501.17.

At the option of the contractor, he may retain possession of the piles ordered as authorized and not used and in this event there will be no compensation from the Commission.

Payment will be made under:

Pay Item	Pay Unit
501.19 Timber Piles, untreated	Linear Foot
501.20 Timber Piles, treated	Linear Foot
501.21 Steel H-beam Piles _____ lbs./ft.	Linear Foot
501.22 Cast-in-place Concrete Piles	Linear Foot
501.23 Loading Tests	Each

SECTION 502 — STRUCTURAL CONCRETE

502.01 Description. This work shall consist of furnishing and placing portland cement concrete for structures and incidental construction in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established by the Engineer.

502.02 Classification. The following classes of concrete are included in these specifications and shall be used where required by the plans.

Class of Concrete	A	B	S	Y
Minimum sacks (94 pounds) cement per cubic yard of concrete	6.50	5.50	6.75	6.75

MATERIALS

502.03 Materials. Materials shall meet the requirements specified in the following subsections of Division 700 — Materials.

Portland Cement	701.01
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Preformed Expansion Joint Filler	705.01
Curing Material	711.01
Air Entraining Admixtures	711.03
Set Retarding Admixtures	711.04
Water	712.01

Calcium Chloride	712.02
Copper Baffle Strip	712.10
Galvanized Iron Baffle Strip	712.11
Drain through Abutments and Retaining Walls	712.13
Steel Pipe (Roadway Drains)	712.14
Cast Iron Roadway Drains	712.15
Heavy Roofing Felt	712.18
Waterstops	712.19
Metal Drain Forms	712.20

502.04 Shipping and Storage. Cement may be shipped in sacks or in bulk from pre-tested and approved silos at the cement mill. The cement shall be completely protected from rain and moisture, and any cement damaged by moisture or which fails to meet any of the specified requirements shall be rejected and removed from the site. If requested by the Engineer, cement stored for a period longer than 60 days shall be re-tested before being used in the work.

Sacks of cement in shipment or storage shall not be piled more than 8 sacks high. Sacks of cement which for any reason have become partially set or which contain lumps of caked cement shall be rejected. Shipments of cement in sacks shall be separately stored in such a manner as to provide easy access for identification and inspection of each shipment.

Handling, shipping and stockpiling of aggregates shall be done in such a way as to minimize segregation and breakage.

Fine aggregate and each size of coarse aggregate shall be stored in definitely separated stock piles on prepared bases constructed of the same material as is to be stockpiled with a minimum thickness of one foot. The ground under the prepared bases shall be reasonably graded to drain away from the stockpile, and free of brush or other harmful vegetation. The base shall be left in place, undisturbed for the duration of the use of the stockpile. Prepared bases can be salvaged for re-use provided this material is reprocessed. Barge floors, wood, metal or other hard surfaces shall be considered acceptable alternates for the above described prepared bases.

CONSTRUCTION REQUIREMENTS

502.05 Composition and Proportioning. Concrete shall be composed basically of portland cement, fine aggregate, coarse aggregate and water, prepared and constructed in accordance with these specifications, at the location, and of the form, dimensions, and classes as shown in detail on the plans.

All concrete shall be air-entrained through the addition of an approved air-entraining admixture. The use of air-entrained cement will not be allowed.

Air-entrained concrete, in addition to conforming to the master limits shown in Tables 1, 2 and 3 of this subsection for the classes specified, shall contain 6 plus or minus 1½ percent entrained air.

A set-retarding admixture shall be used in the concrete mix when called for on the plans, in the special provisions or when ordered by the Engineer.

After the materials furnished by the Contractor have been accepted for the project, the actual batch weights will be designated by the Engineer in accordance with the master limits shown in Tables 1, 2 and 3 of this subsection for the appropriate class of concrete. The proportions will be stated in terms of aggregates in a saturated surface dry condition, and the batch weights will have to be adjusted periodically to take into account the actual moisture of the aggregates at the time of use.

The above determined proportions of coarse and fine aggregate and the slump for the required class of concrete shall not be changed during the progress of the work except as follows:

(a) If it is found impossible to obtain concrete of the desired workability with the proportions originally designated by the Engineer, he will make such changes in aggregate weights as required, provided that in no case shall the cement content originally designated be changed.

(b) Adjustment for new materials. No change in the source or character of the materials shall be made without notice to the Engineer, and no new materials shall be used until the Engineer has accepted such materials and has designated new proportions based on tests.

(c) If the cement content of the concrete as determined by the AASHTO Yield Test T 121 varies by more than 2 percent from the designated value, the proportions will be adjusted by the Engineer so as to maintain a cement content which does not vary more than 2 percent from the designated value.

The designated cement content may be increased up to 3 percent by the Engineer, for the purpose of obtaining the required plasticity and workability and for maintaining the water-cement ratio within the specified limits shown in the following tables.

The percent of sand as a percent of the total aggregate may be varied 2 percentage points.

TABLE 1 — MASTER LIMITS — UNCRUSHED GRAVEL AGGREGATE

(Containing less than 25 percent of crushed material)

Class of Concrete	A	B	S	Y
Designated size of coarse Aggregate—square mesh in inches	1	1 1/2	1 1/2	3/4
Cement Content in sacks per cubic yard	6.50	5.50	6.75	6.75
Maximum gross water content per sack of cement in gallons	5.75	6.25	5.5	5.5
Percent of Fine Aggregate as a percent of Total Aggregate. Surface Dry	39	35	38	45
Consistency Range Slump in Inches	Non-Vibrated	3-5	3-5	3-6
	Vibrated	2-4	2-4	—

TABLE 2 — MASTER LIMITS — CRUSHED GRAVEL AGGREGATE

(Containing 25 to 75 percent of crushed material)

Class of Concrete	A	B	S	Y
Designated size of coarse Aggregate—square mesh in inches	1	1 1/2	1 1/2	3/4
Cement Content in sacks per cubic yard	6.25	5.50	6.75	6.75
Maximum gross water content per sack of cement in gallons	5.9	6.4	5.6	5.6
Percent of Fine Aggregate as a percent of total aggregate. Surface Dry	42	37	40	48
Consistency Range Slump in Inches	Non-Vibrated	3-5	3-5	3-6
	Vibrated	2-4	2-4	—

TABLE 3 — MASTER LIMITS — CRUSHED STONE AGGREGATE

(Containing more than 75 percent of crushed material)

Class of Concrete	A	B	S	Y
Designated size of coarse Aggregate—square mesh in inches	1	1 1/2	1 1/2	3/4
Cement Content in sacks per cubic yard	6.50	5.50	6.75	6.75
Maximum gross water content per sack of cement in gallons	6.0	6.50	5.75	5.75
Percent of Fine Aggregate as a percent of total aggregate. Surface Dry	44	40	43	50
Consistency Range Slump in Inches	Non-Vibrated	3-5	3-5	3-6
	Vibrated	2-4	2-4	—

502.06 Batching. Measuring and batching of materials shall be performed at an approved batching plant, either commercial or otherwise.

In batching aggregate for contracts having an estimated quantity of less than 25 cubic yards of concrete, the Contractor may use approved volumetric measuring devices for both fine and coarse aggregate.

In batching aggregates for contracts having an estimated quantity of 25 cubic yards of concrete or over but less than 100 cubic yards, the fine aggregate shall be weighed. When permitted by the Engineer, the Contractor may use approved volumetric measuring devices for the coarse aggregate. The volume of coarse aggregate to be used in each batch shall be determined by weighing a sample batch and using the volume, so determined, in each batch of concrete produced.

In batching aggregates for contracts having an estimated quantity of 100 cubic yards of concrete or over, all aggregates shall be weighed.

The weighing and batching equipment shall be of such design and construction that the materials for each batch can be quickly and accurately weighed.

(a) *Portland Cement.* Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is measured.

All bulk cement shall be weighed on an approved weighing device. Accuracy of batching shall be plus or minus 1 percent of the required weight.

(b) *Water.* Water shall be measured by an approved device, either by volume or by weight. The accuracy of the device for measuring the water under all operating conditions shall be within a range of error of not over 1 percent of the total mixing water. Measuring tanks shall be equipped with an outside tap and valve to provide for checking the setting unless other means are provided for readily and accurately determining the amount of water in the tank.

The water measuring device at the batching plant shall be so arranged that the flow of water will be automatically stopped when the required quantity has been delivered to the mixer drum. All water measuring systems shall be capable of discharging the total quantity of measured water into the mixer drum within a limit of not greater than $\frac{1}{4}$ of the specified mixing time or $\frac{1}{4}$ of the specified required revolutions.

The water measuring device shall be so arranged that the measurements will not be affected by varied water pressures in the water supply line.

All wash water shall be removed from truck mixers and truck agitators prior to charging with a fresh load.

(c) *Aggregates.* Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and all washed aggregates, shall be stockpiled or binned for a sufficient length of time, as determined by the Engineer, to attain proper draining before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning, only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

Batching of aggregates shall be so conducted as to result in the weights of materials being accurate within plus or minus 2 percent of the required weights.

(d) *Admixtures.* Admixtures shall be added to the batch at the plant by means of an approved mechanical dispenser or other approved method capable of accurate measurement within a limit of accuracy of 3 percent. Admixtures shall be dispensed in such a manner as will insure uniform distribution of the material throughout the batch within the specified mixing period.

When both a retarding admixture and an air-entraining admixture are added in the same concrete mix they shall not be allowed to mix prior to charging the mixer and shall be added separately.

The Engineer will designate the quantity of admixture to be added to each batch.

(e) *Bins and Scales.* The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate.

If cement is used in bulk a separate bin, hopper, and scale for cement only shall be included. The bulk cement weighing hopper shall be properly sealed and vented to preclude dusting during operations, it shall be self-cleaning and it shall be fitted with an attached vibrator to insure complete discharge. The discharge chute shall be so arranged that cement will not lodge in it nor leak from it.

Bins shall have adequate separate compartments for fine aggregate and each size of coarse aggregate and shall be amply partitioned to prevent spilling of separated aggregates into adjacent compartments.

Each aggregate compartment and the cement bin if bulk cement is used, shall be designed to discharge efficiently and freely into the appropriate weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening for removing an overload and for sampling materials from the hopper shall be provided. Weighing hoppers shall be so constructed that: (1) there will be no attachments that might affect the free movement of the weighing mechanism; (2) they shall discharge fully; and (3) there shall be no possibility for accumulation of materials on the inside or outside. The cement shall be kept separate from the aggregates until the batch-ingredients are released for discharge.

The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type, and shall be accurate when static load tested to 0.5 percent of the total capacity of the scale. All exposed fulcrums, clevises and similar working parts of the scales shall be kept clean. Poises shall be designed to be locked in any position to prevent unauthorized change of position. When beam type scales are used, provision shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The device shall indicate within the last 200 lbs. of load and within 50 lbs. overload. All weighing and indicating devices shall be in full view of the operator while charging the hopper and he shall have convenient access to all controls.

The scales shall be tested and sealed as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have readily available not less than 10 fifty-pound weights for scale testing purposes.

Batching plants may be equipped to proportion aggregates and bulk cement by automatic weighing devices of an approved type.

(f) *Transportation.* When batches are hauled to the mixer, bulk cement shall be transported either in waterproof compartments or, if approved by the Engineer, between layers of fine and coarse aggregates. When cement is placed in contact with the aggregates, batches may be rejected

unless mixing is begun within 30 minutes of such contact. Sacked cement may be transported on top of the aggregates.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer, without loss, and when more than one batch is carried on the truck without spilling of material from one batch compartment into another.

The Contractor shall keep the batching equipment, including the scales and bins, clean, in good adjustment and working order and the equipment shall be accurately operated when used for proportioning batches.

All batches which do not contain the proper amount of material shall be rejected.

If, for any reason, equipment previously approved becomes unsatisfactory, it shall be repaired or replaced before proceeding with the work.

The Engineer shall have the authority to require all batch trucks used for transporting unmixed batches from the batching plant to the mixer to be properly covered; that gates between the compartments shall fit properly to prevent leakage of material from one compartment to another; and that the size of the compartments be adequate to handle the volume of material being hauled.

502.07 Mixing and Delivery.

(a) *Mixers and Agitators.*

1. Mixers may be stationary or truck mixers. Agitators may be truck mixers or truck agitators. Each mixer and agitator shall have attached thereto, in a prominent place by the manufacturer, a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades. These plates shall be kept in readable condition at all times.

2. Stationary mixers shall be equipped with approved water measuring devices as specified in subsection 502.06 and timing devices that will not permit a batch to be discharged until the specified mixing time has elapsed. The timing device shall be equipped with a bell or other suitable warning device that will give a clearly audible signal each time the lock is released. In case of failure of the timing device, the Contractor will be permitted to operate while it is being repaired, provided he furnishes an approved time-

piece equipped with minute and second hands. If the timing device is not in good working order within 24 hours, further use of the mixer will be prohibited until repairs are made.

3. All mixers and agitators shall be examined, as frequently as considered necessary, for changes in the condition of the drum, due to accumulation of hard concrete or mortar, and for wear of blades.

(b) Loading.

1. No mixer or agitator shall be loaded in excess of the manufacturer's rated mixing, or agitating capacity, respectively. No material for a batch of concrete shall be placed in the drum of a stationary mixer until all of the previous batch has been discharged.

2. For stationary mixers, batches shall be so charged into the mixer drum that some water will enter in advance of the cement and aggregate and all the water shall be in the drum by the end of the first $\frac{1}{4}$ of the specified mixing time.

(c) Mixing.

1. For stationary mixers, the total mixing time shall be not less than the following: 60 seconds for mixers of less than 2 cubic yards capacity; 75 seconds for mixers of 2 to 4 cubic yards capacity; and 90 seconds for mixers of more than 4 cubic yards capacity. Mixing time shall be measured from the time all aggregates and cement are in the drum, water is being added as required in paragraph (b) of this subsection and the drum or blades are rotating at the manufacturer's recommended mixing speed. This speed shall be maintained throughout the mixing period. Mixing time ends when the discharge chute opens. If such mixing does not result in a uniform and smooth texture, mixing shall be continued at the same rate of speed until satisfactory results are obtained.

2. For truck mixers, mixing shall be accomplished by 60 to 100 revolutions of the drum or blades at the manufacturer's designated mixing speed. Mixing shall be considered as started only after all of the materials, except water added to increase slump, are in the mixer drum. Should it be necessary to hold the concrete in the mixer after mixing has been completed, the drum or blades shall be rotated at the manufacturer's designated agitating speed.

3. Retempering concrete by adding water or by other means will not be permitted, except that with the approval of the Engineer, concrete delivered in transit mixers may have additional water added to the batch materials and meet

the specified requirements, provided, however, all time limits specified are complied with. Concrete that is not within the specified slump limits at the time of placement shall not be used.

4. Mixing of concrete, in all cases, shall begin within 30 minutes of the time that the cement has been added to the aggregate.

(d) Discharging.

1. Concrete, when discharged from mixers or agitators, shall be of the consistency and workability required for the job and shall be in accordance with subsection 502.05.

2. The rate of discharge from a truck mixer shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate, if any, fully opened.

(e) Delivery.

1. Delivery and discharge from the mixer in all cases shall be completed within a maximum of $1\frac{1}{2}$ hours from the time the cement is added to the aggregate, except that in hot weather or under conditions contributing to quick stiffening of the concrete, delivery and discharge from the mixer shall be completed within 1 hour.

2. When a truck agitator, or truck mixer used as an agitator, is used for transporting concrete that has been completely mixed, it shall be operated at the speed designated by the manufacturer as agitating speed so long as the concrete is in the drum.

3. When approved, concrete which has been designed for the purpose may be transported in suitable non-agitating equipment. The bodies of non-agitating equipment shall be of metal, smooth with rounded corners, watertight and equipped with gates which will control the discharge of the concrete. Approved covers shall be provided for protection against the weather. Concrete transported in non-agitating equipment shall be delivered to the site of the work in a thoroughly mixed and uniform mass. Slump tests of representative samples taken during the discharge shall not differ by more than 2 inches. Discharge shall be completed within 45 minutes after introduction of the mixing water to the cement and aggregate.

4. Concrete which has been condemned for any reason shall be removed immediately from the job site and disposed of.

(f) *Certification of Batches.* The Commission shall provide a delivery ticket system when ready-mixed concrete is used.

The ticket will be issued to the truck operator at the batching plant for each truck load. The tickets shall be delivered to the Engineer or his inspector at the time and place of delivery. Loads for which tickets are not provided shall not be used in the work.

502.08 Cold Weather Concrete. Unless authorized by the Engineer, the mixing and placing of concrete shall be discontinued when the atmospheric temperature is below 40° F. in the shade and dropping, and shall not be resumed until the atmospheric temperature is as high as 35° F. in the shade and rising. If authorization is granted for the mixing and placing of concrete under atmospheric conditions different from those specified above, the water shall be heated to a temperature not exceeding 180° F. When either the aggregate or water are heated to above 120° F. they are to be combined first in the mixer before the cement is added. If the atmospheric temperature is below 25° F. the aggregate shall also be heated when directed by the Engineer. Materials containing frost or lumps of frozen material shall not be used. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame, or on sheet metal over a fire. When aggregates are heated in bins, steam coil or water coil heating, or other methods which will not be detrimental to the aggregates, may be used. The heating apparatus shall be capable of heating the mass uniformly and preventing the occurrence of spots of overheated material. The temperature of the mixed concrete shall be between 50° F. and 70° F. when it is placed in the forms. Salt or other chemicals shall not be added to the concrete for any reason whatsoever, except by written permission of the Engineer.

When the use of calcium chloride is authorized for the purpose of hastening the initial set of concrete, it shall be in solution. The solution shall be prepared by dissolving one 100-pound bag of Type 1 (regular calcium chloride) or one 80-pound bag of Type 2 (concentrated calcium chloride) in approximately 15 gallons of water and then adding sufficient water to make 25 gallons of solution. The amount of solution used shall be as directed by the Engineer, but shall not exceed ½ gallon for each sack of cement, and shall be considered as a portion of the mixing water.

When concrete is placed under the above cold weather conditions or when concrete has been in place less than the mini-

mum curing period specified under subsection 502.15 and the ambient temperature drops below 35° F., the Contractor shall furnish sufficient canvas and housing framework, or other type of covering, to enclose and protect the structure. Sufficient insulation or heating apparatus, and fuel to furnish all required heat, shall be supplied. When dry heat or approved insulation is used, means of preventing loss of moisture from the concrete shall be provided. The temperature of the concrete and its surfaces shall be kept above 50° F. for four days and above 32° F. for the remainder of the minimum curing period specified under subsection 502.15 and in the 24 hours following the curing period the temperature of the concrete shall be gradually decreased but not to exceed a total of 50° F. for thin deck and similar sections; 40° F. for moderate sections such as abutments and pier bents; and 30° F. for mass sections such as massive piers.

When permitted by the Engineer, footings may be protected by completely submerging them by admitting water inside the cofferdam. Until submersion takes place the temperature of the concrete and its surface shall be controlled as specified above. Submersion shall proceed slowly and the temperature of the air or water shall be maintained sufficient to prevent ice from forming within the cofferdam for a period of 7 days after the placing of the concrete.

Prior to and at the time of depositing concrete under water there shall be no ice within the cofferdam and this condition shall be so maintained for a minimum period of 7 days, after the concrete has been placed.

Permission given to place concrete under the conditions mentioned above shall not relieve the Contractor of responsibility for obtaining satisfactory results. Unsatisfactory concrete placed under such conditions shall be removed and replaced at the Contractor's expense.

502.09 Consistency. The required consistencies for the various classes of concrete shall be within the ranges shown in the three tables of subsection 502.05. The consistency shall be measured in inches of slump of the mixed concrete.

Consistency tests shall be made, at the discretion of the Engineer, at intervals during the placing of concrete, for the purpose of controlling the uniformity of the mix.

The slump of mixed concrete shall be determined in accordance with the requirements of AASHTO T 119.

502.10 Forms and Falsework.

(a) *Construction of Forms.* All forms shall be well built, substantial and unyielding, securely braced, strutted and

tied to prevent motion and distortion while concrete is being placed in them, and strong enough to support safely, in addition to the weight of the concrete, all superimposed loads (such as run-ways, concrete buggy loads, workmen, scaffolding, etc.) placed upon them. For computing loads and pressures for the design of forms, falsework and centering, concrete shall be assumed to act as a liquid weighing 144 pounds per cubic foot for vertical loads and 72 pounds per cubic foot for horizontal pressure.

All lumber used for exposed surface forms shall be made of sized and dressed tongue and groove lumber with a minimum thickness of 25/32 inch; or lumber that is dressed on one or both sides and both edges to a uniform thickness after dressing of not less than 1 1/4 inches or plywood of an exterior plyform grade, 5-ply, bonded with a waterproof glue and having a minimum thickness of 3/4 inch. Other form material may be used with permission of the Engineer.

Undressed lumber of uniform thickness, otherwise fulfilling the requirements for lumber dressed on one side, may be used for surfaces that will not be exposed in the finished structure.

Lumber for studding, walings, struts, braces, etc., shall be free from winds, cracks and other structural defects rendering it unsatisfactory for the purpose for which it is to be used.

Forms shall be built to conform to the dimensions, location, contours, and details shown on the plans. The faces of forms against which the concrete is to be placed shall be dressed smooth and uniform and shall be free from winds, twists, buckles and other irregularities.

In general, forms shall be constructed so that they can be removed from the bottom upward and shall be designed so that they may be removed without damage to the concrete.

The placing of concrete in excavated pits and trenches without forms will be permitted only in exceptional cases and then at the discretion of the Engineer.

Except in the construction of forms for columns and round ended piers, the form lumber shall be placed horizontally.

All corners within the forms shall be fitted with chamfer strips mitered at their intersections, except that chamfer strips will not be required as follows: (1) on corners of slab blocking of interior steel beams and the inside of exterior steel beams; (2) on corners constructed transversely at the underside of the slab of superstructures which consist of a

concrete slab on steel beams; (3) on footings not exposed to view; and (4) on all structures when more than 2 feet below the final finished ground line.

Chamfer strips shall have a width across the diagonal face between 1/2 and 1 1/4 inch. The size to be adopted for a given portion of the work shall depend upon the general dimensions. Except where special size chamfer strips are shown on the plans, the size of chamfer strips shall be uniform on individual projects. Provision shall be made for the chamfering of the top edges of abutment bridge seats and wing walls, tops of piers, and retaining walls, tops of through girders, roadway curbs, etc., by nailing chamfer strips inside the forms. Unless otherwise provided, all chamfer strips shall produce plain flat surfaces in the concrete.

The forms for beams, girders, and spandrel arches shall be so constructed as to permit the sides to be removed without disturbing the supports.

All sawdust, chips, blocks, shavings and other foreign matter within the forms shall be removed before depositing concrete in them. To ensure and to facilitate thorough cleaning of forms, clean out ports shall be provided in the forms at all horizontal construction joints of abutments, piers, retaining walls and columns; and narrow forms may be built with removable sections.

All forms shall be held rigidly to correct alignment and location by ample supports, walings and braces. In all cases where metal anchorages or ties within or through the face forms are required to hold the forms in their correct position, such anchorages or ties shall be of ample strength and shall be so constructed that the metal work can be removed to a depth of not less than one inch from the face and back surfaces of the concrete without damaging such surfaces.

Elevations will be taken on the top flanges of structural steel beams and girders for the purpose of determining the depth of blocking necessary for the construction of the forms for the concrete slab, after the following conditions have been satisfied:

1. The satisfactory erection of the superstructure structural steel beams or girders, including any required floor-beams and stringers.
2. Shear connectors welded to the beams, in the case of composite construction.
3. No foreign loads supported by the beams or girders.

All forms shall be inspected and approved before the placing of any concrete within them.

(b) *Surface Treatment of Forms.* In order to insure the non-adhesion of the mortar to the forms, the inside surfaces shall be uniformly coated with raw paraffin or other non-staining mineral oil, soaped, or thoroughly wetted with water (except in freezing weather). If soap is used, it shall be mixed with sufficient water to produce a thin jelly-like substance. When forms are used more than once they shall be thoroughly cleaned before each setting and recoated with oil, soap or other approved surface treatment.

When materials for surface treatment other than plain water are to be used the application shall be done before the placing of the reinforcing steel.

Whenever forms are constructed several days in advance of filling them with concrete, they shall be kept moist or otherwise protected against warping and other defects caused by the drying out of the lumber.

In order to protect the concrete from the damaging effect of pitch in knots, all knots in the exposed surfaces of forms shall be thoroughly shellacked before treating forms as described above.

(c) *Construction of Falsework.* All falsework used for supporting reinforced concrete superstructures shall be composed of members having ample structural sections to resist, without appreciable deformation or settlement, the loads imposed upon them. In addition to the weight of the superstructure, these loads shall include all forms, bracing, runways and other loads that may be imposed during construction. The weight of the superstructure shall be taken as the weight of all concrete to be placed before the removal of falsework. Falsework shall be well built, rigid and unyielding, securely braced, struttred and tied to prevent distortion and movement tending to produce vibration and deformation of the superstructure forms.

When the vertical members of falsework consist of piles or when framed or other falsework is supported upon piles, the piles shall be driven to secure a safe load resistance equal to the maximum load that the pile will be required to take.

When falsework is supported upon mud sills, the sills shall consist of at least two layers of timbers, the upper layer being laid transversely to the one beneath. The foundation pressures resulting from the imposed loads upon mud sills (falsework, forms, fresh concrete, scaffolding, etc.) shall, in general, not exceed the following:

1. For firm sand, gravel, rotten rock, very firm clay, and other similar soils in confined thick beds, 2 tons per square foot.

2. For loose sand and gravel, and ordinary clay soils in confined thick beds, one ton per square foot.

3. For soft clay and firm alluvial soils, $\frac{1}{2}$ ton per square foot.

All arch centering and falsework shall be subject to approval, but the work shall be done entirely at the risk of the Contractor, the Engineer's approval in no way relieving the Contractor of his responsibility.

Falsework shall be so constructed that the forms will have a camber, the amount depending upon the length of span, load and conditions of falsework framing.

Forms supported upon falsework shall be provided with a satisfactory means for their adjustment in the event of settlement or deformation of the falsework due to overloading or other causes.

Provision shall be made by means of suitable wedges, sand boxes or other devices for the gradual lowering of falsework and rendering the supported structure self supporting.

(d) *Removal of Forms and Falsework.*

1. Location, weather conditions, materials used, and the character of the structure involved shall be considered in determining the time for the removal of forms. In general, forms shall not be removed until the concrete has set sufficiently to give forth a distinct "stony ring" when struck with a small hammer. In general, depending upon conditions, forms for vertical surfaces as well as supporting forms and falsework for slabs having a clear span of less than 10 feet shall not be removed for at least 7 days. Under similar conditions, supporting forms and falsework for slabs and beams having a clear span of 10 feet or more shall not be removed for a period of 14 to 21 days.

2. In cold weather, the Engineer may require that the length of time that forms and falsework are to remain in place shall be increased.

3. Forms and falsework shall not be removed without the consent of the Engineer. The Engineer's consent shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the time the forms are removed and in no case shall any portion of the wood forms be left in the concrete. In general as the forms

are removed, all projecting wire or metal devices which have been used for holding the forms in place, shall be removed or cut back at least one inch from the exposed surface of the concrete and the holes filled as required in subsection 502.13.

(e) Re-use of forms. When forms are to be re-used they shall be maintained at all times for shape, strength, rigidity, water-tightness and surface smoothness. Any warped or bulged lumber shall not be used. Forms failing to meet these requirements will be considered unsatisfactory and shall not be used.

502.11 Placing Concrete.

(a) *General.* Concrete shall not be placed until forms and reinforcing steel have been checked and approved. The forms shall be clean of all debris. The method and sequence of placing the concrete shall be approved before any concrete is placed.

All concrete shall be placed before it has taken its initial set and, in any case, within 30 minutes after mixing, except as modified under subsection 502.07. Concrete shall be placed in such manner as to avoid separation and segregation of coarse or fine portions of the mixture, and shall be spread in horizontal layers. Comparatively rich mixes will be permitted initially in slabs and girders to facilitate the placing and compacting of the concrete around nests of reinforcing steel, so as to eliminate rock pockets or air bubbles. A sufficient number of men for the proper handling, tamping and operation of vibrators shall be provided to compact each batch before the succeeding one is dumped and to prevent the formation of joints between batches. Extra tamping shall be done along all faces to obtain smooth surfaces. Care shall be taken to prevent mortar from spattering on structural steel, reinforcing steel, and forms. Any concrete or mortar which becomes dried on the structural steel, reinforcing steel or forms shall be thoroughly cleaned off before the final covering with concrete. Following the placing of the concrete, all metal surfaces shall be thoroughly cleaned and any painted surfaces shall not be injured.

Concrete shall not come in contact with sea water during placing and for a period of 72 hours thereafter, except as follows:

1. For seal concrete or any authorized concrete deposited under water, the above requirements will not apply.
2. For concrete footings constructed in the dry and located entirely below low tide or final ground elevation, the

requirement that concrete shall not come in contact with sea water for a period of 72 hours after placing will not apply.

Concrete in any section of a structure which has a depth greater than 18 inches, shall be placed in approximately horizontal layers of such thickness that the entire surface may be covered and succeeding layers placed before the underlying layer has taken its initial set. Layers shall in no case exceed 18 inches in thickness and shall be so compacted as to become an integral part of the layer below. Every effort shall be made to produce a structure monolithic between the joints shown on the plans. However, should the placement be unavoidably delayed long enough to allow the underlying layer to take initial set or produce a so called "cold joint," the following steps shall be taken:

1. An incomplete horizontal layer shall be bulkheaded off to produce a vertical joint.
2. Horizontal joints shall be treated as required in this subsection 502.11.
3. Should a cold joint occur in such a way as would produce a feather edge in the succeeding layer, inset form work shall be built to make the succeeding layer in a body of concrete not less than 6 inches thick.

The concrete in superstructures shall be placed monolithically except when construction joints are shown on the plans or are authorized in accordance with approved details submitted by the Contractor. If the concrete in the stems of T-beams is to be placed independent of the slab section, the construction joint shall be located at the under side of the slab and the bond between stem and slab shall be a mechanical one. The bond shall be produced by embedding 2 x 4 inch wooden blocks having a length approximately 4 inches less than the width of the stem and placed horizontally at right angles to the centerline of the beam in the top surface of the concrete immediately following the completion of the concrete placement. To provide for the uniform spacing of the blocks and their ready removal when the concrete has taken a set sufficient to hold its form, the blocks shall be beveled $\frac{1}{4}$ inch on the sides and ends and shall be firmly nailed upon a board at a distance of one foot center to center. The blocks shall be thoroughly oiled to facilitate their ready removal from the concrete.

In arch spans, the order of construction or sequence of the work, as shown on the plans, shall be followed in the placing of concrete.

In no case shall the work on any section or layer be stopped or temporarily discontinued within 18 inches below the top of any face, unless the plans provide for a coping having a thickness less than 18 inches, in which case at the option of the Engineer, the construction joint may be made at the under side of the coping. When placing concrete in columns for the bearing of girders, beams, or slabs, the work shall not be continued above the top of the columns until a period of at least 2 hours has elapsed. Each column shall be examined for accumulations of "laitance" or other foreign matter which, if present, shall be removed in preparation for resuming the placing of concrete. Concrete in columns shall be placed in one continuous operation, unless otherwise directed. In placing concrete for curbs, rails, rail posts and other similar construction, the forms shall be overfilled 1 to 2 inches and screeded off after a waiting period of about 1 hour.

Sloping top surfaces of abutment wings or retaining walls, when too steep to be struck off in the manner of horizontal surfaces, shall be treated as follows:

1. A series of form baffles shall be constructed on the top of and at right angles to the wing, to permit over filling the forms in steps. The spacing of the baffles shall depend upon the slope of the wing. The steeper the slope, the closer together the baffles shall be placed.

2. As soon as the concrete will support itself, the baffles shall be removed.

3. Immediately following removal of the baffles, the excess concrete shall be removed and the surface shall be finished with a wood float to the neat line at the top of the chamfer strips.

Fresh concrete, threatened with damage by rain shall be protected with a covering of canvas, tarpaulins, waterproof paper, or by other approved means. Sufficient material for covering the work expected to be done in one day shall be on hand at all times for emergency use. The covering shall be supported above the surface of the concrete by suitable frames.

(b) *Chutes, Troughs, Pipes and Buckets.* Sectional drop chutes or short chutes, troughs, pipes and buckets when used as aids in placing concrete, shall be arranged and used in such a manner that the ingredients of the concrete do not become separated or segregated. Where steep slopes are required, troughs and chutes shall be equipped with baffles, or shall be in short lengths that reverse the direction of movement. All chutes, sectional drop chutes, troughs, pipes and

buckets, shall be kept clean and free of coatings of hardened concrete by flushing thoroughly with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Chutes, troughs, pipes and buckets shall be of metal or shall be lined with metal or its equal and when used for placing concrete shall extend as nearly as possible to the point of deposit. When buckets are used, they shall be placed as close as possible to the point of deposit before opening for discharge.

When discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping the concrete a distance of more than 6 feet, unless confined by closed chutes or pipe, or depositing a large quantity at any point and running it or forcing it along the forms will not be permitted. The concrete shall be deposited at or as near as possible to its final position. The coarse aggregate shall be worked back from the forms. After the initial set of the concrete, and before the completion of the curing period, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

The placing of concrete shall be so regulated that the pressures caused by plastic concrete shall not exceed those for which the forms were designed.

(c) *Vibrating.* Mechanical, high frequency internal vibrators shall be used, operating within the concrete, for compacting the concrete in all structures containing more than 50 cubic yards of concrete and in all precast and cast-in-place piles, unless otherwise directed. The vibrators shall be of an approved type, with a minimum frequency of 5,000 cycles per minute and shall be capable of visibly affecting a properly designed mixture with a one inch slump, for a distance of at least 18 inches from the vibrator. A spare vibrator shall be available at all times during the placing of concrete, as an emergency measure. Sufficient vibrators shall be used to consolidate the incoming concrete within 15 minutes after placing. Vibrators shall not be held against forms or reinforcing steel nor shall they be used for flowing the concrete or spreading it into place. Vibrators shall be so manipulated as to produce concrete that is free of voids, of proper texture on exposed faces, and of maximum consolidation. Over-vibrating, tending to cause segregation, shall be avoided.

(d) *Unwatering Forms.* Unless otherwise provided, all forms shall be unwatered before concrete is placed in them. Pumping will not be permitted from the inside of forms while

concrete is being placed. Moving water shall not be permitted to come in contact with fresh concrete.

(e) *Depositing Concrete under Water.* Unless permitted in writing, no concrete shall be deposited under water except that for cofferdam seals when called for. Pumping will not be allowed within the cofferdam while concrete is being placed.

If concrete, other than for cofferdam seals, is permitted to be deposited under water, the proportion of cement to be used shall be increased at least 25 percent to compensate for losses due to wash from the water, and the extra cement shall be at the expense of the Contractor.

To prevent segregation, the concrete shall be placed carefully in a compact mass in its final position by means of a tremie, or a closed bottom-dump bucket, or by other approved means, and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used, it shall consist of a tube not less than 10 inches in diameter, constructed in sections having flanged couplings fitted with gaskets or equivalent water tight couplings. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the seal and to permit its being lowered rapidly, when necessary to choke off or retard flow. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall be kept full to the bottom of the hopper. The flow shall be regulated by raising or lowering the tremie.

When the horizontal area of the tremie seal is large, several tremie hoppers shall be provided and positioned strategically to allow easy deposit of concrete near the point where it is needed to avoid moving concrete horizontally through the water. The number of tremie hoppers and the work plan shall be approved in advance by the Engineer.

When concrete is placed with a bottom-dump bucket, the bucket shall have a capacity of not less than $\frac{1}{2}$ cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the prepared foundation or upon concrete already placed. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as pos-

sible, still water at the point of discharge and to avoid agitating the mixture.

All laitance or other unsatisfactory material shall be removed from the surface of the seal before placing additional concrete thereon. The surface shall be cleaned by scraping, chipping or other means which will not injure the concrete.

The unwatering of seal concrete within cofferdams shall be strictly in accordance with subsection 511.04.

(f) *Construction Joints.* Construction joints shall be located where shown on the plans or permitted by the Engineer. When the concrete is in sea water, except concrete cores for stone masonry, no horizontal construction joint will be permitted between low tide and high tide elevations. Construction joints shall be perpendicular to the principal lines of stress, and in general, shall be located at points of minimum shear.

At horizontal construction joints, temporary gauge strips having a minimum thickness of $1\frac{1}{2}$ inches shall be placed inside the forms along all exposed faces to give the joints straight lines. The joint shall be so constructed that the surface of the concrete will be not less than $\frac{1}{4}$ inch above the bottom of the gauge strip. Before placing fresh concrete, the temporary gauge strip shall be removed, the surfaces of construction joints shall be thoroughly cleaned, drenched with water until saturated, and kept saturated until the new concrete is placed. When requested by the Engineer and immediately prior to placing new concrete the forms shall be drawn tight against the concrete already in place and the old concrete surface shall be coated thoroughly with a very thin coating of neat cement paste. Concrete in substructures shall be placed in such manner that all horizontal joints will be truly horizontal, and if possible, in locations such that they will not be exposed to view in the finished structure. Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Special care shall be taken to avoid construction joints through paneled wing walls or other large surfaces which are to be treated architecturally.

Construction joints shall be bonded by means of metal bars or a mechanical bond produced by a mortise and tenon interlock, which shall be placed or formed before the concrete has taken its set. Metal bars for bonding shall consist, in general, of rods having a diameter of not less than $\frac{1}{2}$ inch and a length of not less than 1 foot 6 inches. However, when approved, metal bar, pipe, castings, or other devices may be

used provided such metal has ample cross section and is free from detrimental foreign matter, rust, scale and grease. In general, bonding bars shall be staggered and their distance center to center shall not exceed 3 feet.

When a mortise and tenon bond is to be used, the tenon shall be produced by building up a continuous section of the concrete, the dimensions of which shall be as follows:

1. Width equal to $\frac{1}{3}$ the cross sectional dimension at the construction joint.

2. Height equal to $\frac{1}{3}$ the width of the tenon, but within the limits of 4 inches and $1\frac{1}{2}$ inches.

Construction joints, both horizontal and vertical, in abutments, retaining walls, and in portions of superstructures, wherein the conditions involved may result in the seepage of water through the joints and the future discoloration of visible surfaces, shall contain waterstops consisting of a sheet of zinc, copper, or galvanized metal 6 inches in width, or when indicated on the plans, other waterstops shall be furnished and installed. The waterstop shall be set at right angles to the joint or the surface of the fresh concrete as placed and at a distance of 6 inches to 8 inches from the face exposed to seepage, unless otherwise indicated on the plans, and shall be embedded one-half of its width in the fresh concrete as placed, with the remaining half to be in the concrete yet to be placed. The sections or strips of metal, when used, shall overlap not less than 6 inches at their ends. When rubber or plastic waterstops are used they shall be of one continuous piece for each designated location, unless otherwise directed. Should splicing of the rubber or plastic waterstops be permitted, it shall be done in accordance with the approved instructions of the manufacturer. In the case of box culverts, except for the superstructure and wings of abutments, waterstops will not be required unless indicated on the plans or in the special provisions.

502.12 Expansion and Contraction Joints. Expansion and contraction joints shall be located and constructed as shown on the plans.

(a) *Expansion Joints.* In filled expansion joints, the thickness, shape and size of the filler to be installed shall be as shown on the plans. If preformed expansion joint filler is required, it shall be fixed firmly against the surface of the concrete already in place in such manner that it will not be displaced when concrete is deposited against it, and it shall be permanently secured to the concrete at one side of the

joint by rust resistant nails cast in the concrete, or other suitable means.

When necessary to use more than one piece of filler to cover any surface, the abutting pieces shall be placed in close contact and the joint between them shall be so treated as to prevent the entry of any concrete mortar from subsequent placements. Immediately after the forms are removed, the expansion joints will be inspected and any concrete or mortar that has sealed across the joint shall be cut neatly and removed. During construction when an opening of $\frac{1}{8}$ inch or more appears in any joint over which any traffic passes, the opening shall be completely filled with an approved material, as directed.

Unless indicated otherwise on the plans, no reinforcement shall extend across an expansion joint.

When required, bars, dowels, load transfer devices and other devices shall be placed as shown on the plans or as directed.

(b) *Contraction Joints.* When indicated on the plans or designated by the Engineer, contraction joints shall be given one coat of a suitable grade of asphalt paint to break the bond between abutting sections. Where preformed expansion joint filler is called for on the plans, the asphalt paint will not be required.

502.13 Repairing Defects and Filling Form Tie Holes in Concrete Surfaces. After the forms and ends of form ties are removed, all porous areas, stone pockets, open or porous construction joints, and holes left by the form ties shall be repaired.

All fins and irregular projections shall be removed from the following: Surfaces which are visible in the completed work; surfaces to be waterproofed; and that portion of face surfaces of substructure units which is below the final ground surface to a depth of 12 inches (not including underwater surfaces).

In patching porous areas, all coarse or fractured material shall be chipped away until a dense uniform surface of concrete, exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form faces having a minimum depth of one inch perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement paste shall be applied. The cavity shall then be filled with thick, reasonably stiff mortar, not more than 30 minutes old, composed of material of the same type and quality and of the same proportions as

that used in the concrete being repaired. The surface of this mortar shall be floated with a wooden float before initial set takes place and shall be neat and workmanlike in appearance. The patch shall be kept wet for a period of 5 days.

If the removal of defective concrete materially impairs the soundness or strength of the structure, the affected unit shall be removed and replaced by the Contractor at his expense.

The holes left by form ties, on the portions of substructure concrete which are to be permanently covered in the finished work, may be filled with an acceptable grade of plastic roofing cement when the temperature of the concrete or ambient temperature is below 35° F. and with the approval of the Engineer. Holes in the bottom of slabs caused by supporting hangers need not be filled.

502.14 Finishing Concrete Surfaces. Neat cement paste, dry cement powder or the use of mortar for topping or plastering of concrete surfaces will not be permitted.

(a) *Float Finish.* A float finish for horizontal surfaces shall be achieved by placing an excess of concrete in the form and removing or striking off the excess with a template or screed, forcing the coarse aggregate below the surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be thoroughly floated to the finished grade with a suitable floating tool of wood, cork or other approved material.

Float finish, unless otherwise required, shall be given to all horizontal surfaces except those intended to carry vehicular traffic and those of curbs and sidewalks.

(b) *Concrete Floor and Wearing Surface Finish.* Immediately after being placed, concrete floors and wearing surfaces shall be struck off with templates to provide proper crowns, and shall be finished to smooth, even surfaces by both longitudinal and transverse movement of wooden floats or by other suitable means. Screed strips or rails shall be supported above the surface being struck off, except when bulkheads or forms at grade are used for screeding. Screed rails and rail supports shall be made of metal. The surface of the concrete shall not be disturbed to remove any portion of the screed support. A concrete wearing surface, when not monolithic with the floor slab, and when the curb is of concrete, shall not be placed until the inside curb forms are removed. When the curb is to be of stone, the wearing surface shall not be placed until the stone curb has been set in its final position. The portion of the curb to be covered

by the concrete wearing surface shall be painted with a suitable grade of asphalt paint that will effectively break the bond between the wearing surface and the curb. When the wearing surface is monolithic with the floor slab, the curb shall be constructed in the order of construction as indicated on the plans or in the special provisions.

In general, the wearing surface shall be divided into the same number of longitudinal sections as there are lanes of traffic on the structure. On steel spans with floor beams, transverse joints shall be made at each panel joint, otherwise the longitudinal section may be placed for the entire length of each span. The forms shall be placed and held firmly at the correct finished grade of the wearing surface or floor slab and have sufficient stability to permit operating the screed upon them. A slight excess of material must be kept in front of the screed at all times, and concrete shall be added where required and the surface restruck.

Immediately after screeding and necessary floating have been completed, the surface of the concrete of both floor slab and wearing surface shall be inspected and all irregularities corrected at once, in order to maintain the surface to a tolerance of $\frac{1}{8}$ inch for wearing surface and $\frac{1}{4}$ inch for floor slabs above or below the required cross sectional elevations and to a maximum irregularity not exceeding $\frac{1}{8}$ inch for wearing surfaces and $\frac{1}{4}$ inch for floor slabs under 10 foot straight edge, longitudinally.

The straight edge shall be furnished by the Contractor and shall be fitted with a handle and all parts shall be aluminum or other light metal.

Just before the concrete takes its initial set, the surfaces of concrete intended to carry vehicular traffic shall be lightly and uniformly broomed at right angles to the center line with an approved barn or street broom, or finished with a float as described for "Sidewalk Finish." Following the brooming or floating of the surface, a 4 inch wide smooth finished margin shall be defined along the face of the curbs by means of a plaster mason's steel trowel. An approved edging tool, 2½ inches wide with a $\frac{1}{4}$ inch radius lip, shall be used at all transverse joints, except where expansion dams or armored joints exist.

(c) *Curb and Sidewalk Finish on Bridges.* Curb and sidewalk finish is a float finish produced by using a short float of wood or other acceptable material, moved in small circles to produce a shell-like pattern on the surface of the concrete.

Curbs and sidewalks shall be given this finish except that roadway curbs one foot or less in width shall be given a rubbed finish.

When a concrete curb is monolithic with a sidewalk or refuge walk and when the combined width is greater than 2 feet, a 6 inch wide smooth margin shall be made along the top of the curb with a plaster mason's steel trowel.

When the sidewalk upon the bridge does not connect with a concrete sidewalk upon the approaches to the bridge, the ends of the sidewalk shall be finished smooth with a margin 4 inches in width. Otherwise, the finish at the ends shall be such as to match the margins used upon the slab of the approach sidewalk.

No smooth margins will be required adjacent to granite curbs.

Unless shown on the plans, the sidewalk area shall not be divided into sections by transverse grooves. At all transverse construction and expansion joints, except where structural steel expansion plates are used, the edges of the joints, on the surface of the sidewalk, shall be finished with a sidewalk edging tool, 2 inches in width, with a $\frac{1}{4}$ inch radius lip.

(d) *Form Surface Finish.* The character of the materials used and the care with which forms are constructed and concrete placed shall be considered in determining the amount of rubbing required. If, through the use of first class form material, well constructed forms and the exercise of special care, concrete surfaces are obtained that are satisfactory to the Engineer, the Contractor may be relieved in part from the requirement of rubbing.

1. *Ordinary Finish.* An Ordinary Finish is defined as the finish left on a surface after the removal of the forms, the filling of all holes and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections, and of uniform texture.

Immediately following the removal of the forms, all defects shall be repaired as provided in subsection 502.13.

All formed concrete surfaces shall be given an ordinary finish.

Repaired areas which do not meet the above requirements or areas which cannot be satisfactorily repaired to meet the requirements for ordinary finish shall be given a rubbed finish. When a rubbed finish is required on any part of a surface, the entire surface shall be given a rubbed finish.

The Contractor may be required to give adjoining surfaces a rubbed finish when necessary to avoid an undesirable appearance.

2. *Rubbed Finish.* After removal of forms the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be thoroughly saturated with water. Sufficient time shall have elapsed before wetting down to allow the mortar used in ordinary finish to become thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions as used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. A thin layer of paste produced by this rubbing shall be left on the surface.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by a second rubbing with a fine carborundum stone using only water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. The paste produced by this second rubbing shall be carefully spread with a moist whitewash brush to form a very thin uniform coating upon the surface of the concrete.

After the final rubbing is completed and the surface has dried, it shall be rubbed lightly with clean and dry burlap to remove excess loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

This finish shall result in a surface of smooth texture and uniform color.

No surface finishing shall be done in freezing weather or when the concrete contains frost. In cold weather the preliminary rubbing necessary to remove the inert sand and cement materials and the surface inequalities may be done without the application of water to the concrete surfaces.

The following portions of concrete structures shall be given a rubbed finish unless otherwise indicated on the plans or in the special provisions:

Railings and posts, including parapet walls — All surfaces except the bottoms of rail bars.

Superstructures — Exterior vertical surfaces except below copings.

Roadway curbs of 12 inches or less in width, barrier, and splash curbs — All surfaces.

Abutment wings and retaining walls — Top and the back to 1 foot 6 inches below top.

For roadway grade separation structures and their approaches, in addition to the above, the following surfaces shall also be given a rubbed finish unless otherwise indicated on the plans or in the special provisions.

Retaining walls and the breast and wing walls of abutments — Face surfaces to 12 inches below the finished ground line.

Piers — All vertical surfaces and the underside of overhanging portions of caps, except that for overpass structures, the piers beyond the outside limits of the roadway pavement, the vertical surfaces on the back which are not visible from the roadway or sidewalk will not require a rubbed finish.

502.15 Curing Concrete. All concrete surfaces shall be kept wet with clean fresh water for at least 7 days after the placing of concrete. Roadway and sidewalk slabs shall be covered with wet burlap, cotton mats or other suitable fabric immediately after the concrete has set sufficiently to receive a curing cover. These materials shall remain in place for the full curing period or they may be removed when the concrete has hardened sufficiently to prevent marring and the surface immediately covered with sand, earth, straw, or similar materials. In any case, the materials shall be kept thoroughly wet for the entire curing period. All other surfaces, if not protected by forms, shall be kept thoroughly wet either by sprinkling or by the use of wet burlap, cotton mats, or other suitable fabric until the end of the curing period. If wood forms are allowed to remain in place during the curing period they shall be kept moist at all times to prevent openings at joints. Other methods of curing concrete may be used, if approved.

When liquid-forming compounds for curing concrete are used they shall conform to the requirements of AASHTO designation M-148 and shall serve as the initial protection and curing as well as final curing.

Type 1 shall contain a fugitive dye and shall be readily distinguishable upon the concrete for at least 4 hours after application.

The compound shall be applied immediately following final finishing and before any marked dehydration of the concrete or surface checking occurs.

The compound shall be applied in a continuous uniform film by means of pressure spraying or distributing equipment at the manufacturer's specified rate but not less than one gallon per 150 square feet of surface. The equipment for applying the compound shall provide for adequate agitation of the compound during application.

If rain injures the film before it has dried sufficiently to resist damage, or if the film is damaged in any other way, a new coat of material shall be applied to the affected area. The treated surface shall be protected from injury for a period of 7 days.

Prior to placing any overlay material on the treated concrete surface or when any surface that has been treated is permanently exposed and the compound leaves an objectionable discoloration, the compound shall be carefully and completely removed by the use of power brushes, sandblasting or other approved means.

When the ambient temperature is expected to fall below 35° F., the Contractor shall make suitable provision to maintain the temperature of the concrete and its surface above the temperatures required in subsection 502.08.

Special attention shall be given by the Contractor to the proper curing of concrete handrails and all surfaces requiring rubbed finishes. Special attention shall also be given to the protection of all concrete surfaces immediately after the placing of the concrete, especially floor slabs, wearing surfaces, sidewalks and curbs, to prevent premature drying and creation of surface cracks or crazing caused by drying winds and low humidity. As a precautionary measure, if deemed necessary by the Engineer, wind breaks shall be used until such time as the concrete has set hard enough to receive a curing cover.

502.16 Loading Structures and Opening to Traffic.

(a) *Loading Structures.* In general, no superstructure concentrated loads such as structural steel beams, girders and trusses, shall be placed upon finished concrete substructures until the concrete has been in place for a period of 7 days.

No load or work will be permitted on reinforced concrete superstructure slabs of composite construction for a period of 7 days, following the placement of the concrete. However, depending on weather conditions, after a shorter period of time the Engineer may permit handwork for form construction and setting stone bridge curb. No curbing or other ma-

materials shall be stored on the bridge during the 7 day period, except that if handwork is permitted in a shorter period, curb stones may be stored in a line near to their final location until ready to be set.

(b) *Filling on and Opening to Traffic.* Neither traffic nor fill material shall be allowed on superstructures of concrete bridges or culverts for a period of from 14 to 21 days after the placing of the concrete has been completed, dependent upon conditions as specified in subsection 502.10 and with the approval of the Engineer.

When a separate portland cement concrete wearing surface is required, the time after the placing of the concrete and prior to opening the surface to traffic shall be not less than 10 days, provided the superstructure on which the wearing surface is placed has been properly cured for the required period as stated in subsection 502.15.

Concrete approach slabs at the end of structures may be opened to traffic, with the approval of the Engineer, 10 days after the placing of the concrete, provided that a minimum thickness of 6 inches of gravel, free of stones greater than 3 inches in size, is placed over the slab for traffic to travel on.

502.17 Roadway Drains and Incidental Drainage. All drains shall be accurately placed at the locations shown on the plans or authorized, and adequate means provided for securely holding them in the required positions during the placing of concrete.

(a) *Roadway Drains.* Galvanized sheet metal shall be used for metal drain forms when this type of roadway drain is called for in superstructure concrete floor slabs.

Cast iron or steel pipe roadway drains, when called for, shall conform to the details and type as indicated on the plans. The exposed surfaces of steel roadway drains shall receive the shop and field coats of paint in accordance with Section 506 — Painting Structural Steel. Welding, when required, shall be in accordance with subsection 504.47 for shop welding and 504.63 for field welding.

(b) *Incidental Drainage.* Drains or weep holes through abutments and retaining walls shall be pipe of the size and shape shown on the plans and shall be of approved cast iron, tile, fibre, or other material that will maintain its shape and alignment during placing of concrete.

For the purpose of providing drainage for any moisture which may collect between the floor slab and the bituminous concrete roadway surface, approved one inch inside diameter

plastic tube drains shall be installed at the low points of the slab surface, adjacent to the end dam or dams. The exact location will be determined in the field by the Engineer and the discharge from them shall be such as to clear the bridge seats and any other portion of the structure in their proximity. The tops of the drains shall be depressed $\frac{3}{8}$ of an inch below the surface of the slab and the outlets shall project two inches below the underside of the slab. Care shall be exercised not to cover the tops of the drains with the required floor slab membrane waterproofing, when it is installed.

502.18 Expansion Bearings. Where sliding joints are to be provided at the ends of slab, T-beam, and girder spans having a length less than 30 feet, the bridge seat or other bearing areas shall be screeded true to grade and carefully finished by the use of a plaster mason's trowel, and when the concrete has become thoroughly set, the bearing areas shall, unless otherwise shown on the plans, be covered with a layer of asphalt-treated roofing felt or preformed expansion joint filler before the superstructure concrete is placed. To insure free movement consistent with the lengths of superstructure spans, the thickness of the layer of felt shall vary correspondingly and shall, in general, be made of sheets of heavy roofing felt, swabbed with tar or asphalt between sheets in only sufficient quantity to hold the sheets in position.

The thickness of layers shall vary as follows:

Span Lengths	Layer Thickness
10 ft. and less	$\frac{1}{8}$ inch
Over 10 ft. to 20 ft.	$\frac{1}{4}$ inch
20 ft. and over	$\frac{3}{8}$ inch

Reinforced concrete T-beam and girder spans of lengths over 30 feet shall in general, be provided with metal expansion bearings for permitting free expansion and contraction movement, unless otherwise indicated on the plans.

Expansion bearings shall be placed in a neutral position at 65° F. When placed at other temperatures correction shall be made in position.

Material and workmanship of structural steel and bronze or copper-alloy plates used in expansion bearings shall conform to the requirements of Section 504 — Structural Steel.

Expansion bearings shall be anchored in correct position according to details shown on the plans.

Special care shall be taken in placing concrete and reinforcing steel around the bearing plates to insure that they do not become dislocated.

502.19 Method of Measurement.

(a) Structural concrete satisfactorily placed and accepted will be measured for payment by the cubic yard, in accordance with the dimensions shown on the plans, or authorized changes in the plans, except as follows:

1. Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges, Structural Concrete Superstructure T-beam Type, Structural Concrete Wearing Surfaces on Bridges, Structural Concrete Box Culverts and Structural Concrete Approach Slabs, complete and accepted, will each be measured as a lump sum unit, unless indicated otherwise in the schedule of prices.

2. Structural concrete for foundations placed on relatively rough and irregular ledge rock; or when used for jacketing or capping of rough and irregular stone masonry abutments, retaining walls and piers, if considered advisable by the Engineer, may be measured by the cubic yard as determined from the theoretical yield of the design mix, or in the case of ready-mixed concrete, by delivery slips, in accordance with the following applicable paragraph (e) or (f) of this subsection.

(b) The limits to be used in determining the quantities of the aforementioned structural concrete items for the purpose of arriving at a lump sum bid price will be as follows:

1. Structural Concrete, Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges, and Structural Concrete Superstructure T-beam type. The limits will be the entire concrete superstructure of the concrete portion of the superstructure, outside to outside, both transversely and longitudinally, except that the items specified in the statement following the list of pay items in this section will not be included.

2. Structural Concrete, Wearing Surfaces. The limits will be the entire concrete wearing surface bounded transversely by the roadway curbs and longitudinally by the extreme ends.

3. Structural Concrete Box Culverts. The limits will be the entire structure, meaning the bottom floor slab, abutments, wings, superstructure floor slab and headwalls or curbs.

4. Structural Concrete, Approach Slabs. The limits will be the entire approach slab or slabs, as shown on the plans.

(c) No deduction will be made for the volume of concrete displaced by structural steel, reinforcing steel, pile heads, expansion joint material, drains, chamfers on corners, inset panels of 1½ inches or less in depth, pipes, weep holes and authorized openings for utilities of 64 square inches or less in cross sectional area, when any of these items occur in structural concrete which is to be paid for on a cubic yard basis.

(d) When foundations for concrete structures are required to be at a definite elevation within ledge excavation, as shown on the plans or otherwise designated, the quantity to be measured for payment will be the number of cubic yards of concrete actually and satisfactorily placed above a plane at 1' 0" below the above mentioned plan elevation and within the neat lines of the structure as shown on the plans or on authorized changes in the plans. If the ledge is excavated below the plane at 1 foot below the plan elevation, without authorization, then this space shall be replaced with concrete of the same composition as required for the structure foundation but will not be measured for payment.

(e) Concrete for structures which are to rest on either undisturbed or prepared ledge rock, when the ledge is relatively rough and irregular, making it impracticable to measure the pay quantity by cross sectional elevations and dimensions, the quantity for payment within the limits as specified in the preceding paragraph from the ledge up to a horizontal plane or elevation selected by the Engineer, in the proximity of the high point of ledge and within the designated area where concrete is to be placed, may be determined from the theoretical yield, in cubic yards, computed from the design mix. When ready-mixed concrete is used for this type of construction, properly executed delivery slips as specified in subsection 109.01 for each load satisfactorily delivered and placed shall be furnished to the Engineer by the Contractor. This delivery slip will be in addition to the delivery ticket required in subsection 502.07.

(f) Concrete for jacketing or capping of stone masonry abutments, retaining walls, and piers, when the masonry is rough and irregular, making it impracticable to measure the pay quantity by the three dimensional method, the quantity in cubic yards up to an elevation selected by the Engineer, in the proximity of the top of the stone masonry, may be determined in accordance with the applicable requirements of paragraph (e) of this subsection.

(g) Set-retarding Admixture will not be measured for payment directly but will be in terms of the number of cubic

yards of concrete, as determined from the design mix yield, to which it is added in conformance with the manufacturer's recommendations and as authorized.

502.20 Basis of Payment. All work done under structural concrete, of the classes and for the types of work required, will be paid for at the contract unit bid price per cubic yard, except that Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges, Structural Concrete Superstructure T-beam Type, Structural Concrete Wearing Surfaces on Bridge, Structural Concrete Box Culverts and Structural Concrete Approach Slabs will be paid for at the contract lump sum price of the respective contract items unless otherwise indicated in the schedule of prices. Payment for both the unit price and the lump sum price items will be full compensation for furnishing and installing metal drain forms, cast iron or steel roadway drains including painting, water stops, expansion joint filler, tile, fiber or plastic tube drains, roofing felt, burlap and asphalt for painting or covering various types of joints, expansion bearings for concrete beams or slabs and all incidentals necessary to complete the work satisfactorily, except that the items specified in the statement following the list of pay items in this section will not be included.

Payment for Set-retarding Admixtures will be at the contract unit price of 1 dollar per cubic yard of concrete.

Payment for Structural Concrete Culvert Connection shall include drilling and grouting the dowels into the existing headwall. Excavation required to construct the connection will be paid for under Item 206.06, Structural Earth Excavation Drainage and Minor Structures. Reinforcing will be paid for under Item 503.12 — Reinforcing Steel, Fabricated and Delivered and Item 503.13 — Reinforcing Steel, Placing.

Reinforcing steel, railings, stone curbs and any material which may be required for bridge lighting systems, will be measured and paid for separately as provided in the appropriate sections.

Payment will be made under:

Pay Item	Pay Unit
502.21 Structural Concrete, Abutments and Retaining Walls	Cubic Yard
502.22 Structural Concrete, Abutments and Retaining Walls (placed under water)	Cubic Yard
502.23 Structural Concrete, Piers	Cubic Yard

502.24 Structural Concrete, Piers (placed under water)	Cubic Yard
502.25 Structural Concrete Superstructure slabs	Lump Sum
502.26 Structural Concrete, Roadway and Sidewalk Slabs on Steel Bridges	Lump Sum
502.27 Structural Concrete, Superstructure T-beam Type	Lump Sum
502.28 Structural Concrete, Rigid Frame Structures	Cubic Yard
502.29 Structural Concrete, Wearing Surface on Bridges	Lump Sum
502.30 Structural Concrete, Box Culverts	Lump Sum
502.31 Structural Concrete, Approach Slabs	Lump Sum
502.32 Structural Concrete, Culvert Endwalls	Cubic Yard
502.33 Structural Concrete, Steps	Cubic Yard
501.35 through 501.39 Vacant	
501.40 Structural Concrete, Box Culverts	Cubic Yard
502.41 Structural Concrete, Superstructure Slab	Cubic Yard
502.42 Structural Concrete, Roadway and Sidewalk Slabs on Steel Bridges	Cubic Yard
502.43 Structural Concrete, Superstructure T-beam Type	Cubic Yard
502.44 Structural Concrete, Wearing Surface on Bridges	Cubic Yard
502.45 Structural Concrete, Approach Slabs	Cubic Yard
502.46 Structural Concrete, Culvert Connection	Cubic Yard

SECTION 503 — REINFORCING STEEL

503.01 Description. This work shall consist of furnishing and placing reinforcing steel in accordance with these specifications and in conformity with the plans.

MATERIALS

503.02 Materials. Reinforcing steel, including welded steel wire fabric, shall meet the requirements of subsection 709.01.

503.03 Schedule of Material. When steel schedules are not furnished by the Commission, the Contractor shall submit order lists and bending diagrams to the Engineer for approval. No material shall be ordered until these lists have been approved; however, such approval shall not relieve the Contractor of full responsibility for the satisfactory completion of this item.

CONSTRUCTION REQUIREMENTS

503.04 Protection of Material. Steel reinforcement shall be stored on skids or other supports above the ground and protected at all times from injury and surface contamination by anything which will impair its bonding qualities.

503.05 Fabrication and Delivery. Unless otherwise specifically authorized, bars shall be bent cold. Stirrups and tie bars shall be bent around a pin having the diameter of the supporting or supported bar but never less than twice the diameter of the stirrup or tie bar. Other bars, up to and including number 8, shall be bent around a pin having a diameter not less than 6 times that of the bar. Bars larger than number 8 shall be bent around a pin having a diameter not less than 8 times that of the bar.

Bending tolerances shall be in conformance to that established in the "Manual of Standard Practice of the Concrete Reinforcing Steel Institute" and the "Detailing Manual of the American Concrete Institute."

Delivery shall be to the project unless otherwise specified.

503.06 Placing and Fastening. All steel reinforcement shall be accurately placed in the positions shown on the plans and shall be firmly held there during the placing and setting of the concrete. Immediately before placing concrete, steel reinforcement shall be free from all foreign material which could decrease the bond between the steel and concrete. Such foreign material shall include but not be limited to dirt, loose mill scale, excessive rust, paint, oil, bitumen and dried concrete or mortar.

Bars shall be fastened together at all intersections except where spacing is less than 1 foot in either direction, in which case, fastening at alternate intersections of each bar with other bars will be permitted providing this will hold all the bars securely in position. This fastening may be tack welding by qualified welders (See subsection 504.63 for qualification of welders) or by tightly twisted wire. Other systems of fastening may be used if approved by the Engineer.

Proper distances from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved means. Blocks used for this purpose shall be precast portland cement mortar blocks of approved shape and dimensions or approved metal or plastic chairs. Layers of bars may be separated by precast portland cement mortar blocks or other approved devices. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks shall not be permitted. The

placing of reinforcement as concrete placement progresses, without definite and secure means of holding the steel in its correct position, shall not be permitted except in the case of welded steel wire fabric or bar mats.

Reinforcement shall be inspected and approved by the Engineer before any concrete is placed.

503.07 Splicing. Splicing of bars other than as shown on the plans shall not be permitted without written approval of the Engineer. When so approved, splices shall be staggered as far as possible.

Where not specified, bars in the bottoms of beams and girders and in walls, columns and haunches shall be lapped 24 diameters to form a splice and bars near the tops of beams and girders, having more than 12 inches of concrete under them shall be lapped 35 diameters.

In lapped splices, the bars shall be placed in contact and wired together in such a manner as to maintain a clear distance no less than the minimum permitted to other bars and to the surface of the concrete. Welding of reinforcing bars, other than tack welding at intersections, shall be done only if called for on the plans or authorized by the Engineer in writing. When permitted, welding shall be done in accordance with the requirements of subsection 504.63.

503.08 Lapping. Sections of welded steel wire fabric shall overlap and be securely fastened to adjoining sections. All laps shall be wide enough to maintain uniform strength but in no case shall they be less than the smaller dimension of the wire fabric.

Bar mats shall be spliced as required for the individual bars.

503.09 Substitution. Substitution of different size bars shall not be permitted except with the written authorization of the Engineer.

503.10 Method of Measurement. Reinforcing steel shall be measured for payment by the computed number of pounds of steel reinforcement authorized.

Weights shall be computed on the following basis:

For structural steel . . . Nominal weight of the section.

For bars:

Size Plain	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1"	1-1/8"φ	1-1/4"□
Size Deformed		#3	#4	#5	#6	#7	#8	#9	#10	#11
Wt. per foot in pounds	.187	.376	.688	1.043	1.502	2.044	2.670	3.400	4.303	5.313

For welded steel wire fabric:

Size in inches and gauge	6 x 6-10/10	3 x 6-10/10	4 x 4-10/10	6 x 6-6/6
Wt. in pounds per 100 sq. in.	21	30	31	42

For other sizes of fabric use the commercially recognized weights.

Measurement for payment will not be made for any materials used to hold reinforcement in place nor for extra weight due to substitutions and splices made for the Contractor's convenience.

503.11 Basis of Payment. Reinforcing steel will be paid for at the contract unit price per pound for each item involved, completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
503.12 Reinforcing Steel, Fabricated and Delivered	Pound
503.13 Reinforcing Steel, Placing	Pound
503.14 Welded Steel Wire Fabric, Complete in Place	Pound

SECTION 504 — STRUCTURAL STEEL

504.01 Description. This work shall consist of detailing, furnishing, fabricating, shop painting, and erecting the structural steel portions of bridges, including self-lubricating bronze or copper-alloy bearing and expansion plates and other related materials as required under this contract.

504.02 Materials. Materials shall meet the requirements specified in the following subsections of Division 700 — Materials:

Structural Steel	713.01
High Strength Bolts	713.02
Preformed Pads	713.03
Sheet Lead	713.04
Copper Bearing Steel	713.05
Wrought Iron	713.06
Steel Forgings	713.07
Carbon Steel Castings	713.08
Chromium Alloy-Steel Castings	713.09
Gray Iron Castings	713.10
Malleable Iron Castings	713.11
Bronze or Copper-Alloy Bearing and Expansion Plates	713.12
Cold-Finished Carbon Steel Shafting	713.13
Metal Bridge Paint (Shop Coat)	708.02

504.03 Drawings. Unless previously prepared and supplied by the Commission the Contractor shall prepare shop detail, erection, and other working plans. Unless otherwise specified, two prints of these plans shall be submitted to the Engineer for approval. Approval of the plans shall be secured before fabrication of the steel work is commenced. Upon the completion of the work, the Contractor shall supply to the Commission the original plans, inked on tracing cloth, or either inked or penciled on polyester drafting film, or may supply as an alternate, exact copies on tracing cloth or polyester drafting film, and these plans shall become the property of the Commission.

All plans shall be 36 inches in length by 22 inches in width. The border line shall be located $\frac{1}{2}$ inch inside the edge on the top, bottom and right end of the plan and 2 inches from the edge on the left end.

Changes on the approved plans shall be subject to further approval and the Engineer shall be supplied with a record of such changes.

Substitution of sections different from those shown on the plans supplied by the Commission, or prepared by the Contractor and previously approved, shall be made only when approved in writing by the Engineer.

The Contractor shall be responsible for the correctness of his plans and for shop fits and field connections, although the plans may have been approved.

504.04 Design. Design, detail and load requirements shall conform to the latest revised AASHO Standard Specifications for Highway Bridges.

FABRICATION AND DELIVERY

504.05 General.

(a) Type of construction whether riveted, bolted, welded, or a combination shall be as shown on the plans.

(b) Workmanship and finish shall be equal to the best general practice in modern bridge shops.

504.06 Notice of Beginning Work. The Contractor shall give the Engineer ample notice of the beginning of work at the mill or in the shop, so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the Engineer has been so notified.

504.07 Facilities for Inspection. The Contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and the inspectors shall be allowed free access to the necessary parts of the works.

504.08 Inspector's Authority. The inspector will have the authority to reject any material or work which does not meet the requirements of these specifications.

504.09 Mill Orders. The Contractor shall furnish the Engineer with as many copies of the mill orders as the Engineer may direct.

504.10 Rejections. The acceptance of any material or finished members by the inspector will not prevent their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

504.11 Mill Tests. The Contractor shall supply to the Commission, without charge, certified copies of the mill tests of all structural steel supplied. In addition to the results of the special chemical and physical tests these test reports shall show the mill number, the name of the manufacturer, the location or mill where produced, and the name of the testing laboratory or other concern making the test.

504.12 Storage of Materials. Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease and other foreign matter, and shall be protected as far as practicable from corrosion.

504.13 Material Identification and Control. When structural steel plates or shapes are delivered to the fabrication shop from the mill and are to be cut, the heat number shall be transferred to all pieces that are to be used in the fabrication. As an alternate, color coding may be used for any individual project for positive identification of ASTM steel classification, preferably by painting the original piece containing the heat mark extensively enough so that all pieces cut therefrom bear a trace of the appropriate color, or by transferring a mark of the appropriate color to each piece as it is cut. If, however, the material is to be stored for future use on the same project, or possible use on a future bridge project, the heat number must be transferred. Failure to comply with this specification may be cause for rejection of the material.

504.14 Straightening Material. Rolled material before being laid off or worked, must be straight. If straightening is

necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends may be cause for rejection of the material.

504.15 Finish. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately.

504.16 Flame Cutting. Structural steel permitted by these specifications or wrought iron may be flame cut, provided a smooth surface free from cracks and notches is secured and provided that an accurate profile is secured by the use of a mechanical guide. Hand cutting shall be done only where approved by the engineer.

In all flame cutting, the cutting flame shall be so adjusted and manipulated as to avoid cutting beyond (inside) the prescribed lines. Flame cut surfaces shall meet the American Standards Association surface roughness rating value of 1,000, except that flame cut surfaces of members not subject to calculated stress shall meet the surface roughness value of 2,000. Flame cut surfaces of members carrying calculated stress shall have their corners rounded to $\frac{1}{16}$ inch radius by grinding after flame cutting.

Re-entrant cuts shall be filleted to a radius of not less than $\frac{3}{4}$ inch.

Surface roughness, exceeding the above values, and occasional gouges not more than $\frac{3}{16}$ inch deep on otherwise satisfactory flame cut surfaces, shall be removed by machining or grinding. Corrections of the defects must be faired with the surface of the cut on a bevel of 1 to 6 or less. Occasional gouges of flame cut edges more than $\frac{1}{16}$ inch deep but not more than $\frac{1}{8}$ inch deep may be repaired by welding with low-hydrogen electrodes not exceeding $\frac{5}{32}$ inch in diameter and with a preheat of 250° F. The completed weld shall be ground smooth and flush with the adjacent surface.

Flame cut edges of ASTM A 242 steel not approved for welded construction and flame cut edges of ASTM A 440 steel $\frac{1}{2}$ inch or greater in thickness shall be removed to a depth of at least $\frac{1}{8}$ inch by machining or grinding except that machine flame cut edges may be used without such removal if the edges are softened after cutting; (a) by heating the cut edge uniformly and progressively to a red heat, visible in ordinary shop light (1,150 to 1,250° F.) to a depth of at least $\frac{1}{16}$ inch; or (b) by means of a post heating torch attached to and following the cutting torch with the tips, gas pressure, speed of travel, and the distance of the post heating

torch from the kerf regulated to the thickness of the steel. Bend test specimens $1\frac{1}{2}$ inches wide and of the full thickness of the material or with thickness reduced to $\frac{3}{4}$ inch in accordance with Paragraph 6.8 of ASTM A 6 and having edges flame cut and flame softened in accordance with this article shall meet the bend test requirements specified in ASTM A 242 or ASTM A 440 as applicable for the thickness of material under consideration.

504.17 Holes for Rivets and High Strength Bolts. All holes for rivets and high strength bolts shall be either punched or drilled. Material forming parts of a member connected by shop rivets and composed of not more than 5 thicknesses of metal may be punched $\frac{1}{16}$ inch larger than the nominal diameter of the rivets or bolts whenever the thickness of the metal is not greater than $\frac{3}{4}$ inch for carbon structural steel or $\frac{5}{8}$ inch for alloy steel.

When there are more than 5 thicknesses or when any of the main material is thicker than $\frac{3}{4}$ inch in carbon steel, or $\frac{5}{8}$ inch for high-strength steel, or when required under subsection 504.20, all holes for rivets and bolts shall be subpunched or subdrilled $\frac{1}{16}$ inch smaller and after assembling, reamed $\frac{1}{16}$ inch larger, or drilled from the solid to $\frac{1}{16}$ inch larger than the nominal diameter of the rivets or bolts.

504.18 Punched Holes. The diameter of the die shall not exceed the diameter of the punch by more than $\frac{1}{16}$ inch. If any holes must be enlarged to admit the rivets or bolts, such holes shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching of holes will be cause for rejection.

504.19 Reamed or Drilled Holes. Reamed holes shall be cylindrical, perpendicular to the member and not more than $\frac{1}{16}$ inch larger than the nominal diameter of the rivets or bolts. Where practicable, reamers shall be directed by mechanical means. Drilled holes shall be $\frac{1}{16}$ inch larger than the nominal diameter of the rivet or bolt. Burrs on the outside surfaces shall be removed. Poor matching will be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the Engineer, assembled parts shall be taken apart for removal of burrs caused by drilling.

Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match-marked before disassembling.

504.20 Subpunching and Reaming of Field Connections. Unless otherwise specified in the special provisions or on the

plans, holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames shall be subpunched or subdrilled and subsequently reamed while assembled or to a steel template, as required by subsection 504.23.

All holes for floor beam and stringer field end connections shall be subpunched and reamed to a steel template or reamed while assembled.

Reaming or drilling full size of field connection holes through a steel template shall be done after the template has been located with utmost care as to position and angle, and firmly bolted in place. Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be so accurately located that the parts or members are duplicates and require no match-marking.

If additional subpunching and reaming is required, it shall be specified in the special provisions or on the plans.

504.21 Accuracy of Punched and Subdrilled Holes. All holes punched full size, subpunched or subdrilled, shall be so accurately punched that after assembling (before any reaming is done) a cylindrical pin $\frac{1}{8}$ inch smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. If this requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin $\frac{1}{16}$ inch smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

504.22 Accuracy of Reamed and Drilled Holes. When holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than $1/32$ inch between adjacent thicknesses of metal.

504.23 Shop Assembling. Complete shop assembly of an entire structure, including floor system, which may be necessary in the case of complicated designs, or shop assembly of each individual (full length) truss, arch, continuous beam, tower (each face), bent or girder which may be necessary in the case of less complicated designs, shall be done when shown on the plans or when stipulated in the special provisions. Otherwise partial assembly as described herein shall

be the minimum amount of shop assembly required before reaming or drilling from the solid is commenced. The fabricator shall have the option of making complete assembly in lieu of partial assembly.

(a) The panels of trusses and open-spandrel arches and the columns of bents and towers shall have their sub-size holes reamed to specified size after initially assembling at least three contiguous shop sections or all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices) and not less than 150 feet, in the case of structures longer than 150 feet. At least one shop section or panel or as many panels as are associated with a chord length shall be added at the advancing end of the assembly before any member is removed from the rearward end so that the assembled portion of the structure is never less than that specified above.

Field connection holes in web members shall be reamed to steel templates. At least one end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member and the templates at both ends of the member shall be accurately located from one of the milled ends or scribed lines.

(b) Abutting main members at field splices and field splice material of continuous beams, plate girders, rigid frames, closed spandrel arches and towers and bents not otherwise specifically provided for in (a) shall be placed in the exact relative field position for erection before reaming or drilling from the solid is commenced. Reaming or drilling full size to templates for either main members or splice material shall not be allowed.

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends, and other deformation.

Preparatory to the shop riveting of full-sized punched material, the rivet holes, if necessary, shall be spear-reamed for the admission of the rivets. The reamed holes shall not be more than $\frac{1}{16}$ inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until riveted.

Parts not completely connected in the shop shall be secured by bolts, insofar as practicable, to prevent damage in shipment and handling. When possible, splice material for continuous beams and plate girders shall be moved back on one of the main members abutting at the field splice so that none of the material projects beyond the end of the main members and shall be firmly secured by bolts for shipment.

504.24 Camber Diagram. When complete shop assembly or shop assembly of each individual full length truss has been required under conditions outlined under subsection 504.23, a camber diagram shall be furnished the Engineer showing the camber of each panel point for each truss measured in assembly. When partial assembly has been used in accordance with subsection 504.23, a camber diagram shall be furnished by the fabricator based on calculated values at each truss panel point.

If camber is required for beams or girders the amount will be so specified on the plans and for more complicated designs, such as continuous girders, a camber diagram will be a part of the plans. Provision shall be made to compensate for loss of camber, resulting from the welding of shear connectors to structural members, when such welding is required (See subsection 505.05).

504.25 Drifting of Holes. The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

504.26 Match-marking. Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished the Engineer.

504.27 Rivets. The size of rivets called for on the plans shall be the size before heating.

Rivet heads shall be of standard shape unless otherwise specified and of uniform size for the same diameter of rivet. They shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

504.28 Field Rivets. Sufficient field rivets shall be furnished to rivet the entire structure with an ample surplus to replace all rivets burned, lost or cut out.

504.29 Bolts and Bolted Connections. The specifications of this subsection do not pertain to the use of high strength

bolts. Bolted connections fabricated with high strength bolts shall conform to subsection 504.30.

(a) *General.* Bolts shall be unfinished, turned or ribbed bolts conforming to the requirements for Grade A Bolts of Specification for Low-Carbon Steel Externally and Internally Threaded Fasteners, ASTM A 307. Bolted connections shall be used only as indicated by the plans or special provisions. Bolts shall have single self-locking nuts or double nuts. Beveled Washers shall be used where bearing faces have a slope of more than 1 to 20 with respect to a plane normal to the bolt axis.

Except as otherwise provided herein, construction shall conform to applicable specifications for riveted structures.

(b) *Unfinished Bolts.* Unfinished bolts shall be furnished unless other types are specified.

(c) *Turned Bolts.* The surface of the body of turned bolts shall meet the American Standards Association roughness rating value of 125. Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed with bolts furnished to provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

(d) *Ribbed Bolts.* The body of ribbed bolts shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 5/64 inch greater than the nominal diameter specified for the bolts. Ribbed bolts shall be furnished with round heads conforming to ASA B 18.5 unless otherwise specified. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If for any reason the bolt twists before drawing tight, the hole shall be carefully reamed and an over-size bolt used as a replacement.

504.30 Connections Using High Strength Bolts.

(a) *General.* This subsection covers the assembly of structural joints using ASTM A 325 high strength carbon steel bolts tightened to a high tension. The bolts are used in holes conforming to the requirements of subsections 504.17, 504.18 and 504.19.

(b) *Bolts, Nuts and Washers.* All bolts, nuts, and washers shall conform to the requirements of subsection 504.02, except as hereinafter provided.

(c) *Bolted Parts.* Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope of more than 1 to 20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale except tight mill scale. They shall be free of dirt, loose scale, burrs, and other defects that would prevent solid seating of the parts.

Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing. Joints will be of the friction-type unless otherwise specified.

(d) *Installation.* Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. A flat washer may be used when the abutting surface adjacent to the bolt head or nut does not have a slope of more than 1 to 20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than 1 to 20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.

All fasteners shall be tightened to give at least the required minimum bolt tension values shown in Table 3 of this subsection, on completion of the joint. Tightening shall be done with properly calibrated wrenches or by the turn-of-nut method. If required because of bolt entering and wrench operation clearances, tightening by either procedure may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

1. *Calibrated Wrenches.* When calibrated wrenches are used to provide the bolt tension specified in Table 3, their setting shall be such as to induce a bolt tension 5 percent to 10 percent in excess of this value. These wrenches shall be calibrated at least once each working day by tightening, in a device capable of indicating actual bolt tension, not less than three typical bolts from the lot to be installed. Power

wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to "touch up" bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the prescribed amount.

2. Turn-of-Nut. Before final tightening of the bolts by this method, the several parts of the joint shall be properly compacted by bringing a sufficient number of bolts to a snug tight condition such as can be produced by a few blows of an impact wrench, or the full effort of a man using an ordinary spud wrench. All bolts shall be tightened in accordance with the provisions given in Table 4, progressing systematically from the most rigid part of the joint toward the free edges, after the plates have been brought to a snug tight fit.

(e) Inspection. Approval of the procedure for calibration of wrenches and installation of bolts will be required prior to the commencement of bolting operations and observations will be made to insure that the approved procedures are followed.

Checks will be made with a calibrated manual torque wrench to insure correct bolt tension.

504.31 Riveting. Rivets shall be heated uniformly to a "light cherry red color" and shall be driven while hot. Any rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale, and other adhering matter. Any rivet which, in the opinion of the Engineer, is scaled excessively, will be rejected.

TABLE 3 — BOLT TENSION

Bolt Size (inches)	Required Minimum Bolt Tension (lbs.)*	Approx. Equiv. Torque for Required Min. (Ft.-Lbs.) Bolt Tension
1/2	12,050	100
5/8	19,200	200
3/4	28,400	355
7/8	36,050	525
1	47,250	790
1 1/8	56,450	1,080
1 1/4	71,700	1,500
1 3/8	85,450	1,960
1 1/2	104,000	2,800

* Equal to the proof load of bolt in ASTM A 325.

TABLE 4 — NUT ROTATION (a), (b) FROM SNUG TIGHT CONDITION

Disposition of Outer Faces of Bolted Parts		
Both faces normal to bolt axis, or one face normal to axis and other face sloped(c) (bevel washer not used)	Both faces sloped(c) from normal to bolt axis (bevel washers not used)	
Bolt length(d) not exceeding 8 diameters or 8 inches	Bolt length(d) exceeding 8 diameters or 8 inches	For all lengths of bolts
1/2 turn	2/3 turn	3/4 turn

(a) For coarse thread heavy hexagon structural bolts of all sizes and lengths and heavy hexagon semi-finished nuts.

(b) Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation: 1/8 turn (60°) over and nothing under.

(c) Slope 1 to 20 maximum.

(d) Bolt length is measured from underside of head to extreme end of point.

All rivets that are loose, burned, badly formed, or otherwise defective shall be removed and replaced with satisfactory rivets. Any rivet whose head is defective in size or whose head is driven off center will be considered defective and shall be removed. Stitch rivets that are loosened by the driving of adjacent rivets shall be removed and replaced with satisfactory rivets. Caulking, recapping or double gunning of rivet heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines when practicable. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required when the size and length of the rivets warrant their use.

Rivets may be driven cold providing their diameter is not over 3/8 inch.

504.32 Edge Planing. Sheared edges of plates more than 5/8 inch in thickness and carrying calculated stresses shall be planed to a depth of 1/4 inch. Re-entrant cuts shall be filleted before cutting.

504.33 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the American Standards Association surface roughness requirements as defined in ASA B 46.1, Surface Roughness, Waviness and Lay, Part 1:

(a) Steel slabs	ASA 2000
(b) Heavy plates in contact in shoes to be welded	ASA 1000
(c) Milled ends of compression members, stiffeners, and fillers	ASA 500
(d) Bridge rollers and rockers	ASA 250
(e) Pins and pin holes	ASA 125
(f) Sliding bearings	ASA 125

504.34 Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed $\frac{1}{4}$ inch.

504.35 End Connection Angles. Floorbeams, stringers and girders having end connection angles shall be built to exact length shown on the plans measured between the heels of the connection angles, with a permissible tolerance of plus 0 inch to minus $\frac{1}{16}$ inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than $\frac{3}{8}$ inch, nor less than that shown on the detail drawings, after facing.

504.36 Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

504.37 Finished Members. Finished members shall be true to line and free from twists, bends and open joints.

504.38 Web Plates. In riveted or bolted girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than $\frac{1}{8}$ inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be $\frac{1}{2}$ inch less in width than the distance back to back of flange angles.

Splices of webs of riveted or bolted girders without cover plates shall be sealed on the top with red lead paste prior to painting.

At riveted or bolted web splices, the clearance between the ends of the web plates shall not exceed $\frac{3}{8}$ inch. The clearance at the top and bottom ends of the web splice plates shall not exceed $\frac{1}{4}$ inch.

504.39 Fit of Stiffeners. End stiffeners of girders and stiffeners intended as supports for concentrated loads shall

be milled or ground to secure an even bearing against the flange. Intermediate stiffeners shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within $\frac{1}{4}$ inch at each end.

Welding will be permitted in lieu of milling or grinding, only if indicated on the plans or in the special provisions.

504.40 Bent Plates. Cold-bent load carrying rolled steel plates shall conform to the following:

(a) They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling.

(b) The radius of bends shall be such that no cracking of the plate occurs. Generally accepted minimum radii, measured to the concave face of the metal, are shown in the following table in which "T" is the thickness of the plate:

AASHTO Specification (ASTM Specification)	Thickness in Inches			
	Up to 1/4	Over 1/4 to 1/2	Over 1/2 to 1	Over 1 to 2
M 183 (A38)	1 1/2T	1 1/2T	2T	2 1/2T
M 161 (A242) M 188 (A441)	2T	3T	a...	b...
M 187 (A440)	2 1/2T	3 1/2T	a...	b...

(a) Material in this thickness range may require hot bending.

(c) If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 1200° F. Hot-bent plates shall conform to the requirements of (a) above. Before bending, the corners of the plate shall be rounded to a radius of $\frac{1}{8}$ inch throughout that portion of the plate where the bending is to occur.

504.41 Annealing and Stress Relieving. Structural members which are indicated in the contract to be annealed or normalized shall have finished machining, boring and straightening done subsequent to heat treatment. Normalizing and annealing (full annealing) shall be as specified in ASTM E 44. The temperatures shall be maintained uniformly throughout the furnace during heating and cooling so that the temperature at no two points on the members will differ by more than 100° F. at any one time.

A record of each furnace charge shall identify the pieces in the charge and show the temperatures and schedule actually used. Proper instruments including recording pyrometers, shall be provided for determining at any time the temperatures of members in the furnace. The records of the

treatment operation shall be available to and meet the approval of the Engineer.

Members, such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together shall be stress relieved in accordance with the procedure of the American Welding Society when required by the plans, specifications or special provisions governing the contract.

504.42 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.

Pins and Rollers 9 inches or less in diameter may be either forged and annealed or cold-finished carbon steel shafting. Pins and Rollers more than 9 inches in diameter shall be forged and annealed.

In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored full length along its axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

504.43 Boring Pin Holes. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside-to-outside of holes in tension members and inside-to-inside of holes in compression members shall not vary from that specified more than 1/32 inch. Boring of holes in built up members shall be done after the riveting is completed.

504.44 Pin Clearance. The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins 5 inches or less in diameter, or by more than 1/32 inch for larger pins.

504.45 Screw Threads. Unless otherwise specified threads for all pins and bolts for structural steel construction shall be the Unified Coarse Thread Series as specified in the American Standard for Unified Screw Threads (ASA B1.1) and shall have class 2A tolerances for pins and bolts and Class 2B tolerances for nuts except that the pin ends having a diameter of 1 1/2 inches or more shall be threaded 6 threads to the inch.

504.46 Pilot and Driving Nuts. Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified.

504.47 Shop Welding. All welding shall conform to the Specifications for Welded Highway and Railway Bridges of the American Welding Society and shall be performed only by prequalified welders and welding operators.

If a fabricating shop prequalifies its welders and welding operators according to the standard qualification procedures of the American Welding Society and certifies to the Engineer that a welder or welding operator has been prequalified and has been continuously engaged in metal-arc welding with no lapses in such employment in excess of 3 months since being prequalified the Engineer may consider such welders or welding operators qualified. In the event that a fabricating shop lacks facilities to prequalify its welders they may become prequalified in accordance with subsection 504.63.

The fabrication shop shall maintain a file of certificates of qualification for its welders and welding operators and make the file available to the Engineer upon request. Each certificate of qualification shall state the name of the welder or welding operator, the name and title of the person who conducted the examination, the kind of specimens, the positions of welds, the results of the tests and the date of the examination.

For each project the fabrication shop shall submit a letter of compliance to the Engineer listing by name all welders and welding operators employed on the fabrication of structural steel for the project. The letter shall certify that these welders or welding operators have been prequalified and that they have been continuously engaged in metal-arc welding with no lapses in such employment in excess of 3 months since being prequalified. For large projects the fabrication shop may be required to submit interim letters of compliance at the request of the Engineer for portions of the work.

Welding shall not be done when the ambient temperature is lower than zero degrees F., when surfaces are wet or exposed to rain, snow, or high wind, or when welders or welding operators are exposed to inclement conditions.

504.48 Bronze or Copper-alloy Bearing and Expansion Plates. Bronze or copper-alloy bearing and expansion plates shall be fabricated in accordance with the details as shown on the plans or called for in the special provisions. The plates shall be self-lubricating and the bearing surface or surfaces subject to sliding action shall be provided with trepanned recesses (not grooves) filled with a lubrication compound. The compound shall be pressed into the recesses by hydraulic presses so to form dense, non-plastic lubricating inserts. The

lubricating area shall comprise not less than 25 nor more than 35 percent of the total area.

The sliding surface or surfaces shall be planed parallel to the prevailing direction of movement of the structure and polished, unless detailed otherwise.

504.49 Shop Painting. Unless otherwise specified steel work shall be given one coat of shop coat paint in conformance with Section 506 — Painting Structural Steel after it has been accepted by the inspector and before it is shipped from the plant with the following modifications.

Surfaces not in contact but inaccessible after assembly or erection shall be painted three coats. The shop contact surfaces shall not be painted. Field contact surfaces shall receive a shop coat of paint, except as hereafter noted and for main splices for chords of trusses and girder splices involving multiple thicknesses of material where a shop coat of paint would make erection difficult. Field contact surfaces not painted with the shop coat shall be given a coat of approved lacquer or other protective coating if it is expected that there will be a prolonged period of exposure before erection.

Surfaces which will be in contact with concrete shall not be painted. Structural steel which is to be welded shall not be painted before welding is complete. If it is to be welded only in the fabricating shop and subsequently erected by bolting, it shall receive one coat of shop paint after shop welding is finished. Steel which is to be field welded shall be given one coat of boiled linseed oil or other approved protective coating after shop welding and shop fabrication is completed.

Surfaces of iron and steel castings, either milled or finished, shall be given one coat of paint.

All machine finished surfaces, except as hereinafter noted, shall be coated as soon as practicable, after being accepted and before removal from the shop, with a hot mixture of white lead and tallow or other approved coating. Abutting joints of girders, chord and column splices, and fixed column and truss shoe base plates, shall receive the aforementioned coat of approved lacquer or other protective coating. Masonry plates and bearing surfaces of expansion bearing rockers shall receive two coats of shop paint.

Erection marks for the field identification of members and weight marks, when required, shall be painted upon surface areas previously painted with the shop coat.

Material shall not be loaded for shipment until thoroughly dry, and in any case not less than 24 hours after the paint has been applied.

504.50 Marking and Delivery. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.

The Contractor shall furnish the Engineer as many copies of material orders, shipping statements and erection diagrams as the Engineer may direct. Members weighing more than 3 tons shall have the weights marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

Bolts and rivets of each length and diameter and loose nuts and washers of each size shall be packed separately. Pins, small parts and packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

504.51 Handling and Storing Materials. Material to be stored at the site of the project shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection.

ERECTION

504.52 General. If the substructure and superstructure are built under separate contracts, the Commission will provide the masonry, constructed to correct lines and elevations and properly finished, and will establish the lines and elevations required for setting the steel.

The Contractor shall erect the metal work, remove the temporary construction, and do all work required to complete the bridge or bridges as covered by the agreement, all in accordance with the plans and these specifications.

504.53 Plans. If fabrication and erection of the superstructure are done under separate contracts, the Commission will furnish detail plans for the bridge or bridges to be erected, including shop details, camber diagrams, erection

diagram, list of field rivets and bolts and copies of shipping statements showing a list of parts.

504.54 Plant. The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of the work.

504.55 Delivery of Materials. If the contract is for erection only, the Contractor shall receive the materials entering into the finished structure, free of charges at the place designated and loaded or unloaded as specified. The Contractor shall unload promptly upon delivery any material delivered on railroad cars or barges which he is required to unload, otherwise he shall be responsible for demurrage charges. The Contractor shall check the material turned over to him against the shipping lists and report promptly in writing any shortage or injury discovered. He shall be responsible for the loss of any material while in his care, or for any damage caused to it after being received by him. Storage of material shall comply with the requirements of subsection 504.51.

504.56 Falsework. The 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.

504.57 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.

504.58 Bearings, Expansion Devices and Anchorages. 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 shown on the plans or directed by the Engineer, they shall be placed on a sheet of lead or a preformed

pad, the same size and shape as the bearing plate, and with holes accurately punched to match the holes in the plate, for the accommodation of the anchor bolts.

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.

When bronze or copper-alloy bearing and expansion plates are used the sliding surfaces of the steel in contact with the bearing and expansion plates shall be coated with a lubricant recommended by the manufacturer of the bronze or copper-alloy plates just prior to the installation.

Unless otherwise indicated on the plans, bearing assemblies such as rockers and hangers for suspended spans, shall be set so as to be plumb and expansion devices set so as to have the specified opening, both at 45° F. The change in span length due to dead load deflection shall be considered in setting the bearing assemblies.

504.59 Straightening Bent Material. The straightening of plates and angles or other shapes shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the Engineer, in which case the heating shall not be to a higher temperature than 1100° F. 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.

504.60 Assembling Steel. The parts shall be accurately assembled as shown on the plans and all 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 or bolted with high strength bolts and all other truss connections pinned and bolted with

fitting up bolts. Rivets shall not be driven nor high strength bolts finally tightened in splices of butt joints of compression members or in railing connections until the span has been swung. Splices and field connections shall have one-half of the holes filled with fitting up bolts and cylindrical erection pins (half bolts and half pins) before riveting or bolting with high strength bolts. Splices and connections carrying traffic during erection shall have three-fourths of the holes filled.

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

504.61 Riveting. Pneumatic hammers shall be used for field riveting, except when the use of hand tools is permitted by the Engineer. Rivets larger than 7/8 inch in diameter shall not be driven by hand. Cup faced dollies fitting the head closely to insure good bearing, shall be used. Connections shall be 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.

504.62 High Strength Bolts. High strength bolts shall be installed in conformance with subsection 504.30.

504.63 Field Welding. All welding shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society, except that the required prequalification of welders shall be in accordance with the following paragraphs of this subsection.

In order for a welder to be considered prequalified he must hold a current certificate issued by the State of Maine, State Highway Commission. Welders who do not hold such a certificate will be issued one by the Commission upon completion of an examination, with satisfactory test results, taken in accordance with the supplemental specifications. A welder may also be issued a certificate by the Commission upon proof acceptable to the Engineer that he has passed qualifying

tests, in conformance with the specifications for Welded Highway and Railway Bridges of the American Welding Society, at an agency satisfactory to the Engineer. In this event the Engineer may also request a notarized copy of the test results.

The only exception to the requirements of the preceding paragraph is that a welder will be considered to be prequalified for field welding if he is in the employ of the fabricating shop which supplied structural steel for the project and is prequalified in accordance with subsection 504.47.

If, in the opinion of the Engineer, there is some specific reason to question a welder's ability an additional examination may be required.

Welding shall not be done when the ambient temperature is lower than zero degrees F., when surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

504.64 Painting Joints and Retouching Defective Paint Areas. As soon as the inspector has examined and approved a completed joint, all exposed surfaces shall be cleaned and thoroughly covered with shop coat paint in conformance with Section 506 — Painting Structural Steel.

All surface areas from which the shop coat paint has been worn off or has otherwise become defective shall be cleaned in accordance with subsection 506.09 and retouched with shop coat paint.

504.65 Pin Connections. Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge. 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.

504.66 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. If the contract provides for complete fabrication and erection the Contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements. If the contract

is for erection only, the inspector, with the cooperation of the Contractor, shall keep a correct record of labor and material used and the Contractor shall render to the Engineer for approval, within 30 days, an itemized bill, made out to the Commission in duplicate.

504.67 Removal of Falsework and Clean-up. Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless material, 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 his 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.

504.68 Method of Measurement. The quantity of structural steel to be measured for payment will be, unless otherwise specified, one unit complete and accepted, consisting of all metal and related materials in the fabricated and erected structure as shown on the plans, excluding railings and drains. Related materials will include, but not be necessarily limited to, preformed pads or sheet lead placed under the bearings, and when required, self-lubricating bronze or copper-alloy bearing and expansion plates.

504.69 Basis for Payment. Structural steel will be paid for at the contract lump sum price for the respective contract items involved.

Payment will be made under:

Pay Item	Pay Unit
504.70 Structural Steel, Fabricated and Delivered	Lump Sum
504.71 Structural Steel, Erection	Lump Sum

SECTION 505 — SHEAR CONNECTORS

505.01 Description. This work shall consist of furnishing and installing connectors for the purpose of transmitting shear between steel beams and concrete in composite members in accordance with these specifications and in conformity with the plans. The connectors, unless otherwise specified, shall be either steel studs or, at the Contractor's option, spirally formed (helical) bars.

MATERIALS

505.02 Materials. Materials shall meet the requirements of the following subsections of Division 700 — Materials, modified as indicated.

Reinforcing Steel	709.01
Steel Bars for Shear Connector Studs	713.14

The bars shall be plain, intermediate grade billet steel made by the open hearth process.

CONSTRUCTION REQUIREMENTS

505.03 Spiral Connectors. Spiral shear connectors shall be fabricated, within standard tolerances, to the plan dimensions. They may be either shop or field welded to the structural beam. Size and location of welds will be shown on the plans. Welding shall comply with the requirements of subsection 504.47 for shop welding and subsections 502.10 and 504.63 for field welding.

505.04 Stud Connectors. Studs shall be automatically end welded to the structural beam, in the shop or in the field, by a process approved by the Engineer and in accordance with supplemental specifications or special provisions.

505.05 Camber. Adequate provision shall be made in the fabrication of structural members to compensate for loss of camber due to welding of the shear connectors, (See subsection 504.24).

505.06 Method of Measurement. Unless otherwise shown on the plans, shear connectors will be measured for payment by the unit consisting of all shear connectors required and acceptably installed.

505.07 Basis of Payment. Shear connectors will be paid for at the contract lump sum price, complete in place.

Payment will be under:

Pay Item	Pay Unit
505.08 Shear Connectors	Lump Sum

SECTION 506 — PAINTING STRUCTURAL STEEL

506.01 Description. This work shall consist of furnishing paint and painting of structural steel, including, unless otherwise provided in the contract, the preparation of the metal surfaces, protection and drying of the paint coatings, all in accordance with these specifications.

506.02 Materials. Materials shall meet the requirements of the following subsections of Division 700 — Materials.

Metal Bridge Paint (Shop Coat)	708.02
Metal Bridge Paint (Field Coat)	708.03

506.03 Number of Coats and Color. All steel shall be painted one prime coat (called shop coat) and not less than 3 field coats, as specified in the supplemental specifications. The color shall be as specified in the supplemental specifications or determined by the Engineer. The coat will be sufficiently different in color to permit detection of incomplete application.

506.04 Mixing of Paint. Paint shall be thoroughly mixed before applying and the pigments shall be kept in uniform suspension during application.

506.05 Weather Conditions. Paint shall not be applied when the following conditions exist:

(a) Temperature of surrounding air or temperature of the metal is below 40° F.

(b) Temperature of the air is expected to drop to at least 32° F. before the paint has dried.

(c) The metal is hot enough to cause the paint to blister and produce a porous paint film, or is otherwise detrimental to the life of the paint.

(d) The surrounding air is foggy, misty, rainy or snowy.

(e) The surfaces to be painted are wet, damp, frosted, or when in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work.

Members painted under cover in damp or cold weather shall remain under cover until dry or until weather conditions permit their exposure in the open.

506.06 Application. Painting shall be done in a neat and workmanlike manner. Paint may be applied with hand brushes or by spraying except that aluminum paint shall be applied by spraying. By either method the coating of paint applied shall be smoothly and uniformly spread so that no excess paint will collect at any point. If work done by spraying is not satisfactory, hand brushing will be required.

When brushes are used, the paint shall be so manipulated under the brush as to produce a smooth, uniform, even coating in close contact with the metal or with previously applied paint, and shall be worked into all corners and crevices.

Power spraying equipment shall apply the paint in a fine, even spray without requiring the addition of any thinner.

Paint when applied with spray equipment shall be immediately followed by brushing or other satisfactory means when necessary to secure a uniform coverage and to eliminate wrinkles, airholes, runs and sags.

On all surfaces which are inaccessible for paint brushes, the paint shall be applied by spraying or with sheepskin daubers to insure thorough covering.

506.07 Removal of Paint. If the painting is unsatisfactory, the paint shall be removed and the metal thoroughly cleaned and repainted.

506.08 Thinning Paint. Paint as delivered in containers, when thoroughly mixed is ready for use. If it is necessary in cool weather to thin the paint in order that it shall spread more freely, this shall be done by heating in hot water or on steam radiators, and no liquid shall be added or removed unless permitted by the Engineer.

506.09 Cleaning of Surfaces. Surfaces of metal to be painted shall be thoroughly cleaned, removing rust, loose mill scale, weld slag, dirt, oil, grease, and other foreign substances.

Three methods of cleaning, Method A, Method B and Method C, are provided herein, any of which may be used unless otherwise specified.

Method A. — Hand Cleaning. The removal of rust, scale and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers or other effective means. Oil or grease shall be removed by the use of benzine or a suitable solvent other than gasoline or kerosene. Bristle or wood fiber brushes shall be used for removing loose dust.

Method B. — Blast Cleaning. Blast cleaning shall be by either the centrifugal wheel or the air blast method. The blast cleaning shall remove all mill scale and other substances down to the bare metal. Special attention shall be given to the cleaning of corners and re-entrant angles. Blast cleaning shall be performed with SAE Number S-330 shot or smaller, SAE Number G-25 grit or smaller, or dry sand passing through a 16 mesh screen, U. S. sieve series.

Before painting, all shot and grit shall be removed from the surfaces. The cleaning shall be approved by the Engineer prior to painting. The material shall be painted before rust forms.

Method C. — Flame Cleaning. Unless otherwise provided, all metal, except the inside of boxed members and other surfaces which will be inaccessible to the flame cleaning operation after the member is assembled, shall be flame cleaned in accordance with the following operations:

(a) Oil, grease and similar adherent matter shall be removed by washing with a suitable solvent. Excess solvent shall be wiped from the work before proceeding with subsequent operations.

(b) The surfaces to be painted shall be cleaned and dehydrated (freed of occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least one. The inner cones of these flames shall have a ratio of length to port diameter of at least 8 and shall be not more than 0.15 inch center to center. The oxyacetylene flames shall be traversed over the surfaces of the steel in such manner and at such speed that the surfaces are dehydrated, and dirt, rust, loose scale, scale in the form of blisters or scabs, and similar foreign matter are freed by the rapid intense heating by the flames. The flames shall not be traversed so slowly that loose scale or other foreign matter is fused to the surface of the steel. The number, arrangement and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated.

(c) Promptly after the application of the flames, the surfaces of the steel shall be wire brushed, hand scraped wherever necessary, and then swept and dusted to remove all free material and foreign particles. Compressed air shall not be used for this operation.

(d) Paint shall be applied promptly after the steel has been cleaned and while the temperature of the steel is still above that of the surrounding atmosphere, so that there will be no recondensation of moisture on the cleaned surfaces.

Unless otherwise provided, the inside surfaces of boxed members and other surfaces which will be inaccessible to the flame cleaning operation after the member is assembled shall be cleaned by Method A, Hand Cleaning. If flame cleaning of such surfaces is required, it will be so stated on the plans or in the special provisions. The inside surfaces of boxed members and other surfaces which will be inaccessible to the flame cleaning operation after the member is assembled, shall be cleaned as specified in paragraphs (a) and (b) and wire brushed but not painted, before the member is boxed or assembled. After all fabrication of the member is

completed, its inside surfaces shall be hand wire brushed or hand scraped wherever necessary in order to remove dirt and other foreign substances which may have accumulated after the surfaces were originally cleaned. The outside surfaces of the members shall then be cleaned and dehydrated, wire brushed, and hand scraped wherever necessary. All surfaces shall then be swept and dusted to remove free material and foreign particles and the member completely painted.

506.10 Shop Painting. Shop painting shall comply with the requirements of this Section 506 — Painting Structural Steel and of subsection 504.49.

506.11 Field Painting. When the erection is complete, the field joints have been painted, surfaces of the structural steel thoroughly cleaned, worn off or defective shop coat paint surface areas retouched in accordance with subsection 504.64, and the paint has thoroughly dried, such field coats as are required may be applied. In no case shall a succeeding coat be applied before the previous coat has dried throughout the full thickness of the paint film. All small cracks and cavities which were not sealed in a watertight manner by the first field coat shall be filled with a pasty mixture of red lead and linseed oil before the second coat is applied.

Utility conduits suspended from the superstructure and their supports shall be painted as required for other steel members.

If, in the opinion of the Engineer, traffic produces an objectionable amount of dust, the Contractor shall, at his own expense, allay the dust for the necessary distance on each side of the bridge and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

The application of the second field coat shall be deferred until adjoining concrete work has been placed and finished. If concreting operations have damaged the paint, the surface shall be recleaned and repainted.

The Contractor shall protect pedestrian, vehicular and other traffic upon or underneath the bridge, and also all portions of the bridge superstructure and substructure, against damage or disfigurement by spray, spatters, splashes and smirches of paint or paint materials.

506.12 Method of Measurement. The quantity to be measured for payment as field painting will be one lump sum unit.

506.13 Basis of Payment. The payment for field painting shall be full compensation for all materials and work necessary to satisfactorily complete the item. Payment for painting the utility conduits and their supports and other pertinent parts or attachments will be included in the contract lump sum price for field painting of structural steel.

Payment will be made under:

Pay Item	Pay Unit
506.14 Field Painting, Structural Steel	Lump Sum

Shop painting will not be paid for separately but will be included for payment as provided in Section 504—Structural Steel.

SECTION 507—RAILINGS

507.01 Description. This work shall consist of the furnishing of all materials and the construction of bridge railings and hand railings as shown on the plans. Railings will be considered as that portion of a structure above the tops of curbs, sidewalks, parapets, retaining walls and steps, for the protection of traffic, except that barrier curbs or splash curbs are not included.

Hand railing, when called for, is intended for use on stairways, private entrance sidewalks and at miscellaneous locations other than bridges.

MATERIALS

507.02 Materials. Unless otherwise specified, materials shall meet the requirements specified in the following subsections of Section 700—Materials.

Steel Pipe	712.14
Wrought Iron Pipe	712.16

Portland cement concrete for railings shall conform to the requirements of Section 502—Structural Concrete, Class Y.

Reinforcing and Structural Steel shall conform to the requirements of Section 503—Reinforcing Steel and Section 504—Structural Steel, respectively.

Aluminum, when called for, shall comply with the requirements specified in the special provisions.

CONSTRUCTION REQUIREMENTS

507.03. Alignment and Grade. Railings shall be brought to the true line and grade called for regardless of any irregu-

larities in the structure on which it rests. Posts and balusters shall be plumb unless otherwise specified. Final alignment and adjustments shall be made after the structure is supporting its full dead load.

507.04 Bridge Railing.

(a) Concrete bridge railing shall be formed, placed and finished in accordance with the requirements of Section 502—Structural Concrete. No concrete railing shall be placed on a bridge until the span is supporting the full load except for the railing and optionally the wearing surface.

(b) Metal bridge railing shall be detailed, fabricated, erected, and when required, painted, in accordance with the requirements of Section 504—Structural Steel and Section 506—Painting Structural Steel.

507.05 Steel Pipe Hand Railing. Steel pipe hand railing shall conform to the requirements of subsection 507.04 (b). Railing posts on masonry or otherwise shall be so secured as to develop the full strength of the post in bending.

507.06 Method of Measurement. Railings will be measured for payment by the number of linear feet of railing erected and accepted. Measurement will be along the grade and line of the railing from outside to outside of end posts or rail projections, whichever is the greater, unless otherwise shown on the plans. Railings with posts on a curve will be measured as above except the measurement will be taken along the bottom of the posts on the side which has the greatest radius of curvature. The length for payment will include any clear opening of one foot or less between the ends of any of the railing elements.

507.07 Basis of Payment. Railings will be paid for at the contract unit price per linear foot, including painting when required for metal railings.

Reinforcement, when authorized and used, will be measured and paid for as provided in Section 503—Reinforcing Steel.

Payment will be made under:

Pay Item	Pay Unit
507.08 Bridge Railing	Linear Foot
507.09 Steel Pipe Hand Railing	Linear Foot

SECTION 508 — MEMBRANE WATERPROOFING

508.01 Description. This work shall consist of a membrane waterproofing applied to the required surface of bridge decks by use of bituminous materials in accordance with these specifications, and in conformity with the plans.

MATERIALS

508.02 Materials. Materials shall meet the requirements specified in the following subsections of Division 700 — Materials.

Bituminous Material for Primer	702.06
Bituminous Material for Waterproofing	702.07
Asphalt Flashing Cement	702.08
Woven Glass Fabric	712.09

CONSTRUCTION REQUIREMENTS

508.03 Surface Preparation. All holes, cracks and depressions in the concrete bridge deck surface to be waterproofed shall be filled flush with mortar composed of one part portland cement and two parts of approved clean sand, by volume, in accordance with the requirements of subsection 502.13. High spots and sharp points and edges shall be chipped or ground smooth. The surface shall be thoroughly cleaned and dried. Damp surfaces may be dried by means of hot sand, subject to the approval of the Engineer.

508.04 General Procedure. Before any material for priming or waterproofing is applied, the surface shall be clean, dry, at a temperature of 35° F. or higher, and approved by the Engineer. No priming or waterproofing shall be done in wet weather or when the ambient temperature is below 35° F. At the option of the Contractor either tar or asphalt may be used for waterproofing.

Priming and waterproofing shall start at the low point or points of the surface and progress upgrade.

Work shall be so regulated that at the close of a day's work all fabric that has been laid shall have received the final mopping of bituminous material.

During waterproofing operations, when asphalt is used, it shall be maintained at a temperature between 300° F. and 350° F., and when tar is used it shall be maintained at a temperature between 200° F. and 250° F. Both shall be stirred frequently to avoid local overheating. The heating kettles shall be equipped with approved thermometers.

No traffic except those workmen necessary to the waterproofing work shall be permitted on the unprotected waterproofing.

508.05 Priming. The primer shall be applied to the properly prepared surface in a single coat at the rate of approximately 1 gallon per 90 square feet. It shall be allowed to cure for at least 24 hours before applying the waterproofing. The primer may be applied cold.

508.06 Waterproofing. This work shall begin by mopping with hot bituminous material, a section a little greater in width than one-half the width of the fabric being used, for the full width or length of the area to be waterproofed. Following this, a strip of fabric of one-half width shall be rolled into it and pressed into place to eliminate all bubbles and to obtain close conformity to the surface. This half strip and an adjacent section of the surface to a total width slightly greater than the full width of the fabric being used shall then be mopped with hot bituminous material and a full width of fabric rolled into it, completely covering the first half strip and pressed into place as before. Approximately half of this second strip and an adjacent section of the concrete surface shall then be mopped with hot bituminous material and a third strip of fabric shall be placed in shingle fashion so as to lap the first strip not less than 2 inches. This process shall be continued until the entire area to be waterproofed is covered, each strip of fabric lapping at least 2 inches over the second previous strip. All end laps shall be at least 12 inches. The entire area shall then be given a final mopping of hot bituminous material.

The completed waterproofing shall be a firmly bonded membrane composed of two layers of fabric, three layers at the 2 inch side laps and the 12 inch end laps, one application of the primer and three moppings of hot bituminous material.

Under no circumstances shall one layer of fabric touch another layer or the concrete surface as there must be at least three complete moppings of bituminous material.

The primer, as applied, shall cover the concrete surface so that no gray spots show and the mopping of the bituminous material on the fabric shall be sufficiently heavy to conceal the weave completely. Not less than 12 gallons of bituminous material shall be used for each 100 square feet of finished work.

508.07 Special Details. At the junction of the bridge deck with the curb, steel expansion joints, and other projections

above the deck, except scuppers, the corner shall be filleted with the asphalt flashing cement which shall also be trowelled onto the deck for a width of approximately 2 inches and up on the vertical projection to within one-half inch of finish grade. This shall be done after application of the primer but before the first mopping of bituminous material.

Both layers of fabric shall be turned up to the top of the flashing cement and mopped on with bituminous material as in the regular waterproofing procedure.

After both layers of fabric have been placed, the edges shall be sealed with the flashing cement before the application of the final mop coat of bituminous material.

Every effort shall be made to secure a watertight joint.

When the membrane waterproofing is required to extend, without a break across a flush joint, the joint shall be slightly overfilled with asphalt flashing cement. After application of the primer and before the first mopping of hot bituminous material, one extra ply of fabric, extending not less than 9 inches each side, shall be laid over the joint. The standard procedure for obtaining the two ply membrane shall then be followed.

508.08 Method of Measurement. Membrane waterproofing will be measured for payment by the number of square yards of surface satisfactorily waterproofed with no allowance for overlapping or for edges turned up at curbs and other projections above the deck.

508.09 Basis of Payment. Membrane waterproofing will be paid for at the contract unit price per square yard which shall be payment in full for all incidentals necessary to satisfactorily complete this item.

Payment will be made under:

Pay Item	Pay Unit
508.10 Membrane Waterproofing	Square Yard

SECTION 509 — STRUCTURAL PLATE PIPES, PIPE ARCHES AND ARCHES

509.01 Description. This work shall consist of furnishing and installing structural plate pipes, pipe arches or arches in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

509.02 Materials. Materials shall meet the requirements of the following subsections of Division 700 — Materials.

Asphalt Filler for Structural Plate Arches	702.09
Bituminous Paint	702.10
Structural Plates	707.09
Structural Steel	713.01

509.03 Pipes. All pipes shall be fabricated elliptically so that the vertical diameter is approximately 5 percent greater, and the horizontal diameter is approximately 5 percent less, than the nominal cylindrical diameter.

509.04 Pipe Arches. Pipe arches shall have a cross section consisting of 4 circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than 180 degrees nor less than 155 degrees. The bottom shall be an arc of not more than 50 degrees nor less than 10 degrees. The top shall be joined at each end to the bottom by an arc having a radius of not more than 34 inches nor less than 16 inches and of not more than 87½ degrees nor less than 75 degrees.

509.05 Fabrication. Plates, bolts and nuts shall be formed and galvanized in accordance with AASHO M 167 with the explicit requirement that the galvanizing shall be complete and unbroken on the fabricated plates.

Plates shall be formed to provide lap joints for bolted assembly. Joints shall be staggered so that no more than three plates come together at one point.

Bolt holes shall be made so that all plates having like dimensions, curvature and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved, before assembly, to the radius necessary to produce the final cross section called for.

End plates shall be neatly cut to the skew and slope specified. Burnt edges shall be free of oxide and burrs and shall be completely galvanized. Special plates and part plates shall be legibly marked to correspond to markings on an erection diagram which shall be furnished by the fabricator. Two sets of shop detail drawings shall be supplied to the Engineer.

Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in two rows, 2 inches apart with one row in the valley and one in the crest of the corrugations. Bolt holes along

those edges of the plates that will form circumferential seams in the finished structure shall be no more than 12 inches apart. The distance from the center of a hole to the edge of the plate shall not be less than $1\frac{3}{4}$ times the diameter of the bolt. The nominal diameter of the bolt holes in the longitudinal seams shall be $\frac{1}{4}$ inch greater than the diameter of the bolts.

For structural plate arches, the metal connector between the substructure and the arch may be either rolled structural or cold formed, galvanized, angles or channels not less than $\frac{3}{16}$ inch thick, with the horizontal leg of the angle or web of the channel securely anchored to the substructure at intervals not to exceed 24 inches. The long vertical leg of the channel or the vertical leg of the angle shall be provided with holes to permit bolting to the bottom row of plates.

CONSTRUCTION REQUIREMENTS

509.06 Field Erection of Pipe and Pipe Arch Structures.

(a) *Excavation.* Excavation for the structure shall be made in conformity with Section 206 — Structural Excavation.

(b) *Bedding.* Pipes and pipe arches shall be bedded on a thoroughly compacted earth foundation of uniform density. Where rock, in either ledge or boulder formation, is encountered, it shall be removed below grade and replaced with selected earth material in such manner as to provide a compacted earth cushion, having a thickness under the pipe of not less than 8 inches. Where a firm foundation is not encountered at the grade specified, excavation shall be continued to such elevation as the Engineer may direct and subsequently backfilled with granular material. Prior to placing any plates, the bed shall be brought to the required line and grade for the invert and shaped to its cross section as much as is practicable without interfering with the bolting up of the plates. The amount of longitudinal camber of the pipe shall be varied to suit the supporting soil and the height of fill and will be specified by the Engineer. Great care shall be exercised so that no permanent camber will be enough to cause a backgrade in the upstream portion of the structure.

(c) *Erection.* Unless otherwise specifically authorized, pipes and pipe arches shall be assembled on the prepared foundation bed. However, if the Engineer does not consider it detrimental to the project, he may authorize the assembly

or partial assembly of the structure elsewhere before being placed in its final position.

In any case, assembly shall be in the sequence and manner recommended by the fabricator and in such a way that no distortion of plates will occur.

Pipe shall be installed with the long diameter vertical.

Bolts of the supplier's recommended length shall be used in all holes. Nuts shall be tightened to 200 foot-pounds plus or minus 100 foot-pounds of torque and any nuts loosened by plates being drawn together shall be retightened.

(d) *Backfilling.* Backfilling shall be done in conformity with Section 206 — Structural Excavation for Culverts and Structures with the following additional requirements:

Selected material of a granular nature with a minimum of clay shall be used for backfill. It shall contain no frozen material, vegetable matter nor anything which will not pass through a 3 inch square opening screen. The 3 inch size limitation shall not apply to areas 5 feet or more from the structure.

Fill material shall be deposited evenly on both sides of the pipe or pipe arch in layers not exceeding 6 inches in depth, loose measure, until the $\frac{3}{4}$ point shall be reached. It shall be thoroughly tamped under the pipe or pipe arch and between it and the sides of the trench. In the case of a wide trench or no trench at all, special side tamping shall extend out at least one pipe diameter or pipe arch span on each side of the structure.

Above the $\frac{3}{4}$ point, fill layers not exceeding a depth of 8 inches, loose measure, may be used.

Backfilling and tamping shall be done in the presence of the Engineer.

The Contractor shall maintain the specified cover or 4 feet, whichever is less, over the top of the pipe or pipe arch where construction equipment is used or traffic is maintained.

509.07 Field Erection of Structural Plate Arches.

(a) *Excavation.* Excavation for the structure shall be made in conformity with Section 206 — Structural Excavation.

(b) *Substructure.* The substructure for structural plate arches shall be constructed under the section appropriate to the material called for except that any angles, unbalanced channels or other metal connectors between the substructure and the plate arch, together with their anchors, shall be fur-

nished and installed as an incidental part of the structural plate arch.

(c) *Erection.* Structural plate arches shall be erected on their substructures in the sequence and manner recommended by the fabricator and in such a way that no distortion of plates will occur. They shall be secured to the substructures by means of the metal connector shown on the plans.

Bolts of the supplier's recommended length shall be used in all holes. Nuts shall be tightened to 200 foot-pounds plus or minus 100 foot-pounds of torque and any nuts loosened by plates being drawn together shall be retightened.

When erection is complete and all bolts properly tightened but before any backfilling is begun, the spaces between the structural plates and the upstanding legs of the unbalanced channels, in front of and behind the arch plates, are to be filled completely with asphalt filler. If an angle is used instead of an unbalanced channel, the spaces between the upstanding leg and the structural plates shall be filled as above and if any other form of metal connector is used, all pockets which could hold moisture shall be filled, completely, with asphalt filler.

Asphalt filler shall be as specified in subsection 509.02 and shall be melted for proper placement.

Furnishing and placing the asphalt filler shall be considered as incidental to the construction of structural plate arches.

(d) *Backfilling.* Backfilling shall be performed in conformance with Section 206—Structural Excavation with the following additional requirements:

Backfill material shall be as specified in subsection 509.06.

When backfilling arches before headwalls are built, a narrow ramp of backfill material shall be built up evenly at each side of the arch and midway between its ends until the specified cover or 4 feet, whichever is less, over the top of the arch is reached. The backfill material used in the ramps shall be thoroughly compacted as it is placed. The remainder of the backfill shall be deposited from the top of the ramp, both ways from the center toward the ends and as evenly as possible on both sides of the arch.

If the headwalls are built before the arch is backfilled, the same procedure as above shall be followed, except that the backfill material shall first be placed in the form of a narrow ramp adjacent to one headwall. When the aforementioned height above the arch is reached, the backfill material

shall be deposited from the top of the ramp toward the other headwall.

In multiple installations extreme care shall be used to bring the backfill up evenly on each side of each arch so that unequal pressures will be avoided.

In all cases the filling material shall be thoroughly but not excessively tamped. Compacting the backfill by means of flooding or ponding the material with water will not be permitted.

509.08 Bituminous Coating. Bituminous coating, when called for, shall be two field coats of the bituminous paint, uniformly applied to both the inside and the outside of the structural plates, nuts and bolt heads and all other metal parts of the structure. The paint shall be applied, so far as possible, after the structure has been completely assembled and all bolts properly tightened. However, lapped areas and other surfaces which cannot be reached after assembly shall be painted before.

The surfaces to be coated shall be clean, dry and at a temperature of 40° F. or higher. Air temperature at time of application shall also be 40° F. or higher.

The paint shall not be thinned nor heated but shall be stirred until it has the consistency of thick molasses. Unless otherwise authorized it shall be applied by brush.

One gallon shall cover approximately 60 square feet of surface per coat. Not less than 24 hours shall elapse between coats nor between the second coat and the start of backfilling.

The coating shall be inspected before and during backfilling operations and all damage to it shall be repaired.

509.09 Method of Measurement. Structural plate pipe, pipe arches and arches will be measured for payment by the unit.

509.10 Basis of Payment. Each accepted structural unit will be paid for at the respective contract lump sum price, which price shall include full compensation for preparation of the bed for pipes and pipe arches; the asphalt cement and metal connectors for arches; and the bituminous coating for pipes, pipe arches and arches, when called for.

Whenever the minimum cover material extends above the subgrade line, the removal of the material which is necessary to complete the work in accordance with the plans will be measured and paid for as Common Excavation as provided in Section 203—Excavation and Embankment.

Payment will be made under:

Pay Item	Pay Unit
509.11 ——— Inch Structural Plate Pipe	Lump Sum
509.12 ——— Inch Span, ——— Inch Rise, Structural Plate Pipe Arch	Lump Sum
509.13 ——— Inch Span, ——— Inch Rise, Structural Plate Arch	Lump Sum
509.14 Reserved	
509.15 ——— Inch Bituminous Coated Structural Plate Pipe	Lump Sum
509.16 ——— Inch Span, ——— Inch Rise, Bituminous Coated Structural Plate Pipe Arch	Lump Sum
509.17 ——— Inch Span, ——— Inch Rise, Bituminous Coated Structural Plate Arch	Lump Sum

Masonry head walls, riprap, substructures, excavation and backfill will be measured and paid for as provided in the appropriate sections.

SECTION 510 — SPECIAL DETOURS

510.01 Description. This work shall consist of the construction, maintenance in good condition and removal of temporary structures and approaches required for the satisfactory maintenance of vehicular and pedestrian traffic. When not furnished by the Commission, as shown on the plans or stated in the special provisions, the necessary right of way for Special Detours shall be provided by the Contractor. When there is no pay item in the contract for Special Detours, traffic, if any, shall be maintained as specified in subsection 104.04.

MATERIALS

510.02 Materials. Materials used for temporary structures must be approved by the Engineer before incorporation in the structures. Materials used in the approaches shall be of such quantity and quality as to fulfill their function satisfactorily.

CONSTRUCTION REQUIREMENTS

510.03 Vehicular and Pedestrian Traffic Not Separated. Special detours, including temporary structures and approaches, shall be located as close as practicable to the new

work and shall be constructed in such a manner as to provide safe and easy passage at all times. They shall be provided with suitable curbs and railings, satisfactory to the Engineer. Requirements for barricades, warning signs, lights and other protective devices shall be as specified in subsection 107.11.

Structures and approaches shall be of sufficient strength to carry safely the legal load permitted on the highway. They shall have a clear traveled way width no less than that indicated in the proposal and shall at all points be higher than the high water elevation that may be expected during the construction period. Grades on the detour shall not exceed 10 percent, and curves, both vertical and horizontal, shall be such as will not be hazardous nor inconvenient to traffic.

510.04 Pedestrian Traffic Only. The provisions of subsection 510.03 shall apply to this item with the following modifications:

- (a) Structures shall be designed for a live load of 75 pounds per square foot.
- (b) The detour shall have a minimum clear width of 5 feet.
- (c) Structures and approaches shall be adequately lighted.

510.05 Vehicular and Pedestrian Traffic Separated. The provisions of both subsections 510.03 and 510.04 shall apply to this item. If vehicles and pedestrians are carried on the same structure, each shall have its own lane as specified. The pedestrian lane shall be protected from vehicular traffic by being at least 9 inches above the roadway surface or suitably protected by means of an adequate curb at least 9 inches in height above the roadway surface.

510.06 Contractor's Responsibility. The provisions in subsections 105.15, and 107.15 shall apply to work under this Section. In addition to normal maintenance, should any part or all of the detour be damaged or destroyed by high water or any other cause prior to opening the new structure to traffic, it shall be repaired or replaced by the Contractor without additional compensation.

510.07 Removal of Detour. When the new structure has been opened to traffic, the temporary structures shall be removed to or below the stream bed or finish ground line and the approaches shall be obliterated. The provisions of subsection 104.08 shall apply.

510.08 Method of Measurement. Special detours will be measured for payment by the respective Special Detour unit required, satisfactorily constructed, maintained and removed.

510.09 Basis of Payment. Special detours will be paid for at the contract lump sum price per unit for the following respective items, as called for in the proposal, constructed, maintained and removed complete. The cost of any necessary right-of-way, when not furnished by the Commission, will be considered incidental to this item.

Payment will be made under:

Pay Item	Pay Unit
510.10 Special Detour, _____foot Roadway Width Vehicular and Pedestrian Traffic Not Separated	Lump Sum
510.11 Special Detour Pedestrian Traffic Only	Lump Sum
510.12 Special Detour, _____foot Roadway Width Vehicular and Pedestrian Traffic Separated	Lump Sum

SECTION 511 — COFFERDAMS

511.01 Description. This work shall consist of the complete construction, maintenance and removal of all cofferdams, caissons, cribs, sheeting, embankments, temporary diversion channels and other similar work, including unwatering, required to allow for the excavation of foundation pits and to permit and protect the construction of structural units, in accordance with these specifications.

MATERIALS

511.02 Materials. If requested by the Engineer, the Contractor shall submit for approval, plans showing the materials to be used and the proposed method of protecting the foundation construction. Construction shall not be started on cofferdams until such plans are approved; however, approval of the plans shall not relieve the Contractor of responsibility for the satisfactory functioning of the cofferdam.

CONSTRUCTION REQUIREMENTS

511.03 Cofferdam Construction. Cofferdams shall, in general, be carried well below the elevation of the bottom of footings and shall be well braced and as watertight as necessary for the proper construction of the foundation. Unless it is contemplated that a concrete foundation seal will be placed under water, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construc-

tion and inspection of forms and to permit pumping outside of forms. Cofferdams shall be so constructed that sea water will not come in contact with concrete, as required in subsection 502.11 (a).

During the placing of the foundation seal, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the seal.

No timber or bracing shall be used in cofferdams or cribs in such a way as to remain in the substructure masonry, without written permission of the Engineer.

Cofferdams shall be constructed so as to protect fresh concrete against damage from the sudden rising of the stream and to prevent damage to the foundation by erosion.

Unless otherwise provided, cofferdams or cribs, including all sheeting and bracing involved, shall be removed after the completion of the substructure, care being taken not to disturb or otherwise injure the finished masonry.

All embankments serving as cofferdams shall be removed, temporary diversion channels filled in, and all areas left in a neat and workmanlike appearance and condition.

511.04 Pumping. Pumping from the interior of any foundation enclosure shall be done in such manner as to prevent any current of water inside the form which would carry away or separate any portion of the concrete materials.

Pumping to unwater a sealed cofferdam shall not commence until the seal concrete has set sufficiently to withstand the hydrostatic pressure but in no case will pumping be permitted within 5 days under normal conditions or 7 days when the temperature of the water outside the cofferdam is less than 40° F.

511.05 Method of Measurement. Cofferdams will be measured for payment by the unit, as indicated on the plans or called for in the Proposal.

511.06 Basis of Payment. Cofferdams will be paid for at the contract lump sum price for the respective cofferdam items.

When required, the elevation of the bottom of the footing of any substructure unit may be lowered, without change in the price to be paid for "Cofferdams," provided, however, that if the average elevation of more than 25 percent of the area of the excavation is more than 3 feet below the elevation shown on the plans, and at the Contractor's request, the entire cost of the cofferdam will be paid for in accordance

with subsection 109.04 instead of at the contract lump sum price.

Payment will be made under:

Pay Item	Pay Unit
511.07 Cofferdams	Lump Sum

SECTION 512 — FRENCH DRAINS

512.01 Description. This work shall consist of furnishing, placing and compacting stone and gravel for French drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

512.02 Materials. Materials shall meet the requirements of the following subsections of Division 700 — Materials.

Aggregate Subbase	603.06
Stones for French Drains	703.24

Gravel for French drains shall be aggregate subbase, gravel.

CONSTRUCTION REQUIREMENTS

512.03 Drains. Drains shall be placed behind and against the structures and with their bottoms at the elevation of the flow line of the weeper openings. They shall be not less than 2 feet wide for the entire length of the structure and shall extend in height from the bottom of the weepers to the subgrade of the road and to within 6 inches of slope surfaces. The lower 2 feet of drain shall consist of stones and the remainder shall be of gravel.

French drains shall be compacted in the same general manner and to the same extent as the adjacent embankment.

512.04 Method of Measurement. French drains will be measured for payment by the cubic yard of material placed and accepted. Measurement will be made in place but shall not extend beyond the limits shown on the plans. Computations may be made by the most convenient and recognized engineering method.

512.05 Basis of Payment. French drains will be paid for at the contract unit price per cubic yard.

Payment will be made under:

Pay Item	Pay Unit
512.06 French Drains	Cubic Yard

SECTION 513 — SLOPE PROTECTION

513.01 Description. This work shall consist of constructing a protective covering of reinforced cast-in-place portland cement concrete or of crushed rock and bituminous material on designated slopes to the prescribed lines and grades as called for on the plans or as designated by the Engineer.

MATERIALS

513.02 Materials. Materials shall meet the requirements of the following subsections of Division 700 — Materials.

Emulsified Asphalt	702.04
Aggregate for Penetration Macadam Pavement	703.12
Reinforcing Steel	709.01

Portland cement concrete for slope protection shall meet the requirements of Section 502 — Structural Concrete, Class Y.

Stone for bituminous slope protection shall be coarse stone, number 357 and cover aggregate number 7. Emulsified asphalt for penetration shall be RS 2 grade.

CONSTRUCTION REQUIREMENTS

513.03 Portland Cement Concrete. The slope on which the concrete for slope protection is to be placed shall be free of frost and frozen material and shall be well compacted. If additional fill material is required to bring the slope to the proper grade, it shall be of the same type material as that required for the slope protection foundation. Immediately prior to placing the concrete the area to be covered shall be thoroughly dampened.

The portland cement concrete shall be placed in alternate sections. Each individual section shall be placed by starting at the lowest extremity of the section and progressing upward on the slope. The reinforcement shall not extend through the construction joints and the bond between sections shall be broken by the application of an approved asphalt cement on the edges of the previously placed slabs.

The surface of the concrete shall be float finished in accordance with the requirements of subsection 502.14 (c) or finished by brooming lightly and uniformly with an approved barn or street broom. An edging tool shall be used on the surface edges of each section and a groover at the transverse center line of each section to form simulated slab figures.

Construction procedures shall be in accordance with Section 502 — Structural Concrete, except that the curing period will be 5 days.

513.04 Vacant.

513.05 Bituminous Slope Protection. The slope on which the bituminous treatment for slope protection is to be placed shall be shaped to an even surface using additional fill, if necessary, and be thoroughly compacted by vibratory tampers.

Penetration macadam pavement, coarse stone, shall be placed on the slope to a depth of 4 inches and the stone compacted until keyed together. Bituminous material shall be applied to the coarse stone at a rate of 1½ gallons per square yard. Immediately following the application of bituminous material, cover aggregate shall be spread and broomed. A seal coat of bituminous material shall then be applied in sufficient quantity to completely fill the remaining voids to capacity and a second application of cover material added to form a tight cover. After the second seal coat has set the excess cover aggregate shall be removed.

Construction procedures shall be in accordance with the applicable requirements, Section 406 — Penetration Macadam Pavement. Precautions shall be taken to prevent spilling and splashing of the bituminous material on concrete structures. Foot traffic shall be kept off the treated stone until it has set properly.

513.06 Vacant.

513.07 Method of Measurement. Slope protection will be measured for payment by the number of square yards of surface area acceptably covered.

513.08 Basis of Payment. Slope protection will be paid for at the contract unit price per square yard which payment shall include necessary excavating, shaping and compacting the slope prior to placing.

Payment for portland cement concrete slope protection shall be full compensation for furnishing and placing all material, including reinforcement, and for all labor and other incidentals necessary to complete the work.

Payment for bituminous treated slope protection shall be full compensation for furnishing and placing all materials, washing aggregates, if necessary, for furnishing and spreading bituminous material and for all labor and other incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
513.09 Slope Protection — Portland Cement Concrete	Square Yard
513.10 Slope Protection — Bituminous Treated Stone	Square Yard

SECTION 514 — CURING BOX FOR CONCRETE CYLINDERS

514.01 Description. This item shall consist of furnishing, installing, operating and maintaining an approved thermostatically controlled curing box for concrete test cylinders, with the equipment as herein specified. The curing box shall be for the sole use of the Engineer for the duration of the contract. The Contractor shall relocate the curing box to a new location, as directed by the Engineer, whenever considered necessary during the progress of the work. The Contractor shall furnish the electrical power and all utility connections necessary for the operation of the curing box. The Engineer shall be provided 2 locks, each with 2 keys, to be used with the 2 securing latches hereinafter described.

CONSTRUCTION REQUIREMENTS

514.02 Construction Details. The curing box for concrete cylinders shall have the approximate internal dimensions of 3 feet 6 inches long, 1 foot 6 inches wide, and 1 foot 7 inches deep. The top of the curing box shall be a lid hinged at the back, with 2 securing latches on the front which are suitable for use in locking the box. The free movement of the lid shall be restricted to an angle of approximately 100 degrees from a closed position to an open position by means of a chain made of a rustproof metal. All the interior surfaces of the curing box shall be of rustproof construction and the exterior surfaces shall be substantially painted with an approved paint. A moisture-proof seal, constructed of an approved cellular strip of 2BE520F26 synthetic rubber complying with the requirements of ASTM D-2000, shall be provided between the lid and body of the curing box.

The curing box shall be constructed so that the required temperature and humidity within the box can be supplied by an immersible heater, minimum 1000 watts, when immersed in a pool of water, approximately 4 inches in depth at the bottom of the box. The heating element shall be located so as to provide free access for cleaning and for ade-

quate circulation of the surrounding water. A drain shall be provided for the water, located at the lower front edge of the box. Access shall be provided to all parts of the box for cleaning. The electrical utility connection to the source of power shall be made in a lockable switch box which is securely attached to 1 end of the curing box. A lock for the switch box with 2 keys shall be furnished to the Engineer.

All electrical connections from the curing box to the utility connection shall conform to the latest requirements of the National Electrical Code. The curing box shall be effectively grounded. Grounding shall be accomplished in one of the following ways:

(a) By means of a grounding conductor run with the circuit conductors in cable assemblies or flexible cords, provided an approved plug is used, 1 fixed contacting member for the purpose of connecting such grounding conductor to the grounded metal raceway or to a grounding conductor installed only for equipment grounding purposes; the grounding conductor in a cable assembly may be uninsulated but where an individual covering is provided for such conductors it shall be finished to show a green color.

(b) A direct connection from the grounding wire, green color, on the Curing Box wiring to an 8 foot non-ferrous metal driven ground rod and ground rod clamp.

For installation, where the Curing Box is outside and exposed to the weather, all wiring and fittings shall be of the weatherproof type.

An approved bimetallic thermometer shall be installed within the Curing Box which will measure the internal temperature and which can be read from the outside without opening the box. This thermometer shall have minimum gradations of 2° F. and shall be protected from physical damage by suitable shielding. Suitable folding metal handles shall be provided on the ends of the box for use in moving.

514.03 Performance Requirements. The Curing Box shall be suitable for maintaining: (a) an internal temperature of 70° F. plus or minus 5° F. when the ambient temperature is as low as minus 10° F.

514.04 Method of Measurement. Curing Box for Concrete Cylinders will be measured for payment by the unit, furnished and satisfactorily maintained.

514.05 Basis of Payment. Payment for the Curing Box for Concrete Cylinders shall be at the contract unit price

each, which payment shall be full compensation for furnishing and maintaining, for all materials, labor, tools, equipment, electrical power, temporary utility changes and adjustments, and all necessary incidentals. At the completion of the contract the Curing Box shall remain the property of the Contractor and shall be removed from the site of the work.

Payment will be made under:

Pay Item	Pay Unit
514.06 Curing Box for Concrete Cylinders	Each

DIVISION 600 — INCIDENTAL CONSTRUCTION

SECTION 601 — VACANT

SECTION 602 — VACANT

SECTION 603 — PIPE CULVERTS AND STORM DRAINS

603.01 Description. This work shall consist of the construction or reconstruction of pipe culverts and storm drains, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

603.02 Materials. Material shall meet the requirements specified in the following subsections of Section 700 — Materials:

Flexible Culvert

Corrugated Metal Pipe and Pipe Arches 707.02

Bituminous Coated Corrugated Metal Pipe and Pipe Arches 707.03

Corrugated Aluminum Pipe and Pipe Arches 707.06

Rigid Culvert

Reinforced Concrete Pipe and Pipe Arches 706.02

Asbestos Cement Pipe 706.10

Joint Mortar 705.02

Rubber Gaskets 705.03

Flexible Plastic Gasket 705.04

Flexible culverts with a diameter of 48 inches or more shall have the ends cut to a partial bevel as called for on the plans. The cut ends shall be regalvanized or painted with a zinc dust - zinc oxide paint conforming to Federal Specification TT-P-641, and if required, bituminous coated before shipping.

Rigid culverts, designated to have the ends shaped to a partial bevel, shall be either cast or cut to the required shape and dimensions. In either case the edges of the pipe shall be even and true with no exposed reinforcing.

CONSTRUCTION REQUIREMENTS

603.03 Excavation. Trenches shall be excavated in accordance with the requirements of Section 206 — Structural Excavation to a width sufficient to allow for jointing of the culvert and compaction of the bedding and backfill material under and around the culvert. Unless otherwise designated, all trench walls shall be as nearly vertical as possible and

the trench width no greater than is necessary for installation of the culvert.

When called for on the plans precompacted embankments will be required. Stumps in the original ground where precompacted embankments are to be placed shall be removed before fill material is placed.

This precompacted embankment shall be of approved material, capable of being excavated as hereinafter specified and shall extend at least 16 feet each side of the centerline of the pipe. The embankment shall be constructed and compacted in conformity with the requirements of the specified embankment method to an elevation above the invert grade of the pipe of $1\frac{1}{2}$ times the pipe diameter. After the precompacted embankment is complete a trench shall be excavated having as nearly vertical walls as possible and a width no greater than is necessary for installation of the culvert.

603.04 Bedding. The culvert shall be bedded on a compacted foundation of uniform density in accordance with the following classes of bedding:

(a) *Class "C" Bedding.* Unless otherwise specified, all drainage pipe shall be bedded by this method. The bottom of the trench shall be shaped by a template to fit the culvert with reasonable closeness for at least 10 percent of the culvert's total height.

(b) *Class "B" Bedding.* When called for on the plans, this method of bedding shall be used.

The material below the bottom of the pipe, for a minimum of 1 foot, shall be excavated and the hole backfilled with granular borrow to a distance above the bottom of the pipe equal to 15 percent of the pipe's overall height. The bottom of the trench shall then be shaped by a template to fit the lower part of the pipe exterior for at least 15 percent of the overall height of the pipe. The pipe shall be carefully placed on the prepared bed.

Soil consisting of granular borrow or approved excavation shall then be rammed and tamped, in layers each of which shall not exceed 8 inches loose thickness, around the pipe for the next 15 percent of its height. The bedding and backfill material shall not contain stones in excess of 3 inch diameter. Backfilling above this elevation to the top of the pipe shall be placed in accordance with the requirements of subsection 603.08.

On all bedding, when bell and spigot pipe is used, the portion of trench at the joints shall be shaped to fit the bell.

603.05 Laying Culvert. Culverts shall not be installed nor backfilled between December 15 and April 1 without the written permission of the Engineer. Laying of the culvert shall begin at the downstream end of the culvert line. Bell or groove ends of rigid culverts shall be placed facing upstream. Metal culverts shall be placed with the longitudinal laps or seams at the sides and the outside laps of circumferential joints pointing up grade. Paved or partially lined culvert shall be laid with the lining on the bottom.

Elliptical shaped or elliptically reinforced culverts shall be placed with the major axis within 5 degrees of the vertical.

603.06 Joining Culverts. The method of joining rigid culvert sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be made with (a) portland cement mortar, (b) portland cement grout, (c) rubber gaskets, or (d) flexible plastic gaskets.

The pipe ends shall be thoroughly cleaned before the joint is made. Mortared joints shall be made with an excess of mortar to form a bead around the outside of the culvert and finished smooth inside. For grouted joints, molds or runners shall be used to retain the poured grout. Rubber ring gasket and flexible plastic gasket joints shall be made in accordance with the manufacturer's recommended procedures.

When portland cement mixtures are used, the completed joints shall be protected against drying by covering.

Flexible culvert sections and metal end sections shall be firmly jointed by coupling bands. These bands shall meet the same applicable requirements as the flexible culvert being joined.

603.07 Shop Strutting. All flexible culverts 48 inches in diameter and larger shall be elongated along the vertical diameter approximately 3 percent by the use of steel tie rods and nuts. The rods shall be placed on the horizontal diameter of the pipe half way between circumferential riveting.

The tie rods shall be $\frac{5}{8}$ of an inch in diameter, threaded 7 inches at both ends, and 8 inches longer than the diameter of the pipe. Softwood blocks, 2 by 4 by 12 inches and steel washers shall be placed over the rods at each end. The long dimension of the blocks shall be parallel with the longitudinal axis of the pipe, except that the end blocks shall be perpendicular to the longitudinal axis of the pipe.

The 3 percent elongation shall be obtained by tightening the rods uniformly from end to end of the culvert, obtaining

approximately $\frac{1}{4}$ of the required elongation each time the nuts are tightened, continuing through the length of the culvert until the full elongation is obtained.

The rods shall be left in place until the embankment over the culvert is completed and compacted, unless otherwise directed. The rods shall be removed by cutting from inside adjacent to the culvert. Any coated areas damaged as a result of cutting the rods shall be repaired by recoating with asphalt.

603.08 Backfilling Culverts and Storm Drains. After the pipe is installed it will be inspected before any backfill material is placed. All pipe found to be out of alignment, unduly settled, or damaged to the extent that full performance is impaired, shall be taken up and relaid or replaced.

Trenches shall be backfilled in accordance with subsection 206.03 and as follows. The backfill material shall be thoroughly rammed under the haunches of the pipe with power or pneumatic operated hand tampers. The remainder of the backfill shall be thoroughly compacted with power tampers or vibratory compactors or other approved equipment or combination of equipment.

When precompacted embankment is not required and the top of the pipe is exposed above the top of the trench, the embankment material around the pipe shall be placed and compacted on each side of the pipe in the aforementioned manner described for backfilling trenches, for a width of 12 feet or twice the horizontal inside diameter, whichever is less. Only that portion of the embankment on each side of the pipe, for a minimum distance equal to the horizontal inside diameter of the pipe, must be of material conforming to the requirements described for backfilling in subsection 206.03. Backfill material beyond these limits may contain stones larger than 3 inches but no greater than the thickness of the layer being placed. The embankment construction around the pipe shall continue up to an elevation 1 foot above the top of the pipe. Above and beyond these limits the embankment shall be placed and compacted in accordance with the embankment construction requirements specified for the work except where the imperfect trench method is prescribed.

When construction equipment is used or traffic is maintained the Contractor shall maintain a minimum cover of 3 feet over all pipes. Whenever this cover extends above the subgrade the Contractor shall temporarily place earth which shall be removed when necessary to complete the work in accordance with the plans or as directed by the Engineer.

Any deviation from this practice shall have prior approval by the Engineer.

603.09 Imperfect Trench. Under this method, for designated rigid pipes only, the embankment shall be completed as specified above, to a height above the culvert equal to the vertical outside diameter of the pipe plus 1 foot. A trench equal in width to the outside horizontal diameter of the pipe shall then be excavated to within 1 foot of the top of the pipe. Trench walls shall be as nearly vertical as possible. The trench shall be loosely filled with highly compressible soil. Straw, hay, cornstalks, leaves, brush or sawdust may be used to fill the lower $\frac{1}{4}$ to $\frac{1}{2}$ of the trench. Construction of embankment above shall then proceed in a normal manner.

603.10 Removing and Relaying Culverts. The pipe shall be carefully removed from its existing location, transported to and installed in the new location in accordance with these specifications for the particular type of pipe involved. Pipe damaged by the Contractor shall be replaced with pipe of similar type by the Contractor without additional compensation.

New metal bands or joint material shall be supplied and installed when necessary.

603.11 Method of Measurement. The amount of pipe to be included for payment of the different types and sizes, both new and relaid, will be the length in linear feet along the invert, laid as directed by the Engineer, complete in place and accepted. Pipe laid in excess of the authorized length will not be included for payment.

When the ends of a pipe are sloped or skewed the amount to be included for payment shall be the length along the invert of the pipe.

The inlet grate units will be the number of units installed, complete in place and accepted.

603.12 Basis of Payment. The accepted quantities of pipe will be paid for at the contract unit price per linear foot, for the types and sizes specified, complete in place.

Inlet grate units will be paid for at the contract unit price each, for the size specified, complete in place.

Excavation for removal of stumps and rocks prior to placement of precompacted embankments will be paid for as Common Excavation, Rock Excavation or Unclassified Excavation, whichever is applicable.

Excavation for culverts and storm drains, including excavation below the pipe, for imperfect trench and for bedding and backfilling will be measured and paid for as provided in Section 206 — Structural Excavation.

Whenever minimum cover material extends above the subgrade, removal of the cover material necessary to complete the work will be paid for as earth excavation or unclassified excavation.

Coupling bands and joint material will not be paid for separately but shall be considered included in the unit bid price for the types of pipe being used or relaid.

Payment will be made under:

Pay Items	Pay Unit
603.13 8 inch Culvert Pipe	Linear Foot
603.14 10 inch Culvert Pipe	Linear Foot
603.15 12 inch Culvert Pipe	Linear Foot
603.16 15 inch Culvert Pipe	Linear Foot
603.17 18 inch Culvert Pipe	Linear Foot
603.18 21 inch Culvert Pipe	Linear Foot
603.19 24 inch Culvert Pipe	Linear Foot
603.20 30 inch Culvert Pipe	Linear Foot
603.21 36 inch Culvert Pipe	Linear Foot
603.22 42 inch Culvert Pipe	Linear Foot
603.23 48 inch Culvert Pipe	Linear Foot
603.24 54 inch Culvert Pipe	Linear Foot
603.25 60 inch Culvert Pipe	Linear Foot
603.26 66 inch Culvert Pipe	Linear Foot
603.27 72 inch Culvert Pipe	Linear Foot
603.28 84 inch Culvert Pipe	Linear Foot
603.29 18 inch span, 11 inch rise Pipe Arch	Linear Foot
603.30 22 inch span, 13 inch rise Pipe Arch	Linear Foot
603.31 25 inch span, 16 inch rise Pipe Arch	Linear Foot
603.32 29 inch span, 18 inch rise Pipe Arch	Linear Foot
603.33 36 inch span, 22 inch rise Pipe Arch	Linear Foot
603.34 43 inch span, 27 inch rise Pipe Arch	Linear Foot
603.35 50 inch span, 31 inch rise Pipe Arch	Linear Foot
603.36 58 inch span, 36 inch rise Pipe Arch	Linear Foot
603.37 65 inch span, 40 inch rise Pipe Arch	Linear Foot
603.38 72 inch span, 44 inch rise Pipe Arch	Linear Foot
603.39 24 inch Reinforced Concrete Pipe, Class IV	Linear Foot

603.40	30 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.41	36 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.42	42 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.43	48 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.44	54 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.45	60 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.46	66 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.47	72 inch Reinforced Concrete Pipe, Class IV	Linear Foot
603.48	8 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.49	10 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.50	12 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.51	14 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.52	16 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.53	18 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.54	20 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.55	24 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.56	30 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.57	36 inch Asbestos Cement Pipe, Class _____	Linear Foot
603.58	through 603.72 Vacant	
603.73	Remove and Relay _____ inch Metal Pipe, Coated and Uncoated	Linear Foot
603.74	Remove and Relay _____ inch Concrete Pipe	Linear Foot
603.75	6 inch Inlet Grate Unit	Each
603.76	12 inch Inlet Grate Unit	Each

603.77	15 inch Inlet Grate Unit	Each
603.78	18 inch Inlet Grate Unit	Each
603.79	21 inch Inlet Grate Unit	Each

SECTION 604 — MANHOLES AND CATCH BASINS

604.01 Description. This work shall consist of the construction, altering, or adjustment to grade, manholes and catch basins in accordance with these specifications, and in reasonable close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

604.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Clay or Shale Brick	704.01
Concrete Brick	704.02
Concrete Masonry Blocks	704.03
Joint Mortar	705.02
Stone Curbing and Edging	712.04
Precast Units	712.06
Tops, Traps and Ladder Rungs	712.07
Corrugated Metal Units	712.08

Except as otherwise provided on the plans, concrete for these structures shall meet the requirements of Section 502 — Structural Concrete

CONSTRUCTION REQUIREMENTS

604.03 Construction Requirements. Catch basins and manholes may be constructed of brick, portland cement concrete blocks, precast portland cement concrete sections or corrugated metal.

Catch basins and manholes constructed of bricks or concrete blocks shall have a portland cement concrete base as shown on the plans. When concrete blocks are used all joints shall be no greater than ½ inch thickness, completely filled with mortar and neatly tooled on the inside of the structure. When bricks are used every fourth course shall consist of headers. The dome shall be composed entirely of headers. The joints shall be no greater than ½ inch thickness, completely filled with mortar, and neatly tooled on the inside of the structure.

Catch basins or manholes constructed of precast sections shall be placed to the required grade on compacted foundation material of uniform density. Cement concrete blocks may be used around the inlet and outlet pipes and either blocks or precast sections used for the remaining upper section of the structure. All joints between precast sections shall be mortared as specified for concrete blocks. Brick or block walls shall not be less than 8 inches thick.

Metal frames and traps, when called for, shall be set in a full mortar bed or otherwise secured as shown on the plans. Castings shall be set accurately to the correct elevation so that no subsequent adjustment will be necessary.

Pipe sections connecting to catch basins with sumps shall be firmly connected to the structure wall with no part of the pipe projecting more than 6 inches inside the wall. When a section of culvert has to be cut, the end shall be finished in a workmanlike manner. When bituminous coated culvert is cut it shall be repainted with bituminous material.

Upon completion, each structure shall be cleaned of any accumulation of silt, debris, or foreign matter of any kind and shall be kept clear of such accumulation until final acceptance of the work.

604.04 Altering Catch Basins and Manholes. Existing catch basins and manholes to be altered or adjusted, shall be reconstructed to the required grade using new or existing metal frames and tops as specified.

When altering or adjusting, the existing structure shall be dismantled sufficiently to allow reconstruction in accordance with the applicable requirements as shown on the standard detail plans for complete catch basins and manholes. When existing frames, covers and grates are used they shall be thoroughly cleaned of existing mortar before placing to the new grade. Each structure, reconstructed or adjusted shall be cleaned of accumulated silt, debris, or foreign matter prior to final acceptance of the work.

604.05 Method of Measurement. The quantity to be included for payment of the respective types of structures will be the number of units, measured as follows, complete and accepted in place.

(a) *Complete Structures.* Each structure having a depth up to 8 feet from the top of the grate or cover to the top of the floor, measured to the nearest foot, will be 1 unit. One-eighth of a unit will be paid for each additional foot over 8 feet measured to the nearest foot. Depths in excess of the dimensions authorized will not be included for payment.

(b) *Existing Structures* to be Adjusted or Altered. Each structure adjusted or altered as specified will be one unit.

(c) *Traps.* Each trap included in the completed structure will be one unit.

(d) *Steps.* Each step included in the completed structure will be one unit.

604.06 Basis of Payment. The accepted quantities of items will be paid at the contract unit price for the number of units, of the respective types, complete in place. Payment for adjusting or altering structures shall include furnishing all materials including new blocks, bricks, mortar, and metal tops and covers when required. Frames, grates and covers for new or rebuilt structures shall be considered part of the structure and no separate payment will be made.

Excavation and backfill will be measured and paid for as provided in Section 206 — Structural Excavation.

Payment will be made under:

Pay Items	Pay Unit
604.07 Catch Basins Type A1	Each
604.08 Catch Basins Type A2	Each
604.09 Catch Basins Type B1	Each
604.10 Catch Basins Type B2	Each
604.11 Catch Basins Type C1	Each
604.12 Catch Basins Type C2	Each
604.13 24 inch Catch Basins, Type E	Each
604.14 30 inch Catch Basins, Type E	Each
604.15 Manholes	Each
604.16 Altering Catch Basins to Manholes	Each
604.17 Altering Manholes to Catch Basins	Each
604.18 Adjusting Manholes and Catch Basins to Grade	Each
604.19 8 inch Traps	Each
604.20 12 inch Traps	Each
604.21 15 inch Traps	Each
604.22 18 inch Traps	Each
604.23 Steps	Each

SECTION 605 — UNDERDRAINS

605.01 Description. This work shall consist of the construction of underdrain, using pipe and filter material and

pipe outlets, or blind drains using granular material or fractured ledge, in accordance with these specifications and the special details and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

605.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials:

Granular Borrow	703.19
Underdrain Backfill Material	703.22
Perforated Concrete Pipe	706.03
Clay Pipe	706.07
Asbestos Cement Pipe	706.10
Perforated Asbestos Cement Pipe	706.11
Bituminized Fiber Pipe	706.12
Perforated Bituminized Fiber Pipe	706.13
Corrugated Metal Pipe for Underdrain	707.04
Bituminized Coated Corrugated Metal Pipe	
for Underdrains	707.05
Corrugated Aluminum Pipe for Underdrains	707.08

Dynamite and detonating devices for Underdrain, Type "D" shall be from fresh stock. Dynamite shall be 60 percent strength unless field conditions and type of ledge require modification.

The material for Ells, Tees and Wyes for underdrain types "B" and "C" shall be at least as thick as the largest size pipe being connected.

CONSTRUCTION REQUIREMENTS

605.03 General. Corrugated metal pipe for underdrain, bituminous coated corrugated metal pipe for underdrain, perforated concrete pipe, perforated asbestos cement pipe, clay pipe, perforated bituminized fiber pipe or corrugated aluminum pipe for underdrain may be used for Type "B" underdrain and underdrain outlet pipe. Corrugated metal pipe for underdrain, bituminous coated corrugated metal pipe for underdrain, perforated concrete pipe, perforated asbestos cement pipe or corrugated aluminum pipe for underdrain may be used for Type "C" underdrain.

605.04 Underdrain Construction.

(a) *Type "A".* The trench shall be excavated to the required width and depth. The specified granular material shall

then be used to fill the trench. This material shall be placed in 8 inch layers, loose measure, and thoroughly compacted.

(b) *Type "B".* The trench shall be excavated to the required width and depth. A bed of the specified granular material, 3 inches in depth shall be prepared in the trench and thoroughly compacted. Six inch perforated pipe shall be laid on this bed with perforations down.

After the pipe has been firmly bedded and joints securely connected it will be inspected before any backfill is placed. The remaining backfill shall be granular material meeting the same requirements as that used for bedding the pipe. The material shall be placed in 8 inch layers, loose measure, and thoroughly compacted except that the initial layer of backfill around the pipe may be placed in a layer not exceeding 10 inches.

The upstream end of all completed underdrain pipe that is to be buried shall be sealed with cement mortar or other matter acceptable to the Engineer. Care shall be taken that soil does not enter the pipe and all pipe so contaminated before backfilling shall be removed, cleaned, and relaid.

(c) *Type "C".* The trench shall be excavated to the width and depth as determined by the size and depth of the pipe to be installed.

The perforated pipe shall be laid to line and grade centered on the bottom of the trench with the perforations uppermost.

After the pipe has been firmly bedded and all joints securely connected it will be inspected before any backfill is placed. The backfill shall be placed in accordance with subsection 603.08 and as shown on the standard detail sheet using the materials specified.

(d) *Type "D".* After normal ledge excavation has been completed, Type "D" underdrain shall be constructed as shown on the detail plans at locations designated. This underdrain shall be constructed by drilling 2 rows of holes, loading each hole with approximately 1 pound of dynamite, filling each hole with sand, and detonating the charge. After blasting, the fractured ledge shall be left in place except that debris remaining above the subgrade line shall be removed. The strength, amount of dynamite and method of detonating may be modified to fit field conditions.

After the underdrain has been constructed, 6 inch underdrain outlet shall be installed at the low end of the ledge cut in a manner to provide an outlet for accumulated subsurface water.

(e) When Underdrain Type "B" or Underdrain Type "C" is constructed, any backfill material placed beyond the underdrain trench lateral limits designated on the plans shall be material conforming to the requirements of Granular Borrow, Underwater Backfill. Material within the underdrain trench limits shall conform to the requirements of the type underdrain being constructed. The Contractor shall take precautions to prevent the underdrain backfill material from becoming contaminated with clay, silts, organic matter or other matter. Methods of placing backfill material shall be limited to the use of hand shovels, backhoes, front end loaders or other similar types of equipment which will place material directly into the trench. Pushing backfill material into the trench by bulldozers, graders, or other types of machines will not be allowed.

605.05 Underdrain Outlets. Trenches for underdrain outlets shall be excavated to the required width and depth. These outlets shall be constructed of the same size and type of pipe used in the underdrain itself, except that the perforations may be omitted.

The pipe shall be laid in the trench with all ends firmly joined by the applicable methods and means. After inspection and approval of the pipe installation the trench shall be backfilled with suitable material in layers and compacted as provided for in subsection 603.08.

605.06 Method of Measurement. The quantity of underdrains and outlets to be included for payment will be the length in linear feet along the centerline of underdrains and outlets of the various types and sizes completed and accepted.

When elbows, "Y's", "T's", or other special connections are required in underdrains, each connection shall be included for payment as 3 additional linear feet of underdrain of each pipe line involved.

605.07 Basis of Payment. The accepted quantities of underdrains and underdrain outlets will be paid for at the contract unit price per linear foot of each type and size specified, complete in place. Outlet pipe for Type C Underdrain will be paid for under Section 603, Pipe Culverts and Storm Drains.

Backfill, couplings and bands, and other miscellaneous related items will not be paid for separately, but shall be considered included in the unit bid price for the type of underdrain being installed.

Excavation will be measured and paid for as provided in Section 206 — Structural Excavation. No allowance for payment will be made for excavating or material excavated beyond the horizontal dimensions shown for Types A, B or C Underdrain, except as determined by proper measurements when Structural Rock is encountered.

Payment will be made under:

Pay Item	Pay Unit
605.08 Underdrain Type "A"	Linear Foot
605.09 6 inch Underdrain Type "B"	Linear Foot
605.10 6 inch Underdrain Outlet	Linear Foot
605.11 12 inch Underdrain Type "C"	Linear Foot
605.12 15 inch Underdrain Type "C"	Linear Foot
605.13 18 inch Underdrain Type "C"	Linear Foot
605.14 21 inch Underdrain Type "C"	Linear Foot
605.15 24 inch Underdrain Type "C"	Linear Foot
605.16 Underdrain Type "D"	Linear Foot

SECTION 606 — GUARD RAIL

606.01 Description. This work shall consist of the construction or removing and resetting guard rail and guard rail elements in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

The types of guard rail are designated as follows:

- Type 1a—Two cable guard rail on round wood posts having the lower portion treated with pentachlorophenol 5 percent concentration and the upper portion stained or painted white as designated on the plans.
- Type 1b—Two cable guard rail on round pressure treated or hot and cold bath treated wood posts.
- Type 2a—Three cable guard rail attached by brackets to round pressure treated or hot and cold bath treated wood posts.
- Type 2b—Three cable guard rail attached by brackets to rectangular pressure treated or hot and cold bath treated wood posts.
- Type 2c—Three cable guard rail attached by brackets to steel posts, all parts galvanized.

Type 3a— Beam type guard rail attached by brackets to rectangular pressure treated or hot and cold bath treated wood posts.

Type 3b— Beam type guard rail attached by brackets to steel posts, all parts galvanized.

Type 4 — Boulder guard consisting of aligned boulders set into the ground.

Type 5 — Wood guard rail with round wood posts having the lower portion treated with pentachlorophenol 5 percent concentration and the upper portion, including rail, painted white.

Type 6 — Rustic log guard rail with round wood posts having the lower portion treated with pentachlorophenol 5 percent concentration and the upper portion, including rail, stained.

The construction of the various types of guard rail shall include the assembly and erection of all component parts and materials complete at the locations shown on the plans or as directed.

MATERIALS

606.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700— Materials:

Exterior Ready Mixed Paint	708.01
Timber Preservative	708.05
Wood Stain	708.07
Wire Rope or Wire Cable	709.02
Metal Beam Rail	710.04
Timber Rail	710.05
Guard Rail Posts	710.07
Guard Rail Hardware	710.08

Boulders for boulder guard rail shall be of sound and durable rock. They shall be a minimum of 3 feet long, 2 feet wide and 1 foot thick.

Materials for removing and resetting shall consist of the existing posts, cables, rails, bolts and other hardware of the existing guard rail.

CONSTRUCTION REQUIREMENTS

606.03 Posts. Posts shall be set plumb in hand dug or mechanically dug holes. Steel posts may be driven if suitable

driving caps and driving equipment are used to prevent excessively battering and distorting. When posts are driven through pavement the damaged area around the post shall be repaired with approved bituminous patching.

Wood posts shall be selected with respect to size so they will present a pleasing appearance after placing. The posts shall be set on a stable foundation with the smaller diameter at the top and the space around the posts backfilled with suitable material thoroughly tamped in layers not exceeding 8 inches, loose measure. After wood posts are set the tops shall be cut and beveled as shown on the plans when necessary, and the required holes bored at the proper location, except that pressure treated and hot and cold bath treated posts shall be cut, bored and beveled before being treated.

(a) *Pentachlorophenol Treatment.* The butt ends of wood posts not pressure treated or hot and cold bath treated shall be immersed to a depth of 4 feet in a tank or barrel containing 5 percent pentachlorophenol solution for a minimum of 60 minutes. All wood posts so treated, unless otherwise specified by the Engineer, shall have been peeled and air seasoned to permit thorough drying for at least 1 month prior to treatment if the post had been cut between May 1 and September 30, and 3 months if cut between October 1 and April 30.

(b) *Pressure or Hot and Cold Bath Treatment.* All posts to be pressure treated or hot and cold bath treated shall be bored and trimmed prior to preservative treatment. The standards for inspection of the American Wood Preservative Association (AWPA M-2) shall be followed by pressure treatment and hot and cold bath treatment.

Posts to be pressure treated shall be treated with creosote oil or 50-50 creosote petroleum solution for a minimum retention of 6 pounds per cubic foot using the empty-cell process.

Posts to be hot and cold bath treated shall, after peeling, be air seasoned to permit thorough drying for a minimum of 3 months if cut between May 1 and September 30, and 6 months if cut between October 1 and April 30. Posts to be hot and cold bath treated shall be treated with creosote oil or 50-50 creosote petroleum solution using Number 6 fuel oil. The hot bath shall be not less than 200° F. and the cold bath not less than 100° F. Minimum retention shall be 6 pounds per cubic foot with full sapwood penetration.

Guard rail posts designated to be removed and reset shall be carefully removed from their present location, temporary

ily stored, if necessary, and reinstalled at the new location. Any materials damaged or lost during or subsequent to removal shall be replaced with new material by the Contractor without compensation. All new materials required shall be equal to, or better than, the material of the existing highway guard rail.

606.04 Rail Elements. Rail elements shall be erected to result in a smooth, continuous installation. Except for adjustment bolts, bolts shall be of sufficient length to extend beyond the nuts but not more than one-half inch. Except for adjustment bolts, all bolts shall be drawn tight.

Both ends of each section of wire cable shall be anchored as shown on the plan. At cable ends the rods shall be screwed against the wedges so as to hold them tightly in place and the cables drawn to take up all noticeable sag between the posts. The cables shall be stretched as the Engineer may direct, and all cables shall have approximately the same tension. Splicing cable will be permitted when necessary, but no single piece of cable shall be less than 50 feet in length. Continuous lines of cable more than 500 feet long shall have intermediate turnbuckles.

The beam rail and fittings, single or double faced, shall be placed and fastened as shown on the plans. Rail elements shall be lapped so that the exposed end of each element is away from approaching traffic. Terminal ends shall be installed as shown on the plans and shall be securely and rigidly attached to the beam section and end post.

Boulders for guard rail shall be set on end with approximately one-third of their height embedded into the ground, the larger end down, spaced as shown on the plans. The face of all boulders next to the highway shall be set so as to make a comparatively uniform line. No boulder shall be set out of line or set leaning so as to create an unstable appearance.

Wood rails for guard rail shall be placed as shown on the plans. Each rail shall be securely fastened to the posts at each end and at the intermediate post. Rails shall be drilled for the spikes to prevent splitting the wood.

Rails for rustic guard rail shall be selected so that matching end diameters are as nearly matching size as possible. The rails shall be attached to the posts by drift pins placed in predrilled holes in the rail and posts. All cuts and notches on rails shall provide uniform bearing and close joints. When the rail is completed the joints shall be made even and smooth. Drift holes shall be countersunk 2 inches and wood plugs placed to seal the hole.

Cables or rails of guard rail designated to be reset shall be installed and adjusted as specified for new guard rail.

606.05 Anchorages. Anchors for cable guard rail shall be installed as shown on the plans. All backfills shall be of satisfactory material placed in layers not exceeding 8 inches, loose measure, and thoroughly tamped. Anchor rods and fittings shall be properly adjusted to equalize the stress in the cables and anchors.

606.06 Single Posts. Single posts shall be installed as specified in subsection 606.03 and shall be designated by type conforming respectively to the posts for guard rail except galvanized steel pipe posts and fittings which shall be constructed as shown on the standard detail sheets. The elevation and shape of the top of the posts shall be as designated by the Engineer.

606.07 Miscellaneous. All galvanized surfaces which have been abraded so that the base metal is exposed, and threaded portions of all fittings and fasteners and cut ends of bolts shall be cleaned and painted with two coats of approved rust resistant paint.

Wood surfaces to be painted shall be dry prior to application of paint.

After installation, wood posts and rails removed and reset shall be cleaned of all loose paint and treated with two coats of white paint. Steel posts and steel beam type rail removed and reset, but not galvanized, shall be cleaned and painted with approved aluminum paint prior to installation. Abraded or rusted surfaces of steel posts and guard rail, designated to be painted, shall be painted with an approved prime coat prior to the application of the aluminum paint.

606.08 Method of Measurement. Guard rail will be measured by the linear foot from center to center of end posts along the slope of the rail except where end connections are made to masonry or steel structures, in which case measurement will be to the face of the structure.

Boulder guard rail will be measured by linear feet from outside to outside of end boulders.

Rustic guard rail will be measured by the linear foot from end to end of the rail including the overhang.

End anchorages, terminal sections and single posts will be measured as units of each kind specified and installed.

Excavation in solid ledge for placement of posts will be measured by the cubic yard determined from the actual depth

of the hole and a hypothetical diameter of 2 feet. For anchorages measurement of ledge will be for the actual ledge rock required to be removed.

606.09 Basis of Payment. The accepted quantities of guard rail, new or reset, will be paid for at the contract unit price per linear foot for the type specified complete in place. End anchorages, terminal sections and single posts will be paid for at the contract unit price per each for the kind specified complete in place. Such payment shall be full compensation for furnishing all material, excavating, backfilling holes, assembling, and all incidentals necessary to complete the work except that excavation for posts or anchorages in solid ledge rock, payment will be made under Item 206.07, Structural Rock Excavation — Drainage and Minor Structures.

Payment for removing and resetting guard rail shall be full compensation for removing, transporting, storing, reassembling all parts, necessary cutting, furnishing new parts when necessary, reinstalling at the new location and furnishing and applying paint and all other incidentals necessary to complete the work. Payment shall also include removing and resetting anchorages and terminal ends where required. No payment will be made for guard rail removed but not reset and all costs for such removal shall be considered incidental to the various contract items.

Anchorages to bridge rails will be considered incidental to the bridge work and connections thereto considered incidental to the unit bid price for guard rail.

Guard rail, Type 3a or 3b required to be placed on a radius of 150 feet or less will be paid for as circular guard rail.

Payment will be made under:

Pay Item	Pay Unit
606.10 Guard Rail Type 1a	Linear Foot
606.11 Guard Rail Type 1b	Linear Foot
606.12 Guard Rail Type 2a	Linear Foot
606.13 Guard Rail Type 2b	Linear Foot
606.14 Guard Rail Type 2c	Linear Foot
606.15 Guard Rail Type 3a — Single Rail	Linear Foot
606.16 Guard Rail Type 3a — Double Rail	Linear Foot
606.17 Guard Rail Type 3b — Single Rail	Linear Foot
606.18 Guard Rail Type 3b — Double Rail	Linear Foot
606.19 Guard Rail Type 3a — Circular — 15 foot radius and less	Linear Foot

606.20 Guard Rail Type 3a — Circular — Greater than 15 foot radius	Linear Foot
606.21 Guard Rail Type 3b — Circular — 15 foot radius and less	Linear Foot
606.22 Guard Rail Type 3b — Circular — Greater than 15 foot radius	Linear Foot
606.23 Guard Rail Type 4	Linear Foot
606.24 Guard Rail Type 5	Linear Foot
606.25 Anchorages for Cable Guard Rails	Each
606.26 Terminal Ends — Single Rail	Each
606.27 Terminal Ends — Double Rail	Each
606.28 Single Post — Type 1a	Each
606.29 Single Post — Type 1b	Each
606.30 Guard Rail, Type 6	Linear Foot
606.31 Single Post — Type 1c	Each
606.32 Single Post, Type 2a	Each
606.33 Single Post, Type 2b	Each
606.34 Single Post, Type 2c	Each
606.35 Vacant	
606.36 Guard Rail, Removed and Reset	Linear Foot

SECTION 607 — FENCES

607.01 Description. This work shall consist of the construction of fence and gates in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. The construction of fencing shall include the assembly and erection of all component parts and materials including barways and gateways complete at the locations shown on the plans or as directed.

MATERIALS

607.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials:

Barbed Wire	710.01
Woven Wire	710.02
Chain Link Fabric	710.03
Fence Posts and Braces	710.06

Wood gates and bars for barways shall be of eastern hemlock, northern white pine, Norway pine, spruce, cedar or

tamarack, equal in quality to the wood posts, with the bark removed and all knots hewn flush with the face. Rails and posts for cedar rail fence shall be of cedar, reasonably straight, machine or hand peeled, and branch stubs cut flush. Metal gates shall be of galvanized steel.

When staples are used the wire shall be galvanized or aluminum coated in accordance with the applicable requirements of woven wire fencing.

Expansion sleeves, turnbuckles, and other fittings and hardware shall be galvanized in accordance with the requirements of ASTM A-153, whichever may apply.

Concrete for anchoring metal posts, metal braces, and wooden gate posts shall meet the requirements of Section 502 — Structural Concrete, except that air entraining will not be required. The class of concrete shall be optional.

CONSTRUCTION REQUIREMENTS

607.03 General. The Contractor shall perform clearing and grubbing as may be necessary to construct the fence to the required grade and alignment.

Posts shall be spaced as called for on the plans except that a variation of two feet back or ahead on line will be allowed at special locations approved by the Engineer. The tops of posts shall be set to the required grade and alignment. Cutting off the tops of posts will be allowed only with the approval of the Engineer.

Cedar rail fence posts shall be set plumb in drilled or in hand dug holes. After the posts are placed, rails installed, and the posts aligned, the post holes shall be backfilled. The completed fence shall have the tops of the posts at uniform height above ground following the grade of the existing ground.

Posts shall be braced with Type I or Type II bracing at designated location as hereinafter specified. Type I bracing shall include diagonal brace and 1 post of the designated size. Type II bracing shall include 2 diagonal braces and 1 post of the designated size.

When the plans require posts, braces, or anchors to be embedded in concrete the Contractor shall, if necessary, install temporary guys to hold the posts in position until the concrete has set sufficiently to hold the post. Unless otherwise permitted, no material shall be installed on posts or strain placed on guys and bracing set in concrete until 48 hours after the concrete has been placed.

Backfilling shall be done with suitable earth placed in 8 inch layers, loose measure, each layer thoroughly compacted.

All surplus material and other debris from this work shall be removed and disposed of to leave a neat and workmanlike appearance.

607.04 Woven Wire or Barbed Wire Fencing. Holes for wood posts shall be dug to full depth. Metal line posts shall be set plumb by means of an approved hand or mechanically operated post driver. Posts which are bent or otherwise damaged shall be removed and replaced. Metal posts to be set in solid rock shall be set in drilled holes of such diameter that grouting with a cement grout composed of 1 part portland cement and 2 parts sand will be possible.

(a) *Bracing.* The maximum distance between bracing shall be 660 feet. At changes in horizontal alignment in excess of 30 degrees, bracing will be required. At changes in horizontal alignment of 15 degrees to 30 degrees, bracing may be required as called for on the plans or by the Engineer. At changes in horizontal alignment angles of less than 15 degrees, bracing will not be required except at intervals of 660 feet as hereinbefore provided.

Line posts in depressions where tension in the fencing may cause lifting of the post will require bracing.

End, corner, gate, barway and intermediate posts shall be braced and anchored as shown on the standard detail plans.

Metal posts for end, corner, gate, barway, and intermediate braces shall be placed in concrete. When the concrete has sufficiently set, the space around the base shall be backfilled with satisfactory material thoroughly tamped. If directed, foundation material consisting of gravel 6 inches or more in depth shall be placed in the post hole.

(b) *Gates.* All gates shall be constructed of metal.

(c) *Barways.* Barways shall be constructed of posts corresponding to the type of posts used for the fence. Wood cross bars shall be furnished.

(d) *Erection of Fabric or Wire.* Fencing shall be stretched taut. Each strand of barbed wire shall be attached to wood posts by at least 1 staple. Top and bottom strands of woven wire shall be attached to each post and alternate interior strands of woven wire fencing shall be attached to alternate posts. Staples for wood posts shall not be driven into line posts so as to restrict the horizontal movement of wire except that at corners, ends and bracing, staples shall be fully

driven into the posts. When attaching fencing to metal posts, approved iron stay fasteners shall be used.

Except as otherwise provided splicing the wire will be permitted at posts only and each horizontal strand of wire shall be wrapped completely around the post. The wire strand shall be securely fastened by winding the end of the wire about the same strand where it leads up to the post. This type of fastening shall be used at each end, corner and gate post and at the barway post set in line of the fence. Other devices designed specifically to splice fencing wire may be used subject to the approval of the Engineer.

The complete fence shall have the tops of all wood posts at a uniform height above the top strand of wire. When permitted, wood posts may be cut to the required height. The top shall be horizontal.

607.05 Chain Link Fence. All foundations shall be cast of portland cement concrete in approved forms. If wood forms are used they shall be removed before backfilling. If fiber forms are used they need not be removed. Posts set in solid ledge rock shall be set in drilled holes of such diameter that grouting with cement grout composed of 1 part portland cement and 2 parts sand will be possible.

(a) *Anchoring and Bracing.* At intervals of 330 feet, at corners, and at terminal sections of fence, bracing shall be installed as shown on the plans. At changes in alignment of less than 15 degrees, bracing will not be required except at intervals of 330 feet as hereinbefore provided. At changes in alignment of 15 degrees to 30 degrees, bracing may be required as called for on the plans or by the Engineer. At changes in alignment in excess of 30 degrees, bracing will be required for all fencing.

(b) *Gates.* Where gates are required for chain link fence they shall be constructed of metal in conformity with the details shown.

(c) *Erection of Chain Link Fabric.* The grade of fence shall be approximately parallel with the grade of the ground. When directed by the Engineer all abrupt depressions shall be filled.

The rails shall pass through post caps and securely fastened to end, corner, brace and gate posts. Joints in top rails shall be made with expansion sleeve couplings. On curves with a radius of less than 500 feet the top rail shall be bent to the arc.

The fabric shall be pulled taut and the ends attached to the posts with stretcher bars and bands. When required, rolls of wire fabric shall be joined by weaving a single strand of mesh wire into the ends of the rolls to form a continuous mesh.

All surplus and excavated material and other debris from this work shall be removed and disposed of to leave a neat and workmanlike appearance.

607.06 Methods of Measurement. Fence will be measured by the linear foot accepted in place. Measurement will be along the grade of the fence from outside to outside of end posts for each continuous run of fence and shall include fence at bracing assemblies but shall not include gates and barways. Gateways and barways will be measured as complete units of the size and type specified. Bracing assemblies will be measured as complete units of the size and type specified. Excavation in solid ledge for placement of fence posts will be measured by the cubic yard determined from the actual depth of the hole and a hypothetical diameter of 2 feet.

607.07 Basis of Payment. The accepted quantities of fence will be paid for at the contract unit price per linear foot of the type and size specified complete in place. Barways, gateways and bracing assemblies will be paid for at the contract unit price for each type specified complete in place. Payment shall be full compensation for furnishing and assembling all materials, for excavating and backfilling holes, and for all incidentals necessary to complete the work except that in solid ledge rock, payment of drilling rock will be made under Item 206.07—Structural Rock Excavation—Drainage and Minor Structures. Excavation of earth to exposed rock shall be incidental to the several items for erection of the fence.

Payment for bracing assemblies shall include furnishing and installing the various larger size and longer length posts, diagonal bracing, ties, anchors and all incidental hardware, all as shown on the standard detail plans. Each panel of bracing shall be considered a unit for payment and bracing points requiring braces on each side of the fence post will be considered 2 units.

Any clearing or removal of single trees, stumps or boulders, required to install the fence shall be incidental to the respective pay item of this section.

Payment will be made under:

Pay Item	Pay Unit
607.08 Woven Wire Fence — Wood Posts	Linear Foot
607.09 Woven Wire Fence — Metal Posts	Linear Foot
607.10 Barbed Wire Fence — Wood Posts	Linear Foot
607.11 Barber Wire Fence — Metal Posts	Linear Foot
607.12 Barways — Wood Posts	Each
607.13 Barways — Metal Posts	Each
607.14 Vacant	
607.15 Drive Gateways — 16 feet — Metal	Each
607.16 Chain Link Fence — 4 feet	Linear Foot
607.17 Chain Link Fence — 6 feet	Linear Foot
607.18 through 607.21 Vacant	
607.22 Cedar Rail Fence	Linear Foot
607.23 Chain Link Fence Gate	Each
607.24 through 607.29 Vacant	
607.30 Bracing Assembly, Type I — Wood Posts	Each
607.31 Bracing Assembly, Type II — Wood Posts	Each
607.32 Bracing Assembly, Type I — Metal Posts	Each
607.33 Bracing Assembly, Type II — Metal Posts	Each
607.34 Bracing Assembly, Type I — Chain Link Fence — 4 feet	Each
607.35 Bracing Assembly, Type II — Chain Link Fence — 4 feet	Each
607.36 Bracing Assembly, Type I — Chain Link Fence — 6 feet	Each
607.37 Bracing Assembly, Type II — Chain Link Fence — 6 feet	Each

SECTION 608 — SIDEWALKS

608.01 Description. This work shall consist of the construction of bituminous or portland cement concrete sidewalks, plain or reinforced as specified, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. This work does not include portland cement concrete sidewalks on bridges.

MATERIALS

608.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Joint Fillers	705.01
Reinforcing Steel	709.01

Portland cement concrete for sidewalks shall meet the requirements of Section 502 — Structural Concrete, Class "A".

Bituminous mix for sidewalks shall meet the requirements of Section 403 — Hot Bituminous Pavement.

CONSTRUCTION REQUIREMENTS

608.03 Portland Cement Concrete Sidewalks.

(a) *Excavation.* Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown on the plan. All soft and yielding material shall be removed and replaced with acceptable material.

(b) *Forms.* Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be true, free from warp and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

(c) *Placing Concrete.* The foundation shall be thoroughly moistened immediately prior to the placing of the concrete. The proportioning, mixing and placing of the concrete shall be in accordance with the requirements of Section 502 — Structural Concrete.

(d) *Finishing.* The surface shall be finished with a wooden float which shall be moved in a circular motion to produce a shell-like pattern. No plastering of the surface with mortar will be permitted.

All outside edges of the slab and all joints shall be rounded with a $\frac{1}{4}$ inch radius edging tool.

(e) *Joints.* Joints shall be located as shown on the plans. Slabs shall be placed alternately and the joints coated with an approved bituminous material before placing the adjacent slab.

When a concrete sidewalk is constructed adjacent to a curb, building, retaining wall or other fixed structure, a $\frac{1}{4}$ inch thick preformed joint filler shall be used between the slab and the structure.

(f) *Curing.* Concrete shall be cured for at least 72 hours. Curing shall be by means of moist burlap or mats, white pigmented curing compound or by other approved methods. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Engineer may direct.

608.04 Hot Bituminous Sidewalk.

(a) *Excavation.* Excavation shall be made to the required depth and width. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown on the plan. All soft and yielding material shall be removed and replaced with acceptable material.

(b) *Base Course.* Base course material shall be placed as shown on the plans and each layer thoroughly compacted.

(c) *Placing Bituminous Sidewalk Material.* Bituminous sidewalk material shall be placed on the compacted base course in two courses so as to give the required depth when rolled. Compaction shall be accomplished by means of a power roller having a minimum total weight of 2,000 pounds with a minimum of 65 pounds per inch of width of the drive roll or by satisfactory power vibratory compaction equipment. In areas inaccessible to other equipment, hand tamping will be permitted. In any case the bituminous sidewalk material shall be uniformly compacted.

608.05 *Method of Measurement.* Portland cement concrete sidewalks will be measured by the square yard of finished surface. Bituminous concrete sidewalks will be measured by the ton of bituminous mixture placed.

608.06 *Basis of Payment.* The accepted quantities of sidewalk will be paid for at the contract unit price per square yard for portland cement concrete sidewalk, per ton for hot bituminous sidewalk, and cubic yard for base course material complete in place. Excavation will be paid for under Section 203 — Excavation and Embankment. Expansion joint material and other related items will not be paid for separately but the cost thereof shall be included in the cost of the sidewalk. Base and subbase material will be paid for under Section 304 — Aggregate Base and Subbase Course. Bituminous mixture for sidewalk will be paid for under Section 403 — Hot Bituminous Pavement.

Reinforcement will be considered incidental to the unit bid price for reinforced concrete sidewalk.

Payment will be made under:

Pay Item	Pay Unit
608.07 Plain Concrete Sidewalk	Square Yard
608.08 Reinforced Concrete Sidewalk	Square Yard

SECTION 609 — CURBING

609.01 *Description.* This work shall consist of furnishing and installing curb or edging, or removing and relaying existing curbing or edging on highways and bridges in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

The types of curb are designated as follows:

- Type 1 — Stone curbing of quarried granite stone — vertical or sloped
- Type 2 — Precast portland cement concrete curbing — vertical or sloped
- Type 3 — Bituminous curbing
- Type 3a — Bituminous curbing with asbestos fibre
- Type 4 — Field stone curbing
- Type 5 — Stone edging of quarried granite stone
- Type 6 — Precast portland cement concrete edging

MATERIALS

609.02 *Materials.* Except as provided below, the materials used shall meet the requirements of the following subsections of Section 700 — Materials.

Bituminous Curbing	712.36
Joint Mortar	705.02
Reinforcing Steel	709.01
Stone Curbing and Edging	712.04
Precast Portland Cement Concrete Curbing	712.05
Epoxy Resin	712.35

Bituminous material for curbing shall meet the requirements of Section 403 — Hot Bituminous Pavement.

Portland cement concrete, bituminous mixes and manufactured curbing materials will be subject to inspection and tests at the plants for compliance with quality requirements.

Curved curbing, terminal sections and transition sections shall be in reasonably close conformity with the shape and

dimensions shown on the plans and to the applicable materials requirements herein for the type of curb specified.

Dowels shall be deformed bars and conform to the requirements of AASHTO M 31.

CONSTRUCTION REQUIREMENTS

609.03 Vertical Curbing, Sloped Curbing, Terminal Sections, and Transition Sections. (Types 1 and 2)

(a) *Installation.* The curb shall be set on a compacted foundation so that the front top arris line conforms to the line and grade required. The foundation shall be prepared in advance of setting the stone by grading the aggregate to the proper elevation and shaped to conform as closely as possible to the shape of the bottom of the stone. The stones shall be fitted together to form an open joint of at least $\frac{1}{4}$ of an inch and no greater than $\frac{5}{8}$ of an inch in width. The required minimum spacing shall be assured by the use of an approved spacing device.

(b) *Backfilling.* All remaining spaces under the curb shall be filled with approved material and thoroughly hand tamped so that the stones will have a firm uniform bearing on the foundation for the entire length and width. Any remaining excavated areas surrounding the curb shall be filled to the required grade with approved materials. This material shall be placed in layers not exceeding 8 inches in depth, loose measure, and thoroughly tamped.

When backfill material is of a type which tends to filter through the joints between the stones, small amounts of joint mortar or other approved material shall be placed in the back portion of the joint to prevent such filtering.

(c) *Protection.* The curb shall be protected and kept in good condition, particular care being taken to prevent discoloration of exposed surfaces. Any exposed surfaces smeared or discolored shall be cleaned and restored to a satisfactory condition or the curb unit removed and replaced.

(d) *Curb Inlets.* Curb placed adjacent to curb inlets shall be installed with steel dowels inserted into pre-drilled holes in the curb and inlet stones as shown on the plans. The steel dowels shall be inserted and cemented into each stone with epoxy grout as follows:

The grout shall be used in accordance with the manufacturer's instructions. The ambient temperature at the time of mixing or using must be 60° F. or above. The grout

shall be forced into the hole, after which the dowel shall be coated with grout for one-half its length and inserted into to grout filled hole. The hole shall be completely filled with grout around the dowel. The grout shall not be used if exposed to the air more than $\frac{1}{2}$ hour. All tools and containers must be clean before using.

(e) *Coating Precast Concrete Curb and Edging.* After the precast units have cured the required time and before placing in the ground, the concrete shall be coated on the top, ends and front face with a light gray colored epoxy resin surface sealant. The sealant may be applied at the place of manufacture prior to delivery to the project. Concrete surfaces to be treated shall be thoroughly cleaned of all dirt, grease, oil, or other objectionable materials, and shall be dust free and surface dry at the time of application of the epoxy resin.

The two components of the epoxy resin formulation shall be thoroughly mixed to produce a uniform light gray color and in quantities that can be applied during the stated pot life of the material.

The rate of application of the mixed epoxy resin coating shall be in accordance with the manufacturer's recommendation, but shall not be less than 1 gallon of unthinned material per 100 square feet. To insure complete sealing of the surface, a touch up coat shall be applied to areas showing voids, pin holes or areas showing excessive absorption into the concrete. This touch up coat shall not be applied for at least 72 hours after applying the initial coat. A longer time may be required if the initial coat has not completely set, or if so stated in the manufacturer's directions. The mixed epoxy resin coating may be thinned with toluol or other product suitable for this purpose to produce a workable consistency, not to exceed an amount recommended by the manufacturer. The air temperature at the concrete surface shall be 50° F. or above at the time of the application, unless otherwise stated by the manufacturer. Care shall be taken to protect areas not to be treated, from splashes and stains. The treated areas shall be protected from damage by subsequent construction operations. Any areas so damaged shall be resealed in the manner described above.

609.04 Bituminous Curb, Type 3 and 3a.

(a) *Preparation of base.* Prior to placing the curb, the foundation course shall be thoroughly cleaned of all foreign and objectionable material by the use of brooms or brushes, combined with washing with water if necessary. String or

chalk lines shall be positioned on the prepared base to provide guide lines. The foundation shall be uniformly painted with tack coat as specified under Section 410 — Bituminous Surface Treatment.

(b) *Placing.* The curb shall be placed by means of an approved power operated extruding type machine. A tight bond shall be obtained between the base and the curb. The Engineer may permit the placing of curbing by means other than mechanical curb placing machines when short sections or sections with short radii are required or for such other reasons as may be warranted. The resulting curbing shall conform in all respects to the curbing produced by the machine.

(c) *Sealing and Painting.* The curb may be required to be sealed with bituminous sealing compound when directed by the Engineer in accordance with Section 612 — Bituminous Hand Sealing. The curbing shall be clean, dry and the bituminous material shall have reached the ambient temperature. When required, the curb shall be painted and coated with glass beads in accordance with Section 636 — Reflectionization of Bituminous Concrete.

(d) *Acceptance.* Curbing may be accepted or rejected on the basis of appearance in regard to texture and/or alignment. Any damaged curb shall be removed and replaced at the Contractor's expense.

609.05 Field Stone Curb, Type 4.

(a) *Installation.* The stones shall be placed on a compacted aggregate base with the longest dimension vertical and the largest end in the ground, with 6 inches exposed. They shall be fitted closely together and the top and face of the stone laid to the line and grade required.

(b) *Backfill.* The backfill, in front of and back of the curb, shall be approved aggregate material and shall be thoroughly compacted.

609.06 Curb, Types 5 and 6. The edging type curb shall be installed, backfilled and protected in accordance with subsection 609.03, except as follows:

(a) *Slope.* The edging shall be set on a slope as shown on the plans or as directed by the Engineer.

(b) *Joints.* Joints shall be open and not greater than $\frac{1}{2}$ inch in width.

609.07 Stone Bridge Curb, Vertical and Sloped, Type 1.

(a) *Installation.* Each stone and the bed upon which it is to be placed shall be cleaned and thoroughly wetted with water prior to placing the mortar for bedding and setting the stone. The stone shall be set on a fresh bed of joint mortar and well bedded before the mortar has set so that the front top arris line conforms to the line and grade required. Whenever temporary supporting wedges or other devices are used in setting the stones they shall be removed before the mortar in the bed has become set and the holes left by them shall be filled with mortar. Concrete behind the stones shall not be placed until the stones have been in place at least 2 days. Whenever there are any other time requirements on the plans or in the specifications, restricting the placing of the concrete, then those requirements shall govern. Bedding and pointing mortar for joints shall be cured as required under Section 502 — Structural Concrete.

(b) *Joints.* Vertical joints shall be $\frac{1}{2}$ inch in width plus or minus $\frac{1}{8}$ of an inch. Whenever possible the face and top of the joint shall be pointed with joint mortar to a depth of $1\frac{1}{2}$ inches, before the bedding mortar has set. Joints which cannot be so pointed shall be prepared for pointing by raking them to a depth of $1\frac{1}{2}$ inches before the mortar has set. Joints not pointed at the time the stone is laid shall be thoroughly wetted with clean water and filled with mortar. The mortar shall be well driven into the joint and finished with an approved pointing tool, flush with the pitch line of the stones.

609.08 Resetting Curb, Including Terminal Sections and Transition Sections.

(a) *Salvage of Curbing.* The Contractor shall carefully remove and store any curbing specified on the plans or designated by the Engineer for resetting. Damaged or destroyed curbing, as a result of the Contractor's operations, because of his failure to store and protect it in a manner that would prevent its loss or damage, shall be replaced with curbing of equal quality at the Contractor's expense.

(b) *Excavation.* Necessary excavation shall be made to the required depth and the base upon which the curb is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material which shall be thoroughly compacted.

(c) *Setting Curb.* The curb shall be set and backfilled in accordance with subsection 609.03, 609.04, 609.05 or 609.06 whichever is applicable.

(d) *Cutting and Fitting.* Cutting or fitting necessary in order to install the curbing at the locations directed shall be done by the Contractor.

609.09 Method of Measurement. All curbing, both new and reset will be measured by the linear foot along the front face of the curb at the elevation of the finished pavement, complete in place and accepted. Curb inlets at catch basins, including dowelling as required, will not be measured for payment, but shall be considered as included in the cost of the catch basin. Transition sections and terminal curb will be measured by the unit. Edging, both new and reset will be measured along the bottom line of the face slope of the edging.

609.10 Basis of Payment. The accepted quantities of curbing will be paid for at the contract unit price per linear foot or per each for each kind and type of curbing as specified.

Payment for terminal curbing shall include only that portion of the curbing modified for installation at ends of curb runs as shown on the detail plans. Curbing adjacent to terminal ends shall be paid for at the contract unit price per linear foot for the type of curb installed.

Curb Type 1 or Type 2 required to be placed on a radius of 60 feet or less, will be paid for as Circular Curb.

Curb, Type 5 required to be placed on a radius of 30 feet or less will be paid for as Circular Curb, Type 5.

There will be no separate payment for cement, reinforcing steel, anchors, tack coat, drilling for and grouting anchors, pointing and bedding of curbing, but these will be considered as incidental to the related curb.

Necessary excavation for installing new or reset curbing will be paid for as earth excavation, ledge excavation, or unclassified excavations as appropriate in accordance with Section 203 — Excavation and Embankments. Base and subbase material will be paid for under Section 304 — Aggregate Base and Subbase Course.

Payment will be made under:

Pay Item	Pay Unit
609.11 Vertical Curb — Type 1	Linear Foot
609.12 Vertical Curb — Circular — Type 1	Linear Foot
609.13 Vertical Bridge Curb — Type 1	Linear Foot
609.14 Vertical Bridge Curb — Circular — Type 1	Linear Foot
609.15 Sloped Curb — Type 1	Linear Foot

609.16 Sloped Curb — Circular Type 1	Linear Foot
609.17 Sloped Bridge Curb — Type 1	Linear Foot
609.18 Sloped Bridge Curb — Circular — Type 1	Linear Foot
609.19 Vertical Curb — Type 2	Linear Foot
609.20 Vertical Curb — Circular — Type 2	Linear Foot
609.21 Sloped Curb — Type 2	Linear Foot
609.22 Sloped Curb — Circular — Type 2	Linear Foot
609.23 Terminal Curb, Type 1	Each
609.24 Terminal Curb, Type 2	Each
609.25 Curb Transition Section A — Type 1	Each
609.26 Curb Transition Section B — Type 1	Each
609.27 Curb Transition Section C — Type 1	Each
609.28 Curb Transition Section A — Type 2	Each
609.29 Curb Transition Section B — Type 2	Each
609.30 Curb Transition Section C — Type 2	Each
609.31 Curb Type 3	Linear Foot
609.32 Curb Type 3a	Linear Foot
609.33 Curb Type 4	Linear Foot
609.34 Curb Type 5	Linear Foot
609.35 Curb — Circular — Type 5	Linear Foot
609.36 Curb Type 6	Linear Foot
609.37 Curb — Circular — Type 6	Linear Foot
609.38 Resetting Curb Type 1	Linear Foot
609.39 Resetting Curb Type 2	Linear Foot
609.40 Resetting Curb Type 5	Linear Foot
609.41 Resetting Curb Type 6	Linear Foot

SECTION 610 — STONE FILL, RIPRAP AND STONE BLANKET

610.01 Description. This work shall consist of excavating for and constructing a protective covering of stone, with or without grout, laid on earth or stone bedding.

Stone Fill — machine placed stone embankment for fill slope

Plain Riprap — machine placed stones on earth bedding

Hand Laid Riprap — hand placed stones on earth bedding

Hand Laid Riprap Face — hand placed stones on stone filled slopes

Stone Blanket — machine placed stones around piers and abutments.

MATERIALS

610.02 Stones used for stone fills, riprap and stone blanket shall consist of sound durable rock which will not become disintegrated by exposure to the action of water or weather. Either field stone or rough unhewn quarry stone may be used.

The exposed stones for plain and hand laid riprap shall be angular and as nearly rectangular in cross-section as practicable. Rounded boulders or cobbles will not be permitted.

(a) Stones for stone fill shall weigh from 10 pounds to a maximum of 500 pounds or larger if approved by the Engineer. Fifty percent, by weight, of the stones shall be approximately 200 pounds.

(b) Stones for riprap, plain or hand laid, shall weigh from 10 pounds to 200 pounds except that when available suitable stones weighing more than 200 pounds may be used. Approximately 50 percent of the stones by volume shall exceed a unit weight of 50 pounds.

(c) Stones for stone blanket shall weigh from 300 pounds to 3,000 pounds. Approximately 50 percent of the stones by volume shall exceed a unit weight of 1,000 pounds.

(d) Stones for crane laid riprap shall have a minimum weight of 500 pounds each and 50 percent of these stones, by volume, shall exceed 1,000 pounds each. No thin flat stones shall be used.

Portland cement concrete for grouting riprap shall conform to the requirements of Section 502 — Structural Concrete, Class "Y" Concrete, Table 3, except that crushed aggregate will not be required and additional water may be used to form a more workable mix.

CONSTRUCTION METHODS

610.03 Stone Fill and Stone Blanket. Material for stone fill shall be deposited to provide a compact mass. The exposed slope shall be finished to the line and grade required without special handling or hand work except when a hand laid riprap face is required in which case finishing the slope shall be in accordance with the work item involved.

Material for stone blanket shall be deposited for protection around piers or abutments as shown on the plans. The stones shall be placed individually, by a crane or other approved means, to form a reasonably compact mass. Spaces between the larger stones shall be filled with stone or spall of suitable size to leave an even surface conforming to the contour required.

610.04 Riprap. Riprap shall be placed upon a slope properly graded and compacted as called for. When required, the bottom of the riprap shall be placed in a trench at the toe of the slope. Plain riprap shall be placed full depth in one operation without special handwork, shall be approximately true to the required slope line and grade and be uniform in appearance. Hand laid riprap or hand laid riprap face shall be random rubble, hand laid for the full depth in one operation to secure interlocking of all face stones and stones placed as backing. Larger stones shall be laid at the base of the slope. The stones shall be laid in close contact with the longer axis perpendicular to the plane of the slope and so as to stagger joints. Except when required to be grouted the openings between the stones shall be filled with spall, or gravel and rocks securely rammed into place.

Portland cement concrete grout shall have a consistency suitable to permit flow readily into the voids between the stones. The grout shall be placed upon the stones and swept into the interstices until all voids between the stones are filled to the full depth of the riprap. After placing, the grout shall be protected from drying for at least 3 days. Grout shall not be placed during freezing weather.

The openings between stones on the face of crane laid riprap shall be filled with spall or small rocks securely rammed into place.

610.05 Method of Measurement. Stone fill, plain riprap, hand laid riprap and stone blanket will be measured by the cubic yard, complete in place, except that when placed under water the quantity may be measured by truck load count and the quantity reduced by one-third. Hand laid riprap face will be measured by the square yard of surface area, complete in place, measured parallel to the slope. Portland cement for riprap grout will be measured for payment by the barrel of portland cement actually used. Riprap grout delivered in transit mix trucks from commercial sources shall be accompanied by a delivery slip in accordance with subsection 109.01, paragraph (f).

610.06 Basis of Payment. The accepted quantities of stone fill, plain riprap, hand laid riprap and stone blanket will be paid for at the contract unit price per cubic yard complete in place. The accepted quantity for hand laid riprap face will be paid for at the contract unit price per square yard complete in place. Portland cement for riprap grout will be paid for at the contract unit bid price per barrel of cement which price shall include furnishing all sand, aggregates, water, and for mixing, transporting, placing and curing the grout.

Costs for all required excavating for riprap, stone fill or for stone blanket will be considered incidental to the various contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
610.07 Stone Fill	Cubic Yard
610.08 Plain Riprap	Cubic Yard
610.09 Hand Laid Riprap	Cubic Yard
610.10 Hand Placed Riprap Face	Square Yard
610.11 Stone Blanket	Cubic Yard
610.12 Portland Cement for Riprap Grout	Barrel
610.13 Crane Laid Riprap	Cubic Yard

SECTION 611 — STONE SLAB FOR BACKSLOPE PROTECTION

611.01 Description. This work shall consist of placing stone slabs on backslopes for protection against erosion in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

611.02 Materials. Materials shall conform to the requirements specified in the following subsections of Section 700 — Materials.

Joint Mortar	705.02
Stone Curbing	712.04 (a)

Finish. The granite slabs shall have an exposed surface free from drill holes, and shall be scabble dressed or sawed to an approximately true plane having no projections or de-

pressions over $\frac{1}{2}$ inch under a 2 foot straightedge or over 1 inch under a 4 foot straightedge. The granite slabs in any one section of backslope must be all the same finish. The arris at the intersection of the top surface and exposed front face shall be pitched so that the arris line is uniform throughout the length of the installed slabs. The sides shall be square to the exposed face unless the slabs are to be set on a radius or other special condition which requires that the joints be cut to fit, but in any case shall be so finished that when the stones are placed side by side no space more than $\frac{3}{4}$ of an inch shall show in the joint for the full exposed height.

Liftpin holes in all sides except the exposed face will be allowed. Holes on the top side and holes on the side which will not drain shall be filled with approved cement mortar or asphalt material.

CONSTRUCTION REQUIREMENTS

611.03 The slabs shall be placed to conform to the required line and grade. They shall be fitted together to form a vertical joint of not less than $\frac{1}{4}$ inch and not greater than $\frac{3}{4}$ inch in width. The space behind the slabs shall be backfilled with approved material thoroughly compacted, special care being taken not to disturb the slabs.

The vertical joints shall be pointed and neatly smoothed before the mortar has taken its initial set. All mortar shall be protected from drying for at least 3 days. All excess mortar shall be removed from the surface of the slab.

The stones shall be protected and kept in a first class condition and particular care will be required to prevent any discoloration of exposed surfaces. Any exposed surfaces smeared or discolored during the construction operations shall be cleaned and restored to a satisfactory condition or removed and replaced with new slab.

611.04 Method of Measurement. Stone slab for back slope protection will be measured by the square yard of slab acceptably placed, measured parallel to the slope but not to exceed the dimensions shown on the plans or authorized by the Engineer.

611.05 Basis of Payment. The accepted quantity of stone slab for back slope protection will be paid for at the contract unit price per square yard complete, including mortar of joints in place.

Excavation and backfill will be measured and paid for as provided in Section 206 — Structural Excavation.

Payment will be made under:

Pay Item	Pay Unit
611.06 Stone Slab for Backslope Protection	Square Yard

SECTION 612 — BITUMINOUS HAND SEALING

612.01 This work shall consist of sealing bituminous mix surfaces with emulsified bituminous sealing compound of the specified color applied at locations shown on the plans or designated by the Engineer.

MATERIALS

612.02 Materials. Bituminous material shall conform to the requirements of subsection 702.12.

CONSTRUCTION REQUIREMENTS

612.03 General. The sealing compound shall be applied in 2 coats. The first coat shall be diluted by the addition of up to 50 percent water to a liquid consistency and applied with brooms or other approved methods at a rate of 0.25 to 0.50 gallons of diluted sealer per square yard. The second coat shall be diluted only to the extent necessary to obtain workability and applied at a rate of 0.25 to 0.50 gallons of diluted sealer per square yard.

612.04 Method of Measurement. Bituminous hand sealing will be measured by the square yard of surface sealed measured parallel to the surface.

612.05 Basis of Payment. The accepted quantities of sealing will be paid for at the contract unit price per square yard complete in place.

Payment will be made under:

Pay Item	Pay Unit
612.06 Bituminous Hand Sealing — Black	Square Yard
612.07 Bituminous Hand Sealing — Green	Square Yard

SECTION 613 — PLANK CURB

613.01 Description. This work shall consist of the construction of wood plank curb where called for on the plans or directed by the Engineer.

MATERIALS

613.02 Materials. Plank curb shall be of sound, seasoned spruce or hemlock. Preservative oil shall be creosote oil, creosote petroleum or pentachlorophenol, conforming to the requirements of subsection 708.05.

CONSTRUCTION REQUIREMENTS

613.03 Plank Curb. The planks shall be treated with two coats of timber preservative after cutting but before fabricating.

The plank shall be placed and fastened together with splices. The splice shall be placed on the outside of the curb and shall be secured to each plank by galvanized spikes sufficiently long to extend through both plank and splice material clinched on the back. The plank shall not be fastened to the guard rail posts.

613.04 Shoulder. The surface of the shoulder from the inside of the plank curb to the edge of the roadway pavement shall be finished with bituminous surfacing as called for on the plans or designated. The surface material shall be placed against the plank curb and sloped upward to form a fillet to cause the water to pass along the shoulder away from the plank. This shoulder shall be satisfactorily rolled or tamped. The gutter shall be depressed at outlets to match the outlet sluice.

613.05 Method of Measurement. Plank curb will be measured by the linear foot complete in place and accepted.

613.06 Basis of Payment. The accepted quantities of plank curb will be paid for at contract unit price per linear foot complete in place. Payment for fillet surfacing on the shoulder will be made under the respective surface item.

Payment will be made under:

Pay Item	Pay Unit
613.07 Plank Curb	Linear Foot

SECTION 614 — METAL SLUICE

614.01 Description. This work shall consist of the construction of a half circle shaped, bituminous coated, metal sluice with metal baffle, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. The con-

struction of metal sluice shall include the assembly and erection of all component parts and materials complete at the locations shown on the plans or as directed.

MATERIALS

614.02 Metal Sluice. The sluice shall be of corrugated metal shaped to a half circle and bituminous coated in accordance with the requirements of subsection 707.03. Flanges at the sides of the sluice shall be formed of the metal sluice material or of steel angles bolted or welded to the sluice.

The entrance baffle shall be fabricated from metal sheets conforming to the same requirements as the sluice and shop welded to a short section of metal sluice as shown on the standard detail plans.

614.03 Rails and Stakes. The rails and stakes shall be of spruce or hemlock. Preservative oil shall be creosote oil, creosote petroleum or pentachlorophenol in accordance with subsection 708.05.

CONSTRUCTION REQUIREMENTS

614.04 All wood shall be treated with 2 coats of preservative oil after cutting but before fabricating.

A trench shall be excavated in the slope to provide a uniform firm bed and shaped to conform to the bottom of the sluice. Each metal sluice flange shall rest for its full length on wood rails and shall be attached to them by the use of spikes. Rails shall be spliced at the location of stakes and shall not be spliced opposite a splice in the rail on the opposite side of the sluice. Stakes shall be driven on each side and fastened to the rails with 2 spikes. When metal sluices are installed with plank curb the upper end of the sluice shall be fitted to the curb and the joint shall be tightly caulked with oakum. When other types of curbing are used, the sluice shall be fitted as shown on the plans. Backfill material shall be tamped firmly around the sluice. Excess material shall be disposed of as directed.

614.05 Method of Measurement. Metal sluice will be measured by the linear foot measured along the center line of the sluice installed in place and accepted. Measurement shall not include that section of sluice attached to the baffle. Metal sluice entrance baffle will be measured as units of each kind installed and accepted. Sluice laid in excess of the authorized length will not be measured for payment.

614.06 Basis of Payment. The accepted quantities of metal sluice will be paid for at the contract unit price per linear foot complete in place. Metal sluice entrance baffle will be paid for at the contract unit price per each complete in place. Necessary excavation for the installation of metal sluice and baffles shall be considered incidental to the items.

Payment will be made under:

Pay Item	Pay Unit
614.07 Metal Sluice	Linear Foot
614.08 Metal Sluice Entrance Baffle	Each

SECTION 615 — LOAM

615.01 Description. This work shall consist of furnishing and placing loam topsoil for seeding or sodding, in reasonably close conformity with the thicknesses called for on the plans or as authorized by the Engineer.

MATERIALS

615.02. The loam shall consist of good quality topsoil obtained from approved sources within the construction limits or outside the right of way. It shall be free of large stones, large clods, roots of trees or shrubs or other foreign matter. Muck, peat, or other excessively acid soil shall not be used unless called for on the plans, special provisions or directed.

CONSTRUCTION REQUIREMENTS

615.03 Preparing Areas. All slopes and other areas where loam is required shall be trimmed and shaped to the required grade. Before placing the loam, the areas under preparation shall be scarified along the contour or otherwise loosened to a depth of at least two inches if hard or compacted.

615.04 Placing Loam. Loam shall be spread on the prepared areas to the uniform depth shown on the plans or as directed. Any remaining clods, roots, stones over two inches in its greatest diameter, or any other foreign matter, shall be removed. Loam shall be brought to a true, even surface, meeting the required grade. On all areas to be seeded according to Method Number 1 as specified in subsection 618.09 (a). All rocks over 1 inch in diameter shall be removed.

615.05 Method of Measurement. Loam will be measured by the cubic yard measured in place after finishing to the

depths as shown on the plans or directed. All lateral measurements shall be taken parallel with the slope of the ground.

Acceptable topsoil existing within the limits of construction may be salvaged and used as loam. If this causes an increase in the amount of other fill material necessary to construct embankments, the Contractor shall furnish such material without cost to the State. The amount of material required to replace the loam so used shall be equal to the measured quantity of loam from this source measured by generally accepted engineering methods with no allowance for shrinkage or swellage.

615.06 Basis of Payment. The accepted quantities of loam will be paid for at the contract unit price per cubic yard complete in place.

Payment will be made under:

Pay Item	Pay Unit
615.07 Loam	Cubic Yard

SECTION 616 — SODDING

616.01 Description. This work shall consist of furnishing and placing approved live sod on a bed of suitable soil for the protection of slopes, drainage ways, and other areas as called for on the plans or as authorized.

MATERIALS

616.02 Materials. Materials shall meet the requirements in the following subsections of Section 700 — Materials:

Fertilizer	712.26
Agricultural Limestone	712.27

The sod shall consist of a dense, well rooted, vigorous growth of turf forming perennial grasses indigenous to the general locality where it is to be used. Sod shall be taken from approved sources where the soil is of such character that the sod will not break or crumble during cutting, transportation, or laying. Sod shall be reasonably free from noxious weeds, annual grasses, moss, large stones, tree roots, or other materials harmful to growth, or that will interfere with future mowing or other maintenance of the sodded areas.

Pegs for holding sod shall be of approved sound wood and be at least $\frac{3}{4}$ inch in thickness, square or round, and at least 12 inches long.

CONSTRUCTION REQUIREMENTS

616.03 Cutting and Transporting. The area from which sod is to be cut shall be mowed to a height of approximately two inches and cleared of excess grass clippings and other foreign matter shortly before sod cutting starts. The sod shall be cut in strips of uniform width having a minimum width of 12 inches and length of not less than 18 inches. The sod shall be cut to a uniform minimum thickness of approximately 2 inches unless otherwise directed and shall contain the majority of the feeding roots of the grasses.

The sod shall be freshly cut by means of an approved sod cutter and transported in an unbroken condition to the area to be sodded. Sod shall be loaded and unloaded by hand and placed in its final position promptly after cutting. No storage of sod will be allowed unless specifically authorized by the Engineer. Cut sod shall be prevented from drying by being protected from sun and wind during the time between cutting and placing.

616.04 Site Preparation. Sod will usually be placed over loam. Before delivery of the sod, areas to be sodded shall be brought to the grades shown on the plans, allowing for the thickness of the sod. Areas to be sodded shall be cleared of large stones, roots, clods, and other debris that might interfere with laying sod or subsequent maintenance of the sodded area. Fertilizer and lime shall be applied at the rate of not less than 30 pounds per 1,000 square feet for fertilizer and not less than 25 pounds per 1,000 square feet for lime. Hard packed soil shall be scarified, harrowed, or otherwise loosened to a depth of at least 2 inches before laying sod, unless otherwise directed.

616.05 Laying Sod. Sod shall be moist when laid and shall be placed on a moist soil bed. The sod shall be placed at right angle to the flow of water, commencing at the lower end and tightly fitted edge to edge to provide a uniform surface. Transverse joints shall be staggered. Any gaps shall be filled with sod plugs or loam to produce a tight surface.

The inlet edges of sod in waterways and other edges exposed to water scour, shall be turned down and buried to a depth of at least 3 inches with tamped earth. Where the sod is in danger of being displaced during sodding operations the workmen shall work from ladders or planks.

The sod shall be compacted and bonded to the soil with an approved tamper or light roller. After tamping or rolling the sod shall present a smooth, even surface free from humps and depressions and true to grade.

In drainage ways and on 2 to 1 slopes or steeper, the sod shall be pegged with wooden pegs unless otherwise directed. The pegs shall be spaced not over two feet apart in any direction and driven through the sod into the ground approximately perpendicular to the ground surface. The top of the pegs shall be driven flush with the surface of the sod.

During July and August and during periods of drought, the Contractor may place sod only if he will water the sod and insure continued growth of the grasses. Sod placed during such time and not surviving shall be removed and replaced by the Contractor at his expense.

Frozen sod shall not be used, nor shall sod be placed upon frozen soil.

616.06 Method of Measurement. Sodding will be measured by the square yard, measured along the slope, complete in place.

616.07 Basis of Payment. The accepted quantities of sodding will be paid for at the contract unit price per square yard complete and accepted in place, which price shall include supplying and applying fertilizer and limestone. Necessary excavation will be paid for under Section 203 — Excavation and Embankments.

Payment will be made under:

Pay Item	Pay Unit
616.08 Sodding	Square Yard

SECTION 617 — EROSION CONTROL MESH

617.01 Description. This work shall consist of furnishing and placing erosion control mesh in waterways and on other areas as called for on the plans or as authorized.

MATERIALS

617.02 Materials. Materials shall meet the requirements specified in the following subsection of Section 700 — Materials.

Erosion Control Mesh 712.30

Loam shall meet the requirements of Section 615 — Loam.

CONSTRUCTION REQUIREMENTS

617.03 Loaming. All areas to be covered with erosion control mesh shall have a prepared bed of loam brought to

the proper grade. The loam upon which the mesh is to be placed shall be loose, smoothly raked and free of all stones, litter or irregularities which will prevent the mesh from close contact with the ground.

617.04 Seeding. Seeding, fertilizing and liming shall be as specified in Section 618 — Seeding, Method Number 2.

Applying hay mulch will be required only if directed by the Engineer.

617.05 Installation. Erosion control mesh shall be applied over the specified area after the seeding has been completed or as directed. Strips shall be rolled on in the direction of the flow of water. Where strips are laid parallel to each other they shall overlap at least 4 inches. Ends shall overlap at least 6 inches. Overlapping shall be done with the upgrade section on top. The up-slope end of each strip of the mesh shall be turned down and buried with the soil firmly tamped against it. The Engineer may require that other edges of the mesh exposed to more than normal flow of water be buried to a vertical depth of not less than 6 inches.

Check slots shall be placed between the ends of strips by inserting a tight fold of the mesh into the ground. These shall be tamped and stapled the same as up-slope ends. Check slots must be spaced so that one check slot or one end occurs within each 50 feet of length of erosion control mesh.

Edges of mesh placed around catch basins and adjacent to structures shall also have the edges buried to a depth of 6 inches.

After the mesh has been spread evenly and smoothly so that it is in close contact with the ground at all points it shall be pressed into the ground with a light lawn roller or by other means.

The mesh must be held tightly to the soil by staples driven vertically into the ground and spaced as shown on the plans.

617.06 Maintenance. The Contractor shall maintain the installation during the life of the contract and shall repair any damage due to excess flow of water or any other cause.

617.07 Method of Measurement. Erosion control mesh will be measured by the area in square yards measured along the slope of the ground.

617.08 Basis of Payment. The accepted quantities of erosion control mesh will be paid at the contract unit price per square yard.

Loam, seed and mulch will be paid for as provided in Section 615 — Loam, Section 618 — Seeding, and Section 619 — Hay Mulch.

Payment will be made under:

Pay Item	Pay Unit
617.09 Erosion Control Mesh (Standard)	Square Yard
617.10 Erosion Control Mesh (Heavy Duty)	Square Yard

SECTION 618 — SEEDING

618.01 Description. This work shall consist of preparing the soil and furnishing and applying lime, fertilizer and grass seed to areas indicated on the plans or authorized by the Engineer.

Seeding, Method Number 1 — Soil preparation, and application of "Park Mixture" to loamed areas such as lawns and traffic islands.

Seeding, Method Number 2 — Soil preparation, and application of "Roadside Mixture" to loamed or unloamed areas such as slopes and medians.

MATERIALS

618.02 Materials. Materials shall meet the requirements in the following subsections of Section 700 — Materials.

Fertilizer	712.26
Agricultural Limestone	712.27
Seed	712.28

CONSTRUCTION REQUIREMENTS

618.03 Rates of Application. Agricultural limestone shall be applied at the rate of 25 pounds per unit (1,000 square feet), each method.

Fertilizer shall be applied at the rate of 30 pounds per unit (1,000 square feet), each method.

The seed mixture shall be sown at the rate of 3 pounds per unit (1,000 square feet), each method.

618.04 Time of Seeding. The recommended seeding periods are from April 1 to June 1, and from August 15 to October 1. The Contractor may seed at other times. Regardless of the time of seeding, he shall be responsible for a full growth of grass. When directed he shall re-fertilize and re-

seed areas on the project which do not develop a satisfactory growth of grass. Re-fertilizing and re-seeding shall be incidental to the original seeding item requirements.

618.05 Fertilizing and Liming — Conventional Method. Fertilizing and liming shall be done when the soil is in a moist condition and at least 24 hours before sowing the seed. The fertilizer and lime shall be applied to the soil by means of a mechanical spreader or other approved method capable of maintaining a uniform rate of application and shall be thoroughly harrowed, raked or otherwise mixed with the soil to a depth of not less than 1 inch. The fertilizer and lime shall not be applied together unless applied hydraulically.

618.06 Sowing Seed — Conventional Method. Grass seed of the required mixture and quality shall be sown by a mechanical seeder or other method which will sow the seed uniformly at the required rate over the entire area to be seeded. The mechanical seeder shall be capable of being operated to avoid the growth of grass in rows and shall be so operated. After seeding, all areas shall be lightly raked by hand to mix the seed and topsoil unless seeding is to be followed by mulching within 24 hours as specified in subsection 618.08. Lawn areas shall be rolled with a light lawn roller.

618.07 Distributing Seed and Fertilizer by the Hydraulic Spray Method. The hydraulic spray method of sowing seed may be used where approved by the Engineer. This work shall be done with an approved machine operated by a competent crew. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates. If the Engineer finds the application uneven or otherwise unsatisfactory, he may require the hydraulic spray method to be abandoned and the balance of the work done as specified under subsections 618.05 and 618.06. Seed must be lightly raked into the surface of the soil unless seeding is to be followed within 24 hours by mulching.

618.08 Mulching. Where called for, hay or straw mulch shall be applied as specified in Section 619 — Hay Mulch.

Mulch will normally be applied directly after sowing the seed but, where hydraulic seeding is to be used, the Engineer may direct that mulch be applied upon completion of the

grading, with hydraulic seeding to follow the mulching at the proper season.

618.09 Construction Method.

(a) Method Number 1.

1. Preparing the Soil: After the areas to be seeded have been brought to grade and loamed as specified in Section 615 — Loam, the soil shall be harrowed or otherwise loosened, if necessary, to bring the top 2 inches to a loose, friable condition. On freshly graded areas the Engineer may allow the harrowing to be omitted if, in his judgment, the surface soil is soft enough to provide a loose bedding for the seed. The area shall be left with a true, uniform, smooth surface. The Engineer may require hand raking unless a satisfactory surface is produced by other means.

2. Fertilizing and Liming: Fertilizer and lime shall be applied to the prepared area as called for under subsections 618.05 or 618.07.

3. Sowing Seed: The Park Mixture of seed shall be sown on the prepared area as called for under subsections 618.06 or 618.07. Unless hay mulch is to be used, seed, fertilizer and lime will be applied as called for under subsections 618.05 and 618.06 unless otherwise directed by the Engineer.

4. Mulching: Where directed, hay or straw mulch will be applied as specified under subsection 618.08.

(b) Method Number 2.

1. Preparing the Soil: After the areas to be seeded have been brought to a true, uniform grade, all ground that is not loose and friable shall be scarified to a depth of at least 2 inches immediately before seeding or mulching. All stones over 4 inches in greatest diameter, and all objects which would be detrimental to mowing, shall be removed and disposed of as approved. Hand raking will not be required provided an acceptable surface can be accomplished by other means.

2. Fertilizing and Liming: Fertilizer and lime shall be applied on the prepared area as specified in subsections 618.05 or 618.07 unless otherwise called for on the plans or as directed.

3. Sowing Seed: The Roadside Mixture of seed shall be sown as specified under subsections 618.06 or 618.07 unless otherwise called for on the plans or as directed.

4. Mulching: Hay or straw mulch will be used as specified under subsection 618.08 unless otherwise called for on the plans or as directed.

618.10 Maintenance. The Contractor shall maintain each seeded area until complete acceptance of the individual area. Maintenance shall consist of providing protection by erecting approved warning signs or barriers and by repairing any areas damaged due to wind, water, fire, vehicles or any other causes. Damaged areas, or areas which do not produce satisfactory growth, shall be repaired to reestablish the condition and grade of the area prior to seeding and re-fertilized and re-seeded as specified for the original work as many times as necessary to produce satisfactory results except as hereinafter provided.

When all other work on the project has been completed and some seeded areas are still in an unsatisfactory condition, the Contractor shall be held responsible for these areas for an additional 60 days, exclusive of the period from November 15th to April 15th, inclusive. The contract may be terminated at any time all seeded areas become acceptable. If, at or near the termination of the 60 day period, unsatisfactory areas still remain the Engineer may, at his option, direct a final re-seeding by the Contractor or deduct the contract value of the unsatisfactory area from money due the Contractor. In either event the Contractors' responsibility for the seeded areas shall terminate at this point and the contract may be accepted as complete.

618.11 Method of Measurement. Seeding will be measured by the area of seeded surface in units of 1,000 square feet measured along the slope of the ground.

618.12 Basis of Payment. The accepted quantities of seeding will be paid for at the contract unit price per unit for the method specified which price shall include furnishing and spreading limestone, fertilizer and seed.

(a) Condition of Payment. Upon completion of seeding the amount due for these items shall be payable. The Engineer may, at his discretion, accept any individual area showing a reasonably thick, uniform stand of grass free from sizeable thin or bare spots. Upon acceptance of each area, the Contractor will be relieved of further responsibility for maintaining the area or repairing damage other than that resulting from his own or subcontractors' operations.

Loam and mulch will be measured and paid for as provided in Section 615 — Loam and Section 619 — Hay Mulch.

Payment will be made under:

Pay Item	Pay Unit
618.13 Seeding, Method Number 1	Unit
618.14 Seeding, Method Number 2	Unit

SECTION 619 — HAY MULCH

619.01 Description. This work shall consist of furnishing and applying hay or straw for covering slopes and other designated areas with a mulch conforming to the requirements of this Section.

MATERIALS

619.02 General. Mulch material shall consist of long fibred hay or straw reasonably free from noxious weeds or other undesirable material. No material shall be used which is so wet, decayed, or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibred material shall be used unless directed.

619.03 Mulch Binder. This material shall be emulsified asphalt, of a type acceptable to the Engineer, meeting the requirements of subsection 702.04. The emulsion may be diluted sufficiently with water to assure even distribution and complete coverage of the mulch.

CONSTRUCTION REQUIREMENTS

619.04 General. Hay mulch shall be spread evenly and uniformly over the designated areas. Unless otherwise directed, mulch shall be applied at the rate of two to three tons per acre. Too heavy application of mulch shall be avoided and lumps and thick spots shall be thinned. The hay shall be anchored in place by uniformly applying a fine spray of emulsified asphalt at the rate of approximately 200 gallons per acre except that on slopes 2 to 1 or steeper and higher than 10 feet measured vertically the Engineer may require a rate of approximately 300 gallons per acre. The application of emulsified asphalt from a nozzle causing a concentrated stream of liquid will not be allowed. Other methods of anchoring the hay may be used subject to the approval of the Engineer.

619.05 Maintenance. The Contractor shall maintain the mulched areas, repair any damage and correct any shifting due to wind, water, or other causes until acceptance of any given area. He shall supply additional mulch necessary as a result of damage or seed failure. Repairs to mulched areas and furnishing of additional mulch shall be incidental to this item.

619.06 Method of Measurement. The quantity of hay mulch to be measured for payment shall be the number of

tons (2,000 pounds) satisfactorily applied, computed from delivery slips as specified in subsection 109.01. Hay shall be weighed when seasoned and thoroughly air dried to the extent that when tested it will burn readily.

619.07 Basis of Payment. The accepted quantities of hay mulch will be paid for at the contract unit price per ton which price and payment shall include supplying and applying emulsified asphalt mulch binder.

Payment will be made under:

Pay Item	Pay Unit
619.08 Hay Mulch	Ton

SECTION 620 — PLANTING STREET TREES

620.01 Description. This work shall consist of furnishing, delivering, planting and caring for trees in accordance with these specifications and in conformity with the plans, or as directed by the Engineer.

MATERIALS

620.02 Materials. Materials shall meet the requirements of the following subsections of Section 700 — Materials.

Trees	712.29
Tree Paint	708.04

Posts for supporting trees shall be of sound, straight spruce wood, or equivalent, 2 inches minimum diameter, at least 8 feet long, free of bark and notched near the top to hold wire.

Stakes for holding guy wires shall be of sound, straight hard pine or approved equal, 2½ inches thick, round or rectangular and at least 24 inches long, notched near the top to hold wire.

Guy wire shall be number 10 gauge galvanized iron wire or an approved equivalent.

Fertilizer shall be an approved base fertilizer of 10-10-10 or similar composition.

Mulch for trees shall consist of wood chips, peat moss, pea stone or other material approved by the Engineer. Sawdust, hay or straw will not be approved.

Trunk wrapping material shall be in the form of strips of approved burlap or heavy waterproof paper.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

CONSTRUCTION REQUIREMENTS

620.03 Planting. All planting of trees shall be done between April 1st and June 15th or between September 1st and November 15th unless otherwise directed by the Engineer. The Contractor shall notify the Engineer not less than 48 hours in advance of the start of planting operations. Trees shall be planted at the same depth in relation to the existing ground level at which they were previously growing, unless otherwise directed. Not less than 12 inches of loam, shall be placed around and under the rootball. The loam shall be firmed, leaving no air pockets, and thoroughly saturated with water until it is well settled in place.

(a) *Fertilizing.* Fertilizer shall be spread evenly over the surface area of the plant pit at the rate of 2 pounds per inch of caliper of the tree trunk and shall be raked into the surface of the soil.

(b) *Pruning.* All trees shall be pruned at the planting site at the time of planting as directed by the Engineer. All pruning shall be done with sharp tools by experienced men, in accordance with the best horticultural practice. Dead, diseased, or injured twigs and branches shall be removed. In order to restore a normal balance between top and roots, hardwood trees shall be thinned by removing uniformly scattered, selected twigs and branches which shall be cut back to a main branch or the trunk of the tree. Cuts shall be made flush with the main branch or trunk. All cuts over $\frac{3}{4}$ inch diameter shall be painted with approved tree paint. The tips of evergreens shall be pruned as directed by the Engineer. The tips of hardwoods may also be required to be pruned in addition to thinning. Trees pruned in such a manner as to seriously impair the appearance or character of the plant will be rejected and must be replaced at the Contractor's expense.

(c) *Watering.* At the time of planting, trees shall be thoroughly watered to the point where the entire rootball and the surrounding earth are well saturated. Each tree shall receive two more heavy waterings at intervals of 1 week to 10 days unless heavy rains intervene. Waterings will continue as needed to keep the trees in healthy growing condition until final acceptance.

(d) *Mulching.* The ground surface over the entire area of the planting pit shall be evenly covered to a uniform depth of 3 inches with mulch material, after complete removal of all grass and weeds.

(e) *Supports.* All trees over 1 inch in caliper or over 6 feet in height shall be staked or guyed.

1. Deciduous trees up to 8 feet high shall be supported by one post set on the side of the prevailing wind or as directed by the Engineer. Posts shall be firmly set at least 24 inches into the ground and as close to the tree trunk as possible without injuring the roots or bark. The top of the post shall be fastened to the tree by a wire passing through a sound piece of garden hose in such a manner as to prevent injury to the tree.

2. Deciduous trees 8 to 12 feet in height and evergreens 6 to 8 feet tall shall each be staked with two posts placed on opposite sides of the tree and set firmly at least 24 inches in the ground. The posts shall be at the perimeter of the rootball. The top of the posts shall be fastened as in 1 above.

3. Larger trees shall be guyed with three guys arranged evenly about the tree. Each guy shall consist of two strands of wire twisted together until taut. Guys shall be attached to the trunk of the tree directly above a substantial limb at a height sufficient to give adequate support and attached to stakes firmly driven into the ground at such distance from the tree that the guy wires shall be at an angle of approximately 45 degrees with the ground. The wire used for guying or staking shall be passed through a sound piece of garden hose of sufficient length and thickness to prevent cutting or chafing of the bark of the trunk or branches. Stakes shall not project for than 8 inches above the ground. Where guy wires may be a hazard to pedestrians or be too difficult to install, the Engineer may require that three or more posts shall be used in place of guy wires.

Where required by the Engineer, a strip of approved, durable, white or red cloth, 2 inches wide and at least 12 inches long, shall be firmly tied to each guy wire at a point approximately 2 feet above ground.

(f) *Wrapping.* Wrapping shall be placed around all trunks of deciduous trees 3 inches or more in diameter. The wrapping shall start at the base of the tree, shall cover the entire trunk surface, and shall terminate not lower than at the first branches. The wrapping shall be tied with approved twine at top, bottom, and at intervals of not more than 2 feet. Wrapping shall be done promptly after planting.

(g) *Clean-up and Repair.* Immediately after planting the Contractor shall carefully clean up the area and repair any damage caused by his operations. Excavated soil and other debris shall be disposed of as directed.

(h) *Maintenance.* It shall be the Contractor's responsibility to protect and care for the trees during the life of the contract. He shall take such steps as necessary to keep the trees in healthy, vigorous growing conditions, including watering, weeding, fertilizing, spraying with approved insecticides or fungicides, providing protection from rodents, or such other items as the Engineer may require.

620.04 Guarantee. All trees shall be guaranteed for a period of 2 years from the date of completion of the project. It will be the responsibility of the Contractor to see that the trees are kept in a healthy growing condition during this period. Any tree that dies during this period, or any tree, a sizeable portion of which dies or becomes unhealthy so as to present an undesirable appearance, shall be removed by the Contractor as soon as his attention is called to it by the Engineer. Such trees shall be replaced at the next subsequent planting season by trees meeting the requirements of this specification for the tree replaced.

620.05 Method of Measurement. Street trees planted and guaranteed as specified will be measured by the single tree unit.

620.06 Basis of Payment. The accepted quantities of street trees will be paid for at the contract unit price per each complete in place, which price and payment shall be full compensation for furnishing stock, excavating, loading, delivering, planting, fertilizing, watering, staking, guying, pruning, wrapping, and for all loam and other incidentals necessary.

The accepted quantity of Guarantee and Replacement of Trees will be paid for at the contract unit price per each, which price and payment shall be full compensation for guarantee of survival of trees under the related item and for furnishing and planting all necessary replacements.

Payment will be made under:

Pay Item	Pay Unit
620.07 Sugar Maple (<i>Acer Saccharum</i>) or Norway Maple (<i>Acer Platanoides</i>) 3 inch - 4 inch caliper	Each
620.08 Guarantee and Replacement of Item 620.07	Each

620.09 European Mountain Ash (<i>Sorbus Aucuparia</i>) 8 feet - 10 feet high	Each
620.10 Guarantee and Replacement of Item 620.09	Each
620.11 Japanese Flowering Crab (<i>Malus Floribunda</i>) or Hopa Crab (<i>Malus Hopa</i>) 6 feet - 8 feet high	Each
620.12 Guarantee and Replacement of Item 620.11	Each

SECTION 621 — LANDSCAPING

This section is reserved for landscape use. Specifications and Item Numbers will be written and assigned for each individual project and inserted in the Proposal Book.

SECTION 622 — TRANSPLANTING SHRUBS, HEDGES AND TREES

622.01 General. This work shall consist of digging, moving and replanting existing shrubs, hedges and trees in accordance with these specifications, and in conformity with the plans or as directed by the Engineer.

MATERIAL

622.02 Loam. Loam shall conform to the requirements of Section 615 — Loam. Fertilizer shall meet the requirements specified in subsection 712.26.

CONSTRUCTION REQUIREMENTS

622.03 Shrubs and Hedges.

(a) *Digging.* All shrubs and hedges to be moved shall be carefully hand-dug with a solid ball of earth encompassing the roots as is customary in good nursery practice. Minimum size of the rootball shall be as indicated in the current edition of the "American Standard for Nursery Stock" sponsored by the American Association of Nurserymen, Inc.

(b) *Moving.* The earth rootball shall be maintained as a solid unit during the moving of the shrubs and hedges and must be protected from breaking or cracking by careful handling. The rootball shall be tightly wrapped with burlap or similar material. Earth rootballs greater than 18 inches in diameter shall be tightly bound with cord or rope

placed over the burlap unless shrubs and hedges are to be replanted immediately after digging.

(c) *Planting.* The plants shall be planted in the designated new location at the same depth in relation to the ground surface as before they were moved. Loam shall be placed to a thickness of not less than 8 inches under and around the rootball, and shall be carefully worked and firmed around the rootball so as to eliminate all air pockets and to support the plant. Insofar as feasible, when hedges are to be transplanted, the individual plants shall be replanted in the same relationship to each other that existed before they were moved.

Fertilizer shall be spread evenly over the surface of the planted area at the rate of $\frac{1}{4}$ of a pound per foot of height for each plant, and shall be raked into the surface of the soil.

(d) *Time of Transplanting.* Plants shall be dug and transplanted only when dormant, preferably in the early spring, unless otherwise directed by the Engineer. When dug, shrubs and hedges shall be moved directly to the final planting site and planted without delay. The rootball must be kept moist at all times during transplanting operations. If construction makes it impossible to replant the plants immediately after digging, the rootballs of the plants shall be kept completely covered with a thick layer of earth, hay, peat moss, or similar material which shall be kept moist at all times while the plants remain unplanted.

(e) *Pruning.* All pruning shall be done with sharp tools by experienced men in accordance with the best horticultural practice. Dead, diseased or injured shoots and branches shall be removed. In order to restore a normal balance between top and roots, deciduous shrubs shall be thinned by removing uniformly scattered, selected branches which shall be cut back to a main stem, as directed by the Engineer. The Engineer may require tip pruning in addition. Tip pruning may also be required for evergreens. In the case of hedges, the Engineer may require shearing to uniform, even surfaces.

(f) *Watering.* As soon as the plants are planted they shall be thoroughly watered to the point where the rootball and the surrounding earth are well saturated.

(g) *Mulch.* After removing all weeds and grass the ground surface over the entire area of the planting pit shall be covered to a depth of 2 inches with a mulch of wood chips, peat moss or other material approved by the Engineer. Sawdust, hay, or straw will not be accepted as mulching material.

622.04 Trees.

(a) *Digging.* All trees to be moved and replanted shall be dug with a solid ball of earth encompassing the roots as is customary in good nursery practice. Diameter of the ball shall be not less than ten times the diameter of the trunk of the tree measured 1 foot above the surface of the ground. Depth of the ball shall be not less than 60 percent of its diameter for balls up to 48 inch diameter. For balls over 48 inch diameter the ball shall have sufficient depth to maintain a solid structure and to encompass all the feeding roots under the ball area. Power shovels and similar machinery may not be used in digging the ball except with written permission from the Engineer.

(b) *Moving.* The ball must be maintained as a solid unit during the moving of the tree. It must be protected from breaking or cracking by careful handling and by being tightly bound with cord or rope over canvas, burlap or similar wrapping. The ball shall be firmly attached to a tree platform of suitable size during moving operation, if required by the Engineer.

(c) *Planting.* The trees shall be planted in the designated new location at the same depth in relation to the ground surface as before they were moved. Good quality loam shall be placed to a distance of not less than 12 inches under the ball and around the periphery of the ball. Loam shall be puddled and firmed in place to eliminate all air pockets and give adequate support to the ball. An approved fertilizer of 10-10-10 or similar composition shall be spread evenly over the surface area of the plant pit at the rate of 2 pounds per inch of caliper of the tree trunk and shall be raked into the surface of the soil.

(d) *Protection.* Every care shall be taken to prevent injury to the tree during the transplanting operation. All parts of the tree shall be carefully protected. Branches shall be tied out of the way of possible injury. No chain, cable or heavy rope may be attached to the trunk or branches without protective padding adequate to prevent bruising or other injury.

(e) *Time of Transplanting.* Trees shall be dug and transplanted only when dormant, preferably in the early spring, unless otherwise directed by the Engineer. When dug, trees shall be moved directly to the final planting site and planted without delay. The ball must be kept moist at all times during transplanting operations. If construction problems make it impossible to replant the tree immediately after digging, the

ball of the tree must be completely covered with a thick layer of earth, hay, peat-moss or similar material which shall be kept moist at all times while the tree remains unplanted.

(f) *Pruning.* All pruning shall be done with sharp tools by experienced men in accordance with the best horticultural practice. Dead, diseased or injured branches shall be removed. In order to restore a normal balance between top and roots, hardwood trees shall be thinned by removing uniformly scattered selected branches which shall be cut back to a main branch or the trunk of the tree as directed by the Engineer. Cuts shall be made flush with the main branch or trunk. All cuts over $\frac{3}{4}$ inch diameter shall be painted with approved tree paint. Evergreens shall be tip-pruned as directed by the Engineer. Tip-pruning of hardwoods may also be required in addition to thinning.

(g) *Watering.* As soon as trees are planted they shall be thoroughly watered to the point where the ball and the surrounding earth are well saturated.

(h) *Mulch.* The ground surface over the entire area of the planting pit shall be covered to a depth of at least 3 inches with a mulch of wood chips, peat moss or other material approved by the Engineer, after removing all weeds and grass. Sawdust, hay or straw will not be accepted as mulch material.

(i) *Supports.* All trees shall be guyed with 3 guys arranged evenly about the tree. Each guy shall consist of 2 strands of No. 10 gauge galvanized iron wire or approved equivalent, twisted together until taut. Guys shall be attached to the bole of the tree directly above a substantial limb at a height sufficient to firmly support the tree, and attached to stakes firmly driven into the ground at such a distance from the tree that the guy wires shall be at an angle of approximately 45 degrees with the ground. The wire used for guying or staking shall be passed through a piece of sound garden hose or approved substitute of sufficient length and thickness to prevent cutting or chafing of the bark of the trunk or branches. Stakes shall be not less than 3 inch diameter and shall be driven not less than 2 feet into the ground.

622.05 Maintenance. It shall be the Contractor's responsibility to protect and care for the plants during the life of the contract. They shall be watered weekly during dry weather unless rains intervene or the Engineer directs otherwise. The Contractor shall take such steps as required to protect the plants from damage and from diseases and insect pests.

Should any damage occur it shall be repaired by the Contractor, according to the best horticultural practice.

622.06 Replacement. If the ball is badly broken or the plants are otherwise badly damaged or if, in the opinion of the Engineer, during the life of the contract the plants show such signs of loss of health as a result of transplanting operations that any appear to be in danger of dying, the Contractor will be required to replace the plants with others of the same size and variety or approved plants of equal value, at the proper season.

622.07 Method of Measurement. Transplanting hedges will be measured by the linear foot in place after transplanting, measured from the extremities of the branches at each end transplanted as specified. A hedge shall be defined as an evenly spaced row of plants of uniform size, growing in close proximity to each other so that the branches are intermingled.

Transplanting shrubs or trees will be measured by the unit transplanted as specified.

622.08 Basis of Payment. The accepted quantities of transplanting hedges will be paid for at the contract unit price per linear foot of hedges properly transplanted and accepted, which price and payment shall include digging, binding, moving, replanting, pruning, mulching, care and maintenance, and if required, replacement of the hedges, and for all loam, mulch, other materials, and for all incidentals necessary to complete the item.

The accepted quantities of transplanting shrubs or trees will be paid for at the contract unit price for each plant properly transplanted and accepted, which price and payment shall include digging, binding, moving, replanting, pruning, mulching, care and maintenance, and if required, replacement of the shrubs, and for all loam, mulch, and other materials, and for all incidentals necessary to complete the item.

Payment will be made under:

Pay Item	Pay Unit
622.09 Transplanting Hedges	Linear Foot
622.10 Transplanting Shrubs	Each
622.11 Transplanting Trees	Each

SECTION 623 — MONUMENTS

623.01 Description. This work shall consist of furnishing and placing or removing and resetting right-of-way monu-

ments and survey monuments at locations shown on the plans or designated by the Engineer in accordance with the plans and specifications and at locations established by the Engineer.

MATERIALS

623.02 Materials. Monuments shall be of granite or of reinforced portland cement concrete. When of granite, the stone shall be of a quality conforming to the requirements of subsection 712.04 (a). When of portland cement concrete, they shall be of Class "Y" concrete as specified in Section 502 — Structural Concrete. The steel used shall conform with the requirements of Section 503 — Reinforcing Steel.

CONSTRUCTION METHODS

623.03 General. Monuments shall be placed in vertical positions in excavated holes at depths shown on the plans, or designated by the Engineer, with 2 sides approximately parallel with the roadway. The depth shall be dependent upon the usage of the ground in which the monument is to be set. The backfill material shall be placed in layers not exceeding 8 inches in depth, loose measure, and firmly tamped.

When removing and resetting monuments special care shall be taken that the stone shall not be broken or damaged. Monuments broken or damaged by the Contractor shall be replaced with monuments of similar type, without added compensation.

When a monument is to be set and it is found that ledge rock exists below ground, it will be permissible to cut off the monument at an authorized length to allow setting on the ledge. A concrete collar with dowels shall be placed around the monument to secure it to the ledge, as shown on the plans. If the ledge is rough enough to provide a firm attachment for a concrete collar no dowels will be necessary. The cement concrete shall meet the requirements of Section 502 — Structural Concrete. The class concrete shall be optional.

When a monument is to be set in surface exposed ledge it shall consist of a bronze pin marker embedded in the ledge as shown on the plans.

623.04 Method of Measurement. Monuments and markers, both new and reset, will be measured by the single unit. Excavation in solid rock will be measured by the cubic yard determined from the actual depth of the hole and a hypothetical diameter of 2 feet.

623.05 Basis of Payment. The accepted quantities of right-of-way monuments, survey monuments and bronze pin markers will be paid for at the contract unit price per each complete in place. Placement of monuments in ledge shall be considered incidental to the contract unit bid price except that actual excavation in solid rock will be paid for under Item 206.07 — Structural Rock Excavation - Drainage and Minor Structures.

Payment will be made under:

Pay Item	Pay Unit
623.06 Right-of-Way Monuments	Each
623.07 Survey Monuments	Each
623.08 Bronze Pin Markers	Each
623.09 Remove and Reset Monuments	Each

SECTION 624 — PROJECT MARKERS

624.01 Description. This work shall consist of the construction of project markers in accordance with these specifications and at locations designated by the Engineer.

MATERIALS

624.02 Materials. Concrete for project markers shall meet the requirements of Section 502 — Structural Concrete, Class "Y". The concrete shall be satisfactorily rubbed.

Steel for reinforcing shall meet the requirements of Section 503 — Reinforcing Steel.

CONSTRUCTION REQUIREMENTS

624.03 General. The project markers shall be precast of portland cement concrete with steel reinforcing, in conformity with the dimensions shown on the plans.

The letters and numerals designating the project shall be placed on the face designated by the Engineer and shall be indented into the concrete by using beveled castings attached to the forms before placing the concrete. All letters and numeral markings shall be painted with an approved black enamel paint or black concrete paint.

The project markers shall be set at each end of the project with the narrow face facing the highway in the required location, and the project number markings facing toward the project. They shall be set in a vertical position extending 4

feet into the ground and the backfill thoroughly tamped in place. When placed in ledge they shall be set as specified in subsection 623.03.

624.04 Method of Measurement. Project markers will be measured by the unit complete in place.

624.05 Basis of Payment. The accepted quantities of project markers will be paid for at the contract unit price per each complete in place. Placement of monuments in ledge shall be considered incidental to the contract unit bid price except the excavation in solid rock will be paid for under Item 206.07 — Structural Rock Excavation - Drainage and Minor Structures and allowance will be made for holes 2 feet in diameter for the depth of the rock actually removed.

Payment will be made under:

Pay Item	Pay Unit
624.06 Project Markers	Each

SECTION 625 — WATER SERVICE SUPPLY LINES

625.01 Description. This work shall consist of the installation of water pipe and pipe sleeve of the sizes designated. Such work shall be in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. The installation shall include the assembly of all components and materials at the locations shown on the plans or as directed.

MATERIALS

625.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Copper Tubing	712.32
Non-metallic Pipe (Flexible)	712.33
Non-metallic Pipe (Rigid)	712.34
Asbestos Cement Pipe	706.10

CONSTRUCTION REQUIREMENTS

625.03 General. This work shall be done with as little interruption of water service as possible. Ample notification shall be given to the users of the water before any disruption of water service.

625.04 Sleeve. Pipe for sleeves shall be non-metallic, rigid and be laid on a firm foundation at the line and grade

designated. When the pipe installation is in a trench all excavating and backfilling shall be in accordance with Section 206 — Structural Excavation.

When the installation is in an embankment, special care shall be taken to protect the pipe from heavy hauling equipment loads, rocks, or any other damage caused by the Contractor's work which may disrupt or break the pipe. All pipe broken from such causes shall be removed and replaced at the Contractor's expense.

625.05 Water Pipe. Water pipe shall be copper tubing or non-metallic pipe, flexible, as called for. After the sleeve has been placed the water pipe shall be inserted into the sleeve and connected to the existing pipes at each end. All connections to existing pipes shall be done in accordance with recognized plumbing practices. Necessary fittings, adapters, and reducers shall be supplied as required.

625.06 Method of Measurement. Non-metallic pipe and copper tubing of the different types and sizes will be measured for payment by the linear foot complete in place.

625.07 Basis of Payment. The accepted quantities of copper tubing and non-metallic pipe will be paid for at the contract unit price per linear foot for the types and sizes specified complete in place, payment for which will include necessary fittings.

Excavation will be paid for under Section 206 — Structural Excavation.

Payment will be made under:

Pay Item	Pay Unit
625.08 _____Inch Copper Tubing	Linear Foot
625.09 Vacant	
625.10 _____Inch Non-metallic Pipe (flexible)	Linear Foot
625.11 through 625.13 Vacant	
625.14 _____Inch Pipe Sleeve	Linear Foot

SECTION 626 — SANITARY SEWER PIPES

626.01 Description. This work shall consist of furnishing and installing pipes for connecting domestic sewer systems to septic tanks and absorption trenches in accordance with these specifications and in reasonably close conformity with the lines and grades established by the Engineer.

MATERIALS

626.02 Materials. Materials used shall meet the requirements specified in the following subsections of Section 700 — Materials.

Non-reinforced Concrete Pipe	706.01
Vitrified Clay Pipe	706.08
Asbestos Cement Pipe	706.10
Bituminized Fiber Pipe	706.12
Cast Iron Pipe	707.01

Materials used shall, as nearly as practicable, be the same as the existing pipe unless otherwise designated on the plans.

CONSTRUCTION REQUIREMENTS

626.03 General. Pipe for sanitary sewers shall be laid on a firm foundation at the line and grade designated. A recess shall be excavated to receive the bell or coupling at each joint if necessary. The pipe shall be joined as specified by the manufacturer to form a tight joint.

Excavation and backfill shall be in accordance with the requirements of Section 206 — Structural Excavation. The backfill around the pipe shall be placed in 8 inch layers, loose measure, with approved material free from large stones, sods, or other material which would prevent the backfill from being thoroughly compacted. Each layer shall be tamped thoroughly around and over the pipe. The layers of fill adjacent to the pipe shall contain no stones or other material which might puncture or otherwise injure the pipe and care shall be taken while tamping backfill to prevent damage to the pipe.

626.04 Method of Measurement. Sanitary sewer pipe will be measured by the linear foot complete in place and accepted. Elbows, "Y's", "T's", or other special connections will be measured as 2 additional linear feet of each pipe involved.

626.05 Basis of Payment. The accepted quantities of sanitary sewer pipe will be paid for at the contract unit price per linear foot for the respective types and sizes specified complete in place. Excavation and backfill will be paid for under Section 206 — Structural Excavation.

Payment will be made under.

Pay Item	Pay Unit
626.06 4 Inch Sanitary Sewer Pipe	Linear Foot
626.07 6 Inch Sanitary Sewer Pipe	Linear Foot
626.08 8 Inch Sanitary Sewer Pipe	Linear Foot

SECTION 627 — SEWAGE DISPOSAL SYSTEM

627.01 Description. This work shall consist of the construction of septic tank, absorption trenches, and distribution boxes, in accordance with these specifications and as shown on the plans or established by Engineer.

The construction of the septic tank, absorption trench, and distribution box shall include the furnishing and assembly of all component parts and materials complete at the locations shown on the plans or as directed.

In addition to these specifications this work shall conform to State or Local Laws and Ordinances.

MATERIALS

627.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Absorption Trench Aggregate	703.23
Nonreinforced Concrete Pipe	706.01
Vitrified Clay Pipe	706.08
Asbestos Cement Pipe	706.10
Bituminized Fibre Pipe	706.12
Timber Preservative	708.05

The septic tank, absorption trench, and distribution box shall conform to the State of Maine Department of Health and Welfare's requirements regarding location, design and materials used.

The septic tank shall be of steel or reinforced concrete with properly designed inlet and outlet connections and baffles and a tight fitting cover. If on steel, the tank shall be completely coated both inside and outside with asphalt after all fabricating and welding of joints has been completed.

Lumber used in the absorption trench shall be spruce or hemlock.

627.03 Installation of Septic Tank. The bed on which the tank is set shall be smooth and level. If a steel tank is used, it shall be lowered into place by such a method as to prevent scarring, scratching, or otherwise damaging the asphalt coating. If the coating is disturbed damaged portions shall be painted with an approved asphaltic paint which shall be allowed to dry before backfill is placed. Before inlet or outlet pipes are connected the excavation for the tank shall be backfilled to the level of the inlet and the outlet pipes. After the inlet and outlet pipes have been installed and approved

the remainder of the backfill shall be placed in a similar manner. Backfilling shall conform to the requirements of subsection 603.08.

627.04 Absorption Trench and Distribution Box. The distribution box and absorption trench conforming to the Standard Design, Maine Department of Health and Welfare, Division of Sanitary Engineering, shall be constructed as directed. The length and layout of the absorption trench shall be designated by the Engineer to fit field conditions.

All lumber in the absorption trench shall be treated with preservatives, after being cut, notched, and fitted and before being fastened together.

Pipes for inlets and outlets shall be installed under Section 626 — Sanitary Sewer Pipes.

627.05 Cleanup. Upon completion of the installation, all surplus material shall be removed and disposed of, and the area graded to conform to the surrounding terrain. Necessary seeding and sodding and placement of loam shall be done and paid for under the appropriate item.

627.06 Method of Measurement. Septic tanks and distribution boxes will be measured by the unit for each unit supplied and installed. Inlet and outlet pipe will be measured by the linear foot in accordance with the provisions of Section 626 — Sanitary Sewer Pipes. Absorption trench will be measured by the linear foot of completed and accepted trench.

627.07 Basis of Payment. Septic tanks and distribution boxes will be paid for at the contract price per each complete in place.

Absorption trench will be paid for at the unit price per linear foot for absorption trench complete in place, including necessary treated pipe, planks and boards, and stone and gravel aggregate.

Excavation and backfill will be paid for under Section 206 — Structural Excavation. Necessary inlet and outlet pipes will be paid for under Section 626 — Sanitary Sewer Pipes.

Payment will be made under:

Pay Item	Pay Unit
627.08 Septic Tank — 500 gal.	Each
627.09 Septic Tank — 750 gal.	Each
627.10 Septic Tank — 1,000 gal.	Each
627.11 Septic Tank — 1,250 gal.	Each

627.12 Septic Tank — 1,500 gal.	Each
627.13 Distribution Box	Each
627.14 Absorption Trench	Linear Foot

SECTION 628 — DITCHING DYNAMITE

628.01 Description. This work shall consist of the construction of drainage ditches by the use of explosives in accordance with these specifications and in reasonably close conformity to the lines and grades shown on the plans or established by the Engineer.

MATERIALS

628.02 Materials. Dynamite and caps for ditching shall be from fresh stock. Dynamite shall be 50 percent strength and especially manufactured for ditching use.

CONSTRUCTION REQUIREMENTS

628.03 General. The dynamite shall be placed in holes prepared at depths and spacing necessary to excavate to the limits designated. The explosives shall be detonated by the propagation or electric method and shall be detonated the same day it is placed in the proposed ditch location.

The finished trench shall have a minimum width of 2 feet at the bottom and shall have no depressions or obstructions which will retard the flow of water. If required, hand or machine shaping and smoothing will be done to finish the ditch.

628.04 Method of Measurement. Ditching dynamite will be measured by the pound as indicated by the net weight on the box packed by the manufacturer and in accordance with Section 109 — Measurement and Payment. Weighing by a certified weigher will not be required.

628.05 Basis of Payment. The accepted quantity of ditching dynamite will be paid for at the contract unit bid price per pound of explosive satisfactorily detonated. Necessary hand shaping and smoothing will be paid for under Section 629 — Hand Labor or Section 631 — Equipment Rental.

Payment will be made under:

Pay Item	Pay Unit
628.06 Ditching Dynamite	Pound

SECTION 629 — HAND LABOR

629.01 Description. This work shall consist of supplying and reasonably supervising personnel for the performance of hand labor work of an unskilled nature when authorized or as directed by the Engineer in accordance with these specifications.

CONSTRUCTION REQUIREMENTS

629.02 General. Labor performed under this section shall require no special skill but shall be accomplished in a workmanlike manner. The personnel used shall be physically capable of performing the work efficiently.

Nothing in this section shall be construed to relieve the Contractor of his responsibility for completing work under other contract items. The intent is that these items shall be used to perform incidental and necessary work not covered or provided for under existing contract bid items.

629.03 Method of Measurement. Hand labor will be measured by the man hours of work actually performed to the nearest $\frac{1}{4}$ hour. Overtime, when authorized, will be computed in compliance with the requirements of the contract. The work week shall be defined as starting on Monday and ending on Saturday, inclusive. The Contractor shall supply, daily, the names and number of hours each man works under this item.

629.04 Basis of Payment. The accepted quantities of hand labor will be paid for at the contract unit price per man hour. Payment for overtime will be made in compliance with the requirements of the contract.

The contract unit price shall be full compensation for hiring, transporting, supervising, payment of workmen's compensation, social security taxes, unemployment insurance, and for all hand tools and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
629.05 Hand Labor, Straight Time	Man Hour

SECTION 630 — TRAFFIC OFFICERS

630.01 Description. The work shall consist of furnishing uniformed traffic officers, when authorized or directed, for the

control of vehicular traffic and pedestrians during construction. This section shall not be construed to release the contractor of his responsibilities as outlined in subsection 104.04 — Maintenance of Traffic. Traffic officers shall be used primarily for the control of traffic during excavating, grading and paving operations in areas where one-way traffic is necessary but only when authorized by the Engineer.

SPECIAL REQUIREMENTS

630.02 General. Traffic officers working under the requirements of this section shall be sworn officers having police powers granted by the proper authority. The officers shall be supplied with an appropriate uniform and display a badge conspicuously. When necessary, they shall be attired in blaze orange vests and caps.

Only hand signal devices and flagging procedures shall be used which conform to the "Manual on Uniform Traffic Control Devices for Streets and Highways," prepared by National Joint Committee on Uniform Traffic Control Devices.

630.03 Traffic Control. Arrangements to expedite the flow of traffic shall be made by the Contractor and approved by the Engineer.

When two-way traffic is restricted to one lane, traffic officers must be used to coordinate the movements at each end of the constructed area so that vehicles are not simultaneously moving in opposite direction in the same lane nor subjected to excessive delays.

630.04 Method of Measurement. Traffic officers will be measured by the man-hour to the nearest $\frac{1}{4}$ hour. No additional allowance will be made for premium time.

630.05 Basis of Payment. The accepted quantities of traffic officers will be paid for at the contract unit price per man hour.

The contract unit price shall be full compensation for hiring, transporting, supervising, payment of workmen's compensation, payment for premium time, social security taxes, unemployment insurance, and for all uniforms, badges, traffic control devices and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
630.06 Traffic Officers	Man Hour

SECTION 631 — EQUIPMENT RENTAL

631.01 Description. This work shall consist of furnishing, operating, and supervising the use of construction equipment when authorized or as directed by the Engineer in accordance with these specifications.

EQUIPMENT REQUIREMENTS

631.02 General. Equipment used for work under this section shall conform to one of the following sets of requirements.

Equipment	Description	Minimum Size
Aerator	Heavy duty disc harrow — front and rear axle angle adjustable	Two tandem rows, 28 inch minimum diameter discs with 2 inch allowance for wear, 7,500 pounds, five foot minimum width
Air Compressor	Gasoline or diesel powered unit with compressor, receiver and adequate air hose	85 cubic feet per minute at 100 pounds per square inch
Air Tool	Single compressed air driven hand drill, tamper, hammer, chipper, or pavement breaker	
All purpose excavator	Approved truck mounted type	3 tons capacity lifting class at 15' radius
Bulldozer	Crawler or pneumatic tired tractor with pushing blade	90 drawbar horsepower
Chain Saw	Gasoline powered with endless chain type blade	5 horsepower
Grader	Tandem drive	14,001 pounds
Mowing Machine	Tractor with sickle bar	6 foot Sickle Bar
Roller (earth or base course)	Self-propelled pneumatic tired type	Shall be in accordance with pneumatic tired type roller specified in subsection 203.13, second paragraph
Roller (pavement)	Self-propelled pneumatic minimum 7 wheels	Gross weight 56,000 pounds; 13 x 24 smooth tread tires capable of 110 psi, inflation pressure; Fully ballasted wheel loads = 8,000 pounds or more
Truck (small)	Pneumatic tired with dump body	5 to 8 cubic yards manufacturer's rated capacity
Truck (large)	Pneumatic tired with dump body	Over 8 cubic yards manufacturer's rated capacity

Other approved equipment may be used subject to the approval of the Engineer.

CONSTRUCTION REQUIREMENTS

631.03 General. Nothing in this section shall be construed to relieve the Contractor of his responsibility for completing work under other contract items. The intent is that these items shall be used to perform incidental and necessary work not covered or provided for under existing contract bid items.

631.04 Aerating. When roadway excavation materials contain excessive moisture which will not permit proper compaction, the Contractor shall, when directed by the Engineer, aerate the materials until a water content suitable for compaction as determined by the Engineer is obtained.

631.05 Grading. All grading shall be done in a manner to leave the area smooth and suitable for machine mowing and to provide proper drainage or as otherwise directed by the Engineer. Suitable excavated material shall be placed and compacted on embankment slopes or other areas as directed. Unsuitable material shall be disposed of in approved waste areas.

631.06 Rolling. All material compacted under this item shall be compacted to the satisfaction of the Engineer. Only those portions of roadway designated by the Engineer shall be rolled. The work shall be performed at times and under conditions such that maximum compacting results can be obtained.

631.07 Method of Measurement. Equipment rental will be measured by the hour to the nearest $\frac{1}{4}$ hour. Time spent in moving to and returning from the site, servicing, maintaining, and changing attachments will not be measured for payment.

631.08 Basis of Payment. The accepted quantities of equipment rental will be paid for at the contract unit price per hour for each type of equipment used. Payment shall include operators, fuel, grease, oil, and other incidentals necessary to operate the equipment. Tractors required to haul aerators will be considered incidental to the contract unit bid price for machine aerating.

Payment will be made under:

Pay Item	Pay Unit
631.09 Aerator (including operator and hauler)	Hour
631.10 Air Compressor (including operator)	Hour
631.11 Air Tool (including operator)	Hour

631.12	All Purpose Excavator (including operator)	Hour
631.13	Bulldozer (including operator)	Hour
631.14	Grader (including operator)	Hour
631.15	Roller, earth or base course (including operator)	Hour
631.16	Roller, Pavement (including operator)	Hour
631.171	Truck — small (including operator)	Hour
631.172	Truck — large (including operator)	Hour
631.18	Chain Saw rental (including operator)	Hour
631.19	Mowing Machine rental (including operator and hauler)	Hour

SECTION 632 — WARNING LIGHTS

632.01 Description. This work shall consist of the installation of flashing warning lights in accordance with these specifications at specified locations designated by the Engineer.

MATERIALS

632.02 Materials. Warning lights shall meet the requirements of subsection 712.23.

CONSTRUCTION REQUIREMENTS

632.03 General. Warning lights shall be installed at locations designated prior to any work being done on the sections of roadway being used by traffic. Upon installation, all lights shall remain in continuous operation during the life of the project unless otherwise authorized by the Engineer.

632.04 Erection. When a suitable 120 volt A.C. power source is available within 500 feet of the designated warning light location, power operated flashing lights shall be erected. Two alternate flashing lamps shall be mounted approximately 24 inches above the construction warning sign at a spacing of approximately 24 inches on center.

When a suitable 120 volt A.C. power source is not available, battery operated flashing lights may be erected. Four flashing lamps shall be mounted approximately 6 inches above the construction warning sign at a spacing of approximately 12 inches on center.

632.05 Electrical Supply. The service connections shall be installed to the satisfaction of both the power company and the Engineer. The Contractor shall make all necessary ar-

rangements for the service connections and be responsible for all charges incurred thereby, including power charges. The Contractor shall also be responsible for all outstanding bills from the electric power company for preliminary work done by said company to facilitate the service connection of these particular installations.

When batteries are required for battery operated flashing lights, they shall be provided by the Contractor as necessary.

632.06 Method of Measurement. Warning lights will be measured by the group of lights furnished.

632.07 Basis of Payment. The accepted quantities of warning lights will be paid for at the contract unit bid price per group complete in place including the necessary power, and remaining in operation during active work of the project or as otherwise directed.

The lamps, fixtures, and the framework required to properly mount the lamps shall remain the property of the Contractor upon completion of their use.

Payment will be made under:

Pay Item	Pay Unit
632.08 Warning Lights	Group

SECTION 633 — PORTABLE BARRICADES

633.01 Description. This work shall consist of the furnishing or removing and resetting of portable barricades, portable barricades with flashing lights and oversized portable barricades with flashing lights, in accordance with these specifications or as authorized by the Engineer.

The furnishing of barricades shall include the assembly of all parts, materials and wiring when required, complete at the locations shown on the plans or as directed. Removing and resetting barricades shall include transporting to, and placing at each new location designated after the initial placing as required under furnishing.

MATERIALS

633.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Exterior Ready Mixed Paint	708.01
Timber Rail	710.05

Reflective Sheeting	712.21
Hazard Markers	712.22
Flashing Lights	712.23
Detour Sign	712.25

CONSTRUCTION REQUIREMENTS

633.03 General. The rails and posts shall be fabricated and fastened in accordance with standard commercial building practices. The hazard markers shall be securely attached to the barricade.

All rails and posts shall be painted on all exposed surfaces with two coats of white paint.

When portable barricades with flashing lights, normal or oversized, are called for, the flashing lights shall be mounted at the locations shown in an approved manner so as to be easily adjusted and locked in the desired horizontal position.

Portable barricades shall be maintained in good condition. The barricades and lights will remain the property of the Contractor upon completion of the work.

633.04 Placement. All portable barricades, new or reset, shall be placed and anchored with large stones, sandbags, or other acceptable methods to prevent movement. Barricades with flashing lights required to be removed and reset shall be reconnected to a power source at the new location in accordance with these specifications.

633.05 Wiring. All wiring shall comply with the requirements of the power company or the Engineer and shall be in accordance with the National Electric Code. Where more than one barricade is used at a single location, the flashing lights on each barricade shall flash in an alternate sequence as approved by the Engineer.

633.06 Meter Box and Service. The Contractor shall provide and install, at the location specified by the Engineer or the power company, a totally enclosed rain tight meter switch and cabinet. The fuses in this switch shall be 20 amperes and, if not adaptable, a fuse reducer shall be furnished.

The service connection shall be installed to the satisfaction of both the power company and the Engineer. The Contractor shall make all arrangements for the service connection and be responsible for all charges incurred thereby. Under no condition shall any equipment, except that specifically agreed to by the power company, be installed on any utility pole.

The Contractor shall be responsible for all outstanding bills from electric power company for preliminary work done by said company to install the service connection of that particular installation.

Cable and wire from the meter to the controller shall not be smaller than Number 8 Awg., and if the power company requires a heavier wire, their requirements shall be met. The method of running the wire for the meter to the controller shall be decided upon by the Contractor and the power company to the satisfaction of the Engineer.

The Contractor shall guarantee the proper operation of the installation. All defects due to faulty mechanism or assembly shall be repaired at the Contractor's expense. Any damage incurred to the barricades during the life of the contract shall be the responsibility of the Contractor.

633.07 Method of Measurement. Portable barricades and portable barricades remove and reset shall be measured for payment as units of each type specified, complete in place and accepted.

633.08 Basis of Payment. The accepted quantities of portable barricades and portable barricades remove and reset will be paid for at the contract unit price per each. Such payment shall be full compensation for furnishing all materials as specified herein, equipment, tools, labor, transportation, and all incidentals necessary to complete the work as specified and disposal of the barricades upon completion of the contract. The unit price for normal or oversized portable barricades with flashing lights new or reset shall include all costs and charges for service connections and all costs for metered power service during the period required for their use, or until flashing warning lights are removed upon order by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
633.09 Portable Barricade	Each
633.10 Portable Barricade with Flashing Lights	Each
633.11 Oversized Portable Barricade with Flashing Lights	Each
633.12 Portable Barricades Remove and Reset	Each
633.13 Portable Barricades with Flashing Lights Remove and Reset	Each
633.14 Oversized Portable Barricades with Flashing Lights Remove and Reset	Each

SECTION 634 — HIGHWAY LIGHTING

634.01 Description. The work to be done under these items shall consist of furnishing and installing a highway electric lighting system in accordance with the plans and these specifications. Signal lighting appurtenances, furnished under Section 643 — Traffic Signals, may be installed on or in items furnished under this section.

MATERIALS

634.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials Details.

Aggregate Base and Subbase	703.06
Reinforcing Steel	709.01
Structural Steel	713.01
Aluminum Light Standard	715.01
Steel Conduit	715.02
Non-metallic Conduit	715.03

Concrete for foundations and junction boxes shall meet the requirements of Section 502 — Structural Concrete. Steel for anchor bolts shall conform to the requirements of structural steel and be galvanized in accordance with ASTM A-153.

Ballasts, luminaries, mercury lamps, cable, and all necessary transformers, fuses, switches, timers, and power will be furnished by others.

CONSTRUCTION REQUIREMENTS

634.03 Fabrication of Light Standard, General. Any improvements in fabricating techniques or aluminum technology beyond those stated in these specifications shall be incorporated in the aluminum poles subject to the approval of the Engineer.

External surfaces of all wrought parts shall be a satin-type finish. Poles shall be suitably protected during shipment and storage, and discoloration or disfiguration will be sufficient cause for rejection by the Engineer.

Detail drawings shall be submitted for approval before any shipment of light standards.

(a) *Strength.* The aluminum pole shall have adequate strength to withstand winds of 90 miles per hour without fracture, permanent deformation or harmful vibration. The shaft shall be able to withstand a transverse load of 500

pounds, 18 inches down from the top, without fracture or permanent deformation after the load is released. Strength requirements shall be sufficient for the type of luminaire used, method of mounting, accessories or modifications designated, and location of pole.

634.04 Shaft. The shaft shall be a round tapered seamless, aluminum shaft with a wall thickness sufficient to meet the strength requirements but in no case less than that shown on the plans. The exterior shall be free of protuberances, dents, cracks, discolorations, and other imperfections detrimental to its strength or appearance.

634.05 Shaft Base Flange. The base flange for the shaft shall be machined to receive the lower end of the shaft. The joint between the base and the shaft shall be completed by circumferential welding both inside and outside in such a manner as to eliminate any cavities between the outer surface of the shaft and the inner surface of the base flange. Drainage slots shall be provided in the bottom to permit drainage of moisture trapped within the shaft.

634.06 Transformer Base. The transformer base shall be sufficiently strong to withstand the test loads when applied to the pole without fracture or permanent deformation. The interior shall have sufficient space to permit the installation of two standard electric ballasts with cap dimensions up to 11 by 7 inches. Provision shall be made for electrical grounding of the light standard by means of a ground stud attached to the inside of the transformer base.

634.07 Single Member Bracket Arms. The single member bracket arms shall be of a tapered elliptical upsweep design. The arm shall be welded to an arm plate which can be hooked to a suitable pole adapter on the shaft and bolted firmly in place. The arm thus mounted shall be capable of withstanding a vertical load of 100 pounds and a transverse load in either direction of 50 pounds applied at the luminaire end of the arm without apparent deformation and no set after the weights have been removed.

634.08 Truss Type Bracket Arm. The truss type bracket arm shall be of a tapered elliptical design consisting of two outstand members and a single strut brace. The three members shall be welded to form an integral unit. The arm shall be welded to arm plates which can be hooked to suitable pole adapters on the shaft and bolted firmly in place. Internal diameters, bends and joints shall be designed to per-

mit internal wiring. The truss type bracket arm shall meet the same loading tests as described under subsection 634.07.

634.09 Welding. All welding shall be performed by the inert gas shielded arc method, using aluminum alloy 43S filler wire ASTM Specification B 285. No welding flux will be permitted. All welds shall be free from cracks and porosity.

634.10 Standard Foundations. Foundations shall be constructed of structural concrete with anchor bolts, in conformance with the dimensions and details as shown on the plans.

634.11 Standards. Standards shall be installed at the designated locations as detailed or shown on the plans, ready to receive luminaires. They shall be free from any defects that impair their strength, serviceability or appearance.

634.12 Junction Boxes. Junction boxes, of the type designated, shall be placed at locations as shown on the plans.

Junction boxes Type "A" shall be constructed of structural concrete in conformity with the dimensions and details shown on the plans. The top surface of the cover shall be finished with a wooden float which shall be moved in a circular motion to produce a shell-like pattern.

Junction boxes Type "B" shall have a base of structural concrete as shown on the plans, and a cast iron box. The box shall be of the outside flanged, recessed cover type, suitable for flush mounting and listed by the Underwriters Laboratories, Inc. as raintight and watertight (NEMA 4). They shall have a plain cover, protective coating of cadmium or tin or zinc, neoprene gasket or an approved equivalent and brass cover screws. The inside dimensions and wall thickness shall meet the specifications of the National Electrical Code, latest edition. Slip holes will be permitted for conduit entrances provided the conduits are fastened in the slip holes by means of locknuts and bushings with lead washers used under locknuts to provide a tight joint. The Contractor shall supply and install fuse studs where directed by the power company.

634.13 Electrical Conduit. The trench for underground conduit shall be excavated to a width and depth as shown on the plans. If the trench is located in wet, spongy, or otherwise unsuitable ground, the trench shall be further excavated to a depth sufficient to overcome this condition and be backfilled with approved gravel. The gravel shall be firmly compacted in layers not more than 8 inches, loose measure. The grade of bottom of trench shall be parallel to the proposed

pitch of the conduit. Between junction boxes, conduit lines shall slope in one direction.

After the trench has been prepared as specified above, the bottom of the trench shall be filled with a sand bedding material and the material thoroughly tamped. After the conduit has been laid, backfilled material shall be placed around the sides and up to the top of the conduit. The entire trench shall then be backfilled with approved material thoroughly tamped.

All conduit and fittings shall be watertight and the end shall be reamed. Metallic conduit runs shall be constructed with white leaded joints and with the lengths butted as closely as possible.

Within 10 days from the completion of each section of conduit, the Contractor, in the presence of the representative of the power company, shall rod and pull through each duct a mandrel and brush of a pattern satisfactory to the power company, but which shall not be more than $\frac{1}{8}$ inch smaller than the bore of the ducts. Where obstructions in the ducts prevent the passage of this mandrel, the Contractor shall, at his own expense, dig up and relay such portions of the ducts as may be necessary to clear the obstructions.

If specified by the power company or the Engineer, the Contractor shall install Number 9 galvanized iron pull-wire which shall be left in the conduit. The ends of the wire shall be secured in such manner as to prevent accidental withdrawal of the wire.

All work shall conform to the standards of the National Electrical Code and to the National Safety Code as set forth in the National Bureau of Standards Handbook H-32.

All cable and wire will be furnished and installed by others.

634.14. Method of Measurement. The quantity to be measured for payment for highway lighting will be one lump sum unit. Junction boxes will be measured by the number of single units. Conduit will be measured by the number of linear feet.

634.15 Basis of Payment. The accepted quantity of highway lighting will be paid for at the contract lump sum bid price for the complete lighting system shown on the plan, except that junction boxes will be paid for by the unit bid price each and conduit will be paid for by the unit bid price per linear foot.

Lump sum payment for highway lighting shall include furnishing, installing and erecting all brackets, poles, trans-

former bases, foundations, and miscellaneous hardware. It shall also include conduit within the foundation, and that portion of conduit extending 12 inches from the face of the foundation.

Payment for conduit shall include full compensation for furnishing and installing conduit, weather heads, and for rodding and pulling pull wire. Conduit extending up the riser of service poles will be paid for per linear foot as though it were located in a trench.

Payment for Junction Box Type B shall include the concrete and conduit, including that portion of conduit extending 12 inches outside the box foundation.

Excavating and backfilling for highway lighting shall be considered incidental to the lump sum bid price and no separate payment will be made, except as hereafter provided. Excavating and backfilling for junction boxes, and excavating, backfilling and sand bedding for conduit shall be considered incidental to the respective unit bid prices for junction boxes and conduit and no separate payment will be made, except as hereafter provided.

Excavating and backfilling, required by the Engineer, to overcome soft or otherwise unsuitable foundation, or excavating rock, will be paid for as provided in Section 206 — Structural Excavation. Gravel backfill, required by the Engineer, except sand bedding as shown on the detail plan, will be paid for as provided in Section 304 — Aggregate Base and Subbase Course.

Payment will be made under:

Pay Item	Pay Unit
634.16 Highway Lighting	Lump Sum
634.171 Junction Box, Type A	Each
634.172 Junction Box, Type B	Each
634.18 Steel Conduit	Linear Foot
634.19 Non-metallic Conduit	Linear Foot

SECTION 635 — PREFABRICATED BIN TYPE RETAINING WALL

635.01 Description. This work shall consist of the construction of bin type retaining wall in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

635.02 Materials. Materials shall meet the requirements specified in the following subsection of Section 700 — Materials.

Metal Bin Type Retaining Wall	713.15
Precast Concrete Units	712.06

Foundation and backfill material shall conform to the requirements of subsection 703.06 (b) Aggregate Subbase.

CONSTRUCTION REQUIREMENTS

635.03 Shop Drawings. The Contractor shall prepare shop detail erection and other working plans and shall submit two prints to the Engineer for approval. Approval of the plans shall be obtained before fabrication of the work is commenced. Changes in the approved plans shall be subject to further approval and the Engineer shall be supplied with a record of such changes. Substitution of sections different from those shown on the plans supplied by the Commission or prepared by the Contractor and previously approved shall be made only when approved in writing by the Engineer.

The Contractor will be held responsible for the correctness of his plans although the plans may have been approved.

635.04 Excavation and Foundation. Excavation for erection of the retaining wall shall be in accordance with Section 203 — Excavation and Embankment, to a width sufficient to allow the proper erection of the wall and thorough compaction of the bedding and backfill material.

The foundation under the entire area of the wall shall be firm. If ledge is encountered, a gravel base of at least 12 inches in thickness shall be provided.

635.05 Erection. The retaining wall members shall be erected in accordance with the manufacturer's instructions and as shown on the plans. Members shall be handled carefully and any which are damaged shall be replaced at the Contractor's expense. All bolts for metal walls shall be placed so that heads are exposed and the nuts tightened on the inside.

635.06 Backfill. The backfilling of the interior of the wall and behind the wall shall progress simultaneously. The material shall be placed in layers not over 8 inches in depth, loose measure, and thoroughly compacted by mechanical or vibratory compactors. Puddling for compaction will not be allowed.

635.07 Method of Measurement. Bin type retaining wall will be measured by the square foot of front surface not to exceed the dimensions shown on the plans or authorized by the Engineer. The area of each panel shall be determined by multiplying the width of each panel, center to center distance of the columns by the total height of the panel. Foundation and backfill material will be measured in place by the cubic yard and computed by the most convenient recognized engineering method.

635.08 Basis of Payment. The accepted quantity of bin type retaining wall will be paid for at the contract unit price per square foot complete in place.

Excavation will be measured and paid for as provided in Section 203 — Excavation and Embankment.

Foundation material and backfill material will be measured and paid for as provided in Section 304 — Aggregate Base and Subbase Course, at the contract unit price per cubic yard complete in place.

Payment will be made under:

Pay Item	Pay Unit
635.09 Metal Bin Type Retaining Wall	Square Foot
635.10 Concrete Bin Type Retaining Wall, Closed Face	Square Foot
635.11 Concrete Bin Type Retaining Wall, Open Face	Square Foot

SECTION 636 — REFLECTORIZATION OF BITUMINOUS CONCRETE

636.01 Description. This work shall consist of furnishing and applying reflector glass beads, or spheres, upon the second of two coats of white acrylic emulsion paint on bituminous concrete curb, and other bituminous concrete surfaces, in accordance with the plans and these specifications, or as directed by the Engineer.

MATERIALS

636.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Acrylic Emulsion Paint	708.06
Glass Beads	712.24

CONSTRUCTION REQUIREMENTS

636.03 General. After the bituminous concrete surfaces to be reflectorized have been exposed as long as project conditions permit, but not less than 7 days, the exposed surfaces shall be thoroughly cleansed of all foreign matter and painted or sprayed with 2 coats of White Acrylic Emulsion Paint.

Before the second coat of paint has dried, the glass reflector beads, or spheres, shall be applied by dropping the beads onto the surface of the undried paint as uniformly as possible and at a rate to obtain adhesion of the maximum number of beads possible. Spots showing a lack of beads, found upon testing after dark, shall, when ordered, be repainted and additional beads applied.

636.04 Method of Measurement. ReflectORIZATION will be measured by the square yards of surface area of the exposed curb and pavement complete and accepted, measured parallel to the surface.

636.05 Basis of Payment. The accepted quantity of reflectORIZATION will be paid for at the contract unit price per square yard, which price shall be full compensation for procuring and applying acrylic emulsion paint and reflector beads complete in place and accepted.

Payment will be made under:

Pay Item	Pay Unit
636.06 ReflectORIZATION of Bituminous Concrete	Square Yard

SECTION 637 — DUST CONTROL

637.01 Description. This work shall consist of furnishing and applying water or calcium chloride on the roadway or haul roads for dust control as directed by the Engineer. When no items for dust control are included in the contract, such work shall be considered incidental to the contract.

MATERIAL

637.02 General. The water shall not be salt or brackish and shall be free from oil, acid, and injurious alkali or vegetable matter. The calcium chloride shall conform to subsection 712.02, except that the requirements for "total alkali chloride" and "impurities" shall not apply.

CONSTRUCTION REQUIREMENTS

637.03 Sprinkling. Water shall be applied by approved methods and with equipment including a tank with a gauge-

equipped pressure pump and a nozzle-equipped spray bar. Water shall be dispersed through the nozzle under a minimum pressure of 20 pounds per square inch, gauge pressure.

637.04 Calcium Chloride. Calcium chloride shall be applied by mechanical spreaders or by hand at the rate designated. Calcium chloride shall be used when authorized by the Engineer for controlling dust on the roadway under construction and on approved haul roads from borrow or gravel pits to the project, or in front of dwellings, and where dust constitutes a hazard to traffic.

637.05 Method of Measurement. Water will be measured by the M.G. (1,000 gallons) by means of calibrated tanks or distributors or by means of accurate water meters. Calcium chloride will be measured for payment by the number of tons (2,000 pounds) satisfactorily applied. Delivery slips as specified in subsection 109.01 will be required except that weight for calcium chloride shall be determined from the weight stated on each bag and the number of bags used. Weighing by a certified weighmaster will not be required.

637.06 Basis of Payment. Water used in sprinkling will be paid for at the contract unit price per M.G.

Calcium chloride will be paid for at the contract unit price per ton.

Payment will be made under:

Pay Item	Pay Unit
637.07 Sprinkling	M.G.
637.08 Calcium Chloride	Ton

SECTION 638 — BRIDGE LIGHTING

This section is reserved for Bridge Lighting use. Specifications will be provided and item numbers assigned for each individual project, and inserted in the proposal book when bridge lighting is required.

SECTION 639 — ENGINEERING FACILITIES

639.01 Description. This work shall consist of furnishing, erecting, lighting, equipping, and maintaining buildings to be used as field offices or testing laboratories for the use of the Engineer and his assistants. Upon completion of the work, the buildings shall remain the property of the Contractor.

MATERIALS

639.02 Materials. Materials shall be of good quality customarily used in standard frame house construction.

CONSTRUCTION REQUIREMENTS

639.03 General. The building of the type called for shall be furnished when work is started and shall remain until work is completed unless earlier removal is authorized. The location shall be approved by the Engineer.

A fire extinguisher shall be provided in each building for electrical and chemical fires, effective on all solvents used in the building.

Walls, roof, floor, windows, and doors shall be tightly constructed to the shape and dimensions shown on the plans. Furnishings shall be supplied as called for. Doors shall be equipped with locks, and all keys shall be in the possession of the Engineer or his assistants. Windows shall be equipped with latches so they may be locked on the inside. Window screens and screen doors shall be supplied when necessary.

The walls, roof and floor of the building shall be completely insulated with a minimum of 2 inches of glass wool, rock wool or other suitable type insulation. The interior walls shall be covered with fibre board, plywood or other suitable wall panelling.

The outside walls of the building shall be matched boards, clapboards, or other type of siding which can be readily painted. The outside shall be painted.

Field offices shall be furnished with one 4 drawer letter size metal filing cabinet with facilities for locking the drawers. Two keys shall be furnished the Engineer.

Testing facilities furnished under this section shall include all facilities for testing as hereinafter described and as designated in the General Notes on the plans. Other types of buildings and facilities may be furnished of equal or better quality.

(a) Testing Laboratory — Soils.

The building and facilities shall be:

1. Same minimum size and quality as Field Office Type "C" placed in an approved location in the vicinity of the project.

2. A bench, 5 feet long by 24 inches wide, 3 feet above the floor, suitable for supporting a sieve shaker and electric dryer.

3. Two electric wall outlets; one to be at least 20 amp, triplex, located near the bench described in 2 above.

4. One clean 55 gallon drum installed on a suitable rack and equipped with a spigot suitable for draining off water. The drum shall be furnished with water at all times.

5. Two stools, 28 inches high, and one straight back office type chair.

(b) Testing Laboratory — Bituminous Mixes.

The minimum building size and minimum facilities shall be:

1. Same minimum size and quality as Field Office, Type "A", placed in an approved location at the mixing plant, with facilities shown, except as follows:

2. Two benches, 5 feet long, 30 inches wide, 3 feet above the floor, suitable for supporting equipment, and 2 stools, 28 inches high.

3. Five duplex electric outlets with ground, 4 to be at least of 20 amp capacity each, placed 2 at each bench described in 2 above. The total service shall have a capacity of at least 60 amperes, at 120V.

4. A heavily constructed rack approximately 2 feet square and 15 inches high, suitable for supporting an asphalt extractor. A ½ inch inside diameter drain pipe leading outside the building for draining liquids for extractions.

5. On the outside of the building, near the inside location of the bench in the larger work area, a covered box (shelf) approximately 1 foot by 2 feet, for the pump of the vacuum extractor. A hole shall be provided thru the wall for the vacuum line. A waterproof outdoor duplex receptacle with ground shall be provided with an inside on-off switch over the bench.

6. A desk with desk chair, or a writing table 4 feet by 2.5 feet, 30 inches above the floor, with an adequate filing cabinet in lieu of the desk, and a straight back office type chair.

7. Suitable forced ventilation, sufficient to remove vapors resulting from testing from the building, with ventilating provisions separate from the doors and/or windows.

8. When required by the Engineer, a rack outside the building suitable for supporting one 55 gallon drum.

9. The facilities shall be reserved for the exclusive use of the Engineer during the paving season.

10. When required by the Engineer, a telephone shall be provided as specified in subsection 639.05.

(c) Testing Laboratory — Bituminous Liquids and Cement.

1. The building and laboratory shall be located conveniently near the plant. The laboratory shall be provided with the equipment necessary for conducting the tests required by the specifications, performed according to the Specified Testing Procedures of the Commission, for the types of Bituminous Material being supplied by the plant.

2. The laboratory may be in a building used for other purposes by the supplier. The laboratory shall be well lighted, and heated as required in subsection 639.04. A ventilated enclosed hood area shall be provided, or suitable forced ventilation with air flow provisions independent from the doors or windows, sufficient to remove vapors resulting from testing.

3. The laboratory shall be of the following minimum areas, according to the number of types of material furnished:

No. of Types of				
Bituminous Material supplied:	1	2	3	4
Minimum area of laboratory, sq. ft.	115	200	250	275
Minimum clear bench space, sq. ft.	45	70	90	100

Bituminous Material types are defined as: Asphalt Cement, Road Tars, Cut-Back Asphalts, and Emulsified Asphalts.

4. The laboratory shall be designated for the primary use of the assigned inspectors during the construction season. Use of the equipment by the supplier's personnel shall be coordinated by those concerned so that testing by the inspectors may be conducted during their working hours and so as not to delay ordered shipments of bituminous material. The laboratory area shall not be used by the supplier during the construction season for any purpose other than testing of materials.

5. In addition to the clear bench space required in 3 above, a desk or a suitable table and a letter size filing cabinet, a typewriter and an office type chair shall be provided.

6. The laboratory shall be provided with a telephone as required in subsection 639.05, except the monthly bill shall be sent to the Pavement Engineer, State Highway Commission, Augusta, Maine.

7. The supplier shall provide and maintain all necessary containers and receptacles, solvents and cleaners necessary for cleaning the equipment.

639.04 Heat. When required by the Engineer, heat shall be supplied by the Contractor to maintain an acceptable room temperature.

639.05 Telephone. The Contractor shall provide a telephone in the Type "A" and "B" field offices for the exclusive use of the State personnel. This telephone shall be on a private line, if available, and shall be listed under, "Maine, State of, State Highway Commission." The Contractor shall be responsible for the initial telephone installation charges and any reinstallation charges following suspended periods. Except during periods of seasonal suspension of work, monthly service charges, including toll call costs, shall be billed by the telephone company directly to the State Highway Commission, in care of the Resident Engineer. During seasonal suspension periods, the telephone company shall be notified to discontinue the services, and the Contractor shall assume any service charges. Upon resumption of work, the telephone service shall be reinstated.

639.06 Method of Measurement. Field office and testing facilities will be measured by the unit for each building furnished, equipped and maintained satisfactorily.

639.07 Basis of Payment. The accepted quantity of field office or testing facilities will be paid for at the contract unit price each or lump sum which shall be full compensation for furnishing, erecting, equipping, maintaining, furnishing electricity, heating, and if necessary, removing the buildings. Payment for testing facilities shall include furnishing all buildings and facilities designated on the plans and as described in these specifications for the testing of materials by the State.

Payment for these items shall be made in 3 parts, the first payment of $\frac{1}{3}$ to be made after the Contractor has supplied the building and it has been approved by the Engineer. The remaining payments shall be made at intervals as follows:

(a) A second payment of $\frac{1}{3}$ shall be made when one-half of the anticipated work has been completed.

(b) The final payment of the remaining $\frac{1}{3}$ shall be made upon completion of the work.

Payment will be made under:

Pay Item	Pay Unit
639.08 Field Office, Type A	Each
639.09 Field Office, Type B	Each
639.10 Field Office, Type C	Each
639.11 Testing Facilities, Soils	Lump Sum
639.12 Testing Facilities, Bituminous Mixes	Lump Sum
639.13 Testing Facilities, Bituminous Liquids and Cements	Lump Sum

SECTION 640 — PILOT VEHICLE AND OPERATOR

This section is reserved. Specifications will be provided and inserted in the proposal book when required.

SECTION 641 — REST AREA FACILITIES

641.01 Description. This work shall consist of the construction of shelters, tables, privies, fireplaces, well, hand pump, chain barricades, and other incidental facilities, all in accordance with these specifications and in reasonable close conformity with the dimensions shown on the plans or established by the Engineer.

MATERIALS

641.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Bituminized Fiber Pipe	706.12
Timber Preservative	708.05
Wood Stain	708.07
Reinforcing Steel	709.01
Guard Rail Posts	710.07
Structural Steel	713.01

Concrete shall be Class "Y" in accordance with Section 502 — Structural Concrete.

Aggregate for base and surface material shall be in accordance with the applicable portions of the specifications for the type of material designated.

Steel chain shall be proof coil chain, galvanized.

The hand pump assembly shall be a hand operated, metal, sanitary drinking fountain pump (Ohio Type), having a mount-

ing base for 6 inch well casing. The pump cylinder shall be 2½ inch (inside diameter) x 15 inch long, brass lined, with a 6 inch stroke, designed to fit the hand pump assembly described.

The well casing shall be standard black pipe (ASTM A 53) with threaded couplings. Drop pipe shall be standard galvanized steel water pipe, (ASTM A 53), with the ends reamed smooth. The connecting rod shall be cold rolled steel, threaded SAE. All pipe, rods and hardware shall be American made.

The seal for sealing the water well casing in ledge shall be a resilient heavy rubber sealing tip with rings or sealing flanges which will yield to permit insertion and then fill the indentations and be flattened by the rock projections in the drill hole.

Wood stain shall be dark brownish red color. Other stains of similar combinations of ingredients may be used subject to the approval of the Engineer.

Paint, of the various types called for on the plans, shall be of good quality for exterior use, approved by the Engineer.

CONSTRUCTION REQUIREMENTS

641.03 General. Rest area facilities shall be constructed in accordance with the notes and drawings shown and placed at locations designated by the Engineer.

All cuts and notches in lumber, timber, and logs shall provide uniform bearing and close joints. Joints shall be fastened by means of bolts, nails or spikes as shown. Nails and spikes shall be driven to set the heads flush with the surface of the wood and special care shall be taken to prevent splitting logs, posts and timbers. Members shall be pre-drilled, if necessary, to prevent splitting.

Work done in connection with the well and pump installation shall be done in conformity with the State of Maine Plumbing Code established by the Department of Health and Welfare. The Contractor shall obtain all permits and pay all fees required.

All scrap lumber, pipe, and all other debris shall be removed from the Rest Area site upon completion of the work and the area left in a neat condition. The Contractor shall exercise care and take all necessary precautions to protect existing trees and bushes which are to remain.

Backfilling around underground structures shall be in accordance with subsection 206.03.

641.04 Concrete Construction. Except as otherwise designated on the plans, concrete construction shall be in accordance with applicable requirements of Section 502 — Structural Concrete. Concrete construction, with the exception of the water well slab with sump, may be precast.

Aggregate foundation material for slabs, anchors, and footings shall be leveled and thoroughly compacted and moistened immediately prior to placing concrete. If precast structures are installed, moistening will not be required.

The concrete slab with sump shall be constructed, cast-in-place monolithically, on a prepared foundation with forms conforming to the dimensions shown.

641.05 Fireplace. After fabrication, the fireplace shall be mounted in a concrete base which shall be approximately 18 inches in diameter by 18 inches deep. Forms will not be required if a well formed hole can be dug in the earth. The fireplace shall be installed plumb and concrete placed to within 6 inches of the surrounding ground line. After the concrete has set, the remainder of the hole shall be filled with approved granular material.

641.06 Privy. The concrete box for the privy shall be placed, with the top level, in a hole with top of the box extending approximately 4 inches above the surrounding ground. The hole shall be backfilled to the top of the tank with excavated material, if suitable, or approved granular material. The cover slab shall be placed on the box and the building and seat riser mounted as shown.

641.07 Well. The water well shall be drilled at a location designated by the Engineer. Six inch pipe casing shall be extended to a suitable water bearing strata or, if ledge is encountered, the casing shall be placed at least 10 feet into solid rock and sealed with a rubber seal to prevent intrusion of surface water. The pipe casing shall extend 20 inches above finished grade.

The Engineer may require the well to be bailed at any time during its construction to determine the yield at that point and direct the Contractor to develop the well or to drill to a greater depth within limits of normal drilling equipment. Upon completion, the well shall be sufficiently bailed or pumped, as directed, to determine its maximum yield.

The Contractor shall, if directed, relocate, continue drilling and furnish a water supply described.

During drilling operations and installations of casings, pipes and pumps, the Contractor shall take all precautions necessary to prevent contamination of the water. In the event the well becomes contaminated, due to the Contractor's operation, he shall eliminate the pollution or relocate and drill another well at his own expense.

Should the Contractor fail to construct the well to the depth specified or to such depth as ordered by the Engineer, or should he abandon the well because of poor alignment, he shall, at his own expense, construct another well adjacent thereto at a point satisfactory to the Engineer. The Contractor shall fill such abandoned hole at his own expense and in accordance with the Engineer's instructions.

Upon completion of the well, the pump and associated attachments shall be installed.

The Contractor shall take the necessary precautions to protect all trees and structures at the site from damage by and during his operations.

641.08 Pump. The Contractor shall notify the Engineer one week in advance of the time of the installation of the pump.

Pump, pipes and rods shall be preassembled and the mechanism approved by the Engineer to insure proper functioning before the pump is installed. The installation shall be done under the direct supervision of the Engineer or other authorized State Highway Commission representative.

The drop pipe, piston rod, cylinder, foot valve and screen shall be installed as shown on the detail plan. Pipe shall be supplied in 21 foot sections except that the section above the pump cylinder may be a shorter length in order to submerge the cylinder 10 feet below static water level. A hole $\frac{1}{8}$ inch in diameter shall be drilled through the drop pipe at the static water level elevation. Galvanized steel couplings shall be used to join sections of the drop pipe. Pipe dope shall be applied to all threaded connections before final installation.

Steel rods extending from the piston bar to the piston shall be of sufficient length to allow a full stroke of the pump handle in all 3 adjustable positions without causing the piston to hit against the bottom or top of the pump cylinder. The rods shall be 21 foot lengths except that one section may be shorter as necessary. They shall be threaded and connected with couplings and lock nuts. Reducers shall be provided as needed, to connect the pump to the piston rod bar above

ground and the plunger tapping on the pump cylinder to the piston bar below ground. In addition to lock nuts, couplings and rods shall be secured by a taper pin using a number 25 drill and a number 1 taper reamer and taper pin. Tension pins may be used in lieu of taper pins.

After the pump is installed and functioning properly, the handle of the pump shall be removed temporarily for 24 hours to prohibit the use of the well for that period. Sodium hypochlorite disinfectant will be introduced into the well at this point by the State. The handle shall be replaced at the end of the 24 hour period.

641.09 Chain Barricade. Posts, conforming to the requirements of Single Posts, Type 1a, subsection 606.06, shall be installed at designated locations. Where the elevation of the ground between the 2 posts is different, they shall be set so the tops are approximately level by raising the lowest post.

All hardware and chain shall be painted with approved black asphalt paint after installation. Posts above ground shall be coated with 2 coats of wood stain.

641.10 (Vacant)

641.11 (Vacant)

641.12 Method of Measurement. Each Rest Area Facility will be measured by the unit for the type of facility supplied except that Hand Pump will be measured on a lump sum basis and Water Well, Piston Rod, Drop Pipe and Wooden Screen each will be measured by the linear foot.

Measurement for Water Well will be determined by the linear foot distance from the surface of the ground to the lowest point reached by the drill point. Measurement for Piston Rod or Drop Pipe will be determined from the total length of individual pieces of rods or pipes placed. Measurement for Wooden Screen will be determined from outside to outside of the end posts.

641.13 Basis of Payment. The accepted quantity of various Rest Area Facilities, except Water Well, Hand Pump, Drop Pipe, Piston Rod, and Wooden Screen will be paid for at the contract unit bid price each. The unit bid price for each Rest Area Facility and the per linear foot bid price for Wooden Screen shall include furnishing all lumber, posts, plywood, shingles, steel, chains, nails, spikes, bolts, screws, incidental hardware, paint and wood stain, and concrete including necessary reinforcing steel and forms, and all other incidentals necessary to complete the work. Payment shall

also include placing the various facilities at the designated locations.

Payment for Water Well shall include drilling, furnishing and placing the casing with necessary seals. In the event the required yield of water is not obtained and the Contractor is directed to drill in another location, designated by the Engineer, payment will be made at the full contract unit bid price per linear foot for both the abandoned well and the new well. If, because of loss of tools, poor alignment, contamination or other causes, the well is required to be redrilled by the Contractor in another location, no further payment will be made until the Contractor has progressed in the new well to a point beyond that at which the abandoned well had been drilled and no payment will be made for the abandoned well.

Lump sum payment for Hand Pump shall include furnishing and installing the hand pump, pump cylinder, foot valve with strainer and all incidentals necessary to complete the work including that portion of 2 inch pipe connecting the pump casing to the 1 1/4 inch Drop Pipe.

Payment for 1 1/4 inch Drop Pipe shall include furnishing and installing the pipe with necessary connections including the amount of pipe placed above and below the pump cylinder.

Payment for 1/2 inch Piston Rod shall include furnishing and installing the 1/2 inch rod to connect the working mechanism of the hand pump and the pump cylinder including necessary connections and reducers.

Excavating and backfilling for the various facilities shall be considered incidental to the bid prices and no separate payment will be made except as hereafter provided. Excavating and backfilling, required by the Engineer, to overcome soft or otherwise unsuitable foundation, will be paid for under item 206.06. Gravel for foundations will be paid for as provided under Section 304 — Aggregate Base and Subbase Course.

Payment will be made under

Pay Item	Pay Unit
641.14 Rest Area Shelter	Each
641.15 Rest Area Table, including bases	Each
641.16 Rest Area Privy, Complete	Each
641.17 Rest Area Fireplace, Steel	Each
641.18 Trash Barrel Base	Each
641.19 Concrete Slab for Well	Each
641.20 Water Well	Linear Foot

641.21 Hand Pump	Lump Sum
641.22 Chain Barricade	Each
641.23 1 1/4 inch Drop Pipe	Linear Foot
641.24 1/2 inch Piston Rod	Linear Foot
641.25 Wooden Screen	Linear Foot

SECTION 642 — WOODEN STEPS

642.01 Description. This work shall consist of the construction of wooden steps in accordance with these specifications in reasonably close conformity to the dimensions shown on the plans.

MATERIALS

642.02 Materials. Materials shall meet the requirements as specified in the following subsections of Section 700 — Materials:

Exterior Ready Mixed Paint	708.01
Timber Preservative	708.05

Wood shall be well seasoned spruce or pine, Number 1 Dimension Lumber. Nails and hardware shall be galvanized.

CONSTRUCTION REQUIREMENTS

642.03 General. Wooden steps shall be fabricated and fastened in accordance with standard commercial building practices.

After members have been cut to size, the ends shall be soaked in pentachlorophenol. Prior to assembling the steps, all contact surfaces shall be painted with 2 coats of pentachlorophenol.

After the steps are completed and installed, they shall be painted 2 coats of paint, color to be designated by the Engineer. The first coat of paint shall be thinned.

642.04 Method of Measurement. Wooden steps will be measured by the lump sum unit or by the square foot of exposed stair tread as designated by the pay item.

642.05 Basis of Payment. The accepted quantity of wooden steps will be paid for at the contract lump sum price or by the contract unit price per square foot of tread complete and accepted in place which price shall include furnishing all materials, labor, and other incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
642.06 through 642.09 Vacant	
642.10 Wooden Steps	Lump Sum
642.11 Wooden Steps	Square Foot

SECTION 643 — TRAFFIC SIGNALS

SECTION 644 — CONSTRUCTION LAYOUT AND STAKING

SECTION 645 — SIGNING AND DELINEATION

SECTION 646 — EMBANKMENT STABILITY CONTROL DEVICES

SECTION 647 — ILLUMINATION OF CONSTRUCTION

SECTION 648 — VACANT

SECTION 649 — PIPELINE PROTECTION

These sections are reserved. Specifications will be provided and inserted in the proposal book when required.

SECTION 650 — HOT BITUMINOUS MIXTURE ADDITIVES

650.01 Description. This work shall consist of furnishing and adding one or more types of additives as designated to hot bituminous mixtures.

650.02 Materials. Materials shall meet the requirements specified in the following subsections of Section 700 — Materials.

Filler	703.15
Hydrated Lime	712.03

CONSTRUCTION REQUIREMENTS

650.03 General. Additives shall not be passed through the drier or hot elevator, but shall be added directly into the designated bins.

(a) Batch Plants. Additives shall be accurately weighed and introduced in the required amounts into the mix through the weigh box. Hydrated lime required for each batch may be measured by volume on the basis of a volume weight relationship and introduced directly into the mixer.

(b) Continuous Flow Plants. Additives shall be accurately and uniformly introduced into the mixer through approved calibrated feeders.

650.04 Vacant.

650.05 Method of Measurement. The quantity of additive or additives used shall be the number of tons used in the accepted pavement. This tonnage shall be determined by multiplying the tonnage of accepted mix by the percent of additive or additives specified. The mixture tonnage shall be the weight used in the accepted pavement and no deductions will be made for bituminous material or added additives incorporated.

650.06 Basis of Payment. The quantity of additives added to the mixture will be paid for at the contract unit price per ton.

Payment will be made under:

Pay Item	Pay Unit
650.07 Mineral Filler	Ton
650.08 Hydrated Lime	Ton
650.09 Ground Limestone	Ton
650.10 Asbestos Fiber	Ton

SECTION 651 — PATROL VEHICLE AND OPERATOR

SECTION 652 — MAINTENANCE OF TRAFFIC

SECTION 653 — POLYSTYRENE PLASTIC INSULATION

These sections are reserved. Specifications will be provided and inserted in the proposal book when required.

DIVISION 700 — MATERIAL DETAILS

GENERAL STATEMENT

If materials are used in the work for which there is no prescribed schedule of testing by the project inspectors or the State Materials Laboratory the Contractor shall furnish 1 copy of a Certificate of Compliance for each material certifying that the material conforms to the required specification.

That certificate shall contain the following information:

- (1) Project number.
- (2) Kind of material.
- (3) Name of contractor to whom material is supplied.
- (4) Quantity represented by certificate.
- (5) Means of identifying consignment; i.e., labels, markings, waybill number.
- (6) Date and method of shipment.
- (7) Statement that "All material meets the requirements of the pertinent project plans, special provisions and specifications of the Maine State Highway Commission in all respects. Processing, product testing and inspection control of raw materials are in conformity with all applicable drawings and/or standards of all articles furnished."
- (8) Statement that "All records and documents pertinent to this certificate and not submitted herewith will be maintained available by the undersigned for a period of not less than three years from date of completion of the project."
- (9) Signature of a person having legal authority to bind the supplier.

The original certificate of compliance with all information required pertinent to the item with paragraphs seven and eight verbatim must be on file with the Resident Engineer prior to incorporating the materials in the work. For items which are delivered in partial shipments during the course of the construction, a certificate of compliance for the entire quantity may be accepted if each shipment can be identified with the certificate at the time of delivery.

The certificate of compliance need not be by the supplier; the prime contractor or subcontractor may assume the responsibility under provisions of seven and eight above. The certificate must be on the letterhead of the party supplying the form.

In the case of small quantities of material when the value is less than 150 dollars and which is not directly involved with the safety of the structure or the roadway, the Engineer may waive the requirement for the certificate and may accept the material.

The Engineer, at his discretion, may test any material either at the point of their manufacture or after delivery to the site of the work. In such cases the results of the test shall govern the acceptance or rejection of the material.

The following is a list of the materials which require a Certificate of Compliance. This list is not intended to be all inclusive since certain special materials not commonly used on all projects will also require certificates.

Asbestos Fibre
Bridge Rail and Hardware
Castings — Grates and Traps
Concrete Additives
Concrete Blocks, Bricks and Precast Sections
Culverts including Underdrain and Structural Plate
Electrical Conduit
Fencing including posts and hardware
Glass Beads
Glass Fabric
Guard Rail including rail, cable, posts, anchor rods, brackets, fittings and bolts
H Beam Piles
Jute Matting
Bin Type Retaining Walls
Paint including Bituminous Paint and Varnish
Reinforcing Steel including Wire Mesh
Seed
Signs including delineators, reflector cluster, panels and posts
Structural Steel
Timber Piles, treated
Wrought Iron Rails

Bituminous materials will be tested and conditionally accepted at the source or storage location prior to delivery from the producer, refiner or manufacturer. The Contractor shall give the supplier or producer sufficient advance notice of orders to permit testing. Material not represented by tests will not be accepted for use on the work.

Bituminous material tested and loadings inspected will be identified by a Test Report for each load. The Test Report

will accompany truck-transport loads and will be mailed to the Contractor's office with the bill of lading for Railroad Tank Car loads.

SECTION 701 — HYDRAULIC CEMENT

701.01 Portland Cement. Portland cement shall conform to the requirements of AASHTO M 85, Type II except that the autoclave expansion shall be limited to a maximum of 0.20 percent. Only one brand of cement shall be used on any one contract except by written permission of the Engineer.

SECTION 702 — BITUMINOUS MATERIAL

702.01 Asphalt Cements. Asphalt Cements shall be furnished in Grades according to the following requirements.

GRADE	AC200 -300	AC180 -200	AC120 -150	AC85 -100	AC60 -70	AC40 -50
Kinematic Viscosity @ 275°F, centistokes:	103+	150+	200+	250+	300+	350+
Flash Point, Cleveland Open Cup, °F	350+	400+	425+	450+	450+	450+
Penetration @ 77°F, 100g, 5 sec.	200-300	180-200	120-150	85-100	60-70	40-50
Solubility in CCl ₄ , % by weight	99.00+	99.00+	99.00+	99.00+	99.00+	99.00+
Thin Film Oven Test: Weight Loss, %	1.30—	1.20—	1.10—	0.90—	0.80—	0.70—
T.F.O.T. Residue: Ductility @ 77°F, cm	125+	115+	100+	75+	50+	25+
Pen. @ 77°F, % Orig.	40+	44+	46+	50+	54+	58+

702.02 Tars. Road Tars shall conform to the requirements of the following table. Other grades, when specified, shall conform to the requirements of AASHTO M 52.

GRADE	RT-4	RT-5	RT-6	RT-7	RT-8	RT-9
Engler Specific Viscosity @ 40°C	22-35	—	—	—	—	—
@ 50°C	—	17-26	26-40	—	—	—
Float Test @ 32°C	—	—	—	50-80	80-120	120-200
Specific Gravity @ 25°C/25°C	1.09+	1.10+	1.10+	1.12+	1.14+	1.14+
Total Bitumen, % by wt. Sol. in CS ₂	88.0+	83.0+	83.0+	78.0+	78.0+	78.0+
Water, % by volume	2.0—	1.5—	1.5—	1.0—	0	0
Distillation, % by wt. to 170°C	5.0—	5.0—	5.0—	3.0—	1.0—	1.0—
to 270°C	30.0—	25.0—	25.0—	20.0—	15.0—	15.0—
to 300°C	40.0—	35.0—	35.0—	30.0—	25.0—	25.0—
Soft. Pt. (R&B) of Dist. Res., °C	35-65	35-70	35-70	35-70	35-70	35-70
Sulfonation Index (when specified) on Distillate: 0 to 300°C	6.0—	5.0—	5.0—	—	—	—
300 to 355°C	1.5—	1.5—	1.5—	—	—	—

702.03 Cut-back Asphalts. Cut-back asphalt shall conform to the requirements set forth in the following tables, according to the type.

When Cut-back Asphalt is produced from a base Asphalt Cement which has been previously tested and approved, tests on the distillation residue will be waived upon reference by Number to the Analysis Report of the Asphalt Cement, as filed in the Augusta office of the Commission.

Viscosities may be determined by means of Saybolt Furol apparatus and method in lieu of Kinematic equipment. Results however shall be converted to Centistokes at 140° F. by Grade, according to testing temperature, using the following table of multipliers:

TABLE OF MULTIPLIERS

For converting SFS to cSt at 140° F.

GRADE	30	70	250	800	3000
SFS TEST TEMP. °F	77	122	140	180	180
MULTIPLIER	0.4	1.167	2.0	8.0	10.0

CUT-BACK ASPHALTS RAPID-CURING TYPE

GRADE	RC-70	RC-250	RC-800	RC-3000
Kinematic Viscosity @ 140°F, Centistokes (cSt.)	70-140	250-500	800-1600	3000-6000
Flash Point, Tag. Open Cup, °F	—	80+	80+	80+
Water Content, % by Vol.	0.2—	0.2—	0.2—	0.2—
Distillation Test: % by Vol. to 374°F	10+	—	—	—
of total to 437°F	50+	35+	15+	—
Distillate to 500°F	70+	60+	45+	25+
to 650°F	85+	80+	75+	70+
Dist. Residue Volume, % by diff.	55+	65+	75+	80+
Tests on Dist. Residue: Pen. @ 77°F, 100 g, 5 sec.	80-120			
Ductility @ 77°F, cm.	100+			
Solubility in CCl ₄ , %	99.50+			

CUT-BACK ASPHALTS MEDIUM CURING TYPE

GRADE	MC-30	MC-70	MC-250	MC-800	MC-3000
Kinematic Visc. @ 140°F, cSt.	30-60	70-140	250-500	800-1600	3000-6000
Flash Pt., T.O.C., °F	100+	100+	150+	150+	150+
Water Content, % by Vol.	0.2-	0.2-	0.2-	0.2-	0.2-
Distillation Test:					
% by Vol. of	0-25	0-20	0-10	-	-
to 437°F	40-70	20-60	15-55	0-35	0-15
Total Dist.	75-93	65-90	60-87	45-80	15-75
to 680°F	50+	55+	67+	75+	80+
Dist. Res. Vol., % by diff.					
Tests on Dist. Residue:			120-250		
Pen. @ 77°F, 100g, 5 sec.			100+	(Note)	
Ductility @ 77°F, cm.			99.50+		
Solubility in CCl ₄ , %					

Note: The material will be acceptable when the residue penetration is over 200 and its ductility is less than 100 @ 77° F., but over 100 at 60° F.

CUT-BACK ASPHALTS SPECIAL BLEND TYPES

GRADE AND TYPE	RC-250ME	RC-800ME	RC-3000MP
Kinematic Viscosity @ 140°F, cSt.	250-500	800-1600	3000-6000
Flash Point, T.O.C., °F	80+	80+	80+
Water Content, % by Volume	0.2-	0.2-	0.2-
Distillation Test			
% by Volume	-	-	-
of Total	10-35	0-20	-
Distillate	30-70	15-50	25+
to 680°F	65-90	50-95	70+
Dist. Res. Vol., % by diff.	66+	75+	90+
Tests on Dist. Residue:			
Pen. @ 77°F, 100g, 5 sec.	100-220		80-120
Ductility @ 77°F, cm.	100+		100+
Solubility in CCl ₄ , %	99.50+		99.50+

Note: "ME" Types consist of a blend of between 30 to 40% RC with the balance MC of the same grade, proportioned as ordered by the Engineer.

702.04 Emulsified Asphalts. Emulsified Asphalts shall conform to the requirements given in the following table. It shall be homogeneous, and shall adhere firmly to the surface of the mineral aggregate even though the aggregate may be of hydrophillic character.

TYPE AND GRADE	RAPID SETTING		MEDIUM SETTING		SLOW SETTING	MIXING		
	RS-1	RS-2	MS-1	MS-2	SS-1	AES-2	AES-3	AE-90
Viscosity SFS, at 77°F (25°C) sec.	35-120	-	20-100	100+	20-100	20-150	50+(a)	30+(a)
at 122°F (50°C) sec.	-	50-400	-	-	-	-	-	-
Distillation Residue %	57+	62+	55+	60+	57+	59+	66+	60+
Oil Distillate, % by volume	0-3	0-3	-	-	-	1-7	0-8	0-3
Settlement, 5 days (b)	5-	5-	5-	5-	5-	5-	5-	5-
Demulsibility in CaCl ₂								
35ml 0.02N, %	50+	60+	-	-	-	-	-	-
50ml 0.10N, %	0.10-	0.10-	0.10-	0.10-	0.10-	-	-	60+
Sieve Test, %								
Coating Tests, minimum % coated,								
Sand	-	-	-	-	-	90+(c)	-	-
Stone	-	-	-	-	-	-	90+(c)	90+(d)
Cement Mixing, Test, %	-	-	-	-	2.0-	-	-	-
Tests on Distillation Residue: (e)								
Pen. @ 77°F, 100g, 5 sec.	100-200		100-200		100-200	-	-	90-300
Float Test @ 140°F, sec.	-		-		-	500+	800+	-
Ductility @ 77°F, cms.	40+		40+		40+	-	-	60+
Solubility in CCl ₄ , %	97.5+		97.5+		97.5+	97.5+	97.5+	97.5+

Notes: (a) Regardless of viscosity, the material shall be readily pumpable at normal storage, spraying, and mixing temperatures.

(b) The settlement test is not required if the emulsion is shipped before the test is completed. However, when specified by the Engineer, the test shall be run for the time elapsed from production and sampling to the time of shipment, not to exceed 5 days.

(c) The Stone and Sand Coating Tests, when required, shall be performed as described in AASHTO T 59 except the mixture of aggregate and emulsion shall be mixed vigorously for 5 minutes, then allowed to stand for 5 hours, after which the mixture shall be capable of being mixed for an additional 5 minutes. The mixture shall then be rinsed with twice its own volume of distilled water, after which the coating of bituminous material on the aggregate shall be 90 percent complete. For the Sand Coating Test, the sand used shall be concrete sand 90 percent, and Portland Cement 10 percent, by weight, of the aggregate used for mixing.

(d) This Stone Coating Test, when required, shall be performed as described in AASHTO T 59, except the mixture of stone and emulsion shall be mixed vigorously for 5 minutes and then immediately drenched with approximately twice its own volume of tap water at room temperature, after which the aggregate shall be at least 90 percent coated with an asphalt film.

(e) The requirements of the residue obtained from distillation, except the float test, shall be met if the emulsion is produced from asphalt cement having a penetration between 85 and 200, and meeting the stated solubility and ductility requirements for the asphalt cement, subsection 702.01. Tests on the asphalt cement shall be evidenced by reference by Serial Number to the Analysis Report of the asphalt cement, as filed in the Augusta office of the Commission, and this Number shall be entered, as well as the test results, on all Test Reports issued for the emulsion produced from that asphalt.

TEMPERATURE - VOLUME CORRECTION TABLES

Multipliers to reduce volume at observed temperature to volume at 60° F.

ASPHALTS (from ASTM D 1250)			TARS (from ASTM D 633)		EMULSIFIED ASPHALTS		ASPHALTS (from ASTM D 1250)		TARS (from ASTM D 633)		ASPHALTS (from ASTM D 1250)		TARS (from ASTM D 633)		ASPHALTS (from ASTM D 1250)	
T °F	Group 0 Sp. Grav. S.G. 0.850 to 0.966+	Group 1 S.G. 0.850 to 0.966+	Group B RT-1 thru RT-12	Group C RT-1 thru RT-4	All Types and Grades	T °F	Group 0 Sp. Grav. S.G. 0.850 to 0.966+	Group 1 S.G. 0.850 to 0.966+	Group B RT-1 thru RT-12	Group C RT-1 thru RT-4	T °F	Group 0 Sp. Grav. S.G. 0.850 to 0.966+	Group 1 S.G. 0.850 to 0.966+	Group B RT-1 thru RT-12	Group C RT-1 thru RT-4	T °F
50	1.0035	1.0040	1.0030	1.0035	1.0025	50	0.9899	0.9847	0.9737	0.9691	150	0.9899	0.9847	0.9737	0.9691	250
55	1.0017	1.0020	1.0015	1.0017	1.0012	55	0.9872	0.9828	0.9723	0.9676	155	0.9872	0.9828	0.9723	0.9676	255
60	1.0000	1.0000	1.0000	1.0000	1.0000	60	0.9855	0.9809	0.9703	0.9657	160	0.9855	0.9809	0.9703	0.9657	260
65	0.9983	0.9980	0.9985	0.9982	0.9988	65	0.9838	0.9790	0.9684	0.9636	165	0.9838	0.9790	0.9684	0.9636	265
70	0.9965	0.9960	0.9970	0.9965	0.9975	70	0.9821	0.9771	0.9665	0.9617	170	0.9821	0.9771	0.9665	0.9617	270
75	0.9948	0.9940	0.9955	0.9948	0.9962	75	0.9804	0.9753	0.9647	0.9599	175	0.9804	0.9753	0.9647	0.9599	275
80	0.9930	0.9921	0.9940	0.9931	0.9950	80	0.9787	0.9735	0.9629	0.9581	180	0.9787	0.9735	0.9629	0.9581	280
85	0.9913	0.9901	0.9925	0.9914	0.9938	85	0.9770	0.9717	0.9611	0.9563	185	0.9770	0.9717	0.9611	0.9563	285
90	0.9896	0.9881	0.9911	0.9896	0.9925	90	0.9753	0.9700	0.9591	0.9543	190	0.9753	0.9700	0.9591	0.9543	290
95	0.9878	0.9861	0.9896	0.9879	0.9912	95	0.9736	0.9683	0.9571	0.9523	195	0.9736	0.9683	0.9571	0.9523	295
100	0.9861	0.9842	0.9877	0.9862	0.9900	100	0.9720	0.9667	0.9555	0.9507	200	0.9720	0.9667	0.9555	0.9507	300
105	0.9844	0.9822	0.9867	0.9844	0.9888	105	0.9703	0.9650	0.9539	0.9491	205	0.9703	0.9650	0.9539	0.9491	305
110	0.9826	0.9803	0.9838	0.9827	0.9875	110	0.9686	0.9633	0.9521	0.9473	210	0.9686	0.9633	0.9521	0.9473	310
115	0.9809	0.9783	0.9818	0.9809	0.9862	115	0.9669	0.9616	0.9504	0.9456	215	0.9669	0.9616	0.9504	0.9456	315
120	0.9792	0.9763	0.9792	0.9792	0.9850	120	0.9652	0.9599	0.9487	0.9439	220	0.9652	0.9599	0.9487	0.9439	320
125	0.9775	0.9744	0.9775	0.9775	0.9838	125	0.9636	0.9583	0.9471	0.9423	225	0.9636	0.9583	0.9471	0.9423	325
130	0.9758	0.9725	0.9758	0.9758	0.9825	130	0.9619	0.9566	0.9454	0.9406	230	0.9619	0.9566	0.9454	0.9406	330
135	0.9740	0.9705	0.9740	0.9741	0.9812	135	0.9602	0.9549	0.9437	0.9389	235	0.9602	0.9549	0.9437	0.9389	335
140	0.9723	0.9686	0.9723	0.9724	0.9800	140	0.9585	0.9532	0.9420	0.9372	240	0.9585	0.9532	0.9420	0.9372	340
145	0.9706	0.9666	0.9706	0.9707	0.9788	145	0.9568	0.9515	0.9403	0.9355	245	0.9568	0.9515	0.9403	0.9355	345
150	0.9689	0.9647	0.9689	0.9691	0.9691	150	0.9552	0.9499	0.9387	0.9339	250	0.9552	0.9499	0.9387	0.9339	350

702.05 Application Temperatures. Bituminous Materials for the several applications indicated in the specifications shall be applied within the temperature ranges indicated in the following table:

TABLE — APPLICATION TEMPERATURES

Type and Grade of Bituminous Material	Spraying Temperature °F		Mixing Temperature °F	
	Min.	Max.	Min.	Max.
Asphalt Cement: All Grades	-	340	As required to achieve a viscosity between 150-300 centistokes, or as otherwise specified	
Road Tars: RT 1, 2, 3	60	130	-	-
RT 4, 5, 6	85	150	85	150
RT 7, 8, 9	150	225	150	225
RT 10, 11, 12	175	250	175	250
Rapid Curing Cutback RC 70	80	150	-	-
RC 250	100	175	80	150
RC 800	160	225	135	185
RC 3000	200	275	175	225
Medium Curing Cutback MC 30	50	120	-	-
MC 70	80	150	-	-
MC 250	100	200	100	200
MC 800	185	260	160	210
MC 3000	225	275	200	250
Special Blend Cutback RC 250 ME	100	175	75	175
RC 800 ME	175	250	150	200
RC 3000 MP	225	300	200	250
All Emulsions	50	140	50	140

702.06 Bituminous Material for Primer. Asphalt for primer shall conform to the requirements of AASHTO M 116. Primer for use with tar shall conform to the requirements of AASHTO M 121.

702.07 Bituminous Material for Waterproofing. Asphalt for waterproofing shall conform to the requirements of AASHTO M 115, Type C unless otherwise specified. Tar for waterproofing shall be a coal-tar pitch conforming to the requirements of AASHTO M 118, Type B unless otherwise specified.

702.08 Asphalt Flashing Cement. Asphalt flashing cement shall be a mixture of bituminous material and mineral filler and shall be of a consistency that will allow trowelling at normal atmospheric temperatures.

702.09 Asphalt Filler for Structural Plate Arches. Asphalt for filling spaces between the structural plates and the

substructure metal connectors of the arch shall conform to the requirements for bituminous material of AASHO M 190.

702.10 Bituminous Paint. Bituminous paint shall have a coal-tar pitch base and shall meet the following requirements:

- | | |
|---|------------------|
| (a) Sag Test | No Sag |
| (b) Ash % by weight | 15 - 25 Ignition |
| (c) Distillation % by weight (ASTM D 20) | |
| 0° - 150° C. (302° F.) | 0 |
| 0° - 235° C. (455° F.) | 20 - 30 |
| (d) Distillation Residue Softening Point
(ASTM D 36) | 205 - 240° F. |
| (e) Penetration at 77° F., 100g. 5 sec.
(ASTM D 5) | 5 - 25 mm/10 |

702.11 Anti-stripping Additives for Liquid Bituminous Materials. Anti-stripping additives shall be restricted to those additives approved by the Commission. A list of approved additives is available at the office of the Commission. Other brands may be approved only after satisfactory test results have been obtained by the Central Laboratory using the proposed additive with the proposed liquid bituminous material in tests on the aggregate proposed for use.

The additives shall be used in accordance with the manufacturer's instructions. An approved procedure for adding the specified amount of additive to each load of liquid bituminous material shall be followed by the Contractor and he will be held responsible for the uniform operation during the progress of the work. The amount of additive to be used will be determined by the Engineer.

The volume of anti-stripping additive used in each load will be verified by the Inspector at the point of incorporation of the additive into the liquid bituminous material. The following information will be entered on the loading invoice and on the test report for the liquid bituminous material:

- (a) The number of gallons of additive added.
- (b) The brand name and type of additive.
- (c) The resulting percentage of additive in the load of material.

702.12 Emulsified Bituminous Sealing Compound. Emulsified Bituminous Sealing Compound shall be an approved commercially prepared product manufactured for the specific purpose of a protective coating, colored as required. It shall

contain fillers, pigments and sand or fibrous materials suspended in a suitable emulsified asphalt or tar. It shall be of such consistency that it can be applied at atmospheric temperatures and capable of being easily diluted with the addition of water and mixed by hand stirring at the site of application.

SECTION 703 — AGGREGATES

703.01 Fine Aggregates for Concrete. Fine aggregate for concrete shall consist of natural sand or, when approved by the Engineer, a combination of washed or dustless stone screenings and sand, containing not more than 50 percent by volume of screenings. Screenings so used shall be obtained by crushing hard, durable rock. 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, except for stone screenings as noted above and for inorganic fine material as noted below.

All fine aggregate shall be free from injurious amounts of organic impurities. Should the fine aggregate, when subjected to the colorimetric test for organic impurities, AASHO T 21, produce a color darker than the reference standard color solution (laboratory designation Plate III), it shall be rejected.

The fine aggregate shall be well graded from coarse to fine, shall meet the following grading requirements when tested according to AASHO T 27.

Percentage by Weight Passing Square Mesh	
Sieve Designation	Sieve Fine Aggregate
¾ inch	100
No. 4	95-100
No. 16	50-85
No. 50	10-30
No. 100	2-10

Fine aggregate failing to pass the minimum requirements for material passing the No. 50 and/or No. 100 sieves may be retested and approved for use provided an approved inorganic fine material is added to correct the deficiency in grading.

The gradation requirements given above are the extreme limits to be used in determining the suitability of materials from all possible sources of supply.

The fineness modulus shall be not less than 2.3 or more than 3.1, nor vary by more than 0.20 from the value assumed in

selecting proportions of the concrete. If this value is exceeded, the fine aggregate will be rejected unless suitable adjustments are made in proportions of coarse and fine aggregate. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages of material by weight retained on U. S. Standard sieves Nos. 4, 8, 16, 30, 50, 100 and dividing by 100.

Mortar cubes containing the fine aggregates and made according to AASHTO T 71 using cement conforming to AASHTO M 85, Type II, shall develop compressive strength, at the age of 7 days, of not less than 90 percent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 plus or minus 0.10. After the initial test for each year and the fine aggregate has been accepted, the above compressive test will not be required unless the Engineer deems it necessary. Fine aggregate, when tested for absorption as specified in AASHTO T 84, shall show a percent of absorption of not more than 2.30.

703.02 Coarse Aggregate for Concrete. Coarse aggregate for concrete shall consist of crushed stone, or gravel having hard, strong, durable pieces, free from adherent coatings and contain less than 15 percent, by weight, of thin or elongated pieces. A thin, or elongated piece is defined as any piece whose length is greater than 5 times its maximum thickness.

The coarse aggregate shall not contain more than 3.0 percent, by weight, of deleterious material. No individual aggregate source or stockpile used for blending shall contain more than 4.0 percent, by weight, of deleterious material. Deleterious material is defined as those particles of aggregate which may be crumbled in the hand and those which have an absorption greater than 3.0 percent by weight determined in accordance with AASHTO T 85 modified for weight of sample. The types which are determined to be deleterious are generally highly absorptive shales, phyllites, sandstones and rotten rock of various kinds.

Coarse aggregate shall conform to the requirements of the following Table for the size or sizes designated and shall be well graded between the limits specified.

Class of Concrete	Percentages by Weight Passing Square Mesh Sieves							
	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8
Y	-	-	100	95-100	-	20-55	0-10	0-5
S	100	95-100	-	40-75	-	20-35	0-10	-
A	-	100	95-100	-	25-60	-	0-10	0-5
B	100	95-100	-	35-70	-	10-30	0-5	-

Gradation tests shall conform to AASHTO T 27.

703.03 Aggregate for Plant Mix Bituminous Base.

(a) *Coarse Aggregate.* Coarse aggregate shall be crushed stone, or crushed gravel and shall conform to the quality requirements of subsection 703.07.

(b) *Fine Aggregate.* Fine aggregate shall conform to the requirements of subsection 703.07.

The total aggregate shall be a blend of coarse and fine aggregate and shall conform to the requirements of subsection 703.09 and as designated on the plans.

703.04 Aggregate for Road Mix Bituminous Base. Aggregate for road mix bituminous base construction shall be crushed rock, crushed or natural gravel which meets the quality requirements of AASHTO M 62 Sections 2 and 3(b). The total aggregate shall be well graded and shall conform to the gradation specified in subsection 703.11. The aggregate shall contain not more than 8 percent, by weight, of deleterious material. Deleterious material is defined in subsection 703.02.

703.05 Aggregate for Penetration Macadam Base. Aggregates for penetration macadam base shall meet the requirements of subsection 703.12 and as designated on the plans.

703.06 Aggregate Base and Subbase.

(a) Aggregate Base shall be screened or crushed gravel consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay, and other deleterious substances. The gradation of the part that passes a 3 inch sieve shall meet the grading requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Screened	Crushed
1/2 inch	35-75	45-70
1/4 inch	25-60	30-55
No. 40	5-25	5-20
No. 200	0-5	0-5

Screened gravel base shall not contain particles of rock which will not pass the 4 inch square mesh sieve. Crushed gravel base shall not contain particles of rock which will not pass the 1½ inch square mesh sieve.

(b) *Aggregate Subbase.* Aggregate Subbase shall be sand or gravel consisting of hard, durable particles which are free from vegetable matter, lumps or balls of clay, and other deleterious substances. The gradation of the portion which will pass a 3 inch sieve shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Granular	Percentage by Weight Sand	Percentage by Weight Gravel
1/4 inch	—	60-100	25-70
No. 40	0-70	0-50	5-30
No. 200	0-10	0-7	0-7

Granular subbase and gravel subbase shall not contain particles of rock which will not pass the 6 inch square mesh sieve. Sand subbase shall not contain particles of rock which will not pass the 4 inch square mesh sieve.

Gradation tests shall conform to AASHO Method T-27 except that the material may be separated on the ½ inch sieve.

703.07 Aggregates for Flexible Pavements — General. Coarse aggregate, and fine aggregate for flexible pavements shall be of such gradation that when combined in proper portions (including filler if required) the resultant blend shall meet the required composition of mixture for the specific type under the contract.

(a) Coarse aggregate (retained on the No. 8 sieve) shall be crushed stone or crushed gravel and unless otherwise stipulated shall consist of clean tough durable fragments free from an excess of flat, elongated, soft, or disintegrated pieces and free from stone coated with dirt or other objectionable matter. In addition, the allowable amount of deleterious particles shall not exceed 16 percent by weight for material obtained north of the location of the Canadian Pacific Railroad, and 8 percent for material obtained south of this location. Deleterious material is defined in subsection 703.02.

When crushed gravel is used, not less than 50 percent of the particles shall have at least 1 fractured face. The coarse aggregate shall be of such gradation that when combined with other required aggregate fractions in proper proportions the resultant mixture will meet the gradations required under the composition of mixture for the specific type under the

contract. Only one kind shall be used on the project except by permission of the Engineer.

(b) Fine aggregate (passing the No. 8 sieve) shall consist of natural sand or sand prepared from stone, or gravel, or combination thereof. It shall consist of hard, tough grains, free from injurious amounts of clay, loam or other deleterious substances. In addition, the absorption of the fine aggregate as determined by AASHO T 84 shall not exceed 3.0 percent by weight for use in mixes exposed to traffic and weather.

The fine aggregate shall be of such gradation that when combined with other required aggregate fractions in the proper proportions, the resultant mixtures will meet the gradation requirements.

(c) *Composition of Mixture.* The following requirements shall apply to the composite blend resulting when the stock piled aggregates are combined to produce a mixture conforming within specified tolerances to the gradation stated in the job mix formula.

The amount of natural or crushed gravel aggregates retained on the No. 8 sieve in a composite blend requiring crushed stone aggregate shall not exceed 15 percent of the total aggregate.

The gradation of the composite blend shall be such that the portion passing the No. 200 sieve shall not exceed 50 percent of the portion passing the No. 50 sieve.

Samples of the composite blend obtained immediately prior to addition of bituminous material shall be tested in accordance with AASHO Designation T 176. The sand equivalent value found shall be in excess of 50.

703.08 Aggregate for Sheet Asphalt Pavement. The coarse and fine aggregate shall meet the requirements of Subsection 703.07. The several aggregate fractions for mixtures shall be sized, graded, and combined in such proportions that the resulting composite blends will meet the grading requirements of the following table or as otherwise specified.

Sieve Designation	Percentage by Weight No. 1 Binder	Percentage by Weight No. 2 Binder	Percentage by Weight Surface Course
1 1/2 inch	100	—	—
1 inch	95-100	100	—
3/4 inch	—	95-100	—
3/8 inch	40-80	—	—
No. 4	—	20-40	100
No. 8	15-35	15-35	95-100
No. 50	—	—	40-85
No. 100	—	—	15-50
No. 200	—	—	9-20

703.09 Aggregate for Hot Plant Mix Bituminous Pavement. The coarse and fine aggregate shall meet the requirements of subsection 703.07. The several aggregate fractions for mixtures shall be sized, graded, and combined in such proportions that the resulting composite blends will meet the grading requirements of the following tables or as otherwise specified.

Sieve Designation	MIX USE Grading	FINE SIDEWALKS REGULAR SUR- DRIVES & SHIM				
		BASE BINDER	SURFACE	FACE		
		B	C	D	E	
		Percentage by Weight Passing Square Mesh Sieves				
2 inch	100	-	-	-	-	-
1 1/2 inch	90-100	-	-	-	-	-
1 inch	-	100	-	-	-	-
3/4 inch	50-80	80-100	100	-	-	-
1/2 inch	-	50-85	95-100	100	100	-
3/8 inch	35-65	-	75-100	95-100	90-100	-
No. 4	25-50	28-60	50-76	60-80	70-100	-
No. 8	20-40	20-50	34-60	46-65	50-90	-
No. 16	13-33	14-39	22-45	25-55	36-78	-
No. 30	-	-	16-37	16-40	24-66	-
No. 50	6-24	6-24	10-26	10-30	15-50	-
No. 100	4-16	4-16	6-15	6-22	8-30	-
No. 200	1-8	1-8	3-8	3-8	3-8	-

703.10 Aggregate for Untreated Surface Course and Levelling Course. Aggregate for untreated surface and levelling course shall be screened or crushed gravel consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay, and other deleterious substances. The gradation of the material shall meet the grading requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Levelling Course	Surface Course
1 inch	100	100
3/4 inch	90-100	90-100
No. 4	40-60	40-70
No. 10	10-40	15-50
No. 200	0-5	0-10

Gradation tests will conform to AASHTO Method T-27.

703.11 Aggregate for Road Mix Bituminous Pavement. Aggregate for road mix bituminous pavement shall be crushed rock or crushed or natural gravel which meets the quality requirements of AASHTO M 62, Sections 2 and 3(b). The aggregate shall contain not more than 8 percent, by weight, of deleterious material. Deleterious material is defined in subsection 703.02. At least 25 percent of the gravel retained on the Number 4 sieve shall have one crushed face if crushed material is specified. The total aggregate shall be well graded and shall conform to the following gradation requirements as specified.

Percentage by Weight Passing Square Mesh Sieves

Sieve Designation	Gradation A	Gradation B
	Crushed Stone or Crushed Gravel	Uncrushed Gravel
1 1/2 inch	-	100
1 inch	100	95-100
3/4 inch	90-100	70-90
No. 4	45-65	30-50
No. 8	32-52	-
No. 50	10-22	-
No. 200	2-8	0-5

703.12 Aggregate for Penetration Macadam Pavement. The aggregate shall be obtained from rock of uniform quality and shall consist of clean, tough, durable, angular fragments of broken rock free from soft disintegrated pieces or other objectionable matter.

The aggregate shall meet the following elongation requirement: Not over 8 percent of the pieces shall have a length greater than five times their maximum thickness. The aggregate shall contain not more than 8 percent, by weight, of deleterious material. Deleterious material is defined in subsection 703.02.

Cover aggregate when tested in accordance with AASHTO T 182 shall have a retained bituminous film above 95 percent. Acceptable anti-stripping additives conforming to subsection 702.11 shall be used when necessary to meet this requirement.

The aggregate shall meet the gradation requirements as specified in AASHTO M 43 and as shown in the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves				
	Base Stone	Coarse Stone	Key Stone	Cover Aggregate	Cover Aggregate
	No. 3	No. 357	No. 6	No. 7	No. 8
2 1/2 inch	100	100	-	-	-
2 inch	95-100	95-100	-	-	-
1 1/2 inch	35-70	-	-	-	-
1 inch	0-15	35-70	100	-	-
3/4 inch	-	-	95-100	100	-
1/2 inch	0-5	10-30	20-55	95-100	100
3/8 inch	-	-	0-15	40-70	85-100
No. 4	-	0-5	0-5	0-15	10-30
No. 8	-	-	-	0-5	0-10
No. 16	-	-	-	-	0-5

703.13 Aggregate for Cover Coat Material. Stone chip aggregate shall be crushed stone or crushed gravel that will meet the quality requirements of subsection 703.12. Sand cover shall be granular material consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay and other deleterious substances. Only one type of

aggregate shall be used on the project unless alternate types are approved. The gradation of the materials shall conform to the grading requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves Stone Chips	Sand Cover
1/2 inch	100	-
3/8 inch	85-100	85-100
No. 4	10-30	50-80
No. 8	0-10	-
No. 16	0-5	-
No. 200	-	0-5

When tested in accordance with AASHTO T 182, the stone chip aggregate shall have a retained bituminous film above 95 percent. Stone chip aggregates which do not meet this requirement may be used for bituminous treatments and seal coats provided a satisfactory chemical additive or wetting agent conforming to subsection 702.11 is used to provide a water resistant film. The stripping tests may be omitted if the total quantity of stone chip aggregate is less than 50 cubic yards or if it comes from a source which has given satisfactory performance.

703.14 Blotter. Aggregate for blotter material shall consist of sharp durable particles of sand conforming to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
3/4 inch	100
No. 4	40-100
No. 200	0-5

The aggregate shall be free from vegetable and other deleterious material.

703.15 Filler. These materials shall conform to the following specification requirements for the designated materials.

Mineral filler shall conform to the requirements of AASHTO M 17.

Asbestos Fiber shall meet the requirements of Canadian Quebec Mining Specification for Grade 7M.

Ground limestone shall meet the following gradation requirements:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
No. 8	100
No. 50	80-100
No. 200	30-70

703.16 Vacant.

703.17 Aggregate for Stabilized Base. Aggregates for bituminous stabilized base course shall consist of granular material containing hard, durable particles conforming to the gradation requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 1/2 inch	100
3/8 inch	60-100
No. 4	50-85
No. 8	38-74
No. 50	8-34
No. 200	0-10

The gradation shall be uniform within the limits specified and shall not vary from the low limit on one sieve size to the high limit on the adjacent sieve size. The material passing the No. 200 sieve shall be not more than one-half of the fraction passing the No. 50 sieve.

703.18 Common Borrow. Common borrow shall consist of earth, suitable for embankment construction. It shall be free from frozen material, perishable rubbish, peat and other unsuitable material.

When placed in embankments common borrow shall not have a moisture content greater than 2 percent above optimum unless that portion passing a 1 inch screen has less than 35 percent passing a number 200 mesh sieve. In no case shall the moisture content exceed 4 percentage points above optimum.

The optimum moisture content shall be determined in accordance with AASHTO T 180, Method C or D.

703.19 Granular Borrow. Granular borrow shall consist of earth meeting the requirements of subsection 703.06 (b) except that the gradation of that portion passing a 3 inch sieve shall meet the gradation requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves Material for Underwater Backfill	Material for Embankment Construction
No. 40	0-70	0-70
No. 200	0-10	0-20

It shall contain no particles or fragments with a maximum dimension in excess of the compacted thickness of the layer being placed.

703.20 Gravel Borrow. Gravel borrow shall consist of uniformly graded granular material having no rocks with a maximum dimension of over 6 inches and that portion passing a three inch square mesh sieve shall contain not more than 70 percent passing a ¼ inch mesh sieve and not more than 10 percent passing a number 200 mesh sieve.

703.21 Rock Borrow. Rock borrow shall consist of hard durable rock broken to various sizes that will form a compact embankment with a minimum of voids. The maximum size for any rock shall be 3 feet in its greatest dimension.

703.22 Underdrain Backfill Material. Granular material for Type "A" underdrain shall conform to the requirements of subsection 703.06 (b), Aggregate Subbase.

Granular material for Type "B" underdrain shall be free from organic matter and shall conform to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 inch	95-100
1/2 inch	75-100
No. 4	50-100
No. 20	15-80
No. 50	0-15
No. 100	0-10

Crushed or uncrushed material for Type "C" underdrain shall conform to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 inch	100
3/4 inch	90-100
3/8 inch	0-75
No. 4	0-25
No. 10	0-5

Gradation tests for each type of underdrain trench backfill material, except Type "D" shall conform to AASHTO T 27.

703.23 Absorption Trench Aggregate. Stone for absorption trenches shall consist of screened gravel stones or crushed quarry stone conforming to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
3 inch	100
2 inch	0-5

703.24 Stone for French Drains. Stones for French drains shall consist of hard durable rock and shall conform to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
6 inch	90-100
1 1/2 inch	0-5

Gradation tests shall conform to AASHTO Method T 27 except that the total material sampled shall be sieved and the minimum weight of the sample will be 120 pounds.

SECTION 704 — MASONRY UNITS

704.01 Clay or Shale Brick. Except as modified below, brick shall conform to the requirements of one of the following specifications:

Type	Specification
Sewer Brick	AASHTO M 91, Grade MA or NA or ASTM C 32, Grade MA
Building Brick	AASHTO M 114, Grade SW, or ASTM C 62, Grade SW

Size Number 1 brick of a nominal length of 7½ inches may be used.

704.02 Concrete Brick. Concrete brick shall conform to the requirements of ASTM C 55, Grade P-II and shall not have an absorption exceeding 12 percent when determined in accordance with ASTM C 140.

704.03 Concrete Masonry Blocks. Concrete masonry blocks may be rectangular or segmented and, when specified, shall have ends shaped to provide interlock at vertical joints. The blocks shall conform to the requirements of ASTM C 139, or, for hollow blocks, to ASTM C 90, Grade P-II. Blends of Type I and Type III Cement, known as "block cement," will be allowed.

SECTION 705 — JOINT MATERIALS

705.01 Preformed Expansion Joint Filler. Preformed expansion joint filler shall be a nonextruding and resilient bituminous type and shall conform to the requirements of AASHTO Designation M 153, Type I or III.

705.02 Joint Mortar. Joint mortar shall consist of one part portland cement and two parts sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

The cement shall conform to the requirements of portland cement Type IIA.

The sand shall meet the requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve
1/4 inch	100
No. 8	85-100
No. 50	15-45
No. 100	0-15
No. 200	0-5

The sand shall also be subjected to the colorimetric test for organic impurities and when color darker than standard is obtained the material will be rejected.

705.03 Rubber Gaskets. The ring gaskets shall conform to the requirements of AASHTO M 198.

705.04 Flexible Plastic Gasket. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents. The gasket sealer shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope-form of suitable cross section and of such size as to fill the joint space when the pipes are laid. The gasket joint sealer shall be protected by a suitable removable two piece wrapper designed so that one-half may be removed longitudinally without disturbing the other half.

The sealing compound when immersed separately in a 5 percent solution of caustic potash, a 5 percent solution of hydrochloric acid, a 5 percent solution of sulfuric acid and a saturated hydrogen sulfide solution for 30 days at ambient room temperature shall show no visible deterioration.

PROPERTIES OF THE GASKET MATERIAL

Test	Analysis	
	Min.	Max.
Bitumen (Petroleum Plastic Content) %	ASTM D 4	50 70
Ash Inert Mineral Matter %	AASHTO T 111	30 50
Volatile Matter %	ASTM D 6	2.0
Specific Gravity @ 77°F	ASTM D 71	1.20 1.35
Ductility @ 77°F (cm) Min.	ASTM D 113	5.0
Softening Point @ 77°F Min.	ASTM D 36	320°F
Penetration		
32°F (300 gms) 60 Sec.	ASTM D 217	75
77°F (150 gms) 5 Sec.		50 120
115°F (150 gms) 5 Sec.		150
Flashpoint C.O.C. °F	ASTM D 92	600°F
Firepoint C.O.C. °F	ASTM D 92	625°F

Other types of gasket or joint sealer with satisfactory performance records may be considered for use on individual contracts on a trial basis.

705.05 Joint Sealing Compound. Unless otherwise specified the joint sealer for all cement concrete pavement joints shall be a rubberized joint sealing material conforming to Federal Specifications for Sealer, Hot Poured Type SS-S-164.

SECTION 706 — CONCRETE, CLAY, AND FIBER PIPE

706.01 Nonreinforced Concrete Pipe. This pipe shall conform to the requirements of AASHTO M 86 for the specified diameters and strength classes.

706.02 Reinforced Concrete Pipe and Pipe Arches. Circular pipe shall conform to the requirements of AASHTO M 170 for the specified diameters and strength classes. Elliptical pipe shall conform to the requirements of AASHTO M 207. Pipe arch shall conform to the requirements of AASHTO M 206. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

Precast reinforced concrete special sections shall conform to the requirements of the cited specifications to the extent to which they apply.

706.03 Perforated Concrete Pipe. This pipe shall conform to the requirements of AASHTO M 175 for the specified diameters.

706.04 Vacant.

706.05 Vacant.

706.06 Vacant.

706.07 Clay Pipe. This pipe shall meet the requirements of AASHTO M 65, for pipe with full circle cross sections, for the specified diameter. Unless otherwise specified, "standard strength" pipe shall be furnished.

706.08 Vitrified Clay Pipe. This pipe shall meet the extra strength requirements of AASHTO M 65 for the specified diameters for circular, unglazed, unperforated pipe.

706.09 Vacant.

706.10 Asbestos Cement Pipe. This pipe shall meet the requirements of ASTM C 428.

706.11 Perforated Asbestos Cement Pipe. This pipe shall meet the requirements of AASHO M 189.

706.12 Bituminized Fiber Pipe. This pipe shall meet the requirements of AASHO M 158.

706.13 Perforated Bituminized Fiber Pipe. This pipe shall meet the requirements of AASHO M 177. Unless otherwise indicated either Type 1 or Type 2 couplings may be furnished.

SECTION 707 — METAL PIPE

707.01 Cast Iron Pipe. This pipe shall conform to the requirements of AASHO M 64 or ASTM A 142, for the specified diameters and strength classes. Unless otherwise specified, either smooth, corrugated or ribbed pipe may be furnished. Pipe of diameter in excess of 48 inches shall conform to the ASA standard for Cast Iron Pit Cast Pipe for the specified diameters and strength class.

707.02 Corrugated Metal Pipe and Pipe Arches. These pipes and the coupling bands shall conform to the requirements of AASHO 36 for the specified sectional dimensions and gauges. Shop-formed elliptical pipe and shop-strutted pipe shall be furnished where specified. Special sections, such as elbow and flared end sections, for these conduits shall be of the gauge called for on the plans and conform to the applicable requirements of AASHO M 46. Modification to coupling bands resulting in strength requirements which equal or exceed the requirements of M 36 will be allowed upon approval of the Engineer.

Resistance spot welded corrugated metal culvert pipe conforming to the requirements of AASHO M 209 may be supplied at the option of the Contractor.

707.03 Bituminous Coated Corrugated Metal Pipe and Pipe Arches. These pipes and the coupling bands shall conform to the requirements of AASHO M 190 Type C for the specified sectional dimensions, gauges, and type of bituminous coating, except that the paved invert may be either smooth or corrugated as follows.

(a) *Smooth Pavement.* Additional bituminous material shall be applied in such a manner that a smooth pavement will be formed in the invert (bottom of pipe when installed), filling the corrugations for one-quarter the circumference of the pipe. The pavement, except where the upper edges intersect the corrugations, shall have a minimum thickness of $\frac{1}{4}$ inch above the crests of the corrugations.

(b) *Corrugated Pavement.* A corrugated bituminous pavement shall be formed in the invert (bottom of pipe when installed), extending over $\frac{1}{4}$ of the circumference of the pipe. The corrugated pavement shall conform to the shape of the corrugations, and shall have a minimum thickness of not less than $\frac{3}{8}$ inch.

The width of pavement in pipe arches shall not be less than 40 percent of the periphery. Invert paving of metal sluice will not be required.

Coupling bands shall be fully coated with bituminous material. The temperature of the bituminous material used for coating, except that material used for invert paving shall be a minimum of 390° F. when applied to the pipe.

Special sections, such as elbows and metal end sections, for these pipes shall be of the gauge called for on the plans and shall conform to the applicable requirements of AASHO M 190. Coating and invert paving shall be of the type specified.

Shop-formed elliptical pipe and shop-strutted pipe shall be furnished where specified.

707.04 Corrugated Metal Pipe for Underdrain. This pipe shall conform to the requirements of AASHO M 136 for the specified diameters except that within each group, the rows of perforations shall be spaced circumferentially approximately 1 inch center to center and in each row the perforations shall be located either on the inside crests or on one of the neutral axes of all corrugations, except that perforations are not required within 4 inches of each end of each length of pipe or in the crests of corrugations where seams are located. Unless otherwise specified, any one of the four types may be furnished.

707.05 Bituminous Coated Corrugated Metal Pipe for Underdrain. This pipe shall conform to the requirements of subsection 707.04 and shall be coated with bituminous material to meet the requirements of AASHO M 190, Type A coating except that minimum coating thickness shall be 0.03 inch. Coupling bands shall be fully coated.

707.06 Corrugated Aluminum Pipe and Pipe Arches. These pipes and coupling bands shall conform to the requirements of AASHO M 196 for the specified sectional dimensions and gauges. Shop-formed elliptical pipe and shop-strutted pipe shall be furnished where specified. Special sections, such as elbows, and aluminum metal end sections for these pipes shall

be of the gauge called for on the plans and shall conform to the applicable requirements of AASHO M 196. Corrugated aluminum pipe arches shall consist of round corrugated aluminum pipe which has been converted into a shape meeting the dimension requirements of Table III of AASHO M 36.

707.07 Vacant.

707.08 Corrugated Aluminum Pipe for Underdrains. This pipe shall conform to the requirements of AASHO M 197 for the specified size and type.

707.09 Structural Plates. Plates, bolts and nuts shall conform to the requirements of AASHO M 167 except that there will be no maximum weight limit for a single plate.

SECTION 708 — PAINTS

708.01 Exterior Ready Mixed Paint. Exterior paint for coating wood structures shall conform to the requirements of AASHO M 70, Type I Class A or B. When white paint is called for the paint shall be Class A. When tinting is required Class B shall be supplied.

708.02 Metal Bridge Paint (Shop Coat). The shop or prime coat of paint for metal shall be a red lead paint and shall conform to the requirements of AASHO M 72, Type I or Type II or a red lead conforming to the requirements of AASHO M 71.

708.03 Metal Bridge Paint (Field Coat). All materials shall conform in all respects to the requirements of the supplemental specification.

708.04 Tree Paint. Tree paint shall be an approved asphaltic base paint prepared and customarily used for tree surgery purposes.

708.05 Timber Preservative. Timber preservatives shall conform to the requirements of AASHO M 133.

708.06 Acrylic Emulsion Paint. The paint shall be an Acrylic Emulsion paint containing no alkyds, butadiene styrene or vinyls and shall be thinned with water only. The paint shall be of a quality that shall provide a suitable binder for the addition and retention of reflectance type glass beads or spheres at the time of application.

All materials used in the manufacture of the paint shall be of good commercial quality entirely suitable for the purpose intended under normal conditions of use. For white paint, the opaque portion of the pigment shall be rutile titanium dioxide, and the vehicle shall consist of 100 percent acrylic polymer dispersed in water together with the minimum amounts of necessary additives, such as pigment dispersants, anti-foaming agents and preservatives; but no driers shall be used.

The paint shall meet a minimum requirement of total solids (percent by weight of paint) of 50 percent and a maximum pigment content (percent by weight of paint) of 33 percent. The white paint shall contain not less than 2.5 pounds per gallon of rutile titanium dioxide. A minimum fineness of grind of 4 and a viscosity (Krebs units) of 65 minimum and 85 maximum is required. The paint shall brush easily and have good flowing, levelling and spreading characteristics and shall be suitable for application by spray equipment.

The paint shall meet the following Solvents Resistance Test:

Obtain a sample of unreduced paint for a draw-down of 0.003 inch wet film thickness on glass and air dry for 24 hours. Remove the dried paint film in sheets from the glass and weigh out one gram. Place one gram of paint film in a 50 milliliter beaker and add 20 grams of Toluol, Federal Specification TT-T-548. Cover the beaker and observe effect of the solvent. The beaker shall be rotated periodically during the test period. The paint film shall not crumble, cloud the liquid, or otherwise disintegrate in the liquid within 48 hours and the Toluol shall remain clear and colorless throughout the test. Failure of the film to pass this test shall disqualify the product. Procedures for all other tests shall be as described in Federal Specifications for Paints, Pigments, Varnishes and Products No. TT-P-0019, "Acrylic Emulsion Exterior Paint."

The paint shall be suitable for use over all types of bituminous surfaces and when applied over emulsified asphalt or tar surfaces, it shall not cause lifting, crazing, peeling or other damage to the base. The material shall be approved before being used.

708.07 Wood Stain. Wood stain shall consist of a mixture of the following ingredients mixed in the prescribed manner and proportions. The formula for mixing 5 gallons of stain shall be:

Boiled Linseed Oil	3 gallons
Mineral spirits or turpentine	1 gallon
Colors in oil (Colors as called for on the plans)	1 quart
Paraffin wax	1 pound
Pentachlorophenol concentrate 10:1	½ gallon
Zinc stearate	2 ounces

Mixing. The paraffin wax and zinc stearate shall be thoroughly mixed in a pan over heat. This mixture shall be poured into the mineral spirits and stirred vigorously while it is being used. There should be no open flame while the paraffin mixture is being added to the mineral spirits. After the mixture has cooled to room temperature the pentachlorophenol concentrate and the linseed oil shall be added. When thoroughly mixed, the colors-in-oil shall be added, small amounts at a time, and the entire mixture stirred until a uniform color is obtained.

708.08 Graphite Lubricant. Graphite lubricant shall be a mixture of graphite paste and a vehicle having quick drying characteristics.

The paste shall be thoroughly mixed and have the following composition:

	Percentage by Weight	
	Minimum	Maximum
Pigment (Flake Graphite)	55	65
Vehicle	35	45

The graphite pigment shall have a minimum of 85% graphite carbon conforming to the following gradation:

	Percentage by Weight Passing Square Mesh Sieve
Number 100	84-92
Number 325	46-50

The paste vehicle shall consist of 52 percent fixed oils and the remainder shall be volatile thinners and dryers.

The lubricant may be prepared for use by mixing at the job site or may be pre-mixed by the supplier.

The graphite lubricant shall be thoroughly mixed with 40 percent, by weight of a 60/40 mixture of trichlorethane or carbon tetrachloride with naphtha.

SECTION 709 — REINFORCING STEEL AND WIRE ROPE

709.01 Reinforcing Steel. Reinforcing steel shall conform to the following AASHO specifications:

Type	Specification
Rail-Steel Bars for Concrete Reinforcement	AASHO M 42
Axle-Steel Bars for Concrete Reinforcement	AASHO M 53
Billet Steel Bars for Concrete Reinforcement	AASHO M 31
Fabricated Steel Bar or Rod Mats for Concrete Reinforcement	AASHO M 54
Welded Steel Wire Fabric for Concrete Reinforcement	AASHO M 55

Unless otherwise specified, bar reinforcement shall conform to the requirements of AASHO M 31 and be the deformed class, intermediate grade billet steel made by the open hearth process except that bars for spiral reinforcement may be either deformed or plain. Number 2 bars need not be deformed. Deformations shall conform to the requirements of AASHO M 137.

The use of cold twisted bars shall not be permitted.

Dowel bars used in load transfer devices of concrete pavement shall be plain round bars conforming to AASHO M 31. They shall be free from burring or other deformation restricting slippage in the concrete.

The combination sleeve and cap for use on the unbonded end of expansion joint dowels shall be not more than 4 inches in length and shall cover the dowel for not less than 2 inches nor more than 3 inches. The sleeve shall be of sufficient inside diameter to fit closely around the dowel yet allow free movement and shall be of such design that it does not collapse during construction. The cap shall be manufactured from sheet metal, 32 gauge minimum, (U. S. Standard) and have a suitable flange pressed into it to keep the end of the dowel about 1 inch from the end of the cap. The closed end shall be watertight.

Tie bars used in longitudinal joints in concrete pavements shall be deformed bars.

Structural shapes used as reinforcement in concrete shall conform to the requirements of subsection 713.01.

709.02 Wire Rope or Wire Cable. The wire rope or wire cable for highway guard rail shall conform to the requirements of AASHO M 30 for the specified diameter and strength class.

SECTION 710 — FENCE AND GUARD RAIL

710.01 Barbed Wire. Barbed wire shall conform to the requirements of ASTM A 121, Class 1, with 12½ gauge

4-point round barbs wrapped around both wires, interlocked with one barb projecting through the strand and spaced 6 inches apart or less. At the option of the Contractor, barbed wire may be aluminum coated with a minimum of 0.4 ounces of coating per square foot of uncoated surface in place of galvanizing.

710.02 Woven Wire. Wire and stays shall conform to the requirements of ASTM A 116, Class 1, Design Number 1047-12-11 or better. At the option of the Contractor woven wire may be aluminum coated with a minimum of 0.4 ounces of coating per square foot of uncoated surface in place of galvanizing.

710.03 Chain Link Fabric. Chain Link fabric shall conform to the requirements of AASHO M 181 Zinc-coated Steel Fabric or Aluminum-coated Steel Fabric.

710.04 Metal Beam Rail. The rail elements shall be corrugated sheet steel beams conforming to the requirements of AASHO M 180 of the designated strength class. The beams shall be galvanized.

When metal beam rail is to be set on a curve having a radius of 150 feet or less the steel beam sections shall be shop fabricated to the radius required. An additional bolt hole shall be provided at the mid-point of the rail.

710.05 Timber Rail. The timber rail shall be cut from dry, well seasoned and dressed timber of Number 2 common grade stock of northern white pine, Norway pine, or Number 1 construction grade of eastern spruce, eastern hemlock, pitch pine, southern yellow pine, Douglas fir, or tamarack.

710.06 Fence Posts and Braces. Wood posts shall be of cedar, white oak or tamarack if not pressure treated or hot and cold bath treated. If pressure treated or hot and cold bath treated, they may be of cedar, white oak, tamarack, Norway pine, southern yellow pine, pitch pine, Douglas fir, maple, beech, birch, or red oak. All posts shall be of the diameter or section and length shown on the plans.

All round wood posts shall be of seasoned stock straight and sound, and shall have been cut from live growing trees. They shall have the outer and inner bark removed and all knots trimmed flush with the surface of the post. Rotted, loose or hollow knots, plugged or open holes will not be permitted. Sound knots will be permitted if the diameter of any 1 knot or the combined diameter of 2 or more knots occurring in the same cross section is not greater than one-third of the

circumference of the post at that cross section. Posts shall be of uniform taper from top to butt not to exceed 1½ inches in taper in 7 feet. Unless pressure treated or hot and cold bath treated, the minimum diameter of heartwood in line posts at their small end shall be no less than 3 inches. The minimum diameter of line posts at the small end shall be no less than 3 inches. The maximum diameter of line posts at the small end shall be 6 inches. Unless pressure treated or hot and cold bath treated the minimum diameter of heartwood in end, corner, gate and barway posts shall be 4½ inches at the small end. The minimum diameter of end, corner, gate and barway posts at the small end shall be 4½ inches. The maximum diameter of end, corner, gate and barway posts shall be 8 inches. That portion of wood posts to be set below ground, if of untreated wood, shall be given the treatment described under subsection 606.03 (a). After being treated the posts shall be piled in a manner to permit thorough drying before being set in the ground. Line posts, end, corner, gate and barway posts, if to be pressure treated or hot and cold bath treated, shall be prepared for treatment and treated as described under subsection 606.03 (b).

Braces shall be of spruce, eastern hemlock, Norway pine, pitch pine or tamarack timbers, or spruce, cedar, or tamarack round posts of sufficient length to make a diagonal brace between adjacent posts. If other than cedar, white oak or tamarack, braces shall be given the treatment as described under subsection 606.03 (a) except that they shall be immersed full length.

Metal posts and braces, except pipe, shall be rolled from new billet steel conforming to the requirements of ASTM A 15 or shall be of rail steel conforming to the requirements of ASTM A 16 or ASTM A 499. All steel posts, rails, and braces shall be galvanized according to the requirements of AASHO M 111. Steel pipe used for posts, rails or bracing shall conform to ASTM A 53, galvanized.

710.07 Guard Rail Posts. Railing posts shall be of either wood or steel and shall be of the diameter or section and length shown on the plans.

(a) Round wood posts shall be of cedar, white oak or tamarack if to be used without pressure treatment or hot and cold bath treatment. They shall be of seasoned stock, straight and sound, and have been cut from live growing trees. The outer and inner bark shall be removed and all knots trimmed flush with the surface of the post. Rotted, loose or hollow knots, plugged or open holes will not be permitted. Sound

knots will be permitted if the diameter of any 1 knot or the combined diameter of 2 or more knots occurring in the same cross section is not greater than $\frac{1}{8}$ of the circumference of the post at that cross section. Posts shall be of uniform taper from top to butt and shall be free from kinks and bends.

(b) Rectangular wood posts shall be of well seasoned, straight and sound timber, cut from live growing trees, free from loose knots or other structurally weakening defects of importance such as shake, holes over 1 inch in diameter, heart rot over 1 inch in diameter. The posts shall be free from season checks that exceed $\frac{1}{4}$ inch in width. A tolerance of 1 inch in length and $\frac{1}{4}$ inch in width or thickness is permitted in the dimensions of rectangular posts. They shall be well sawn and have square edges except that wane not more than $1\frac{1}{2}$ inches wide and extending not more than $\frac{1}{2}$ the length of the piece will be allowed on that portion of the post to be placed below ground. Sound, tight, well spaced knots to $2\frac{1}{2}$ inches diameter will be permitted.

(c) When wood posts are designated to be pressure treated or hot and cold bath treated, as described in subsection 606.03 (b), posts shall be of Norway pine, southern yellow pine, pitch pine, Douglas fir, maple, beech, birch, or red oak. The posts shall be fabricated before treatment.

(d) Steel posts shall be of the section and length shown on the plans. Steel shall conform to the requirements of AASHO M 183. The posts shall be galvanized in accordance with the requirements of AASHO M 111.

(e) *Posts and rails.* Guard rail, type 6, shall be of cedar, straight, with all bark removed and all limb stubs cut flush. There shall be no more than 2 inches difference between the top end and the butt end diameter. Rotted, loose or hollow knots, plugged or open holes will not be permitted.

710.08 Guard Rail Hardware. Offset brackets of the resilient and non-resilient types shall be of the type shown on the plans. They shall be punched and formed from spring steel, after which they shall be tempered and drawn. After fabrication, the bracket and cable retaining pin shall be double hot-dipped galvanized to meet the requirements of AASHO M 111.

The completed bracket shall meet the following strength requirements: When compressed under a load of 15,000 pounds, held for 1 minute, the spring shall compress not less than 1 inch, and when released shall not show a permanent set greater than $\frac{1}{2}$ inch. During the test, the back of

the bracket shall rest against the stationary head of testing machine, with short lengths of three-quarters of an inch wire guard rail cable held in each of the cable slots by a standard cable retaining pin and the prescribed load applied directly on the nose of the bracket. The measurements shall be made from the outside limits of the bracket (front to back).

Splices and end connections shall be of the type and design shown on the plans, and shall be of such strength as to develop the full design strength of the rail elements.

End anchors, end anchor rods and accessories shall be as shown on the plans and shall be of such size and strength as to develop the full design strength of the rail elements. Concrete for end anchorages shall be Class B except that air entraining admixtures will not be required.

All fittings, bolts, washers and other accessories shall be galvanized in accordance with the requirements of AASHO M 111 or ASTM A 153, whichever may apply. All galvanizing shall be done after fabrication.

Pins for attaching rails to posts, Guard Rail, Type 6, shall be steel.

SECTION 711 — CONCRETE CURING MATERIALS AND ADMIXTURES

711.01 Curing Materials. Curing materials shall conform to the following requirements as specified:

Type	Specification
Cotton Mats for Curing Concrete	AASHO M 73
Burlap Cloth made from Jute or Kenaf	AASHO M 182
Waterproof Paper for Curing Concrete	AASHO M 139
Liquid Membrane-Forming Compounds for Curing Concrete	AASHO M-148
White Polyethylene Sheeting (Film) for Curing Concrete	AASHO M 171

Polyethylene coated burlap blankets shall consist of burlap complying with AASHO designation M 182 — Burlap cloth made from Jute or Kenaf — Class 3 which shall have a uniform coating of not less than 2.5 ounces per square yard of white opaque polyethylene film complying with AASHO Designation M 171 — White Polyethylene Sheeting (Film) for Curing Concrete — except that the test for DIMENSION and TENSILE STRENGTH and ELONGATION will not be required. The polyethylene film shall be secured to one side of the burlap by impregnation or extrusion and the resultant

blankets shall be free of visible defects and shall be uniform in appearance.

711.02 Vacant.

711.03 Air-entraining Admixtures. Air-entraining admixtures shall be in accordance with the requirements of AASHTO M 154 except that tests for the requirements of paragraphs 3a, 3e, and 3f will not be required.

The materials used shall comply with one of the following requirements:

(a) A material included in an approved list maintained by the Commission. The Contractor may select any brand included in this list.

(b) A material which is not on the approved list but which has been tested by a recognized laboratory. The Contractor must submit acceptable documentary evidence from these laboratories that the material conforms to the above sections of AASHTO M 154. A "recognized laboratory" is any State Highway, Bureau of Public Roads, or cement and concrete laboratory regularly inspected by the Cement Concrete Reference Laboratory of the National Bureau of Standards.

711.04 Set-retarding Admixtures. Set retarding admixtures shall conform to the requirements of ASTM C 494, Types B or D.

A list of approved set-retarding admixtures is maintained at the office of the Commission at Augusta and from this list the Contractor shall make a selection or shall submit data from a recognized laboratory ("recognized laboratory" is defined in subsection 711.03), showing that the set retarding admixture conforms to the above requirements.

If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material a certificate shall be submitted stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

SECTION 712 — MISCELLANEOUS

712.01 Water. Water used in mixing or curing concrete shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or substances injurious to the finished product. If required by the Engineer, it shall be tested by comparison with water of known satisfactory quality. Comparison

shall be made by means of standard cement tests for soundness, time of setting, and mortar strength. Any indication of unsoundness, marked change in time of setting, or a reduction of more than 10 percent in strength from results obtained with mixtures containing water of known satisfactory quality shall be sufficient cause for rejection of the water that is being tested. Water, known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

712.02 Calcium Chloride. Calcium chloride shall conform to the requirements of AASHTO M 144.

712.03 Hydrated Lime. Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

712.04 Stone Curbing and Edging.

(a) *General.* Curb stone shall be approved granite from acceptable sources. The stone shall be hard and durable, predominantly gray in color, free from seams which impair its structural integrity, and of smooth splitting character. Natural color variations characteristic of the deposit will be permitted. The dimensions, shape and other details shall be as shown on the plans.

The exposed faces of stone curb shall be free from drill holes or indications of same. Half drill holes not larger than $\frac{3}{4}$ inch diameter will be permitted in the arris line in the plane of the back.

(b) *Vertical Curb, Type 1.* All vertical Curb, Type 1 shall have a top surface sawed or dressed to an approximate true plane with no depression or projection on that surface of over $\frac{1}{8}$ inch. The top front arris line shall be pitched straight and true with no variations from a straight line greater than $\frac{1}{8}$ inch. The top back arris line shall meet the same requirement except that indentations of a maximum of $\frac{3}{8}$ inch will be allowed. There shall be no projection or depression on the back face which would exceed a batter of 1 horizontal on 3 vertical for a distance down from the top of 3 inches.

The front face shall be at right angles to the top and shall be smooth split. It shall have no projections greater than 1 inch or depressions greater than $\frac{1}{2}$ inch, measured from the vertical plane of the face through the top arris line, for a distance down from the top of 8 inches. The remainder of the face shall have no projections or depressions greater than 1 inch from the plane of the face.

The ends of the curb shall be approximately square with the planes of the top, back, and face and so finished that when the sections are placed end to end with the required minimum spacing of $\frac{1}{4}$ inch no more than $\frac{5}{8}$ inch space shall show in the joint for the full width of the top surface and for the entire exposed front face. The remainder of the end may extend back no more than 8 inches from the plane of the joint.

Drill holes through the curb will be allowed providing they are at least 9 inches below the top and are mortared full with portland cement mortar before placing the stone.

(c) *Miscellaneous Stone Curb.* When a depressed or modified section of curb is called for on the plans or ordered by the Engineer, for driveways, crossings, closures, transitions or for other reasons, the Contractor shall furnish curbing with the required modifications.

(d) *Curb Inlets.* Inlets used at catch basins shall conform to the applicable requirements of Curbing, Type 1 and to the shape, dimensions and details as shown on the plans.

(e) *Sloped Curb, Type 1.* Unless otherwise indicated on the plans, Sloped Curb, Type 1 shall conform to the requirements for vertical stone curb, Type 1, except that the face and top shall be sloped or bevelled as called for on the plans. This sloped surface shall be finished as required for the top surface under (b) above.

(f) *Bridge Curb (Vertical or Sloped), Type 1.* Bridge Curb, Type 1 shall conform to the requirements of (a), (b), and (d) above, except as indicated on the plans and as follows:

1. The back face of the curb stones shall have no projections or depressions greater than 1 inch, measured from the vertical plane of the back face through the arris or pitch line down to the bottom of the stone. The front face shall be finished as required for vertical stone curb, Type 1, except that it shall be finished the full distance down on the face. Bottoms of curb stones shall be approximately parallel to the top and sawed or dressed to lay with a bedding of approximately 1 inch for the full length of the stone.

2. Anchor holes shall be provided in the back of the stones pitched down at the approximate angle shown on the plan, a maximum of 12 inches from each end of the stone, and spaced horizontally at approximately 2 feet center to center. A minimum of 2 anchor holes shall be provided in each stone.

3. The ends of all stones at expansion joints between spans and at ends of bridge shall be cut to present a vertical

face when set in position, bevelled to the skew angle, if any, and the entire end finished in the same manner as the top.

4. The ends of the stones at intermediate joints shall be square with the planes of the top and front face, free from drill holes at exposed edges and shall be finished for a depth of $1\frac{1}{2}$ inches from the top and front faces with no projections or depressions greater than $\frac{1}{8}$ inch. Lengths of stones shall be so scheduled that joints will be uniform in width at exposed faces. Joints shall be $\frac{1}{2}$ inch plus or minus $\frac{1}{8}$ inch. There shall be a joint at each curb and sidewalk contraction joint of the bridge.

5. Stones set transversely at ends of bridge shall have the top bevelled to fit the grade of the bridge when the grade exceeds 2 percent.

6. Mortar for bedding shall be composed of 1 part portland cement and 2 parts sand with sufficient water to form a workable mix. Cement, sand and water shall conform to Section 502 — Structural Concrete.

7. Mortar for pointing shall be composed of equal parts of sand and portland cement with sufficient water to form a workable mix and shall conform to Section 502 — Structural Concrete.

8. Portland cement grout shall be made the same as mortar for pointing, except that consistency shall be such that it will flow readily.

- (g) *Curbing, Type 5.* Curbing Type 5 shall conform to the requirements of (a) regarding color and quality of stone.

The exposed face shall be smooth split to an approximate true plane having no projections or depressions which will cause over 1 inch to show between a 2 foot straightedge and the face when the straightedge is placed as closely as possible on any part of the face. Half drill holes not more than 3 inches in length and $\frac{3}{4}$ inch in diameter will be permitted along the bottom. The arris line, top front, shall be straight and true with no variation from a straight line greater than $\frac{1}{8}$ inch. The arris lines at the bottom of the face shall be straight and true so that not over 1 inch shall show between the stone and a straightedge for the full length of the stone. The ends shall be square to the length at the face and so finished that when the stones are placed end to end, no space more than $1\frac{1}{2}$ inches shall show in the joint for the width of the face.

When Curbing, Type 5 is required on a radius, the pieces shall be shaped as described in the table on the standard detail.

(h) *Curb, Type 4.* The stones shall be field stones or other approved rock material. They shall be sound and durable, from 5 to 7 inches thick, at least 6 inches wide and at least 15 inches in length.

712.05 Precast Portland Cement Concrete Curbing. Precast portland cement concrete curb units shall be constructed in accordance with Section 502 — Structural Concrete, and as shown on the plans. Reinforcing steel shall conform to the requirements of AASHO M 31. After the units have been cured for the required time they shall be stored for a period of not less than 28 days from the time the concrete was placed in the forms.

The forms for precasting the units shall be of steel or plywood or other approved material, without seams on the front face so that no form joint marks will be visible when the precast curb and edging units are set in final position.

Curbing to be set on a radius of 60 feet or less shall be cast to the curve required with the ends cut on the radial line. Curbing to be set on a radius of between 61 feet and 160 feet shall consist of segments of straight curb the lengths of which shall be 4 feet to 6 feet, with the ends cut on the radial line.

When Curbing, Type 2 and Curbing Type 6 are required on a radius, the pieces shall be shaped as described in the table on the standard detail.

When required for driveways, crossings, closures, or for other reasons, a depressed or modified section of curb is indicated on the plans or ordered by the Engineer, the Contractor shall furnish curbing with the required modification.

712.06 Precast Units. Precast units shall conform to the plan dimensions and shall meet the requirements of ASTM 478 except as modified below.

Cement shall conform to subsection 701. An approved air entraining admixture shall be added to concrete made with Type IIA cement if needed to obtain the required entrained air content.

Aggregates shall meet the quality requirements of subsection 703.01 and subsection 703.02 except that limitations on grading and the fineness modulus are hereby omitted. The concrete mix design shall be approved by the Laboratory and inspections will be made to assure that proper gradation and weight requirements are being met. Concrete shall contain 6 percent entrained air, plus or minus 1½ percent.

712.07 Tops, Traps and Ladder Rungs. These metal units shall conform to the plan dimensions and to the following specification requirements for the designated materials.

Gray iron castings shall conform to the requirements of AASHO M 105, Class 30 unless otherwise designated.

Carbon-steel castings shall conform to the requirements of AASHO M 103. Grade shall be 65 - 35 unless otherwise designated.

Structural steel shall conform to the requirements of AASHO M 183 or ASTM A 283, Grade B, or better.

Wrought iron items shall conform to AASHO M 99 for plates, AASHO M 100 for shapes and bars, and ASTM A 152 for rivets.

Galvanizing, where specified for these units, shall conform to the requirements of AASHO M 111.

Malleable iron castings shall conform to the requirements of AASHO M 106. Grade shall be optional unless otherwise designated.

Aluminum castings for steps shall conform to the requirements of Federal specification QQ-A-200/8 aluminum magnesium silicide type alloy.

712.08 Corrugated Metal Units. The units shall conform to plan dimensions and the metal to AASHO M 36. Bituminous coating, when specified, shall conform to AASHO M 190, Type A.

712.09 Woven Glass Fabric. Woven glass fabric may be either coated or uncoated.

When uncoated glass fabric is used it shall conform to ASTM 1668 and as follows:

(a) When asphalt priming and waterproofing is used the fabric shall be treated with asphalt.

(b) When a primer for use with tar (AASHO M 121) is used for priming and tar is used for waterproofing, the fabric shall be treated with coal-tar pitch.

When coated glass fabric is used the material shall conform to the requirements of Federal Specification HH-C-466b, subsection 3.1 to 4.5, and the coating shall be compatible with asphalt base or coal-tar compounds.

712.10 Copper Baffle Strip. Copper baffle strip shall conform to the AASHO M 138, 26 gauge minimum.

712.11 Galvanized Iron Baffle Strip. Galvanized iron baffle strip shall conform to ASTM A 525, Class 1.25 commercial, 26 gauge minimum.

712.12 Zinc Baffle Strip. Zinc baffle strip shall conform to AASHTO M 113, Type II, rolled zinc, 26 gauge minimum.

712.13 Drains Through Abutments and Retaining Walls. Weep holes through abutments and retaining walls shall be pipe of the size and shape shown on the plans. The pipe shall be approved cast iron, tile, fiber or other material that will maintain its shape and alignment during the placing of the concrete.

712.14 Steel Pipe. Steel pipe for bridge railing shall conform to the requirements of ASTM A 53, Types E or S, Grade B, open hearth or basic oxygen steel with sulphur content not to exceed .05 percent.

Steel pipe for hand railing shall conform to the requirements of ASTM A 120.

Steel pipe for roadway drains shall be standard weight steel pipe as called for on the plans.

712.15 Cast Iron Roadway Drains. Cast iron roadway drains shall conform to AASHTO M 105, Class Number 30.

712.16 Wrought Iron Pipe. Wrought iron pipe for railing shall conform to AASHTO M 101.

712.17 Metal Shells for Cast-in-place Concrete Piles. Metal shells for cast-in-place concrete piles shall be of such thickness, strength, and design as to hold their original form with no harmful distortion during driving and filling with concrete. They may be tapered, cylindrical, step tapered or a combination of these at the Contractor's option. However, only one type shell shall be used on a job.

The minimum tip diameter shall be 8 inches. The diameter of the butt end of cylindrical shells shall be as shown on the plans. The diameter of tapered shells shall increase at a uniform rate of not less than 1 inch in 8 feet of length.

All shells shall be furnished with an approved water-tight heavy steel point.

The Contractor shall submit for approval details of the pile shell he proposes to use. No material shall be ordered until these details have been approved; however, such approval shall not relieve the Contractor of full responsibility for the satisfactory functioning of this product.

712.18 Heavy Roofing Felt. Wherever heavy roofing is called for on the plans an approved standard brand of asphalt saturated roofing felt, weighing about 55 pounds per 100 square feet, shall be used.

712.19 Waterstops.

(a) **Rubber Waterstops.** The waterstops shall consist of a durable, elastic, cured rubber compound, capable of effectively sealing joints in concrete against the infiltration of moisture with the following physical properties:

Shore A Durometer

hardness	ASTM D 2240	60 to 70
Elongation	ASTM D 412	425 percent minimum
Tensile strength	ASTM D 412	2500 pounds per square inch minimum

Water absorption		5 percent maximum by weight after immersion in water for 2 days at 158° F. ($\pm 2^\circ$).
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Compression set	ASTM D 395 Method B	30 percent maximum after 22 hours at 158° F.
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The waterstops shall have a dense and homogeneous cross section and shall be free from porosity and other imperfections. Minor surface defects including surface peel covering less than $\frac{1}{4}$ inch in longest lateral dimension and less than $\frac{1}{16}$ inch deep will be acceptable.

(b) **Polyvinylchloride Waterstops.** The waterstops shall conform to U. S. Army Corps of Engineers Specification for Polyvinylchloride Waterstops, CRD-C 572-63.

712.20 Metal Drain Forms. Metal drain forms shall conform to ASTM A 525 Class D for zinc coated (galvanized) iron or steel sheets, minimum 25 gauge.

712.21 Reflective Sheeting.

(a) **General.** The reflective sheeting used shall consist of spherical lense elements embedded within a transparent plastic having a smooth, flat outer surface. The sheeting shall be weather resistant and have a protected pre-coated adhesive backing.

(b) Adhesive Requirements.

1. The reflective sheeting shall include pre-coated tack free adhesive designed for mechanical application and which will adhere to prescribed surfaces only when activated by heat or solvent. For manual application of sign borders, sign

repair and emblems, the pre-coated adhesive shall be pressure sensitive. The pre-coated adhesive shall not require additional adhesive coats on the reflective sheeting or application surface.

2. The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for 4 hours at 150° F. under weight of 2.5 pounds per square inch.

3. The adhesive coated sheeting shall form a durable bond to smooth, corrosion and weather resistant surfaces and adhere securely at temperatures of 80° to 200° F. The pre-coated adhesive, 48 hours after application, shall be: tough enough to resist scuffing and marring during handling, elastic enough at low temperatures to resist shocking off when struck at -10° F., vandal resistant and strong enough to resist peeling the reflective sheeting from the application surface when a 5 pounds per inch-wide force is applied as outlined in ASTM Standard D 903. The pre-coated adhesive shall have no staining effect on the reflective sheeting and must be mildew resistant.

(c) *Reflective Characteristics.* Reflective sheeting for background and screened signs shall have the following minimum brightness values at .2° and .5° divergence expressed as average candlepower per foot-candle per square foot of material. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex-reflectors of the Society of Automotive Engineers.

Color	Silver	
Divergence Angle	.2	.5
Angle of Incidence		
0°	40	17
15°	32	18
30°	20	10
45°	8	5

The brightness of the reflective sheeting, totally wet by rain, shall not be less than 90 percent of the values specified above. Wet performance measurements shall be conducted in conformance with the standard rainfall test specified in Military Specification MIL-R-13689A, or as amended.

(d) *Physical Characteristics.* Reflective sheeting shall be free from ragged edges, cracks, scale, and blisters, and shall be sufficiently flexible to be easily cut to shape and permit application over and conformance to moderate, shallow em-

bossing characteristic of certain sign borders and symbols. Reflective sheeting shall be moisture resistant and readily cut with scissors, knife, blade, or shears, without crazing, checking, or flaking.

Conditioned 48 hours, the tensile strength of the sheeting shall be 5 to 20 pounds per inch-width when tested in accordance with ASTM Standard D 828, with 10 - 45 percent elongation (ASTM Standard D 987). Following liner removal, the reflective sheeting shall not shrink more than $\frac{1}{32}$ inch in 10 minutes nor more than $\frac{1}{4}$ inch in 24 hours in any dimension per 9 inch square at 75° F. and 50 percent relative humidity.

The sheeting when applied according to manufacturer's recommendations to cleaned and etched .015 x 2" x 8" aluminum, conditioned (48 hours) and tested at 72° F. and 50 percent relative humidity shall be sufficiently flexible to show no cracking when bent around a $\frac{3}{4}$ inch mandrel.

(e) *Surface.* The sheeting surface shall be smooth and flat to facilitate cleaning and wet performance, and exhibit 85° F. gloss-meter rating of not less than 40 (ASTM Standard D. 523). The sheeting surface shall be readily processed and compatible with recommended transparent and opaque process inks and show no loss of the color coat with normal handling, cutting, and application. Following accelerated exposure as outlined in paragraph (f) of this subsection, no process inks shall be removed when tested by scratching through the ink surface, applying cellophane tape over the scratched area, and removing the tape with one quick motion. The sheeting shall permit cutting and color processing at temperatures of 60 - 100° F. and relative humidities of 20 - 80 percent. The sheeting shall be heat resistant and permit force curing of unapplied sheeting at temperatures up to 200° F. on applied sheeting. The sheeting surface shall be solvent resistant and may be cleaned with gasoline, VM & P naphtha, mineral spirits, turpentine, methanol, and xylol.

(f) *Lens Elements.* The reflective sheeting shall possess stable and durable spherical lens elements which, following extraction, shall show no deterioration following submersion in 5N solution of sulphuric acid (H_2SO_4) for 30 minutes at 72° F.

(g) *Durability.* Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning shall show no appreciable discoloration, cracking, crazing, blistering, or dimensional change and not less than 80 percent of the specified

minimum brightness values when exposed to accelerated weathering for either 175,000 Langley's (approximately 1 year), south facing, unprotected at 45° F. in south Florida; or 1,200 hours Atlas Twin arc weathering in accordance with ASTM Standard E 42, Type D.

The sheeting surface may be readily refurbished by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

(h) *General Characteristics and Packaging.* The reflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks, scales, and blisters and shall be furnished in both rolls and sheets. There shall be no more than 4 splices per 50 yard length and splices shall be suitable for application as supplied.

712.22 Hazard Markers.

(a) *General.* The hazard markers shall consist of acrylic plastic prismatic center mount type reflectors assembled to an aluminum holder plate.

(b) *Design and Fabrication of Holder.* The reflector holder shall be aluminum alloy 3003 conforming to the requirements of ASTM Specification B 209. The holder shall be embossed to form a circular recess for the location of the required reflectors. A hole shall be provided in the center of each recess to permit the attachment of a center mount type reflector.

(c) *Finishing of Holders.* After metal fabrication has been completed, the finishing process shall be as follows:

1. Aluminum holder plates shall be degreased, etched, neutralized, and treated with a light, tight amorphous chromate type coating or an Alodine 1200 solution — such treatment shall be in conformance with the recommendations of the manufacturer.

2. After treating, the front surface of the holders shall be primed and enameled with a high quality synthetic baking primer and enamel in the color specified.

(d) *Assembly Hardware.* Reflectors shall be attached to finished holder plates by means of an aluminum grommet.

(e) *Prismatic Reflectors.* The reflector shall consist of a clear and transparent plastic face, with 7 square inches of reflective area, herein referred to as the lens, and a heat sealable plastic coated metallic foil back fused to the lens under heat and pressure around the entire perimeters of the lens and a central mounting hole to form a unit permanently

sealed against dust and water. The reflector shall be yellow. The lens shall consist of a smooth front surface free from projection or indentations other than a central mounting hole and identification with a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trade mark shall be molded legibly into the face of the lens. The reflector lens shall be methyl methacrylate meeting requirements of Federal Specifications L-M-500a, Type 1, Class 3.

(f) *Sampling and Testing Procedure.* For qualification purposes only, 50 reflectors required for all of the tests set forth in this specification shall be submitted by the manufacturer. For acceptance purposes, the 50 samples will be selected at random by the purchaser from each shipment. All tests shall be performed in the following sequence:

(g) *Optical Requirements.*

1. *Definitions.* Entrance angle shall mean the angle at reflector between direction of light incident on it and direction of reflector axis. Observation angle shall mean the angle at reflector between observer's line of sight and direction of light incident on reflector. Specific brightness shall mean candlepower returned at the chosen observation angle by a reflector per square inch of reflecting surface for each foot-candle of illumination at the reflector.

2. *Optical Testing Procedure.* The reflex reflector to be tested shall be located at a distance of 100 feet from a single uniformly bright light source having an effective diameter of 2 inches; the light source shall be operated at approximately normal efficiency. The return light from the reflector shall be measured by means of a photoelectric photometer having a minimum sensitivity of 1×10^{-7} foot-candles per mm scale division.

The photometer shall have a receiver 0.5 inches in diameter, shielded to eliminate stray light. The distance from light source center to receiver center shall be 2.1 inches. During testing the reflectors shall be spun so as to average orientation effect. If a test distance other than 100 feet is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance.

3. Specific intensity of each reflex reflector intended for use in delineators or markers shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

Observance Angle Degrees	Entrance Angle Degrees	Specific Intensity Candlepower per Foot-Candle Yellow
1/10°	0°	71
1/10°	20°	28

Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested. Upon failure of more than two of the 50 samples tested a resample of 100 reflectors shall be tested. Failure of more than four of these samples shall be cause for rejection of the lot.

(h) *Durability.*

1. Seal Test. The following test shall be used to determine if a reflector is adequately sealed against dust and water. Submerge 50 samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches gauge pressure for five minutes. Restore atmospheric pressure and leave samples submerged for 5 minutes, then examine the samples for water intake. Upon failure of more than two of the 50 samples tested a resample of 100 reflectors shall be tested. Failure of more than 4 of these samples shall be cause for rejection of the lot.

2. Heat Resistance Test. Three reflectors shall be tested for 4 hours in a circulating air oven at 175° F. plus or minus 5° F. The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test the samples shall be removed from the oven and permitted to cool in air to room temperature. The samples, after exposure to heat, shall show no significant change in shape and general appearance when compared with unexposed control standards. No failure will be permitted.

3. Corrosion Test. The reflector assembly shall withstand the combined corrosion test set forth in ASTM B 117.

712.23 Flashing Lights.

(a) Power operated flashing lights shall consist of housing, adapters, lamps, sockets, reflectors, lens, hoods, and other necessary equipment, which shall be designed to give clearly visible signal indications within an angle of at least 45 degrees and from 10 to 300 feet under all light and atmospheric conditions. Two circuit flasher controllers with a two-circuit filter capable of providing alternate flashing operations at the rate of 60 flashes per minutes shall be provided.

The lamps shall be standard 60 watt, 120 volt traffic signal lamps with sockets constructed so as to properly focus and hold the lamp firmly in position.

The housing shall be provided with a rotatable sun visor not less than 7 inches in length, designed to shield the lens.

Reflectors shall be of such design that light from a properly focused lamp will reflect the light rays parallel. Reflectors shall have a maximum diameter at the point of contact with the lens of approximately 8 inches.

The lens shall consist of a round one-piece convex amber material which, when mounted, shall have a visible diameter of approximately 8 inches. They shall be of such character as to distribute light and not diffuse it. The distribution of the light shall be asymmetrical in a downward direction. The light distribution of the lens shall not be uniform, but shall consist of a small high-intensity portion with narrow distribution for long distance throw, and a larger low-intensity portion with wide distribution for short distance throw. Lenses shall be marked in some manner as to indicate the top and bottom of the lens.

(b) Battery operated flashing lights shall have amber lenses, 7 inch minimum diameter with a minimum instantaneous candle power of flash 71, peak effective candle power of flash 19. Reflectors shall be amber color approximately 3 inches in diameter.

712.24 Glass Beads. The beads or spheres shall conform to the following requirements:

The beads shall be spherical in shape, and shall not include more than 30 percent of irregularly shaped particles. They shall be essentially free of sharp angular particles, and particles showing milkiness, surface scoring or scratching. At least 70 percent of the spheres shall be true spheres, when tested in accordance with ASTM Method of Test D 1155, Method of Test for Determining Roundness of Glass Spheres.

Gradation. The beads shall meet the grading requirements of the following table.

Sieve Designation	Percentage by Weight Retained Square Mesh Sieve
No. 20	0
No. 30	2-15
No. 50	30-68
No. 80	20-40
No. 120	5-30
No. 230	3-18
Passing	0-10

Index of Refraction. The beads or spheres shall show an index of refraction within the range of 1.50 - 1.65.

Stability. True spheres, determined by paragraph above, passing U.S. Standard Sieve Number 20 and retained on U.S. Standard Sieve Number 30, also true spheres passing U.S. Standard Sieve Number 30 and retained on U.S. Standard Sieve Number 40, shall be submitted to crushing resistance test in accordance with ASTM Method of Test D-1213. The minimum crushing strength shall be as follows:

Passing Number 20, Retained on Number 30 - 40 pounds

Passing Number 30, Retained on Number 40 - 30 pounds

Silica Content. The silica (SiO_2) content of the glass spheres or beads shall be not less than 60 percent.

Chemical Stability. Beads or spheres which show any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture, dilute acids or alkalis or paint film components, may, prior to acceptance, be required to demonstrate satisfactory reflectance behavior and maintenance under such tests as may be prescribed.

712.25 Detour Sign. The sign base material shall be Douglas Fir Plywood, high density, exterior type, all cores and faces overlaid with 60/60 phenolic or melamine resin-impregnated surface, conforming to the requirements and tests set forth in Commercial Standard CS45, "Douglas Fir Plywood," published by the U. S. Department of Commerce. Both plastic faces shall be black in color.

712.26 Fertilizer. Commercial fertilizer for seeding shall be 10-10-10 grade containing at least 10 percent available nitrogen, 10 percent readily available phosphoric acid and 10 percent total available potash in conformity with the Standards of the Association of Official Agricultural Chemists. The fertilizer shall be supplied in unopened bags with the weight, contents and guaranteed analysis shown thereon or on a securely attached tag. The Engineer may approve the use of fertilizers other than the standard 10-10-10 formula provided that the application provides not less than the minimum amounts of each of the basic ingredients as specified for the 10-10-10 fertilizer.

712.27 Agricultural Limestone. Agricultural limestone shall be ground limestone composed of not less than 85 percent calcium and magnesium carbonates; at least 60 percent shall pass a 60 mesh screen, 95 percent shall pass a 10 mesh screen.

712.28 Seed. All seed shall be certified as to mixture, germination and purity, as being in conformity with the following requirements:

Each variety of seed shall have a percentage of germination of not less than 80, a percentage of purity of not less than 85, and shall have not more than one percent of weed content. All seed shall be from the same or previous year's crop unless recent tests by an approved testing agency demonstrate that older seed meets the above requirements.

Seed Mixtures. The seed mixtures shall consist of seeds proportioned by weight as follows:

Method Number 1 Park Mixture		Method Number 2 Roadside Mixture	
Creeping Red Fescue	45%	Creeping Red Fescue	40%
Kentucky Bluegrass	30%	Kentucky Bluegrass	25%
Red Top	10%	Red Top	10%
Italian or Perennial Ryegrass	15%	Kentucky 31 Fescue	20%
		White Clover	5%

712.29 Trees.

(a) All trees shall be first class representatives of their species or varieties, unless otherwise specified. All plants must have a good, healthy, well formed upper growth and a large, fibrous, compact root system.

Large deciduous trees shall have straight trunks and a single leader or as may be characteristic of the species. Tops shall be fully branched, densely foliated, well balanced, and in good proportion to the height of the tree. Trees with weak trunks, thinly or irregularly branched, or with unnatural shape or proportion due to undesirable pruning practices or for any other cause, will be rejected. Trees with leaders or branches too severely cut back or with bottom limbs trimmed too high will be rejected.

Small growing deciduous trees shall be well branched with a well balanced, natural shape. Plants which are poorly furnished or have grown or been pruned into unnatural shapes will be rejected.

Unless otherwise specified, all coniferous (evergreen) trees shall be uniformly and thickly branched from the ground up, with a shape characteristic of the species.

(b) All trees shall have been grown under climatic conditions similar to those in the locality of the site of the project under construction, or have been acclimated to such condi-

tions for at least 2 years. All trees must have been grown in a latitude north of Washington, D. C.

(c) All trees shall be nursery grown unless otherwise stipulated. No tree will be considered nursery grown unless it has been transplanted at least once and has been growing in a nursery for at least 2 years.

(d) All trees shall conform to the requirements of the current edition of the "American Standard for Nursery Stock," sponsored by the American Association of Nurserymen, Inc., unless otherwise indicated in the plans or specifications.

(e) All trees must be healthy, vigorous, and free from disease, injurious insects, and their eggs or larvae, mechanical wounds, broken branches, decay or any other defects. All dealers in nursery stock operating in Maine must obtain a license from the State Horticulturist (State House, Augusta, Maine).

(f) All trees shall be true to name and each tree shall be legibly and securely labelled. The current edition of "Standardized Plant Names," prepared by the Editorial Committee of the American Joint Committee on Horticultural Nomenclature, shall be the authority for all plant names.

(g) All precautions that are customary in good trade practice shall be taken to insure that upon arrival at the planting site the plants are in good condition for successful growth. All plants must show appearance of normal health and vigor. Plants with loose or broken balls, dried out roots or twigs or which are found not to comply with these specifications in any way will be rejected. All rejected plant materials shall be immediately removed by the Contractor. The Engineer will not assume responsibility for such rejected material.

(h) The tree measurements specified in "The American Standard of Nursery Stock" are the minimum sizes acceptable. Plants that meet the measurements specified but do not have a normal shape and balance between height and spread will be rejected. Thin, poorly branched or sparsely rooted plants will be rejected.

(i) All trees shall be balled and burlaped or grown and delivered in approved containers. Root balls shall be secured by strong, tight, heavy wrapping. Trees must come from a soil that will hold a firm root ball. The size of root balls shall be not less than that indicated in the "American Standard for Nursery Stock."

(j) Trunk diameter shall be the determining measurement and shall be taken at 6 inches above the ground level (nursery site) for up to and including 4 inches caliper size; at 12 inches above the ground for trees larger than 4 inch caliper size.

(k) Upon arrival at the site of the project all tree balls shall be kept constantly moist until planted. If trees must be stored more than 2 days before planting the root balls must be kept completely covered with at least 6 inch thickness of moist hay, leaves, loam, or other approved material to protect against drying.

712.30 Erosion Control Mesh.

(a) *Standard Erosion Control Mesh.* Erosion control mesh shall be a uniform plain weave of single jute yarn averaging approximately 130 pounds per spindle of 14,400 yards. The yarn shall be of loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness more than one-half its normal diameter. The mesh shall be woven 48 inches in width, plus or minus 1 inch; 78 warp ends per width of cloth; 41 weft ends per yard and shall be furnished in lengths of not less than 100 feet. The weight shall be approximately 1.22 pounds per lineal yard with a tolerance of plus or minus 8 percent. All material shall be new and unused.

The Engineer may approve mesh with minor variations in material or weave provided that weight requirements per unit of area are met. He may also approve mesh of a different width.

(b) *Heavy Duty Erosion Control Mesh.* Heavy duty erosion control mesh shall be made from jute yarn averaging approximately 190 pounds per spindle of 14,400 yards, the mesh to have an average weight of approximately 1.8 pounds per linear yard with a tolerance of plus or minus 8 percent. Width of the mesh shall be 45 inches plus or minus 1 inch. All other provisions shall be as called for under Standard Erosion Control Mesh.

(c) *Staples.* Staples for fastening erosion control mesh shall be made from 11 gauge or heavier steel wire stiff enough to be forced vertically into the ground without bending. Staples shall be approximately 6 inches long except that, in loose soil, the Engineer may require the use of staples up to 12 inches in length.

712.31 *Herbicide.* The herbicide shall be an approved chemical customarily used for stump or basal bark treatment.

It shall be prepared to form an herbicidal spray mixture according to the manufacturer's direction or the direction of the Engineer.

712.32 Copper Tubing. Copper tubing and fittings shall conform to the requirements of ASTM B 88 Type "K" or better.

712.33 Non-metallic Pipe (Flexible). Non-metallic pipe, flexible, and fittings shall be acceptable flexible pipe manufactured from virgin polyethylene polymer suitable for transmitting liquids intended for human or animal consumption.

712.34 Non-metallic Pipe (Rigid). Non-metallic pipe, rigid, shall be a rigid plastic pipe of an extrudable synthetic thermoplastic of styrene copolymer, polyethylene or polyvinyl chloride or approved equivalent. The pipe shall be corrosion resistant, uniform wall thickness, smooth circular bore, standard wall IPS dimensions with inside walls smooth enough and hard surfaced to permit the insertion of water supply lines. Fittings shall be of the same material of the weld socket type, screw type or plug type with clamping bands.

712.35 Epoxy Resin. Epoxy resin for grouting or sealing shall consist of a mineral filled thixotropic, flexible epoxy resin, having a pot life of approximately one hour at 50° F. The grout shall be an approved product suitable for cementing steel dowels into the preformed holes of curb inlets and adjacent curbing. The sealant shall be an approved product, light gray in color and suitable for coating the surface of portland cement concrete curbing.

712.36 Bituminous Curb. Bituminous curb shall be in reasonable conformity to the dimensions shown on the plans and of a shape acceptable to the Engineer. The asphalt cement shall be penetration grade 85-100. The aggregate shall conform to the requirements of subsection 703.07. The coarse aggregate portion (retained on the Number 10 sieve) may be either crushed rock or crushed gravel.

The mineral constituents of the bituminous mixture shall be sized and graded, and combined in a composite blend that will produce a stable durable curbing with an acceptable texture.

Bituminous curb with asbestos shall conform to Curb Type 3 with the addition of asbestos fiber. The fiber shall be incorporated into the mix in the proportion of approximately 2 percent of the total mix. The fiber shall be introduced into the pugmill during the dry mixing period and sufficient dry

mixing time allowed to thoroughly distribute the asbestos throughout the aggregate before the asphalt is added.

SECTION 713 — STRUCTURAL STEEL AND RELATED MATERIALS

713.01 Structural Steel. Structural steel shall conform to the requirements of AASHTO M 160 (ASTM A 6) and unless otherwise specified of AASHTO M 183 (ASTM A 36).

713.02 High Strength Bolts. Bolts, nuts and washers shall conform to the requirements of AASHTO M 164 (ASTM A 325), except as otherwise provided hereinafter.

Bolt dimensions shall conform to the requirements for heavy hexagon structural bolts, and nut dimensions shall conform to the requirements for heavy semi-finished hexagon nuts of ASA Standard B 18.2 as found in Table 1, this specification.

Heavy hexagon structural bolts manufactured in accordance with ASTM A 325 are identified on the top of the head by three radial lines, the legend "A 325," and the manufacturer's mark.

Heavy semi-finished hexagon nuts manufactured in accordance with ASTM A 325 are identified with three circumferential markings, 120 degrees apart, or alternatively, with C, 2, D, 2H or DH.

Circular washers shall be flat and smooth. Beveled washers shall be square or rectangular and taper in thickness. Washer dimensions shall conform to those given in Table 2, this specification. Where necessary, washers may be clipped on one side to a point not closer than 7/8 of the bolt diameter from the center of the washer.

TABLE 1 — BOLT AND NUT DIMENSIONS

Nominal bolt size	Bolt Dimensions, in Inches				Nut Dimensions, in Inches	
	Width across Flats	Height of Head	Thread length	Add to grip for bolt length(a)	Width across Flats	Height
1/2	7/8	5/16	1	13/16	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 3/16	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 5/16	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 7/16	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 11/16	1 13/16	1 7/64
1 1/4	2	25/32	2	1 13/16	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	1 15/16	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 1/16	2 3/8	1 15/32

(a) Allowance for one circular washer is included.

Note: Grip is thickness of material to be connected (exclusive of washers).

Determine bolt lengths by adding the grip to the values given in Table 1, (5th column) and adjusting, if necessary, upwards to next $\frac{1}{4}$ inch increment. When beveled washers are to be used, add $\frac{1}{8}$ inch to the grip for one washer and $\frac{1}{4}$ inch for two.

Note: ASA Standards B 18.2 shall govern tolerances on dimensions listed in Table.

TABLE 2—WASHER DIMENSIONS (Inches)

Circular Washers					Square or Rectangle Beveled Washers for American Standard Beams and Channels		
Bolt Size D	Nominal Outside Diameter (b)	Nominal Diameter of Hole	Thickness		Minimum side dimension	Mean thickness	Slope or taper in thickness
			Min.	Max.			
1/2	1 1/16	17/32	.097	.177	1 3/4	5/16	1:6
5/8	1 5/16	21/32	.122	.177	1 3/4	5/16	1:6
3/4	1 15/32	13/16	.122	.177	1 3/4	5/16	1:6
7/8	1 3/4	15/16	.136	.177	1 3/4	5/16	1:6
1	2	1 1/16	.136	.177	1 3/4	5/16	1:6
1 1/8	2 1/4	1 1/4	.136	.177	2 1/4	5/16	1:6
1 1/4	2 1/2	1 3/8	.136	.177	2 1/4	5/16	1:6
1 3/8	2 3/4	1 1/2	.136	.177	2 1/4	5/16	1:6
1 1/2	3	1 5/8	.136	.177	2 1/4	5/16	1:6

(b) May be exceeded by $\frac{1}{4}$ in.

713.03 Preformed Pads. Preformed pads shall be made with new unvulcanized rubber and unused fabric fibres and shall be approximately $\frac{1}{8}$ inch thick after compression and vulcanizing with a proportion of fibre content sufficient to maintain strength and stability. The surface hardness expressed in standard rubber hardness figures shall be 85 to 95 Shore A Durometer. The ultimate breakdown limit of the pad under compressive loading shall be no less than 10,000 pounds per square inch.

713.04 Sheet Lead. The lead shall be a single $\frac{1}{8}$ inch sheet, and shall conform to the requirements for Common Desilverized Lead of AASHO M 112 (ASTM B 29).

713.05 Copper Bearing Steel. When copper bearing steel is specified, the steel shall contain not less than 0.2 percent of copper.

713.06 Wrought Iron. Wrought iron shall conform to the following requirements:

Plates: AASHO M 99 (ASTM A 42).

Rolled shapes and bars: AASHO M 100 (ASTM A 207).

Welded pipe: AASHO M 101 (ASTM A 72).

713.07 Steel Forgings. Steel forgings shall conform to the requirements of AASHO M 102 (ASTM A 235). Class C1 shall be furnished unless otherwise specified.

713.08 Carbon Steel Castings. Carbon steel castings shall conform to the requirements of AASHO M 103 (ASTM A 27). Grade 65-35 shall be furnished unless otherwise specified.

713.09 Chromium Alloy-steel Castings. Chromium alloy-steel castings shall conform to the requirements of AASHO M 163 (ASTM A 296). Grade CA-15 shall be furnished unless otherwise specified.

713.10 Gray Iron Castings. Gray iron castings shall conform to the requirements of AASHO M 105 (ASTM A 48). Class Number 30 shall be furnished unless otherwise specified.

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.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect.

All castings must be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

713.11 Malleable Iron Castings. Malleable iron castings shall conform to the requirements of AASHO M 106 (ASTM A 47). Grade Number 35018 shall be furnished unless otherwise specified.

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.

The castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. The surfaces shall have a workmanlike finish.

All castings must be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

713.12 Bronze or Copper-alloy Bearing and Expansion Plates. Bronze or copper-alloy bearing and expansion plates shall be self-lubricating. The bronze bearing and expansion plates shall conform to the requirements of AASHO M 107 (ASTM B 22), Alloy B and, copper-alloy bearing and expansion plates.

sion plates shall conform to AASHO M 108 (ASTM B 100), Alloy Number 1 unless otherwise specified. The lubrication compound shall consist of graphite and metallic substances with a lubricating binder capable of withstanding atmospheric elements.

713.13 Cold-finished Carbon Steel Shafting. Cold-finished carbon steel shafting shall conform to the requirements of AASHO M 169 (ASTM A 108). Grade Designation 1021-1030 inclusive, shall be furnished unless otherwise specified.

713.14 Steel Bars for Shear Connector Studs. Steel for shear connector studs shall conform to the requirements of AASHO M 169 (ASTM A 108), Cold Drawn Bars, Grades 1015, 1017, or 1020, either semi- or fully kilned.

713.15 Metal Bin Type Retaining Wall. The base metal for bin type retaining wall members shall conform to the applicable requirements of AASHO M 36.

Coating. The galvanized metal sheets used to form the retaining wall, except the base plates and connecting channels, shall be coated on both sides with a layer of asbestos fibers applied in sheet form by pressing it into the molten spelter. Immediately after the metallic bond has solidified the asbestos fibers shall be thoroughly saturated with a bituminous saturant conforming to the following requirements:

Penetration at 25° C., 100g., 5 sec.	35-45
Loss of heating at 163° C., (325° F.)	
50g., 5 hrs.	Not more than 1.5%
Flash point (open cup)	Not less than 440° F.
Penetration at 25° C., 100g., 5 sec., of residue after heating at 163° C., (325° F.) as compared with penetration of asphalt before heating	Not less than 70%
Insoluble in carbon disulfide	Not more than 2%

Testing shall be in accordance with methods specified in AASHO M 20.

The connecting channels shall be given 1 application of an approved asphalt varnish and the varnish allowed to dry before being incorporated into the wall.

Whenever possible in the manufacture of the units, a minimum forming radius of 1 inch is to be maintained. All units that are formed with less than 1 inch radius shall be hot-dipped galvanized after forming.

Bolts. Bolts shall conform to the requirements of AASHO M 164 and galvanized in accordance with ASTM Designation A 153.

SECTION 714 — TIMBER

714.01 Untreated Timber Piles. Unless otherwise designated, untreated timber piles for pile foundations shall consist of white or red oak, hackmatack, spruce, Norway pine, or other species of wood which will withstand the action of the hammer during the process of driving. Species not named above shall be used only when approved.

Quality shall be as specified in AASHO M 168.

(a) *Soundness.* Piles shall be of sound wood, free from decay, red heart, or insect attack. Southern pine piles may have unsound knots not exceeding half the permitted size of a sound knot, provided that the unsoundness extends to not more than 1½ inch depth and that the adjacent areas of the trunk are not affected. Piles having sound turpentine scars undamaged by insects may be accepted.

(b) *Knots.* Sound knots in piles 50 feet or less in length, and in ¼ of the length from the butt of piles longer than 50 feet, shall be no larger than 4 inches, or ½ the diameter of the pile at the point where they occur, whichever is the smaller. Sound knots in the remaining ¾ of the length of piles longer than 50 feet shall be no larger than 5 inches, or ½ the diameter of the pile at the point where they occur, whichever is the smaller. The size of a knot shall be its diameter measured at right angles to the length of the pile. Unsound knots shall not be permitted except in Southern pine piles as specified above. The sum of sizes of all knots in any foot of length of the pile shall not exceed twice the size of the largest permitted single knot. Cluster knots are prohibited. A cluster knot is 2 or more knots grouped together, the fibers of the wood being deflected around the entire unit. A group of single knots with fibers deflected around each knot separately is not a cluster, even though the knots may be in close proximity.

(c) *Holes.* Holes less than ½ inch in average diameter may be permitted provided the sum of the average diameters of all holes in any square foot of pile surface does not exceed 1½ inches.

(d) *Splits and Shakes.* Splits shall not be longer than the butt diameter of the pile. The length of any shake or combination of shakes in the outer half of the radius of the butt of the pile, when measured along the curve of the annual ring, shall not exceed ½ the circumference of the butt of the pile.

(e) *Piles for Treatment, Sapwood.* Untreated piles for preservative treatment shall have not less than 1 inch of sapwood at the butt end.

(f) *Heartwood and Density.* In untreated piling for use in exposed work, the diameter of the heartwood at the butt shall be not less than 0.8 of the diameter of the pile at the butt. If high heartwood content is required for untreated foundation piles, the ratio of heartwood to total diameter shall be specified. If high structural strength is required, a limitation on the minimum number of annual rings per inch of radius shall be shown on the plans or in the special provisions.

(g) *Peeling.* Piles shall be peeled by removing all of the outer bark and at least 80 percent of the inner bark, well distributed over the surface of the pile. When piles are to receive preservative treatment, no strip of inner bark wider than ½ inch shall remain.

CIRCUMFERENCES AND DIAMETERS OF TIMBER PILES

Length Feet	3 feet from butt				At tip	
	Minimum		Maximum		Minimum	
	Circumference	Diameter (approximate)	Circumference	Diameter (approximate)	Circumference	Diameter (approximate)
	Inches	Inches	Inches	Inches	Inches	Inches

SOUTHERN YELLOW PINE, DOUGLAS FIR, NORWAY PINE, HACKMATAK, HEMLOCK OR SPRUCE

Under 40	38	12	63	20	25	8
40 to 50 inc.	38	12	63	20	22	7
51 to 70 inc.	41	13	63	20	22	7
71 to 90 inc.	41	13	63	20	19	6
Over 90*	..	..	..	..	..	..

OAK AND OTHER HARDWOODS

Under 30	38	12	57	18	25	8
30 to 40 inc.	41	13	63	20	22	7
Over 40	41	13	63	20	19	6

* Dimensions of piles over 90 feet in length shall be as given in the special provisions.

(h) *Cutting and Trimming.* Butts and tips shall be sawed square with the axis of the pile. All knots and limbs shall be trimmed or smoothly cut flush with the surface of the pile except that knots may be hand trimmed flush with the surface of the swell surrounding the knots.

(i) *Straightness.* A straight line from the center of the butt to the tip shall lie entirely within the body of the pile.

(j) *Tapers.* Piles shall be cut above the butt swell and shall have a continuous taper from the point of butt measurement to the tip.

(k) *Twist of Grain.* Twist of grain in any 20 feet of length shall not exceed ½ of the circumference at the midpoint of length measured.

(l) Dimensions

1. *Circumferences and Diameters.* The circumferences of piles measured under the bark shall have minimum and maximum values as given in Table I, except that 10 percent of the piles in any lot may have circumferences 2 inches less than the tabulated minimum values.

The ratio of the maximum to the minimum diameter at the butt of any pile shall not exceed 1.2.

2. *Order Lengths.* Piles shall be furnished cut to any of the following lengths as specified: 16 to 40 feet in multiples of 2 feet; over 40 feet in multiples of 5 feet. Individual piles may vary from the length specified as much as 1 foot plus or minus in piles shorter than 40 feet and 2 feet plus or minus in piles 40 feet or longer. The average length of all piles of a specified length in each lot shall be not less than the length specified.

714.02 Pressure Treated Timber Piles. Treated timber piles shall be southern yellow pine, Norway pine or Douglas fir unless other wood is approved by the Engineer.

Quality and dimensions shall be as specified in subsection 714.01.

Preservative shall be creosote oil as specified in AASHO M 133.

Piles shall be treated by the empty cell process and the minimum amount of preservative retained shall be 12 pounds per cubic foot for southern yellow pine or Norway pine and 10 pounds per cubic foot for Douglas fir, unless otherwise indicated on the plans.

SECTION 715 — LIGHTING

715.01 Aluminum Light Standard. Material for aluminum light poles shall be fabricated from corrosion resistant alloys conforming to the physical and mechanical properties of ASTM B 221.

The shaft shall be of ASTM B 241 aluminum alloy 6063-T6 and after fabrication shall have mechanical properties equivalent to the T6 temper of ASTM B 241.

The base flange of the shaft shall be a permanent mold casting of ASTM B 26 alloy SG-70A. The bolt covers for the shaft base flange bolts shall be of cast aluminum ASTM B 26 alloy S5 A. Machine screws for fastening the bolt covers to the base flange shall be of aluminum alloy 745-T4 anodized or of stainless steel.

Transformer bases shall be made from ASTM B 26 alloy cast aluminum 356-T6.

Pole caps shall be made from aluminum ASTM B 26 alloy S5 A.

The bracket arms, both single arm and truss type, shall be made from aluminum alloy ASTM B 241 alloy 6063-T6.

All nuts, bolts and washers (except anchor bolts) used in the fabrication of lighting standards shall be made from polished 18-8 stainless steel alloy.

715.02 Steel Conduit. Steel conduit shall be of uniform thickness with a scale-free, smooth circular bore and thoroughly welded seams to permit cutting of clean, true threads.

Every length of steel conduit, including factory made elbows, shall be threaded on both ends. All conduit and all threads to be evenly zinc protected as manufactured. The weight of zinc coating shall not be less than 2.0 ounces per square foot of total coated surface as designated in ASTM A 120. The pitch and shape of threads shall conform to the American Standard for pipe threads.

Where steel conduit is noted on the plans or mentioned in the specifications, it shall be galvanized steel conduit.

715.03 Non-metallic Conduit. Non-metallic conduit shall be bituminous fiber asbestos cement or plastic as hereinafter specified. The Contractor may supply any one of these types but only one type of non-metallic conduit shall be used on any one project.

Bituminous fiber conduit and fittings shall be composed of waterproof bituminous insulating compound reinforced with an interwoven fibrous structure and shall conform with Federal specification W-C-581. The conduit and fittings shall be free from all substances which may injuriously affect wire or cable covering; such as on rubber-covered wire, weather-proof wire, or lead-on-lead alloy-covered cable.

The bituminous fiber conduit and fittings shall be of the tapered sleeve joint type, and a coupling shall be provided for each length of conduit and for each bend or elbow.

Asbestos cement Type II conduit and fittings shall be composed of a mixture of cement and asbestos fiber and shall be formed under pressure and cured to meet the physical requirements of ASTM C 296. The conduit and fitting shall be free from bulges, dents, and tears on the inside surface that might be injurious to any wire or cable covering. Machined ends of the conduit that receive the coupling shall be free from dents and gouges which will affect the tightness of the joint.

The asbestos cement conduit and fittings shall be of tapered sleeve joint (Harrington) type, and a coupling shall be provided for each length of conduit and for each bend or elbow.

Plastic Conduit. Rigid plastic conduit, elbows, couplings and terminal adapters shall be of an extrudable synthetic thermoplastic manufactured as one of the following trade types: Styratoy (Styrene Copolymer), Polyethylene, or Geon, (Polyvinyl Chloride) or an approved equivalent. The conduit shall possess the following properties; corrosion resistance, uniform wall thickness, smooth circular bore, standard wall IPS dimensions with an inside wall sufficiently smooth and hard-surfaced to permit easy pulling of wires or cables.

The runs of conduit shall be made up with fittings designed for the conduit being used; solvent weld socket-type, screw-type or plug-type with clamping bands.

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