

STATE OF MAINE



State Highway Commission

Standard Specifications

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DIVISION I

GENERAL REQUIREMENTS AND PROVISIONS

SECTION 101

DEFINITION OF TERMS

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

101-1. A.A.S.H.O. The American Association of State Highway Officials.

101-2. Article. A paragraph or group of paragraphs of the specifications carrying an identifying number and applying to a particular phase of the work.

101-3. A.S.T.M. The American Society for Testing Materials.

101-4. Base. That portion of the roadway constructed of selected material, on the subgrade and supporting the surface or pavement.

101-5. Bidder. Any individual, firm or corporation submitting a proposal for the work contemplated, acting directly or through a duly authorized representative.

101-6. Bridges. Structures having a clear span of ten (10) feet or more, measured under the copings along the center line of the road and multiple span structures when the combined clear spans exceed ten (10) feet.

101-7. Commission. The State Highway Commission of the State of Maine, being party of the first part to the contract.

101-8. Construction Limit Lines. The limits or boundary lines of the area of land within which the work is to be performed.

101-9. Contract. The agreement covering the performance of the work and the furnishing of materials for the proposed construction.

It should be understood by all concerned that the "Notice to Contractors", "Proposal", "Plans", "Standard Specifica-

tions", "Supplemental Specifications", "Special Provisions", "Notice of Award", "Contract Agreement", "Contract Bond", "Notice to Commence Work", as well as any papers attached to, or bound with any of the above, also any and all "Supplemental Agreements" made or to be made are a part of the contract and are to be considered as one instrument.

The intent is to make them explanatory, one of the other. No papers attached to, or bound with any of the above shall be detached therefrom, as all are a necessary part thereof.

101-10. Contract Agreement. An agreement executed by and between the Contractor and the Commission providing for the construction, completion and payment for work contemplated.

101-11. Contract Bond. The approved form of security furnished by the Contractor and his Surety as a guarantee of good faith on the part of the Contractor to execute the work in accordance with the terms of the Contract.

101-12. Contractor. The party of the second part to the Contract, acting directly or through his lawful agents or employees.

101-13 Culverts. All Structures not defined as bridges which provide an opening under the roadway.

101-14. Drainage. The system of pipes, drainage ways, ditches, and structures by which surface or sub-surface waters are collected and conducted from the highway area.

101-15. Engineer. Chief Engineer of the State Highway Commission, acting directly or through an authorized representative.

101-16. Extra Work. Work to be performed or labor and materials to be furnished by the Contractor in order to complete the project in an acceptable manner, but for which there is no applicable basis of payment either direct, or indirect, or contingent, provided in the proposal.

101-17. Equipment. All machinery, together with the necessary supplies for upkeep and maintenance, and also all tools and apparatus necessary for the proper construction and acceptable completion of the work.

101-18. Highways. The right of way reserved for the use of traveling public.

101-19. Inspector. An authorized representative of the

Engineer assigned to make necessary inspection of the work and materials.

101-20. Intention of Terms. In order to avoid cumbersome and confusing repetition of expressions in these specifications, whenever it is provided that anything is, or is to be done, if, or as, or when, or where, "contemplated", "required", "directed", specified", "authorized", "ordered", "given", "designated", "indicated", "considered necessary", "deemed necessary", "permitted", "suspended", "approved", "acceptable", "unacceptable", "suitable", "unsuitable", "satisfactory", "unsatisfactory", or "sufficient" it should be taken to mean and intended "contemplated", "required", "directed", "specified", "authorized", "ordered", "given", "designated", "specified", "indicated", "considered necessary", "deemed necessary", "permitted", "suspended", "approved", "acceptable", "unacceptable", "suitable", "unsuitable", "satisfactory", "unsatisfactory", or "sufficient" by or to the Engineer, and it is understood that the directions, orders, instructions, methods, and quality of work and/or materials to which these phrases relate are limited to the details shown on the plans and the provisions included in the Contract.

101-21. Laboratory. The official testing laboratory of the Commission or any other testing laboratory which may be designated by the Engineer.

101-22. Legal Holidays. They shall be construed as being the following days: New Year's Day, Washington's Birthday, Patriot's Day, Memorial Day, Independence Day, Labor Day, Armistice Day, Thanksgiving Day and Christmas Day.

101-23. Lines of Improvement. The irregular lines through the points farthest from the center line of the road to which the finished grading, ditching, or other similar work will be extended.

101-24. Materials. Any substances specified for use in the construction of the project and its appurtenances.

101-25. Notice of Award. A written notice to the successful bidder stating that his bid has been accepted and that, in accordance with the terms of the Notice to Contractor and the Specifications, he is required to execute the Contract Agreement and furnish a satisfactory Contract Bond.

101-26. Notice to Commence Work. A written notice to the Contractor of the date, on or before which, he is to begin the prosecution of the work.

101-27. Owner. The legal owner of the building or premises on which the contract work is to be performed.

101-28. Plans. The official approved general and detail plans, or the exact reproductions thereof, including cross-sections and such working plans as may be furnished or approved by the Engineer from time to time.

101-29. Premises. Land of the "Owner" on which the building or buildings now stand or to which they are to be moved.

101-30. Project. A designated, planned undertaking within limits shown on the plans.

101-31. Proposal. The written offer of the Bidder, when submitted on the approved forms, to perform the contemplated work.

101-32. Proposal Guaranty. The security designated in the proposal, to be furnished by the Bidder as a guaranty of good faith to enter into a Contract with the State, if the Contract be awarded to him.

101-33. Reference Stakes. Wooden stakes, generally set beyond the lines of improvement on which reference marks are placed, from which lines of improvement and grades may be obtained.

101-34. Right of Way. All lands or other property interest provided or acquired for the development and operation of a public highway.

101-35. Roadbed. That portion of the Roadway between the outside edges of the finished shoulders.

101-36. Roadside. A general term denoting the area adjoining the outer edge of the roadway.

101-37. Roadway. That portion of the highway within limits of construction.

101-38. Section. A group of related articles forming a part of the specifications and applying to or controlling the procedure of an operation or regulation.

101-39. Shoulders. That part of the roadway lying immediately outside of the pavement.

101-40. Skew or Skew Angle. The acute angle formed by the intersection of the line normal to the center line of the

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

101-41. Special Provisions. Specific clauses which shall prevail over all other Specifications and over all Plans, setting forth conditions or requirements peculiar to the Project under consideration, and covering work or materials involved in the proposal and estimate but not satisfactorily covered by the Standard and Supplemental Specifications.

101-42. Specifications. The directions, provisions and requirements contained herein and included in Supplemental Specifications and Special Provisions pertaining to the method and manner of performing the work, or to the quantity or quality of materials to be furnished under the Contract.

101-43. State. State of Maine.

101-44. Sub-Contractor. The individual, firm or corporation undertaking the execution of a part of the work under the terms of the contract by virtue of an agreement between himself and the Contractor.

101-45. Subgrade. That portion of the roadway upon which the base and shoulders are constructed.

101-46. Substructure. That portion of a bridge below the bridge seats or below the spring line of arches, except that backwalls and parapets of abutments and wing walls will be considered as parts of the substructure.

101-47. Supplemental Specifications. Specifications adopted subsequent to the publication of these Standard Specifications. They generally involve new construction items or substantial changes in the Standard Specifications and shall prevail over them.

101-48. Supplementary Agreement. A written agreement executed by the Contractor and the Commission covering the furnishing of materials and/or the performance of work not included in the original Contract which is necessary to the proper completion of the Project.

101-49. Superstructure. That portion of a bridge not included in the Substructure.

101-50. Surety. The corporate body, individual, or body of individuals bound with and for the Contractor; which corporate body, individual, or body of individuals engages to be responsible for the Contractor's payment of all debts per-

taining to, and for his acceptable performance of the work for which he has contracted.

101-51. Surfacing. That portion of the roadway constructed on the base course and being the pavement course.

101-52. Work. It shall be understood to 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 duties and obligations imposed by the Contract.

101-53. Working Day. It shall be any day, other than a legal holiday, a Saturday or a Sunday, on which weather and working conditions permit the contractor to make effective use of not less than 70% of the regular working hours. Saturday shall be considered one half of a working day if the Contractor's forces work two or more hours during the forenoon; if the work is carried on after 12 o'clock noon, it shall be considered as one working day. Legal holidays on which the Contractor's forces engage in work, requiring the presence of an inspector, will be considered as working days. Reference is made to Article 107-7.

SECTION 102

PROPOSAL REQUIREMENTS AND CONDITIONS

102-1. Notice to Contractors. An official notice to Contractors stating the time and place for the submission of sealed proposals upon designated projects or proposed work. This 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.

102-2. Contents of Proposal Forms. The prospective Bidders will be furnished by the Commission with proposal forms which will state the location and description of the contemplated construction, the approximate estimate of the various quantities of work to be performed and materials to be furnished, with a schedule of items for which unit bid prices are invited. The proposal forms also will state the number of working days to complete the work, or the time limit stated in the Special Provisions; the date, place and time of the opening of proposals; the amount of the proposal guaranty which must accompany the proposal; and will contain special provisions and/or supplemental specifications, as

well as forms for the contract agreement and the contract bond. All papers bound with or attached to the proposal forms are necessary parts thereof and must not be detached.

102-3. Method of Obtaining Plans, Specifications and Proposal Forms. Plans, specifications and proposal forms may be seen at the office of the State Highway Commission, Augusta, Maine. Prospective Bidders may secure specifications or proposal forms upon the payment of two (\$2.00) dollars each. A set of plans may be obtained upon making a deposit of fifteen (\$15.00) dollars. Checks shall be made payable to: State Highway Commission. A refund of twelve (\$12.00) dollars will be allowed for each set of plans that are returned in good condition not later than ten (10) days after the date of the opening of bids.

102-4. Interpretation of Estimate of Quantities. The Bidder's attention is called to the fact that the estimate of quantities of work to be done and materials to be furnished under these specifications, as shown on the plans and in the proposal forms, is approximate and is given only as a basis of calculation for comparing bids. These quantities are not guaranteed to be accurate and are furnished without any liability on the part of the Commission, which reserves the right to increase or diminish the quantities shown or to omit any item, as it deems necessary. Final payment will be made for the actual quantities of work done and materials furnished at the unit prices set forth in the contract for each item of work. No allowance will be made for loss of anticipated profits due to an increase or decrease in quantities.

102-5. Familiarity With Proposed Work. The Bidder should make a careful examination of the site of the proposed work, the proposal form, plans and specifications before submitting a proposal. He should fully inform himself as to the quality and quantity of materials required and the character of the work, and he should further investigate the location and make a careful examination of the source of supply for materials. The Commission will assume that he has satisfied himself as to the conditions to be encountered, as to the character, quality and quantities of work to be performed and materials to be furnished, and as to the requirements of these specifications 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. Said borings, test excavations, and other subsurface investigations are not warranted to show the actual subsurface conditions except at the location of said borings, tests or investigations and at these points are subject to inaccuracies inherent in drilling methods and to variations in the drillers' classification and interpretation of soil layers. It is the obligation of the Bidder to draw his own conclusions of subsurface conditions from his own investigations prior to submitting his proposal. The Contractor agrees, in signing his contract, that he will make no claims against the Commission, if in carrying out the work he finds that the actual conditions encountered do not conform to those interpolated between said borings, test excavations and subsurface investigations.

102-6. Preparation of Proposal. The Bidder must submit his proposal on the forms furnished by the Commission. All writings and figures in the proposal must be in ink. The blank spaces in the proposal forms must be filled in correctly, where indicated, for each and every item for which a quantity is given and the Bidder must state the prices for which he proposes to do each item of the work contemplated. In case of discrepancy, the written words shall be considered as being the prices bid. He shall also show the products of the respective unit prices and quantities in the column provided for that purpose and the total amount of the proposal obtained by adding the amounts of each item. 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 bid entered above or below it and initialled by the Bidder, also in ink. The Bidder shall sign his proposal correctly. If the proposal is made by an individual, his name and address must be shown. If made by a firm or partnership, the name and address of each member of the firm or partnership must be shown. If made by a corporation the person signing the proposal must sign in the name of the corporation, per his name as an official of said corporation, and the names, titles and business addresses of the President, Secretary, and Treasurer must be given.

102-7. Rejection of Irregular Proposals. Proposals that contain omissions, erasures, alterations, or additions not called for, conditional or alternate bids unless called for, or that contain irregularities of any kind including proposals in which the prices are obviously unbalanced, may be rejected

as informal. The Commission reserves the right to waive technicalities and make the award for the best interests of the State.

102-8. Proposal Guaranty. No proposal will be considered unless accompanied by a **Certified Check, Cashier's Check or U. S. Postal Money Order**, made payable to the Treasurer of the State of Maine, in the amount specified in the Proposal Form.

102-9. Delivery of Proposals. Each proposal must be submitted in a sealed special envelope furnished by the Commission. The blank spaces on the envelope must be filled in correctly so as to clearly indicate its contents. If forwarded by mail, the above mentioned envelope shall be enclosed in another addressed to: State Highway Commission, Augusta, Maine; if forwarded otherwise than by mail it shall be delivered at the office of the Engineer. Proposals will be received until 10 o'clock A.M. Eastern Standard Time, of the date set for the opening thereof, unless otherwise specified in the published Notice to Contractors.

102-10. Withdrawal of Proposals. Bidders will be given permission to withdraw a proposal after it has been deposited with the Commission, provided the Bidder makes his request in writing to the Commission or Engineer before the time set for opening the bids.

In addition to the above, any Bidder who has submitted proposals on more than one project at any one letting may, at his option and upon written request, withdraw any or all of his additional proposals after the official of the State Highway Commission opening and reading the bids 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 proposals for other projects in the letting will be returned to the Bidder unopened. No returned bids will be considered after the Bidder has exercised his privilege to withdraw the same. Any Bidder exercising the privilege of so withdrawing his bid or bids, waives all claims that may arise should it be found that his opened proposal is informal or for any other reason is unacceptable to the Commission.

102-11. Opening of Proposals. Proposals will be publicly opened and read by the Commission in the order in which they are drawn, at the time and place set in the Notice to Contractors. Bidders are invited to be present.

102-12. Disqualification of Bidders. Any one or more of the following causes may be considered as sufficient for the disqualification of Bidder and the rejection of his bid or bids:

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

(b) Evidence of collusion among Bidders. Participants in such collusion may receive no recognition as Bidders for any future work.

(c) Lack of competency as revealed by the financial statement, experience, plant and equipment statements submitted.

(d) Lack of responsibility as shown by past work judged 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 contracts, in litigation with the Commission, or having defaulted on a previous contract.

(g) If a successful Bidder refuses to accept an award, the Commission may refuse to consider any proposal of the Bidder for a period of three (3) years from the date of such refusal.

102-13. Competency of Bidders. Bidders must be capable of performing the various items of work bid upon. Any Bidder who has not been awarded a contract by the Commission within the five years previous to the date of opening of bids; or if requested by the Commission at any time, shall submit with his proposal, on forms furnished by the Commission, a completely executed "Questionnaire and Financial Statement for Bidders". In filling out the questionnaire the following information is necessary: a statement covering experience on similar work; a list of machinery, plant or other equipment available; a financial statement and other pertinent information.

102-14. Material Samples. Before any contract is awarded, the Bidder may be required to furnish a complete statement of the origin, composition and manufacture of any or all materials to be used in the construction of the work, together with samples, which may be subject to the tests provided for in these specifications to determine their quality and fitness for the work.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103-1. 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 bid schedule by the unit bid prices. The results of such comparisons will be immediately available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid price shall govern.

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

103-2. Award of Contract. The contract will be awarded or the proposal rejected by the Commission within thirty (30) days after the opening of the bids. If awarded, it shall be to the lowest responsible Bidder whose proposal shall comply with all the provisions required. The successful Bidder will be notified in writing that his bid has been accepted and that he has been awarded the contract.

103-3. Return of Proposal Guaranty. All proposal guaranties except those of the two (2) lowest Bidders will be returned within three (3) days after the opening of bids. The Proposal Guaranty of the second Bidder will be held until the contract is executed by the Contractor, 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 bids are rejected, all guaranties will be returned within three (3) days of the date of the action. Unopened bids will be returned immediately.

103-4. Requirements of Contract Bond. The successful Bidder, at the time of the execution of the contract, must furnish a bond payable to the Treasurer of the State of Maine, or his successors in office, in the sum of seventy-five (75) per cent of the amount of the contract awarded, in case a surety company bond is provided; or fifty (50) per cent of the amount of the contract awarded if a certified check or other security is provided, as noted below. The form of bond

shall be that provided by the Commission and the surety shall be acceptable to the Commission. This bond shall guarantee due execution and faithful performance and completion of the work to be done under the contract, and the payment in full of all bills and accounts for material and labor used in the work, and for all other things contracted for or used in connection with the contract; the contract shall not be considered in force until such bond has been filed and accepted by the Commission. If a surety company bond is provided it shall be procured from an insurance company licensed to do business in the State of Maine and must be executed or countersigned on the part of such surety company by an agent resident in the State of Maine. If a surety company bond is not provided, a certified check payable to the Treasurer of the State of Maine or other negotiable security acceptable to the Commission, in the sum of fifty (50) per cent of the amount of the contract awarded 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 bond, and to such agreements as may be required by the Commission.

103-5. Execution of Contract. The individual, firm, or corporation to whom or to which the contract has been awarded shall sign the necessary agreements entering into contract with the Commission, and return them to the office of the Commission, at Augusta, Maine, within ten (10) days after the notice of award of contract. In the event the contract is not executed by the Commission within twenty (20) days after the date of the notice of award of contract, the successful Bidder shall have the right to withdraw his bid without loss of his proposal guaranty. No proposal shall be considered binding upon the Commission until the execution of the contract by the Commission.

103-6. Failure to Execute Contract. Failure of the successful Bidder to execute the contract within the time stated shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty to the State, not as a penalty, but as liquidated damages. The award may then be made to the next lowest responsible bidder, the work may be readvertised or done otherwise, as the Commission may decide.

103-7. Triplicate Copies of Contract. The contract shall be executed in triplicate; one copy shall be kept by the Commission, one copy shall be delivered by the Commission to the State Controller, and one returned to the Contractor.

SECTION 104

SCOPE OF WORK

104-1. Intent of Plans and Specifications. The intent of the plans and these specifications is to provide for the execution and completion in every detail of the work described herein, and it is understood that the Contractor for all or any part, will furnish all labor, material, equipment, tools, transportation, and necessary supplies, such as may reasonably be required to execute the contract in a satisfactory and workmanlike manner, and in accordance with the plans, specifications, and terms of the contract.

104-2. Increased or Decreased Quantities. The right is reserved for the Engineer to make such alterations in the plans or in the character of the work as he may deem necessary or desirable from time to time during the progress of the work, to omit such items as he may find unnecessary, to increase or decrease quantities, and to shorten or extend the limits of the contract, in order to complete the project fully and satisfactorily. Whenever such changes shall increase or diminish the total original contract amount by more than twenty-five (25) per cent, a supplemental agreement acceptable to both parties of the contract shall be executed before the work is performed. Compensation to the Contractor for such changes shall be made as provided in Article 108-3.

104-3. Extra Work. The Contractor shall perform unforeseen or other 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, and such extra work shall be performed in accordance with the specifications; provided, however, that before any extra work is started, a supplemental agreement shall be entered into, or an order for force account work shall be issued. Compensation to the Contractor for such work shall be made as provided in Article 108-4.

104-4. Maintenance of Traffic. On all contracts, unless otherwise specified, the work shall be carried on in such manner as to provide safe passage at all times for the public travel and with a minimum of obstruction to traffic. When it is necessary for traffic to pass over sections of the roadway where the Contractor is carrying on any phase of the work, the Contractor shall at all times maintain a surface satisfactory for the safe passage of traffic and he shall provide protection as specified in Article 106-10. The Contractor

tor shall provide and maintain, in a safe and passable condition, such temporary by-passes and temporary bridges as may be necessary to accommodate the traffic on the work under construction, and shall provide and maintain in a safe condition temporary approaches to, and crossings of, intersecting highways. When installing roadway culverts, the Contractor shall provide at all times over or around the installation, a traffic lane having a minimum width of fourteen (14) feet.

When the project or any part thereof shall be closed to public travel during the construction, the Contractor will not be held liable for the maintenance of a detour but he shall be responsible for the construction, maintenance, and protection of adequate barriers, watchmen, or lights at both ends of the portion of the project closed.

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.

Residents and abutting land owners along the project under construction shall be allowed access by vehicle to driveways, field, or woods entrances and other normal necessary outlets for the conduct of their affairs.

Except as specified under Section 802 and/or when the work is suspended, all work required under this article shall be considered to be incidental to other contract items and shall be performed without direct compensation. When, due to unusual conditions, the area within the roadway limits that is necessary for the maintenance of traffic becomes unsuitable for the safe and convenient passage of public travel, granular material may be added to the travel lanes. When authorized, such material will be paid for as granular borrow or gravel borrow. If both items occur on a project, payment will be made at the lower delivered price.

The Engineer may authorize a suspension of the work in accordance with the provision of the Article 107-6 when unfavorable weather or other conditions not the fault of the Contractor make 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 sections of the project to be used by public vehicular traffic during periods of suspension shall have a minimum width suitable for two lanes of traffic. In order to provide space for snow removal, this

width shall be a minimum of thirty-six (36) feet in cuts. During this period of suspension the Contractor shall not be liable for maintenance of the portions so opened.

104-5. 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 to the satisfaction of the Engineer by the Contractor. Payment for such work shall be considered as subsidiary 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 and structures being maintained by the Commission, the Contractor shall not then be held liable for the damage caused.

104-6. Removal and Disposal of Structures and Obstructions. Unless otherwise specified or permitted, title to all guard rail, drainage pipe, culverts, and bridges found on the project shall remain vested in the State or other owner.

All of the above mentioned structures or material found within the right of way which are not to remain in place, shall be carefully salvaged by the Contractor and stored neatly within the right of way at a location designated by the Engineer, the haul not to exceed two thousand (2000) feet. Unless specifically provided for in the contract, the work prescribed herein shall not be paid for separately, but shall be considered as subsidiary to the several items of the contract.

104-7. Rights in and Use of Materials Found on the Project. The Contractor, with the approval of the Engineer, may use in the construction of the work any suitable earth, sand, gravel, or stone found in the excavation. Whenever such excavated material is allowed by the Engineer to be used for any other item for which there is a contract unit price, such as gravel borrow, gravel base, gravel surface, stone base, crushed stone base, surface courses, concrete materials, or rip-rap, no charge will be made for the material so used, but such material, if anticipated for other construction use, shall be replaced by the Contractor with satisfactory material, without additional compensation.

The Contractor shall not excavate or remove any material which is not within the excavation limits, as indicated by plans, slope stakes, or grade lines, and he shall not waste

any excavated material suitable for use, unless authorized by the Engineer.

104-8. Final Cleaning Up. The work will not be considered as completed until the Contractor shall clean and remove from the highway, bridge structure, lawns, and property adjacent to the project, all surplus and discarded materials, rocks, rubbish, temporary structures and equipment; restore in an acceptable manner all property, both public and private, which has been damaged during the prosecution of the work and shall leave the highway, all borrow pits, and all ground occupied by the Contractor in a neat and presentable condition.

SECTION 105

CONTROL OF WORK AND MATERIALS

105-1. Authority of the Engineer. The Engineer shall decide any and all questions which may arise as to the quality and acceptability of materials furnished and work performed, and as to the manner of performance and rate of progress of the work. He shall decide all questions which may arise as to the interpretation of the plans and specifications, the fulfillment of the contract on the part of the Contractor, and to the rights of different contractors on the Project. The Engineer shall determine the amount and quantity of the several kinds of work performed and materials furnished which are to be paid for under the contract.

105-2. Plans and Working Drawings. Plans, consisting of general drawings and showing such details as are 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, 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 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 structure.

Working drawings for steel structures shall consist of shop detail, erection, and other working plans showing de-

tails, dimensions, sizes of material, and other information necessary for the complete fabrication and erection of the metal work.

Working drawings for concrete structures shall consist of such detailed plans as may reasonably be required for the successful prosecution of the work and which are not included in the plans furnished by the 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 three 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 these 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 sets will be retained by the Engineer.

It is expressly understood that the approval by the Engineer 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.

The Contractor shall furnish the Engineer with copies or reproductions of the working drawings as may be required for approval and construction purposes.

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

105-3. Conformity With the Plans and Allowable Deviations. The lines, grades, typical cross-sections and dimensions contained in the plans shall be implicitly followed, except where conditions make it necessary or desirable for the Engineer to modify the same, in which case all deviations or changes shall be authorized by the Engineer in writing.

105-4. Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions. The plans, standard specifications, supplemental specifications, special provisions, and all supplementary documents are essential parts of the contract and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for the completion of the

work. In case of discrepancy, figured dimensions, unless obviously incorrect, shall govern over scaled dimensions, supplemental specifications shall govern over the standard specifications, plans shall govern over specifications and special provisions shall govern over both plans and specifications. The Contractor shall take no advantage of any error or omission in the plans or of any discrepancy between the plans and specifications, and the Engineer shall make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the specifications and of the plans as construed by him.

Where the plans provide that new work is to connect with existing structures, the Contractor must verify all dimensions before proceeding with the work.

105-5. Cooperation by the Contractor. The Contractor will be supplied with the necessary sets of approved plans, proposal forms, and copies of the standard specifications. He shall have available on the work at all times during the prosecution of the work, one copy each of plans, proposal forms, and specifications.

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

The Contractor shall at all times have on the work, as his agent, a competent English-speaking superintendent or foreman capable of reading and thoroughly understanding the plans and specifications, and thoroughly experienced in the type of work being performed. The superintendent shall have full authority to receive and execute the 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.

He shall provide all reasonable 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. No materials for which samples and tests are required shall be used until the samples have been tested and approved.

105-6. Public Utilities. It shall be the duty of the Commission to notify all utility companies, all pipe line owners, or other parties affected, and to endeavor to have all necessary adjustments of the public or private utility fixtures, pipe

lines, and other appurtenances within or adjacent to the limits of construction, made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals and all other utility appurtenances within the limits of the proposed construction are to be moved by the owners without expense to the Contractor, unless otherwise provided for, or as noted on the plans.

Any work done upon or within the right-of-way of a railroad company shall be under the supervision and control of the Chief Engineer or other designated officer of said railroad company to the extent necessary, in the judgment of said Chief Engineer or other designated office, 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.

105-7. 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 any Contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other and in case of dispute the Engineer shall be the referee and his decision shall be final and binding on all.

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 and he shall assume all responsibility for all work not completed or accepted because of the presence and operations of the other Contractors.

The Contractor shall as far as possible arrange his work and shall place and dispose of the materials 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.

105-8. Reference Stakes, Lines, and Grades. The Engineer will set reference stakes, establishing lines, slopes, continuous profile-grade, center line and bench marks as he may deem necessary, and he shall furnish the Contractor with all necessary information relating to lines, slopes, and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall govern and execute the work. All reference stakes shall be furnished by and remain the property of the Commission.

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

105-9. Source of Supply and Quality of Materials. The source of supply of each of the materials required shall be approved by the Engineer before delivery is started. Representative preliminary samples may be submitted by the Contractor, producer, or owner of the supply for inspection or tests. The results obtained from testing such samples may be used for preliminary approval but will not be used as a final acceptance of the materials. All materials proposed to be used may be tested at any time during their preparation and use. If, after trial, it is found that sources of supply which have been approved do not furnish a product of uniform quality, or if the product from any source proves unacceptable at any time, the Contractor shall furnish approved material from another source.

Samples of all materials for test upon which is to be based the acceptance or rejection, shall be taken by the Engineer. Materials may be sampled either prior to shipment or after being received at the place of construction. All 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 the samples until tests have been made and the material found to be acceptable. Only materials conforming to the requirements of these specifications and which have been approved by the Engineer shall be used in the work. Any material which, after approval, has for any reason become unfit for use shall not be incorporated in the work.

105-10. Sampling and Testing of Materials. Except as otherwise provided, sampling and testing of all materials, and the laboratory methods and testing equipment required under these specifications shall be in accordance with the latest edition of the "Standard Specifications for Highway Materials and Methods of Sampling and Testing" of A.A.S.H.O. Sampling and testing of materials not covered by A.A.S.H.O. specifications, and not otherwise provided for, shall be in accordance with the latest Standards and Tentative Methods of the A.S.T.M.

The testing of samples and materials shall be made at the expense of the Commission; the Contractor shall furnish the required samples without charge. The Contractor shall give sufficient notification of the placing of orders for materials to permit testing.

105-11. Storage and Stockpiling of Materials. Materials shall be so stored as to insure the preservation of their quality and fitness for the work. When considered necessary they shall be placed on wooden platforms or other hard clean surfaces and not on the ground, and shall be placed under cover when directed. Stored materials shall be located so as to facilitate prompt inspection.

Stockpiling of aggregates will be permitted if placed in horizontal layers as directed and in such manner as to avoid segregation. Stockpiling of aggregates in cones will not be allowed.

105-12. Authority and Duties of the Inspector. Inspectors shall have access to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The Inspector is not authorized to alter or waive provisions of these specifications.

An Inspector is placed on the work to keep the Engineer informed as to the progress of the work and the manner in which it is being done; also to call the Contractor's attention to any nonconformance with the plans or specifications. He will not be authorized to approve or accept any portion of the work, to issue instructions contrary to the plans and specifications, or to act as foreman for the Contractor. The Inspector will have authority to reject defective material and to suspend any work that is being improperly performed subject to the final decision of the Engineer. The suspension order shall be in writing.

105-13. Field Office. The Contractor shall supply for the Engineer's and Inspector's use a building independent of any

building used by himself or his employees located on the project at an approved site. This building shall be plainly, but substantially built, and floor, roof, and sides shall be weather-proof. Sidewalls shall be plain T & G lumber and the roof shall be covered with roofing felt. One wall shall be fitted with a door having a satisfactory lock. Screened sliding windows shall be provided on at least two sides to insure good ventilation and to furnish a minimum of twenty (20) sq. ft. of natural light.

This office shall consist of a room having a minimum floor space of one hundred (100) sq. ft. and the height at the eaves above the floor shall be at least 6' 0".

It shall be equipped with a substantial table at least 36" x 72", at least two chairs or stools, and racks, shelves, etc., for storing plans and equipment. When required on account of cold weather, the building shall be fitted with a stove complete and satisfactory for heating the building. Necessary fuel shall be furnished by the Contractor.

Suitable electric lighting shall be furnished when reasonably available, and when a telephone is not available in the Contractor's project office, the Contractor shall have installed and shall furnish a telephone in the Engineer's office if service is reasonably available.

When the contract amount is less than Thirty Thousand (\$30,000) Dollars, a building fulfilling the above requirements shall be supplied, except that a floor space of sixty-five (65) square feet will be acceptable.

105-14. Plant Inspection. If the volume of the work, construction progress, and other considerations warrant, the Engineer may undertake, without obligation to do so, the inspection of materials at the source.

Plant inspection will be undertaken only under condition that:

(a) The cooperation and assistance of the Contractor and the producer with whom he has contracted for materials is assured.

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

(c) When required by the Engineer, an approved weatherproof building shall be furnished for the use of the In-

spector, such building to be located conveniently near the plant and independent of any building used by the material producer, and shall conform to the requirements of Article 105-13—Field Office.

(d) It is understood that the Engineer reserves the right to re-test all materials which have been tested and accepted at the source of supply after the same have been delivered, and to reject all materials which, when re-tested, do not meet the requirements of these specifications.

105-15. Inspection of Work. All materials and each part or detail of the work shall be subject at all times to inspection by the Engineer or his authorized representatives, and the Contractor will be held to the intent of the specifications in regard to quality of materials, workmanship, and the diligent execution of the contract. Such inspection may include mill, plant, or shop inspection, and any material furnished under these specifications is subject to such inspection. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is 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 standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed shall be paid for as Extra Work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, shall be at the Contractor's expense.

Any work done or materials used without inspection and approval by the Engineer may be ordered removed and replaced at the Contractor's expense.

105-16. Unauthorized Work. Work done without lines and grades being given, work done beyond the lines and grades shown on the plans or as given, except as herein provided, or any extra work done without written authority, will be considered as unauthorized and may not be subject to measurement or payment. The Contractor, if ordered by the Engineer, shall remove or replace such work without compensation.

105-17. Removal of Defective and Unauthorized Work and Materials. All work which has been rejected or condemned shall be repaired, or if it cannot be satisfactorily repaired, be removed and replaced at the Contractor's expense. Materials not conforming to the requirements of the specifications shall be removed immediately from the site of the work and replaced with satisfactory material by the Contractor. Work done without lines and grades having been given, work done beyond the lines and grades shown on the plans, or as given, except as herein provided, work done without proper inspection, or any extra work done without written authority and prior agreement in writing as to price, will be done at the Contractor's risk and will be considered as unauthorized and, at the option of the Engineer, may not be measured and paid for; and may be ordered removed and replaced at the Contractor's expense.

Upon the failure of the Contractor to repair satisfactorily or to remove and replace, if so directed, rejected, unauthorized, or condemned work or materials immediately after receiving formal notice from the Engineer, the Commission may recover for such defective work or materials on the Contractor's bond or by action in a court having proper jurisdiction over such matters or may employ labor and equipment and satisfactorily repair or remove and replace such work and charge the cost to the Contractor, which cost will be deducted from any money due him.

105-18. Claims for Adjustment and Disputes. In any case where the Contractor deems that extra compensation is due him for work or material not clearly covered in the contract or not ordered by the Engineer as an extra, as defined herein, the Contractor shall notify the Engineer in writing of his intention to make claim for such extra 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 strict account of actual cost as defined for force account, then the Contractor shall have no claim for such extra compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, shall not in any way be construed as proving the validity of the claim. In case the claim, after consideration by the Engineer, is found to be just, it shall be allowed and paid as an extra as provided herein for force account work. Nothing in this article shall

be construed as establishing any claim contrary to the terms of Article 104-2.

105-19. Materials Furnished by the State. The Contractor shall furnish all material required to complete the work, except as otherwise specified in the Special Provisions.

When materials are to be furnished by the State as called for in the Special Provisions, they will be delivered or made available to the Contractor at the points specified.

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 material delivered to him, and deductions will be made from any monies due him 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 due to delinquency in unloading.

105-20. Final Acceptance. Whenever all the materials have been furnished, all the work has been performed, and the construction provided and contemplated by the contract has been satisfactorily completed, the Engineer shall make final inspection.

Upon due notice from the Contractor of presumptive completion of the entire project, the Engineer shall make an inspection and if at such inspection, all construction provided for and contemplated by the contract is found satisfactorily completed, and all required reports submitted, such inspection shall constitute the final inspection and acceptance. The Contractor shall be notified of such acceptance in writing.

If, at this inspection, any work in whole or in part is found unsatisfactory, the Engineer shall give the Contractor the necessary instructions as to replacement of material and performance or re-performance of work necessary and prerequisite to final completion and acceptance, and the Contractor forthwith shall comply with and execute such instructions. Upon satisfactory replacement of such material and performance or re-performance of such work, another inspection shall be made which shall constitute the final inspection if the said material is found to have been replaced and the work completed satisfactorily. In such event the Engineer shall make the final acceptance and the Contractor shall be notified of such acceptance in writing.

SECTION 106

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

106-1. Laws to be Observed. The Contractor is assumed to be familiar with, and at all times shall observe and comply with, all Federal and State laws, and local by-laws, ordinances and regulations in any manner affecting the conduct of the work, and shall indemnify and save harmless the State and its representatives against any claim arising from the violation of any such law, by-law, ordinance or regulation, whether by the Contractor himself or by the Contractor's employees.

The Contractor shall maintain such insurance as will protect him from claims under Workmen's Compensation acts and from any other claims for damages for personal injury, including death, which may arise from operations under this contract, whether such operation be by himself or by any sub-contractor, or any one directly or indirectly employed by either of them. Certificates of such insurance shall be filed with the State Highway Commission, if they so require, and shall be subject to their approval for adequacy of such protection.

106-2. Non-Resident Contractors. The successful bidder, if a corporation established under laws other than of this State, 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 Section 127 of Chapter 53 of the Revised Statutes.

The successful bidder, if a resident of another state and not a corporation, shall file, at the time of the execution of the contract, with the Commission 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 the authority shall continue in force so long as any liability remains 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:

1. Any person who is not a resident of the State of Maine.
2. Any partnership that has no member thereof resident of the State of Maine.
3. Any corporation established under laws other than those of the State of Maine.

106-3. 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, except that transportation charges assessed on contractor-furnished materials such as cement, sand, gravel, crushed stone, pipe, steel, or any other material which may be shipped for, and remain in, the complete project, are exempt from the three (3) per cent Federal tax imposed by United States Public Law No. 591 (83rd Congress) provided such materials are consigned to the Maine State Highway Commission.

In order that the State may receive the benefit of any savings occasioned by this condition, the Contractor is hereby required to consign any such materials used in this work to the Maine State Highway Commission in care of the Contractor, the Contractor to pay all freight, demurrage, and other lawful charges (assessed on the exempted shipments) direct to the railroad or carrier and, upon completion of the work, to furnish the Commission a written statement certifying that there are no outstanding freight, demurrage, or other transportation charges against any exempted shipment(s) which were consigned as above prescribed.

106-4. Patented Devices, Materials, and Processes. If the Contractor is required or desires to use 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 and a copy of this agreement shall be filed with the Commission; if no such agreement is made or filed as noted, the Contractor and the surety shall indemnify and save harmless the State, any affected railroad or railway company, 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.

106-5. Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street or to grant permits for the same, at any time, is hereby expressly reserved by the Commission for the proper authorities of the municipality in which the work is done and the Contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.

Upon the presentation of a duly authorized and satisfactory permit which provides that all necessary repair work will be paid for by the party to whom such permit is issued, the Engineer may authorize the Contractor to allow parties bearing such permit to make openings in the highway. The Contractor shall, when ordered by the Engineer in writing, make in an acceptable manner all necessary repairs due to such openings and such necessary work ordered, by the Engineer, shall be paid for on the basis of extra work, as provided in Article 108-4 of these specifications, and shall be subject to the same conditions as original work performed.

106-6. Water Traffic and Stream Discharge. The Contractor shall so conduct his work that log driving on the river, stream or other waters affected thereby, may be carried on without serious interruptions or obstructions. 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 lights, signals, and other warnings as, in the opinion of the Engineer, may be required for public safety and convenience, or to conform with Federal regulations.

All expense connected with the maintenance of water traffic and all loss 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 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 works, 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.

106-7. Federal Participation. When the United States Government pays all or any portion of the cost of a project, the work shall be subject to the inspection of 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.

106-8. Sanitary Provisions. The Contractor shall provide and maintain in a neat and sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State and local authorities having jurisdiction thereof. No source of inconvenience, complaint or nuisance shall result to the public or to residents or others in the vicinity of the work.

106-9. Public Convenience and Safety. The Contractor shall at all times so conduct his work as to insure 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 "Maintenance of Traffic"—Article 104-4.

Materials stored upon the highway shall be placed so as to cause no more obstructions to the travelling public than is considered necessary.

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

106-10. Barricades and Warning Signs. The Contractor shall provide, erect, and maintain all necessary barricades,

suitable and sufficient red lights, danger signals, and other signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and the safety of the public. Highways closed to traffic shall be protected by effective barricades, and obstructions shall be illuminated at night.

Suitable warning signs, illuminated at night by lanterns or flares, shall be provided to mark the places where surfacing ends or is not compacted. All lights for this purpose shall be kept burning from sunset to sunrise.

The Contractor shall erect approved warning signs in advance of any place on the project where operations interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road.

Furthermore, whenever temporary means are provided for the transfer of traffic over or around a bridge site, either by other existing highways or by temporary structures and roads, the Contractor shall erect and maintain legal caution signs. The signs shall be conspicuously placed at each end of the construction work and at distances of two hundred to five hundred feet therefrom whenever possible.

106-11. Use of Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property. The Contractor shall be responsible for any and all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner, in compliance with the State and local laws and ordinances, and all such storage places shall be legally marked.

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" within 300 feet of any travelled way shall be marked by approved signs with information similar to the following:

"BLASTING AREA

TURN OFF RADIO TRANSMITTERS"

and on the reverse side:

"END OF BLASTING AREA".

These signs shall be conspicuously placed at a distance of three hundred to five hundred feet from each end of the

"Blasting Area" and shall remain in place only while the above conditions are in effect and shall be removed after the blast or after all caps have been removed from the area.

The Contractor shall notify each public utility company, having structures in proximity to the site of the work, of his intention to use explosives and such notice shall be given sufficiently in advance to enable the companies 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 resulting from his blasting operation.

All persons 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.

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

106-12. Protection and Restoration of Property. The Contractor shall not enter upon private property for any purpose without first obtaining permission. He shall be responsible for the preservation of all public and private property, crops, trees, monuments, highway signs and markers, fences, etc., along and adjacent to the highway, and shall use every precaution necessary to prevent damage or injury thereto. He 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. He shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location and shall not remove them until directed.

The Contractor shall be responsible for all damage or injury to property during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in his manner or method of executing said work, or due to defective work or materials. This responsibility shall not be released until the project has been completed and accepted. If any direct or indirect damage or injury be done to public or private property by, or on account of, any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the nonexecution thereof on the part of the Contractor, he shall restore, at his own expense, such prop-

erty to a condition similar or equal to that existing before such damage or injury was done, or he shall make good such damage or injury in an acceptable manner.

106-13. Responsibility for Damage Claims. The Contractor and his surety 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 construction of the work; or because of any act or 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 of 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 shall 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 damages as aforesaid shall have been settled and suitable evidence to that effect furnished to 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, and 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 said Contractor in the prosecution of the work, shall be presented to said Commission, the Commission may retain such sum or sums from the moneys 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, and until the validity of such claims shall be established and finally determined, and if determined and finally established as valid, all such claims shall be paid from the amount so retained if it be sufficient

for that purpose; otherwise, or if at any time the Commission shall be satisfied that any of 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, and neither the said 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 moneys so retained under this contract are insufficient to pay all such claims presented to said Commission and adjudged by any court of competent jurisdiction to be valid obligations of said Contractor, the Commission may at its discretion pay the same 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 moneys 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 thirty (30) days after the completion of the work, but continuing unsatisfied for a period of ninety (90) days, the Commission may pay such claim and deduct the amount thereof from the balance due the Contractor.

106-14. Opening Sections of Project to Traffic. At the option of the Engineer, certain sections of the work may be opened for the use of traffic. Such opening shall not constitute acceptance of the work or any part of it or a waiver of any provisions of the contract. Any damage to the highway, which may occur on such opened sections, resulting from deficiencies of workmanship and/or materials shall be repaired by the Contractor at his expense. Any unavoidable "slide" shall be removed and paid for at the respective contract unit prices for the quantities and items of work involved.

If the Contractor is dilatory in completing shoulders, drainage structures, or other features of the work, the Engineer may order all or any 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 or hazard to traffic.

106-15. Contractor's Responsibility for Work. Until final acceptance of the work by the Engineer, as evidenced in writ-

ing, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, or from any other cause, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to acts of God, of the public enemy or of governmental authorities. The repair of such excepted damage shall be done by the Contractor and paid for at the respective contract unit prices for the quantities and items of work involved.

In the case of a contract for the placing of a base and/or surface course or courses upon work previously constructed, the Contractor shall be required to maintain such work ahead of his other operations.

106-16. Contractor's Responsibility for Utility Property and Services. At points 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, and that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

In the event of interruption to water or utility services as a result of accidental breakage, or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority. He shall cooperate with the said authority in the restoration of service as promptly as possible.

106-17. Personal Liability of Public Officials. In carrying out any of the provisions of these specifications, or in exercising any power to 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 under-

stood that in all such matters they act solely as agents and representatives of the State.

106-18. No Waiver of Legal Rights. No estimates, payments or acceptance of work shall be taken as a waiver, upon the part of the Commission, of its right at any time of showing the true and correct amount and character of the work performed and materials furnished by the Contractor, and of demanding and recovering from the Contractor such damages as may be sustained by reason of his failure to have complied with the plans, specifications and contract.

106-19. Preferred Employees. The Contractor in the construction of the work shall give preference to employment of citizens of the town in which the work is located. After meeting this requirement, the Contractor shall give preference to the employment of citizens of the State of Maine. To enforce these preferences, the Contractor, upon request, must submit to the Engineer the names and positions of all people from outside the State whom he proposes to employ. The Engineer reserves the right to reject any such person, if, in his opinion, the position can be suitably filled by a person residing in the State of Maine.

106-20. An Act Relating to Minimum Wages for Laborers. In the employment of laborers in the construction of public works, including state highways, by the State, or by persons contracting therewith for such construction, preference shall first be given to citizens of the State who are qualified to perform the work to which the employment relates, and, if they cannot be obtained in sufficient numbers, then to citizens of the United States; and every contract for such work shall contain a provision to this effect. The wages for a day's work paid to laborers employed in the construction of public works, including State highways, as aforesaid shall be not less than the prevailing rate paid by the State for similar work done by the Highway Commission. Any Contractor who knowingly and wilfully violates this section shall be punished by a fine of not more than \$100. Each day that any Contractor employs a laborer at less than the wage minimum herein stipulated shall constitute a separate violation of this section, Chapter 30, Section 56, Revised Statutes 1954.

The above provisions pertaining to wages and conditions of employment shall apply to all work performed on the contract by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence, and to all work performed by sub-contract.

SECTION 107

PROSECUTION AND PROGRESS

107-1. Subletting or Assigning 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. The Contractor shall file with the Commission copies of all assignments. No sub-contracts, or transfer of contract, shall in any case release the Contractor of his liability under the contract and bond.

107-2. Notice to Commence Work. The "Notice to Commence Work" will stipulate the date on which it is expected the Contractor will begin the construction and on and after that date contract time will be charged as specified in Article 107-7. Commencement of work by the Contractor, with prior notice to the Engineer, shall be deemed and taken as a waiver of this notice. In no case, however, shall the Contractor begin work prior to the date of approval of the contract.

107-3. Prosecution of Work. The Contractor shall begin work at such points and proceed in such order as set forth in the "Schedule of Operations" when such schedule is included in the Special Provisions. If at any time during the construction of the project satisfactory progress is not being made, the Contractor upon order of the Engineer shall increase the force, machinery and equipment as directed by the Engineer; but 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 in this contract. 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 twenty-four (24) hours before again resuming operations; the Engineer may require the Contractor to resume operations by giving him a written twenty-four (24) hour notice.

107-4. Limitations of Operations. The Contractor shall conduct the work at all times in such a manner and in such sequence as will insure 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 of work already started, and the Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional section.

The Contractor shall not carry on construction operations on Sundays, unless of an emergency nature and only then with the permission of the Engineer.

107-5. Character of Workmen, Methods and Equipment. The Contractor shall employ only competent and efficient superintendents, foremen and workmen, and whenever in the opinion of the Engineer, any employee is careless, incompetent, obstructs the progress of the work, acts contrary to instructions or conducts himself improperly, disorderly or intemperately on the work, the Contractor shall, upon complaint of the Engineer, discharge or otherwise remove such employee from the work and shall not again employ him thereon.

The working force, methods, equipment and appliances used on the work shall be such as will produce a satisfactory quality of work and shall be adequate to complete the contract within the time limit specified.

107-6. Temporary Suspension of Work. The Engineer shall have the authority to suspend the work wholly or in part by written order, for such period as he may deem necessary due to unsuitable weather, to conditions considered unfavorable for the suitable prosecution of the work, or to failure on the part of the Contractor to correct conditions unsafe for workmen or the general public, or to carry out orders given, or to perform any provisions of the contract.

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 unnecessarily, 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, etc., and erect temporary structures where necessary.

107-7. Determination and Extension of Contract Time for Completion. It is essential that the Contractor shall perform fully, entirely and in an acceptable manner the work under contract within the time stated in the contract. The number of days allowed for the completion of the work will be fixed by the Engineer and will be stated in the Proposal Form and Contract, and will be known as the "contract time".

The number of days for performance allowed in the contract is based on the original contract amount. If satisfactory

fulfillment of the contract with extensions and increases authorized under Article 104-2 shall require the performance of work in greater quantities than those set forth in the proposal form, 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.

If the Contractor finds it impossible 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. 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.

Unless otherwise specified in the Proposal Form, the period from November 15th to April 15th, inclusive, and all other days as specified under Article 101-53 shall be allowed the Contractor and shall be excluded from the number of working days.

When the contract time is on a working day basis, the Engineer will furnish the Contractor a 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.

107-8. Failure to Complete the Contract on Time. Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Commission of the administration of the contract, including engineering, inspection, and supervision, as well as the inconvenience to the public, obstruction of traffic and interference with business, will be increased as the time occupied in the work is lengthened.

For each working day that any work shall remain uncompleted after the contract time specified for the completion of the work provided for in the contract, the amount per working day, given in the schedule shown in Article 107-9, unless

otherwise specified in the Proposal Form, 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 Article 107-7.

107-9. Schedule of Liquidated Damages.

Original Contract Amount		Amount of Liquidated Damages Per Day
\$	10,000 and less	\$ 15.00
More than	10,000 and less than \$ 50,000	30.00
More than	50,000 and less than 100,000	45.00
More than	100,000 and less than 250,000	60.00
More than	250,000 and less than 500,000	75.00
More than	500,000 and less than 1,000,000	100.00
	1,000,000 and more	150.00

107-10. Default and Annulment of Contract. If the Contractor fails to begin the work under contract within the time specified in the "Notice to Commence Work"; or fails to perform the work with sufficient workmen and equipment; or with sufficient materials to ensure the prompt completion of said work; or shall perform unsatisfactory work; or shall neglect or refuse to remove materials; or perform anew such work as shall be rejected as defective and unsuitable; or shall discontinue the prosecution of the work; or shall fail to resume, within a reasonable time after notice to do so, work which has been discontinued; or if the Contractor shall become insolvent or be declared bankrupt; or commit any act of bankruptcy or insolvency; or allow any final judgment to stand against him unsatisfied for a period of 10 days; or shall make an assignment without authorization by the Commission for the benefit of creditors; or for any other cause whatsoever shall not carry on the work in an acceptable manner; the Engineer shall give notice in writing to the Contractor and his surety of such delay, neglect or default, specifying the same.

If the Contractor or surety, within a period of 10 days after such notice, shall not proceed in accordance therewith, then the Commission shall, 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 to take the prosecution of the work out of the hands of the Contractor. It is agreed between the parties to the contract that this action shall not constitute a

breach of the contract on the part of the Commission. 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 the contract according to the terms and provisions thereof; or use such other methods as in its opinion shall be required for the completion of the contract in an acceptable manner.

All costs and charges incurred by the Commission, together with the cost of completing the work under contract, shall be deducted from any monies due, or which may become due, the Contractor. In case the expense so incurred by the Commission shall be less than the sum which would have been payable under the contract, if it had been completed by the Contractor, then he shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the State the amount of the excess.

107-11. Termination of Work. The project will be considered complete when all work has been finished and the final inspection made by the Engineer in accordance with Article 105-20. The Contractor will be relieved of any further work, including maintenance of the project, upon final inspection and acceptance of the project.

SECTION 108

MEASUREMENT AND PAYMENT

108-1. Measurement of Quantities. 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 make final measurements to determine the quantities of various items of work accepted as the basis for final settlement. 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 in place, as shown by the final measurements. All work completed and accepted under the contract shall be measured by the Engineer according to the standards of weights and measures recognized by the National Bureau of Standards.

When the average end area method for computing volume is specified, vertical measurements for depth and thickness and horizontal measurements for longitudinal and transverse dimensions shall be used.

All measurements referring to the term of "ton" shall mean the short ton consisting of 2000 pounds avoirdupois.

108-2. Scope of Payment. Payments to the Contractor will be made for the actual quantities of contract items performed and accepted in accordance with the plans and specifications. Upon completion of the construction, if these actual quantities show either an increase or decrease from the quantities given in the Proposal Form, the contract unit prices will still prevail, except as provided in Article 108-3 or Article 108-4.

The Contractor shall accept the compensation, as herein provided, in full payment for furnishing all materials, labor, tools, equipment, and incidentals necessary to the completed work and for performing all work contemplated and embraced under the contract; also for all loss or damage arising from the nature of the work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the work and until its final acceptance by the Engineer, and for all risks of every description connected with the prosecution of the work, except as provided in Article 106-15; also for all expenses incurred in consequence of the suspension of the work as herein authorized.

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

108-3. Payment for Increased or Decreased Quantities. When alterations in the plans or quantities of work not requiring supplemental agreements, as hereinbefore provided for in Article 104-2, are ordered and performed, the Contractor shall accept payment in full at the contract price for the actual quantities of work done. No allowance will be made for anticipated profits. Increased or decreased work involving supplemental agreements will be paid for as stipulated in such agreements.

108-4. Extra and Force Account Work. Extra work performed in accordance with the requirements and provisions of Article 104-3 shall be paid for at the unit prices or lump sum stipulated in the supplemental agreement which, when executed, shall become a part of the original contract, and

shall be paid for in the same manner as any other contract item. In lieu of such agreement, the Commission may require the Contractor to do extra work on a force account basis, to be compensated for in the following manner:

(a) *Labor.* For all labor and foremen in direct charge of the specific operations, the Contractor shall receive the rate of wage (or scale) agreed upon before beginning work, for each and every hour that said labor and foremen are actually engaged in such work. Except in emergencies the rate of wage (or scale) shall not exceed the average hourly rate paid to each workman for the week in which this work is done. To such labor costs shall be added an amount equal to thirty (30) per cent 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 and social security taxes on the force account work.

(b) *Materials.* For all materials used, and incorporated in the permanent work, the Contractor shall receive the actual cost of such materials, including freight and delivery charges, as shown by original receipted bills, plus fifteen (15) per cent of such actual cost. 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 fifteen (15) per cent will be made to the Contractor.

(c) *Equipment.* 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 agreed upon in writing for the actual time that such equipment is in operation on the work, to which rental sum no percentage shall be added.

(d) *Superintendence, Etc.* No allowance shall be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

(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. Each day the Contractor and the Engineer shall compare and reconcile records of the cost of work done as ordered on a force account basis.

(f) *Statements.* All statements shall be accompanied

and supported by original 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 original 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.

108-5. *Omitted Items.* Should any items contained in the proposal be found unnecessary for the proper completion of the work contracted, 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 items so eliminated in making final payment to the Contractor, except for such actual work as may have been done and materials actually purchased prior to notification of the elimination of the items. Payment for such work shall be made as specified for "Extra and Force Account Work"—Article 108-4.

108-6. *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 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.

108-7. Partial Payments. Partial payments shall be made monthly as the work progresses. They may be made semi-monthly if mutually agreed upon by the Engineer and the Contractor. All partial estimates and payments shall be subject to correction in the final quantity estimate and payment.

No 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 in his judgment the total value of the work done since the last estimate amounts to less than \$500.

The partial payments will be based upon estimates prepared by the Engineer of the value of the work performed, and materials complete in place in accordance with the contract, and for materials delivered in accordance with Article 108-8 of these specifications. From the total of the amounts so ascertained will be deducted ten (10) per cent of the whole, which ten (10) per cent will be retained by the Commission until after completion of the entire contract in an acceptable manner; and the balance, being ninety (90) per cent of the whole, less all previous payments, shall be certified for payment. 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 reserve as it deems equitable.

108-8. 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, timber and lumber, metal culverts, stone, sand, gravel and other materials delivered on the work or in 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 amount thus paid by the Commission shall go to reduce estimated amounts due the Contractor as the material is used in the work.

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 Article 108-4.

108-9. Final Payment. The Engineer shall make, as soon as practicable after the completion of the project, a final quantity estimate of the amount of work performed under the contract and the value of such work, and the Commission shall then pay the entire sum found to be due, after deducting therefrom all previous payments and all amounts to be retained or deducted under the provisions of this contract. Any money retained under the provisions of the contract may be held by the Commission for a period of sixty (60) days after the completion of the final quantity estimate, or until such time as the Contractor submits satisfactory evidence that all bills for labor and materials used under this contract have been paid and all required reports submitted to the Engineer.

The acceptance by the Contractor of the final payment under the contract shall constitute a release to the Commission from all claims and liabilities under such contract. Upon "Termination of Work" (Article 107-11) and acceptance of the final payment by the Contractor, the Contractor shall then be released from further obligations, except as set forth in the Contract Bond.

DIVISION II

GRADING

Grading shall consist of all clearing, removing trees, grubbing, roadway and drainage excavation, excavation for structures, construction of embankments, common borrow, granular borrow, gravel borrow, trimming slopes, disposal of surplus material, preparation of subgrade, and all subsidiary work included in this division; all of which work shall be executed in accordance with the specifications and in conformity with the plans.

SECTION 201

CLEARING

DESCRIPTION

201-1. General. "Clearing" shall consist of cutting and disposing of all trees, down timber, stubs, brush, bushes, and other vegetation, from areas outlined on the plans, which interfere with excavation, embankment or clear vision, or are considered otherwise objectionable. Grubbing will not be required under this item.

CONSTRUCTION METHODS

201-2. General. The areas denoted on the plans to be cleared shall be designated at the site by the Engineer. All trees or shrubs marked to be saved shall be carefully preserved by the Contractor.

Trees unavoidably falling outside the specified limits must be cut up, removed and disposed of in a satisfactory manner. In order to minimize damage to trees that are to be left standing, trees shall be felled toward the center of the area being cleared. The Contractor shall preserve and protect from injury all trees not required to be removed. In embankments of two (2) feet or more in depth, measured below the subgrade, and in areas beyond the lines of improvement, all trees, stubs, stumps, bushes, roots and other vegetation shall be cut off as close to the ground as is practicable, but not to exceed six (6) inches above the ground surface.

All branches of trees extending over the area occupied by the roadway shall be carefully trimmed by skilled workmen or tree surgeons to give a clearance of sixteen (16) feet

and all cut surfaces shall be painted with an approved bituminous paint. Such work shall be incidental to other contract items.

All timber and wood shall become the property of the Contractor unless otherwise provided, and this, along with debris which will not be burned, shall be removed and disposed of outside the right of way limits and entirely out of sight from the highway. The removal and disposal of such material by the Contractor shall be a part of and incidental to this item as bid. The clearing shall be done at a satisfactory distance ahead of the grading operations. Material to be burned shall be placed either in cleared areas near the center or in adjacent open spaces within the right of way where no damage to trees or other vegetation will occur.

Because of the disease-carrying characteristics of elm trees, especially after being cut, the Contractor shall take special care to completely dispose of all elm trees removed, either by burning or by burying under soil in waste areas. These trees shall be disposed of immediately after cutting.

METHOD OF MEASUREMENT

201-3. The area of "Clearing" to be measured for payment shall be the number of acres actually cleared within the clearing lines. The length of the areas cleared shall be measured along the construction center line and shall not exceed the station limits indicated on the plans. The width of the areas cleared shall be measured at right angles to the construction center line and between the clearing lines shown on the plans. Where construction follows an existing road, the area of "Clearing" within the station limits designated, shall be shown by inside and outside clearing lines on the plans.

BASIS OF PAYMENT

201-4. The item of "Clearing" shall be paid for at the contract unit price per acre, which payment shall include full compensation for all equipment, materials, tools, labor and all incidentals necessary to complete the work. When no item for "Clearing" is included in the contract, payment for such work shall be considered to be incidental to earthwork items.

When the Engineer shall direct the Contractor to clear lines of sight or waterways, outside the station limits; or to clear areas between the outside clearing line shown on

the plans and the right of way line, the work shall be paid for at the contract unit price per acre for "Clearing" when such pay item is included in the proposal; otherwise it shall be paid for as "Extra Work".

ITEM FOR PAYMENT

Item 201-5, Clearing —per acre

SECTION 202

REMOVING TREES

DESCRIPTION

202-1. General. "Removing Trees" where called for on the plans, or as encountered, or removing stumps, when required, which are shown on the plans as trees, occurring outside of areas designated for clearing, shall include cutting such trees, removing their stumps and roots from the ground and disposing of the material.

CONSTRUCTION METHODS

202-2. General. The trees shall be removed and disposed of as specified under "Clearing", Article 201-2.

METHOD OF MEASUREMENT

202-3. Trees measured for payment shall be determined by the average diameter of the tree trunk measured at a point three (3) feet above the ground line at the base of the tree. Trees which have multiple trunks coming from a single base trunk shall be measured for payment as a single tree. The classified size shall be determined by 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, measured at the specified elevation.

Individual trunks of multiple trunk trees having a diameter of less than nine (9) inches shall not be included in the summation of trunk areas to determine the size of a tree for payment.

BASIS OF PAYMENT

202-4. Removing trees less than nine (9) inches in diameter, or removing stumps which are not shown on the plans

as trees, or removing trees when no bid item is included in the contract, shall be considered as incidental to work of earth excavation or other related items.

"Removing Trees" shall be paid for at the contract unit price each, which payment shall include full compensation for all equipment, materials, tools, labor and all incidentals necessary to complete the work.

Removing stumps shown on the plans as trees, or removing trees when the removal of the stump is not required will be paid for at one-half ($\frac{1}{2}$) the contract unit price each for "Removing Trees" as bid under the item for the respective size.

SUMMARY OF ITEMS FOR PAYMENT

Item 202-5, Removing Trees (9" - 24")	—each
Item 202-6, Removing Trees (over 24")	—each

SECTION 203

EXCAVATION

DESCRIPTION

203-1. General. "Excavation" shall consist of removing, and satisfactorily disposing of all material except that defined as "Structural Excavation" and "Loam Excavation" encountered within the limits of the work, or required to construct the project in accordance with these specifications; and in conformity with the dimensions and typical sections shown on the plans; and in accordance with the required lines and grades.

Suitable material taken from excavation shall be used in the formation of embankment, subgrade, and for backfilling as indicated on the plans, 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.

203-2. Classification. All material excavated, under this section, shall be classified as follows:

(a) "Earth Excavation" meaning the excavation and disposal of all material encountered in grading the project, within the limits of the right of way and in driveways, which is not otherwise classified and paid for in this contract. Earth excavation shall include the removal and disposal of

boulders containing less than one (1) cubic yard 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 two (2) feet below the original ground surface.

(b) "Rock Excavation" meaning the removal and disposal of all hard ledge rock found in place, which requires blasting, and all boulders containing a volume of one (1) cubic yard or more.

(c) "Unclassified Excavation" meaning the removal and disposal of both "Earth Excavation" and "Rock Excavation" combined as above classified and not separately measured.

(d) "Muck Excavation" meaning the removal and disposal of material encountered in fill areas unsuitable for supporting embankments, occurring below a depth of two (2) feet under the original ground surface.

CONSTRUCTION METHODS

203-3. General. The excavation for the highway, inter-sections, approaches and entrances shall be made to the required alignment, grade and cross-section. Material, conforming to the requirements of section 207—"Embankment", removed by excavating shall be used as far as practicable in the formation of embankments, berms, subgrade, shoulders (unless of gravel), slopes, backfilling, approaches and in such other work as shown on the plans. Any loam within the construction area, considered to be suitable by the Engineer, shall be excavated and stored at an approved location for use under Section 908.

The excavation shall be carried on so that sufficient material will be left above the designated grade to allow for compaction to the required grade. Should the Contractor, through negligence or other fault, excavate below the designated grade, he shall, at his own expense, fill such excavation with material which is of at least equal quality to the material removed and in conformity with the requirements for embankment material and compaction.

Material unsuitable for the formation of embankments shall be used to flatten slopes or disposed of in approved waste areas.

No payment will be made for any excavated material which is used for purposes other than those designated. All spoil

or waste areas shall be graded to present a neat appearance before the project is accepted.

All fences, located within the limits of the work, which can be salvaged in a usable condition, must be removed and carefully stored by the Contractor on property outside of but adjacent to the highway right-of-way unless otherwise directed. Such work shall be considered to be incidental to items in this section.

If, during the prosecution of the work, existing drainage, sewers, conduits, or utilities are interrupted, or any structures or parts thereof disturbed, the Contractor shall immediately notify the Engineer and the utility owner. The owner shall be responsible for any necessary removal or adjustment required as specified under Articles 105-6 and 106-16. The Contractor shall take all necessary precaution to protect and preserve any temporary services. The Contractor shall, at his own expense, satisfactorily repair all damage to such facilities or structures which may result from his negligence during the period of the contract.

203-4. Roadway Excavation (Earth and Rock). Roadway excavation shall be made as indicated on the plans; to the lines, grades and elevations shown. The degree of finish for the grading of slopes in excavation areas shall be that obtainable from machine operations.

Excavated material shall be placed in accordance with the requirements for "Embankment", Section 207.

No excavating shall be started until the Engineer has taken elevations and measurements of the existing ground surface and has staked out the proposed work. During the process of excavating, the subgrade shall be maintained in such condition that the excavation will be well drained at all times. When necessary, temporary drains and drainage ditches shall be constructed to intercept or divert surface water which may adversely affect the condition of the excavation or the prosecution of the work.

Excavation adjacent to the roots of trees or shrubs which are to be saved, shall be removed by hand. Roots removed shall be cleanly cut and asphaltic paint applied to the cut areas left.

When "Rock Excavation" is encountered, the Contractor shall remove sufficient earth overburden to provide ample opportunity for the Engineer to promptly take the necessary elevations and measurements for determining the existing surface of the rock, before it shall be disturbed.

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.

203-5. Muck Excavation. When muck, as defined under Article 203-2 is encountered it shall be excavated to the lines and grades as shown on the plans. Before and after removal of muck, the Contractor shall give the Engineer adequate opportunity to take all necessary elevations and measurements for determining the volume removed. Excavated muck shall be deposited adjacent to the area from which it is excavated and outside the lines of improvement. After the embankment is completed, the deposited muck shall be used to flatten adjacent slopes or graded over adjacent areas. If this is not feasible, surplus muck shall be loaded and hauled to waste areas.

203-6. Haul. No payment will be made for haul of any material used under this section, "Excavation". All haul 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 price 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 two thousand (2000) feet 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.

METHOD OF MEASUREMENT

203-7. General. For "Earth Excavation", "Rock Excavation", "Unclassified Excavation" and "Muck Excavation", the amount to be measured for payment shall be the number of cubic yards of material acceptably excavated, handled and disposed of, measured in its original position by the method of cross-sectional elevations and the volume computed by the method of average end areas.

Unless otherwise authorized, measurement allowance for "Earth Excavation" shall not exceed six (6) inches beyond the lines indicating the back slope as shown on the plans.

Unavoidable earth slides shall be measured as "Earth Excavation".

Measurement allowance for "Rock Excavation" shall be made only to the lines and grades indicating the subgrade and/or back slope as shown on the typical cross sections and plans.

No material will be included for measurement under this section which is required to be excavated under another item.

"Overbreakage" of rock excavation will be classified and measured as "Rock Excavation", except that no measurement will be allowed for "Overbreakage" occurring beyond a distance of twelve (12) inches horizontally from the neat line shown on the plans, at the ditch elevation, or as authorized, and extending at a slope not flatter than one-half ($\frac{1}{2}$) to one (1).

Rock encountered in "Rock Excavation" or in "Unclassified Excavation" not placed in embankments, when there exists on the project suitable locations for "Rock Embankments", will be deducted from the measured-for-payment quantity.

When surplus "Muck Excavation" exists which cannot be used to flatten adjacent slopes or graded over adjacent areas, the amount requiring loading, hauling and disposing of in waste areas or other approved locations shall again be measured for payment.

BASIS OF PAYMENT

203-8. General. The work done under "Earth Excavation", "Rock Excavation", "Unclassified Excavation", and "Muck Excavation" will be paid for at the respective contract unit price per cubic yard, which payment shall be full compensation for excavating, hauling and disposing of all materials encountered under these classifications, in an acceptable manner; and shall include the satisfactory forming and compacting of embankment and backfill, as provided under Section 206, preparing subgrade and grading slopes, as provided under Section 207, disposing of excess and unsuitable materials; and for furnishing all labor, equipment, tools, explosives, and all incidentals necessary to complete the work, except:

(a) That 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 four (4) times the contract unit price for "Earth Excavation".

(b) That 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 for "Earth Excavation".

(c) That when no item for "Clearing" and/or "Removing Trees" is included in the contract, such work shall be considered to be incidental to other contract items.

SUMMARY OF ITEMS FOR PAYMENT

Item 203- 9	Earth Excavation	—per cubic yard
Item 203-10	Rock Excavation	—per cubic yard
Item 203-11	Unclassified Excavation	—per cubic yard
Item 203-12	Muck Excavation	—per cubic yard

SECTION 204

STRUCTURAL EXCAVATION

DESCRIPTION

204-1. General. "Structural Excavation" shall consist of excavating, removing and satisfactorily disposing of all material encountered within the limits of the work, as required for the construction of bridges, retaining walls, drainage structures, drainage systems, and all other structures; for inlet and outlet ditches to culverts; and for berm ditches at the top of slopes, all in accordance with the specifications and in conformity with the required lines and grades.

204-2. Classification. Material excavated under this section shall be defined as earth or rock. Rock shall mean hard ledge rock requiring blasting, boulders, concrete masonry, or stone masonry (having an individual rock or a group of rocks firmly mortared together) of one (1) cubic yard or more in volume.

Such material shall be classified as follows:

(a) "Structural Earth and Rock Excavation for Drainage", meaning the excavation and disposal of all material encountered in excavating for drainage systems, for inlet and outlet ditches, for berm ditches and for drainage structures unless otherwise specified or indicated on the plans.

(b) "Structural Earth and Rock Excavation for Abutments and Retaining Walls or Piers", meaning the excavation and disposal of all material, including existing wood or masonry piers or abutments encountered in preparing foundation pits for abutments and 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 Rock Excavation for Channels", meaning the excavation and disposal of all material encountered in excavating for channel diversion, channel widening or straightening, unless otherwise specified or indicated on the plans.

CONSTRUCTION METHODS

204-3. General. All suitable material removed from the excavation shall be used for back-filling or for the formation of embankments. Unsuitable or surplus material shall be disposed of in an approved waste area.

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

Any material removed or excavated before these measurements have been taken shall not be included for payment.

After each excavation is completed, the Contractor shall notify the Engineer and no 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.

Structural excavation shall be made to the lines, grades and elevations required to permit proper construction or placing of all structure foundations, drainage structures or other installations; and to permit proper back-filling and tamping around them.

When the foundation is to be placed on solid rock, the rock shall be cleaned of all loose material and excavated to a firm surface either level, stepped or serrated. In trenches for pipe culverts, sectional plate pipes and sectional plate pipe arches, when solid or disintegrated rock, or boulders are encountered, such areas shall be excavated to a minimum depth of eight (8) inches below the grade established for the bottom of the pipe, and the additional depth excavated shall be backfilled with granular material having a minimum requirement equal to that of "Granular Borrow", article 205-3,

except that the maximum size particles shall not exceed three (3) inches, and shall be thoroughly compacted.

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; and final removal of the material to grade shall not be made until just before the concrete or masonry is to be placed.

In case the foundation material is soft or otherwise unsatisfactory, the Engineer shall order the Contractor either to reduce the amount of ground water seepage or to excavate to a greater depth; and to either backfill with approved granular material, thoroughly compacted, or to establish a lower elevation for the bottom of the structure.

All pits and trenches in which piles are to be driven shall be completed before pile driving is commenced, and following the driving of piles, all loose soil, chips and bark shall be removed. All other material necessary to attain the established grade shall be removed from the excavation before any concrete or other substructure material is placed.

All foundations, where practicable, shall be constructed in open excavation and, where necessary, the excavation shall be shored, braced or protected by cofferdams.

Where channel excavation is called for on the plans, the channel, beyond the allowable limits for other classes of structural excavation, shall be excavated, widened or straightened to the required lines and grades. The material excavated shall be disposed of as herein specified unless otherwise called for on the plans.

204-4. Haul. No payment will be made for haul of any material used under this section, "Structural Excavation". All haul 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 price 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 two thousand (2000) feet 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.

METHOD OF MEASUREMENT

204-5. General. For "Structural Excavation", the amount of excavation to be measured for payment shall be the num-

ber of cubic yards of material acceptably excavated, handled and disposed of, measured in its original position by the method of cross-sectional elevations; and the volume computed by the method of average end areas. The cross-sectional area measured shall not include water or other liquids, but shall include mud, muck or other similar semi-solids.

No material will be included for measurement under "Structural Excavation" which is required to be excavated under another item.

204-6. Structural Earth and Rock Excavation—Drainage.

(a) *Inlet, Outlet and Berm Ditches.* For "Structural Excavation" removed from inlet ditches, outlet ditches, berm ditches, the quantity being measured for payment shall be the number of cubic yards of material actually and satisfactorily excavated to the required lines and grades.

(b) *Underdrain.* For "Structural Excavation" removed from trenches for installing various types of underdrain, the quantity to be measured for payment shall be the number of cubic yards of material actually excavated to the required neat lines of the trench. Where rock is encountered, the allowance for material actually excavated shall not exceed a volume bounded by vertical planes six (6) inches outside and a horizontal plane six (6) inches below the required neat lines of the underdrain.

(c) *Culverts and Sewers.* For "Structural Excavation" removed from trenches for installing pipe culverts, storm or sanitary sewers, the quantity to be measured for payment shall be the number of cubic yards of material actually excavated, bounded by vertical planes at least twelve (12) inches, but not exceeding fifteen (15) inches each side of the outside of the barrel of the pipe. Subject to the above, where rock is encountered, the volume measured shall be the actual amount removed to a horizontal plane not exceeding a depth of ten (10) inches below the bottom of the pipe.

(d) *Structures.* For "Structural Excavation" removed from foundation pits, or trenches for constructing box culverts, drop inlets, catch basins, manholes, retaining walls, etc., the quantity to be measured for payment shall be the number of cubic yards of material actually excavated, provided, however, that the maximum allowable width shall be that width bounded by vertical planes eighteen (18) inches outside the base dimensions shown upon the original or revised plans.

(e) *Sectional Plate Pipes and Pipe Arches.* For "Structural Excavation" removed from pits or trenches for installing sectional plate pipes and pipe arches, the quantity to be measured for payment shall be the number of cubic yards of material actually excavated, bounded by vertical planes at least twenty-four (24) inches, but not exceeding thirty (30) inches each side of the outside of the pipe. Subject to the above, where rock is encountered, the volume measured shall be the actual amount removed to a horizontal plane not exceeding a depth of ten (10) inches below the bottom of the pipe.

204-7. Structural Earth and Rock Excavation—Abutments and Retaining Walls or Piers. For "Structural Excavation" removed from foundation pits, or trenches for constructing abutments, retaining walls, and for footings for sectional plate arches, and piers, the quantity to be measured for payment shall be the number of cubic yards of material actually excavated, provided, however, that the maximum allowable width shall be that width bounded by vertical planes eighteen (18) inches outside the base dimensions shown upon the plans. For structures constructed on grillages, the maximum allowable width shall be that width bounded by vertical planes six (6) inches outside the grillage.

204-8. Structural Earth and Rock Excavation—Channels. For "Structural Excavation" removed from channels, the quantity to be measured for payment shall be the number of cubic yards of material actually and satisfactorily excavated to the required lines and grades.

BASIS OF PAYMENT

204-9. General. The work done under all items classified as "Structural Excavation" will be paid for at the contract unit price per cubic yard, which payment shall be full compensation for excavating and disposing of all materials encountered under these classifications in an acceptable manner; it shall include the satisfactory forming and compacting of embankment, backfill, grading slopes, disposing of excess and unsuitable materials; and for furnishing all labor, equipment, tools, explosives and all incidentals necessary to complete the work, except:

(a) That 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 four (4) times the contract unit

price for "Structural Earth Excavation" of the corresponding classification.

(b) That when it is necessary to carry the excavation classified under "Structural Earth Excavation, Abutments, and Retaining Walls" or "Structural Earth Excavation, Piers", below the elevation shown on the plans, payment for such excavation will be made at one and one-half (1½) times the contract unit price for the item classification applying where the extra depth is required.

(c) That if excavated material cannot be placed in its final position in one operation, and the material is stockpiled for future use, when it is rehandled and placed as backfill or in embankment, it shall be measured and paid for as "Common Borrow" or as "Special Backfill" in accordance with the classification under which it is placed. The work shall 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 backfill or fill can be placed in its final position.

Subject to the above, any acceptable material wasted by reason of methods and operations adopted by the Contractor in the execution of the work, shall be replaced by him at his expense.

When no bid items are included in the contract for any or all of the following: "Clearing", Section 201, "Removing Trees", Section 202, "Maintenance of Traffic", Section 802, "Cofferdams", Section 803, "Removal of Existing Superstructure", Section 801, work done under these items shall not be paid for direct, but shall be considered to be incidental to other contract items.

SUMMARY OF ITEMS FOR PAYMENT

Item 204-10	Structural Earth Excavation— Drainage,	—per cubic yard
Item 204-11	Structural Rock Excavation— Drainage,	—per cubic yard
Item 204-12	Structural Earth Excavation, Abutments and Retaining Walls,	—per cubic yard
Item 204-13	Structural Rock Excavation, Abutments and Retaining Walls,	—per cubic yard
Item 204-14	Structural Earth Excavation— Piers,	—per cubic yard
Item 204-15	Structural Rock Excavation— Piers,	—per cubic yard

- Item 204-16 Structural Earth Excavation—
Channel, —per cubic yard
- Item 204-17 Structural Rock Excavation—
Channel, —per cubic yard

SECTION 205

BORROW

DESCRIPTION

205-1. General. Borrow shall consist of furnishing, excavating, hauling and placing approved material obtained from beyond the required cut slopes for completing embankments and for other purposes necessary to complete the grading, when sufficient quantities of suitable materials are not available from roadway or structural excavation.

MATERIAL

205-2. Common Borrow shall be material meeting the requirements for "Embankment Material" (article 207-2).

205-3. Granular Borrow shall be material meeting the requirements for "Granular Material Embankments" (article 207-2, Par. 2).

205-4. Gravel Borrow shall be uniformly graded coarse granular material having no rocks with maximum dimensions over nine (9) inches and shall contain not more than seventy (70) per cent passing a $\frac{1}{4}$ inch mesh sieve and not more than ten (10) per cent passing a number 200 mesh sieve.

CONSTRUCTION METHODS

205-5. General. It shall be the Contractor's responsibility to locate and obtain the supply of borrow; and to insure that no material is removed from the borrow pit except for use under this contract.

The Contractor shall notify the Engineer sufficiently in advance of beginning the excavation to allow the taking of measurements and the testing of the material, and no borrow shall be removed until the Engineer has taken elevations and measurements of the existing ground surface.

Borrow pits shall be excavated to regular lines to permit accurate final measurements, and all slopes shall be dressed uniformly and left in a neat and presentable condition.

Where practicable the bottom of all pits shall be graded to drain the pit.

METHOD OF MEASUREMENT

205-6. General. For "Borrow", the amount to be measured for payment, except as provided below, shall be the number of cubic yards of material acceptably excavated, handled and placed, measured in its original position by the method of cross-sectional elevations and the volume computed by the method of average end areas.

"Borrow" placed without authorization beyond the limits specified in Article 207-4 "Embankment Construction" shall be deducted from the amount of "Borrow" to be measured for payment.

Materials used in replacing wasted suitable material removed beyond the limits specified under the various classes of excavation shall not be measured for payment.

When small quantities of "Borrow", not exceeding five hundred (500) cubic yards for a single project, are involved, and it is impracticable to measure the amount by the above method, the quantity may be measured in vehicles at the point of delivery, or measured in place. When measured in vehicles, the amount to be measured for payment shall be ninety (90) percent of the quantity as determined from amounts shown on "Delivery Slips", specified in Article 401-9; when measured in place, the amount to be measured for payment shall be one hundred fifteen (115) percent of the quantity.

BASIS OF PAYMENT

205-7. General. All work done under this section will be paid for at the contract unit price per cubic yard for "Borrow", which payment shall be full compensation for obtaining, excavating, hauling and satisfactorily placing all material required under this classification; it shall include full compensation for furnishing all labor, equipment, material, tools and all incidentals necessary to complete the work, except that "Overhaul", as specified in section 308, and "Stripping Pits", Section 309, shall be paid on material under the classification of "Granular Borrow" and "Gravel Borrow".

SUMMARY OF ITEMS FOR PAYMENT

Item 205-8	Common Borrow	—per cubic yard
Item 205-9	Granular Borrow	—per cubic yard
Item 205-10	Gravel Borrow	—per cubic yard

SECTION 206

BACKFILL AND SPECIAL BACKFILL

DESCRIPTION

206-1. General. Backfill shall mean the refilling with suitable material, of all spaces excavated and not occupied by culverts, drainage structures, drainage systems, abutments, retaining walls, piers and other permanent structures up to the elevation of the surrounding ground.

MATERIAL

206-2. General. All material for backfill, not classified as "Special Backfill", shall be of suitable quality for the location where it is to be used. Where selected excavation or selected common borrow is not suitable, granular borrow, gravel borrow or gravel base shall be used.

Material for "Special Backfill" shall consist of a mixture of rocks and coarse gravel suitable for the location where it is to be used.

CONSTRUCTION METHODS

206-3. General. All spaces excavated and not occupied by culverts, drainage structures, drainage systems, abutments, retaining walls, piers and other permanent structures shall be filled up to the elevation of the surrounding ground with suitable materials obtained from excavation or borrow sources.

Material placed around culverts, drainage structures, drainage systems and piers, or behind abutments or retaining walls where it is impossible to satisfactorily compact the material by ordinary methods, due to the inability to operate heavy equipment in the area, shall be compacted by tamping with power tampers, Article 206-5. The backfill material shall be placed in layers not exceeding nine (9) inches in depth before compaction. Where backfill is being placed around a pipe or structure, the layers shall be placed on all sides to approximately the same elevation at the same time and each layer shall be compacted. Water shall be added when necessary to obtain compaction.

No backfill shall be placed against any gravity sections of masonry abutments, wing walls, box culvert or other structures requiring forms, until the masonry has been in place at least seven (7) days. For reinforced sections, no backfill shall be placed until the masonry has been in place at least

fourteen (14) days. Backfilling around pipe culverts, catch basins, and manholes, the joints of which are made with cement mortar, shall not be done until the mortar has been in place at least twelve (12) hours.

The backfill around abutments and wing walls of all bridge structures shall be placed in such a manner as to prevent the possibility of any forward movement.

In general, backfill as a contract item will be called for only when it is to be used in particular areas, such as in excavated spaces in front of abutments and wing walls and around piers, when these areas are subject to scour. Such backfill shall be designated as "Special Backfill". Jetting of the fill behind abutments and wing walls shall not be permitted.

206-4. Special Backfill. "Special Backfill" shall be used to fill excavations in areas subject to scour, such as locations in front of abutments, wing walls, around piers, etc.

Such material shall be placed up to the surface of the surrounding ground. All backfill shall be thoroughly compacted and its top surface shall be neatly graded.

206-5. Power Tampers. "Power Tampers" shall consist of approved type of power tamping equipment, which shall exert a minimum blow of two hundred and fifty (250) foot pounds per square foot of area of the tamping face.

METHOD OF MEASUREMENT

206-6. Special Backfill. The quantity of "Special Backfill" to be measured for payment shall be the number of cubic yards acceptably placed, measured in place; but it shall not include excavated material placed as backfill in one operation, or of material measured and paid for under another classification, or for material used in replacing material removed beyond the limits specified under the various classes of excavation.

BASIS OF PAYMENT

206-7. General. There will be no separate measurement or payment for backfill (except "Special Backfill"). All costs incidental to placing backfill in layers, compacting, shaping and all other necessary operations shall be considered incidental to the item representing the source of the material used, such as the items of excavation, borrow or base.

206-8. **Special Backfill.** The work done under this item will be paid for at the contract unit price per cubic yard for "Special Backfill", which payment shall be full compensation for all material acceptably placed under this item and shall include full compensation for furnishing all material, labor, equipment, tools and all incidentals including power tampers necessary to complete the work.

ITEM FOR PAYMENT

Item 206-9 Special Backfill —per cubic yard

SECTION 207

EMBANKMENT

DESCRIPTION

207-1. **General.** Work under this section shall consist of placing in embankment, suitable material obtained from excavation or borrow sources, in accordance with the specifications and in conformity with the required lines, grades and cross-sections.

MATERIALS

207-2. **Embankment Materials.** The requirements for embankment material are specified in the following paragraphs:

1. *Earth Embankments:* Materials for earth embankments shall conform to the following requirements:

(a) Complete freedom from frozen material and perishable rubbish.

(b) Organic content not more than three (3) percent as determined by an ignition test of a representative sample. The organic content shall be computed as:

$$\frac{\text{weight loss by ignition}}{\text{initial oven-dry weight}} \times 100\%$$

(c) No particles or fragments with maximum dimension in excess of the compacted thickness of the layer being placed.

(d) Maximum dry density of not less than 100 pounds per cubic foot, as determined by the current Method of Test for the Compaction and Density of Soil, A.A.S.H.O., Designation: T-99.

2. *Granular Material Embankments:* Granular materials containing not more than twenty (20) percent passing

the number 200 mesh sieve and which may contain rocks having maximum dimensions not exceeding the compacted thickness of the layer, shall be used in forming embankments under this classification. The material shall also meet the requirements of (a) and (b) under "1" above.

3. *Rock Embankments:* Rock fragments, having maximum dimensions exceeding six (6) inches, together with sufficient finer material where required to fill the voids, shall be used in forming embankments under this classification. The material shall also meet the requirements of (a) and (b) under "1" above.

Materials failing to meet the requirements under "1", "2" or "3" above shall be used only when analysis of their mechanical properties has shown that they will function properly in the proposed embankments, or when the embankments have been designed in accordance with the properties of the compacted material.

CONSTRUCTION METHODS

207-3. **Preparation of Embankment Area.** When the depth of an embankment, measured vertically below subgrade, does not exceed two (2) feet, the area on which the embankment will be placed shall be grubbed. When an embankment is more than two (2) feet in depth, all vegetation in the embankment area shall be cut as specified under "Clearing", Article 201-2. For embankment areas which have been "Cleared" only, the embankment material shall first be placed in a layer to a depth great enough to cover all stumps, and then compacted as required under "Formation of Embankment".

When an embankment is to be made on a steep hillside having a slope of 2 to 1 or steeper, or upon a steep existing embankment, the slope or the original ground upon which the embankment is to be placed shall be cut into steps before the filling is commenced or as the filling progresses. When such steps are required they shall be indicated on the cross-sections or called for under the Special Provisions. The removal of material in making the steps shall be paid for under the class of material involved.

207-4. **Embankment Construction — General.** Embankments shall be formed of suitable material obtained from excavation or borrow sources, and placed in successive horizontal layers distributed uniformly over the full width of the cross-section, except that when traffic is to be maintained

over the embankment and it is impractical to construct layers over the full width of the section, partial width layers may be authorized.

When partial width layers are authorized, in order to eliminate uncompacted material from being incorporated in the embankment, the adjacent slope of the previously placed embankment shall be stepped back to a point where full compaction has been obtained. This work shall be incidental to "Embankment Construction".

Embankments shall be made of sufficient height and width so that after compaction they will conform to the typical sections shown on the plans with no variation therefrom at any point on the slopes more than five tenth (0.5) foot above or below the established grade measured at right angles to the slope. The degree of finish for the grading of the slopes shall be that obtainable from machine operations; the smoothness of surface finish ordinarily associated with template or string line and hand operations will not be required. Slopes may be flattened at locations authorized, with materials approved by the Engineer. In general, slopes shall be flattened with surplus material from excavation or with material from excavation unsuitable for embankments.

In the construction of embankments, starting layers shall be placed in the deepest portion of the fill, and as placement progresses, layers shall be constructed approximately horizontal, but not steeper than the finished surface grade line.

All embankments shall be crowned at all stages of construction so as to permit ready runoff of rain water. No depressions or ruts will be permitted on the upper surface of the embankment.

Frozen material shall not be placed in the embankment. The embankment shall not be placed upon frozen material, except that the construction of embankments may be allowed when the depth of the fill plus the depth of frozen ground beneath does not exceed five (5) feet.

The construction of embankments may continue during cold weather, if all frozen material in the top of the embankment is moved to the outside of the slopes before placing additional material. All material added must be free from frost.

When filling in layers of specified thickness is not feasible, such as filling in water, the embankment may be constructed in one layer to the minimum elevation at which the compacting equipment can be operated. The embankment, when placed in water, shall be constructed, to such minimum ele-

vation, with granular material (or rock) suitable for use under the conditions encountered, and as indicated on the plans. The fill material not placed in water in this manner shall be compacted by rolling or tamping or other methods capable of producing a thoroughly consolidated embankment. Above this minimum elevation the embankment shall be constructed in layers of the specified thickness.

Where filling over slopes or embankments when the fill is too narrow to permit the operation of equipment for compacting, and where the material in the existing slope or embankment is such that steps cannot be cut in it, the embankment shall be constructed as specified in the above paragraph.

In areas where embankments are being constructed behind abutments or retaining walls and it is impossible to satisfactorily consolidate or compact the embankment with heavy equipment because of the inability to operate such heavy equipment in close proximity to the structure, the embankment material shall be compacted by tamping with power tampers as specified under Article 206-5, to insure that each layer shall reach the proper compaction.

Where guard rail is required, rock shall not be allowed in the embankment, under the location of the guard rail, to a depth of four (4) feet below the finished grade of the shoulder.

207-5. Embankment Construction—Earth.

(a) *Layer Method.* This method will be required unless otherwise specified. The material shall be deposited and spread in layers not more than twelve (12) inches in depth, loose measure upon compact material. The conveying equipment shall be operated over the layer being placed. In the case of clay or loam soils each layer shall be compacted by use of a sheepsfoot or tamping-type roller having a minimum weight on each tamper, under working conditions, of 200 pounds per square inch of cross-sectional bearing area; and in the case of sand or gravel soils, by heavy tread-type equipment, 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.

(b) *Controlled Density Method.* The material for the embankment shall be deposited and spread in layers not more than twelve (12) inches in depth, loose measure, upon

compact material. Each layer shall be compacted, by the use of suitable compaction equipment, to the following requirements:

<i>Maximum Density in Pounds Per Cubic Foot</i>	<i>Per Cent of Minimum Compaction</i>
100 to 115	95
115 to 117.5	94
117.5 to 120	93
120 to 122.5	92
122.5 to 125	91
125 or higher	90

The maximum density shall be determined by the current Method of Test for the Compaction and Density of Soil, A.A.S.H.O., Designation T-99.

The Engineer will make known to the Contractor, upon request, both the maximum density and optimum moisture content of the various materials to be used in embankment construction. It shall be the responsibility of the Contractor to notify the Engineer, not less than forty-eight (48) hours in advance, as to which materials he proposes to use in construction.

207-6. Embankment Construction — Granular Material. The material shall be placed in layers not exceeding twelve (12) inches in depth, loose measure, upon compact material. The material shall be compacted by heavy treadtype equipment; by pneumatic-tired or wobbly wheel rollers drawn by heavy tractors; and if necessary by the addition of water. A combination of the above or other approved methods capable of producing equivalent results may be used. The operations of compacting shall be continued until each layer is compacted to its full depth and width.

207-7. Embankment Construction — Rock. The material for rock embankment shall be placed across the entire width of the embankment in compacted layers not exceeding three (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 over the end 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.

This method shall be used only in fills in excess of four (4)

feet in depth. In no case shall the rock embankment be placed within one (1) foot of the subgrade.

Where structures are located under rock embankment, they shall be covered with not less than one (1) foot of earth excavation or borrow before the rock embankment is placed over the structures.

207-8. Precompacted Embankment. Where called for on the plans, for locations where culverts are to be placed in embankments, "Precompacted Embankment" will be required.

This embankment shall be made of approved selected material for the full width of the section and it shall be of a length of twelve (12) feet each side of the center line of the culvert. The embankment shall be constructed to a plane parallel with and one and one-half (1½) times the pipe diameter above the flow line grade of the pipe. This embankment shall be made in conformity with the requirements of Article 207-5 (a) "Embankment Construction — Earth, Layer Method".

After the "Precompacted Embankment" is satisfactorily completed, the trench for the pipe shall be excavated and paid for as required in Section 204, "Structural Excavation".

MEASUREMENT AND PAYMENT

207-9. There will be no separate measurement or payment for constructing embankment. All costs incidental to placing embankment in layers, compacting, mixing, sloping, shaping and all other necessary operations for the formation of the embankment will be considered incidental to the work of excavation, borrow or other related items.

SECTION 208

SUBGRADE

DESCRIPTION

208-1. General. That portion of the roadway upon which the base and shoulders are constructed is known as the subgrade.

208-2. Preparation and Protection of the Subgrade. All soft and unstable material, and portions of the subgrade which cannot be compacted readily, shall be removed and disposed of as directed. These areas shall be brought to grade and cross-section with satisfactory material, and the entire subgrade shall be shaped and maintained to a toler-

ance of one (1) inch above or below the required grade and cross-section for a distance of at least two hundred (200) feet ahead of the base course operations.

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. The required compaction shall be the same as required for embankments and when the subgrade occurs in cuts, the required compaction shall apply to the top six (6) inches below the subgrade.

Ditches and drains along the subgrade shall be maintained to effectively drain the subgrade at all times.

In handling materials, tools, equipment, etc., the Contractor shall protect the subgrade from damage. In no case shall vehicles be allowed to travel in a single track and form ruts. If ruts of two (2) inches or more in depth are formed, the subgrade shall be reshaped. No base material shall be deposited on a subgrade of different material until the subgrade has been checked and approved.

MEASUREMENT AND PAYMENT

208-3. There will be no separate measurement or payment for "Subgrade". All costs for preparing, shaping and maintaining subgrade will be considered incidental to excavation, borrow or other related items.

DIVISION III

BASE COURSES

Base courses shall consist of foundation courses constructed on the prepared subgrade or on other base courses for the purpose of carrying other base courses, surface courses or pavements.

SECTION 301

SAND BASE COURSE

DESCRIPTION

301-1. General. Sand Base Course shall consist of a foundation course of sand, constructed in conformity with the plans.

MATERIAL

301-2. General. The sand shall consist of hard, durable particles of granular material. It shall conform to the following gradation limits:

<i>Screen Size Square Openings</i>	<i>Per cent by Weight Passing</i>
4 inch	100
1 inch	95 - 100
¾ inch	70 - 100
# 100 mesh	0 - 20
# 200 mesh	0 - 5

Material may be used only if its organic content is less than two (2) percent, as determined by an ignition test of a representative sample. The organic content shall be computed as:

$$\frac{\text{Weight loss by ignition}}{\text{Initial oven-dry weight}} \times 100\%$$

CONSTRUCTION METHODS

301-3. General. The material shall be spread and rolled in one or more courses (having a maximum depth of twelve (12) inches) with each layer compacted to the density specified in Article 207-5(b). Rolling shall be performed by an approved type pneumatic tired roller, a bulldozer, a power grader or other heavy construction equipment, or a combination of the above capable of accomplishing the desired compaction.

The Contractor shall maintain the moisture content of the material at the proper degree to attain the required com-

paction. No separate payment will be made for the addition of water.

When the sand base cannot be compacted by methods specified above, gravel conforming to the gradation requirements of material for "Crushed Gravel Base Course", shall be placed at the top of the sand base in an amount required to permit compaction of the course.

In order to utilize to the best advantage the materials available, the division line between "Sand Base Course" and "Gravel Base Course" may be adjusted.

"Sand Base Course" may be placed upon frozen subgrade only when such subgrade has been properly constructed and compacted of unfrozen material and/or on unfrozen embankment.

METHOD OF MEASUREMENT

301-4. Sand Base Course—In Place Measurement. The quantity of "Sand Base Course—In Place Measurement" to be measured for payment shall be the number of cubic yards of sand, including gravel used as a stabilizer, forming this course, completed, accepted and measured in place.

301-5. Sand Base Course—Pit Measurement. The quantity of "Sand Base Course—Pit Measurement" to be measured for payment shall be the number of cubic yards of material including gravel used as a stabilizer, forming this course, acceptably excavated, handled and placed, measured in its original position in the pit, by the method of cross-sectional elevations, and the volume computed by the method of average and areas.

Such quantity of material shall be reduced by one hundred fifteen (115) percent of the volume of any material removed from the same source and used in an in-place-measured item, when such material is included in the amount measured, as specified above. This shall apply to a quantity of in-place measured material not exceeding three hundred (300) cubic yards for the entire project.

BASIS OF PAYMENT

301-6. General. All work done under "Sand Base Course—In Place Measurement" or "Sand Base Course—Pit Measurement" will be paid for at their respective contract unit prices per cubic yard, which payment shall be full compensation for obtaining, excavating, hauling, and satisfactorily placing and compacting all material required under the respective classifications; for furnishing all labor, equip-

ment, tools and all incidentals necessary to complete the work except that:

(a) "Overhaul", as specified in Section 308, shall be paid for on items in this section.

(b) "Stripping Pits", as specified in Section 309, when included as a contract item, shall be paid for on items in this section.

SUMMARY OF ITEMS FOR PAYMENT

Item 301-7 Sand Base Course—	
In Place Measurement	—per cubic yard
Item 301-8 Sand Base Course—	
Pit Measurement	—per cubic yard

SECTION 302

GRAVEL BASE COURSE

DESCRIPTION

302-1. General. Gravel Base Course shall consist of a foundation course of gravel, constructed in conformity with the plans.

MATERIAL

302-2. General. The Gravel shall consist of hard, durable particles of granular material meeting the following requirements:

REQUIREMENTS FOR GRADATION OF GRAVEL

Screen Size Square Openings	Lower Course 9" Pit Run Gravel % by weight passing	Upper Course 6" Uncrushed Gravel % by weight passing	Upper Course Crushed Gravel % by weight passing
12 inch*	100		..
6 inch	..	100	
3 inch	..		100.
1 inch		50- 80	50- 80
¾ inch	25- 70	25- 60	30- 60
#200 mesh	0- 5	0- 5	0- 5

(a) For Uncrushed Gravel Base Course: Materials failing to meet the above gradation requirements, encountered in deposits from which material for the nine (9) inch upper gravel base course layer is produced, shall be removed by screening. Oversize materials may be crushed to the required (6" maximum) size if the Contractor elects.

(b) For Crushed Gravel Base Course: The materials shall be crushed and shall conform to the above gradation for "6" Upper Course Crushed Gravel".

*All base material below either the nine (9) inch upper gravel base course layer or below the crushed gravel base

course as shown on the plans, may be pit run material containing no stones whose size exceeds the compact depth of the lower base course layer or layers and in no case whose size exceeds twelve (12) inches measured along the greatest axis.

Material may be used only if its organic content is less than two (2) percent, as determined by an ignition test of a representative sample. The organic content shall be computed as:

$$\frac{\text{Weight loss by ignition}}{\text{Initial oven-dry weight}} \times 100\%$$

CONSTRUCTION METHODS

302-3. General. Gravel base shall be placed in layers with the compacted depth of any one layer not exceeding twelve (12) inches, unless otherwise directed in writing.

Each layer of material shall be placed uniformly over the full width of the base cross-section, except that the Engineer may authorize the Contractor to place less than full width layers when existing traffic or other conditions restrict operations over the full width of the improvement.

Segregation within the material will not be permitted.

Each layer shall be compacted to the density specified in Article 207-5(b), by rolling with a ten (10) ton, three (3) wheel or tandem, power roller, an approved pneumatic-tired roller, heavy construction equipment, or a combination thereof.

The Contractor shall maintain the moisture content of the material at the proper degree to attain the required compaction. No separate payment will be made for the addition of water.

Gravel Base Course may be placed upon frozen subgrade when such subgrade has been properly constructed and compacted of unfrozen material and/or on unfrozen embankment.

Rolling shall begin at the lower side and progress to the higher part of the layer, with lapped rolling parallel with the center line. The entire surface area of the base course shall be shaped and maintained to a tolerance of one-half ($\frac{1}{2}$) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one-half ($\frac{1}{2}$) inch under a ten (10) foot straight edge longitudinally, except:

(1) That when "Bituminous Concrete Base Course", "Bituminous Concrete Surface Course" or bituminous concrete or portland cement concrete sidewalk is to be placed on the

"Gravel Base Course", the tolerance for the top of the gravel base course shall be one quarter ($\frac{1}{4}$) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one quarter ($\frac{1}{4}$) inch under a ten (10) foot straight edge longitudinally.

(2) That when "Portland Cement Concrete Base Course" or "Portland Cement Concrete Pavement" is to be placed on the "Gravel Base Course", the tolerance for the top of the gravel base course shall be one-eighth ($\frac{1}{8}$) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one-eighth ($\frac{1}{8}$) inch under a ten (10) foot straight edge longitudinally.

Any section of gravel base course, which has not been paved prior to the date of suspension called for in the specifications, and which is to be opened to traffic, shall be graded and surface treated with bituminous material when directed. If any settlement occurs during the suspension period, the base shall be again brought to grade. Payment for this work shall be made at the contract unit price of the materials used.

METHOD OF MEASUREMENTS

302-4. Gravel Base Course—In Place Measurement. The quantity of crushed or uncrushed gravel base course—in place measurement, to be measured for payment, shall be the number of cubic yards of material forming this course, completed, accepted, and measured in place.

When material requires screening (and/or crushing), the amount of material to be measured for payment under "Screening" shall be the number of cubic yards of such material actually screened (and/or crushed) and incorporated in the base course. Materials excluded by screening shall not be measured for payment.

The quantity of "Gravel Base Course" used for driveways (and/or other locations difficult to accurately measure by average end area methods) in amounts not exceeding a total per project of three hundred (300) cubic yards may be measured for payment as eighty (80) percent of the number of cubic yards of material accepted and used, measured in vehicles at the point of delivery, as shown by "Delivery Slips", specified in Article 401-9.

302-5. Gravel Base Course—Pit Measurement. The quantity of crushed or uncrushed gravel base course—pit measurement, to be measured for payment, shall be the number of

cubic yards of material forming this course, acceptably excavated, handled and placed, measured in its original position in the pit, by the method of cross-sectional elevations, and the volume computed by the method of average end areas.

Such quantity of material shall be reduced by one hundred twenty (120) percent of the volume of any material removed from the same source and used in an in-place measured item, when such material is included in the amount measured, as specified above. This shall apply to a quantity of in-place measured material not exceeding three hundred (300) cubic yards for the entire project.

When material requires screening (and/or crushing), the amount of material to be measured for payment under "Screening" shall be the number of cubic yards of such material actually screened (and/or crushed) and incorporated in the base course. Materials excluded by screening shall not be measured for payment.

BASIS OF PAYMENT

302-6. General. All work done under the items in this section will be paid for at their respective contract unit prices per cubic yard, which payment shall be full compensation for obtaining, excavating, crushing, hauling and satisfactorily placing and compacting all material required under the respective classifications; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work except that:

(a) "Overhaul", as specified in Section 308, shall be paid for on items in this section.

(b) "Stripping Pits", as specified in Section 309, when included as a contract item, shall be paid for on items in this section.

(c) "Gravel Base Course" when required for foundations and bedding under drainage structures will be paid for at twice the contract unit price for the respective "Gravel Base Course" item.

(d) Screening of material required for the respective gravel base item will be paid for at the contract bid price for "Screening Gravel Base" in addition to the contract bid price for the gravel base item.

(e) Crushing required for the respective "Crushed Gravel Base Course" items shall be considered incidental to the cost of the item and payment shall include full compensation for processing the material.

SUMMARY OF ITEMS FOR PAYMENT

Item 302-7 Gravel Base Course—In Place Measurement	—per cubic yard
Item 302-8 Screening Gravel Base Course—In Place Measurement	—per cubic yard
Item 302-9 Crushed Gravel Base Course—In Place Measurement	—per cubic yard
Item 302-10 Gravel Base Course—Pit Measurement	—per cubic yard
Item 302-11 Screening Gravel Base Course—Pit Measurement	—per cubic yard
Item 302-12 Crushed Gravel Base Course—Pit Measurement	—per cubic yard

SECTION 303

BITUMINOUS MACADAM BASE COURSE

DESCRIPTION

303-1. General. "Bituminous Macadam Base Course" shall consist of a foundation course of crushed rock and bituminous material constructed in conformity with the plans.

MATERIAL

303-2. Bituminous Material. This material shall meet the requirements for "Asphalt Cement", Article 502-2, penetration grade of 100-120.

303-3. Coarse Aggregate. This material shall consist of angular fragments of broken rock, having uniform quality and having not over five (5) percent of pieces whose length is greater than three (3) times their maximum thickness nor over five (5) percent of soft or disintegrated rock. Washing of all stone (including keystone and chips) will be required. Any approved method of washing which will produce clean stone free from dirt or other matter occurring either free or as a coating on the rock may be used. Material shall be obtained from rock having a per cent of wear of not more than forty-five (45) at 500 revolutions, as determined by A.A.S.H.O. Method T-96 (Los Angeles Test).

The gradation of the stone shall meet the following requirements:

PER CENT PASSING SIEVES WITH SQUARE OPENINGS

Aggregate Size	3"	2½"	2"	1½"	1"	¾"	½"	⅜"	No. 4
No. 1 Stone	100	90-100	—	25-60	—	0- 10	0- 5	—	—
No. 2 Stone	—	100	95-100	—	—	0- 15	—	—	—
Keystone	—	—	—	—	100	90-100	20- 55	0-15	—
Chips	—	—	—	—	—	100	90-100	—	0-15

EQUIPMENT

303-4. **General.** The equipment required for this course shall be as specified in Article 403-4.

CONSTRUCTION METHODS

303-5. **General.** The base course shall be constructed of two equal depth layers or a single layer not exceeding four (4) inches in depth.

The first layer shall consist of No. 1 stone spread uniformly by means of self-propelled mechanical spreaders and shall be rolled sufficiently to key the stone together. All rolling shall be performed with three-axle tandem rollers. Any of the stone which has become coated or mixed with dirt or foreign substances shall be removed and replaced with clean stone; all segregation of stone shall be corrected.

Asphalt cement shall be applied as soon as a section of crushed stone has been placed, rolled and keyed. If the stone shall have become dusty it must be thoroughly cleaned before the asphalt is applied, and at the time of the application the stone shall be dry and the air temperature not below 50° F.

The asphalt shall be applied at a temperature of 275° F. to 325° F. at the rate of approximately one (1) gallon per square yard by a pressure distributor, as specified in Article 502-3, working at a pressure of not less than forty (40) pounds per square inch.

After the asphalt has been applied clean keystone or chips shall be uniformly spread over the surface in sufficient quantities to fill all voids. Rolling shall then be started and shall be continued until the stone is compacted. Rolling shall begin at the lower side and progress to the higher part of the layer, with lapped rolling parallel with the center line. Water shall be applied to the rolls, when necessary, to prevent the roller from picking up the treated stones.

The top layer shall consist of No. 1 and/or No. 2 stone, spread, rolled and keyed in the same manner as the bottom layer. Asphalt cement shall then be applied at the rate of approximately one (1) gallon per square yard under the same conditions as for the bottom layer.

Immediately after the asphalt has been applied to the top course, clean keystone or chips in sufficient quantities to fill all voids shall be evenly spread over the entire surface and broomed to provide uniform coverage. Rolling shall be started as soon as the chips are broomed and shall be continued until the stone is compacted.

As soon as the second course of the base has been completed to its full width, the entire base shall be rolled as specified above.

The surface area of each layer of this base course shall be shaped and maintained to a tolerance of one-quarter ($\frac{1}{4}$) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one-quarter ($\frac{1}{4}$) inch under a ten (10) foot straight edge longitudinally.

If any of the stone becomes rutted or loosened by traffic before constructing the next layer, the Contractor, at his own expense, shall bring the surface to its required cross-section.

Stockpiling of aggregate will be permitted if placed in such manner as to avoid segregation. Piling the aggregate in cones will not be allowed.

Weighing shall be in accordance with the requirements of Article 403-6, "Weighing Procedure".

METHOD OF MEASUREMENT

303-6. **Bituminous Macadam Base Course.** The quantity of "Bituminous Macadam Base Course" to be measured for payment shall be the number of tons (of 2,000 pounds) of all aggregate forming this course, completed in accordance with typical cross-sections of the plans, and accepted, as computed from "weigh slips" required in Article 403-6.

BASIS OF PAYMENT

303-7. **General.** This work will be paid for at the contract unit price per ton for "Bituminous Macadam Base Course", which payment shall be full compensation for obtaining, processing, washing, hauling, placing and rolling all aggregate required; for furnishing all labor, equipment, materials, tools and all incidentals necessary to complete the work, except that asphalt cement will be paid for under Article 502-6, "Asphalt Cement".

ITEM FOR PAYMENT

Item 303-8 Bituminous Macadam Base Course —per ton

SECTION 304

BITUMINOUS CONCRETE BASE COURSE

DESCRIPTION

304-1. **General.** "Bituminous Concrete Base Course" shall consist of a foundation course composed of a hot mixture of

"Coarse Aggregate", "Fine Aggregate", and "Bituminous Material" constructed in conformity with the plans.

MATERIALS

304-2. Bituminous Material. This material shall meet the requirements for "Asphalt Cement", Article 502-2, penetration grade of 85-100.

304-3. Aggregate.

(a) The coarse aggregate (retained on the No. 10 sieve) shall be composed of either crushed rock or gravel consisting of fragments of clean, durable stone having not over five (5) percent of pieces whose length is greater than three (3) times their maximum thickness, nor over five (5) percent of soft or disintegrated rock and shall be free from dirt, vegetable and other foreign matter. The aggregate shall be tested in accordance with the latest revision of the A.A.S.H.O. designation T-96, and shall show a loss not greater than forty-five (45) percent after 500 revolutions.

(b) The fine aggregate (passing the No. 10 sieve) shall be composed of sand or stone screenings or mixtures of these. The sand shall consist of hard, clean, durable grains free from clay, loam or other foreign matter. The stone screenings shall be free from weathered or soft particles and shall be produced from stone equal in quality to that specified for the coarse aggregate.

304-4. Composition of Mixtures. The several mineral constituents for the bituminous concrete base course shall be so sized and graded and combined in such proportions that the resulting composite blend will meet the grading requirements of the following table. To such composite blended aggregate (considered as 100 per cent) shall be added bitumen within the percentage limits set forth in the following table.

REQUIREMENTS FOR COMPOSITION OF MIXTURES	
Screen Size Square Openings	Percentage by Weight Passing
1 1/4 inch	100
3/4 inch	50- 85
No. 4 mesh	20- 40
No. 10 mesh	16- 30
No. 40 mesh	10- 22
Bitumen (Sol. in CS ₂) %	4- 6

304-5. Job Mix. Before any base is placed the Contractor shall submit to the Engineer in writing a balanced "Job Mix" stating the proposed percentage of each ingredient to be used in the mixture and a resultant screen test and bitumen percentage from such combination. The mix shall not be used until approved and no change shall be allowed unless authorized.

The bituminous concrete mixture shall not vary from the fixed mean of the "Job Mix" formula by more than the following allowable tolerances (and in all cases the grading requirements shall not exceed the limits specified in Article 304-4):

Total passing 3/4 inch sieve (by weight), plus or minus	7 percentage points
Total passing No. 4 sieve (by weight), plus or minus	5 percentage points
Total passing No. 10 sieve (by weight), plus or minus	5 percentage points
Total passing No. 40 sieve (by weight), plus or minus	4 percentage points
Bitumen, plus or minus	0.5 percentage points

EQUIPMENT AND CONSTRUCTION METHODS

304-6. General. Equipment and construction methods for "Bituminous Concrete Base Course" shall conform to those specified for "Bituminous Concrete Surface Course", Section 404, except that:

(a) Test cores will not be required,

(b) The depth of individual courses for various depths of base course shall conform with the requirements of the following table:

MAXIMUM DEPTH OF COURSES

Total Depth in inches	Number of Courses	Depth of Each Course in Inches
6	3	2
5	2	2 1/2
4	2	2
3	2	1 1/2

(c) The surface area of each layer of this base course shall be shaped and maintained to a tolerance of one quarter (1/4) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one quar-

ter ($\frac{1}{4}$) inch under a ten (10) foot straight edge longitudinally.

(d) The work of placing the base course may be permitted to continue when overtaken by local rain showers up to the amount of material which may be in transit at the time precipitation starts at the project, provided the Contractor assumes all responsibility, including replacement in kind, for any failure which may develop in such areas.

METHOD OF MEASUREMENT

304-7. The quantity of "Bituminous Concrete Base Course" to be measured for payment shall be the number of tons (of 2,000 pounds) of the mixture forming this course completed in accordance with the plans, and accepted, as computed from "weigh slips" specified in Article 403-6.

BASIS OF PAYMENT

304-8. This work will be paid for at the contract unit price per ton for "Bituminous Concrete Base Course" which payment shall be full compensation for obtaining, processing, hauling, placing and rolling the mixture; for furnishing all labor, equipment, aggregate, asphalt and other materials, tools, and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 304-9 Bituminous Concrete Base Course —per ton

SECTION 305

REMOVAL OF BITUMINOUS PATCHES

DESCRIPTION

305-1. General. This item shall consist of removing unstable bituminous mixture from the existing surface where repairs have been made.

CONSTRUCTION METHODS

305-2. General. When bituminous concrete surface course or levelling course is to be placed over areas where patching or repairs have been made with bituminous mixtures containing bituminous material in quantities sufficient to cause softening of the patch or of the hot bituminous mixture to be laid thereon, such patches shall be removed.

METHOD OF MEASUREMENT

305-3. The quantity of "Removal of Bituminous Patches" to be measured for payment shall be the number of square yards of surface area of the patch removed.

BASIS OF PAYMENT

305-4. This work will be paid for at the contract unit price per square yard for "Removal of Bituminous Patches", which payment shall be full compensation for excavating, disposing of all material, for furnishing all labor, equipment, tools and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 305-5 Removal of Bituminous Patches
—per square yard

SECTION 306

LEVELLING COURSE

DESCRIPTION

306-1. General. "Levelling Course" shall consist of a mixture of fine aggregate and asphalt used as a trueing up layer, placed on an existing foundation course and on which a surface course or pavement is to be placed.

In general "Levelling Course" shall be used for depths where it is not practicable to place "Bituminous Concrete Base Course" or where called for on the plans.

MATERIALS

306-2. Asphalt. This material shall meet the requirements for "Asphalt Cement", Article 502-2, penetration grade of 85-100.

306-3. Fine Aggregate. This material shall be composed of sand or stone screenings or mixtures of these. The sand shall consist of clean, hard durable grains free from clay, loam, or other foreign matter. The stone screenings shall be free from weathered or soft particles and shall be produced from stone equal in quality to that specified in Article 304-3.

306-4. Composition of Mixture. The fine aggregate for the levelling course shall be sized and graded to meet the grading requirements of the following table. To such fine aggregate (considered as 100 per cent) shall be added asphalt cement within the percentage limits set forth in this table.

REQUIREMENTS FOR COMPOSITION OF MIXTURE

<i>Screen Sizes Square Openings</i>	<i>Percentage by Weight Passing</i>
$\frac{3}{8}$ inch	100
No. 4 mesh	75-100
No. 10 mesh	60- 90
No. 40 mesh	35- 65
No. 80 mesh	10- 40
No. 200 mesh	0- 10
Bitumen (Sol. in CS ₂) %	6- 10

EQUIPMENT AND CONSTRUCTION METHODS

306-5. **General.** Equipment and construction methods for "Levelling Course" shall conform to those methods specified for "Bituminous Concrete Surface Course", Section 404, except that:

(a) test cores will not be required.

(b) the surface area of this course shall be shaped and maintained to a tolerance of one quarter ($\frac{1}{4}$) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one quarter ($\frac{1}{4}$) inch under a ten (10) foot straight edge longitudinally.

METHOD OF MEASUREMENT

306-6. The quantity of "Levelling Course" to be measured for payment shall be the number of tons (of 2,000 pounds) of the mixture forming this course, as computed from "weigh slips" required in Article 403-6, completed and accepted.

BASIS OF PAYMENT

306-7. This work will be paid for at the contract unit price per ton for "Levelling Course" which payment shall be full compensation for obtaining, processing, hauling and satisfactorily placing the mixture; for furnishing all labor, equipment, aggregate, asphalt and other materials, tools, and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 306-8 Levelling Course —per ton

SECTION 307

PORTLAND CEMENT CONCRETE BASE COURSE DESCRIPTION

307-1. **General.** This work shall consist of a one-course foundation of Portland cement concrete base, with or without reinforcement as shown on the plans, placed in accordance with the plans.

MATERIAL

307-2. **General.** "Portland Cement Concrete Base Course" shall conform with the requirements of the specifications for "Portland Cement Concrete", Section 701 and shall be Class "B" Concrete.

Steel Reinforcement shall meet the requirements of Section 705, "Reinforcing Steel".

EQUIPMENT AND CONSTRUCTION METHODS

307-3. **General.** The equipment and construction methods for "Portland Cement Concrete Base Course" shall conform with those specified for "Portland Cement Concrete Pavement", Section 405, except as follows:

The final surface texture for the base course shall be accomplished by a steel or fiber broom operated at right angles to the center line. Joints and edges will not be required to be finished with an edging tool.

METHOD OF MEASUREMENT

307-4. The quantity of "Portland Cement Concrete Base Course" to be measured for payment shall be the number of square yards of surface area of this course, completed and accepted.

The length shall be the actual surface length measured at the center line of the roadway. The width shall be the width of the pavement shown on the cross-sections of the plans. No deductions for areas occupied by drop inlets, catch basins and manholes shall be made.

BASIS OF PAYMENT

307-5. All work done under plain or reinforced "Portland Cement Concrete Base Course" will be paid for at the contract unit price per square yard, which payment shall be full compensation for furnishing, processing, mixing, hauling, placing, finishing and curing; for furnishing all labor, equipment, materials (including cement, steel reinforcing, dowels,

load transfers, longitudinal joint supports and bituminous joint material), tools, and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 307-6	Plain Portland Cement Concrete Base	
Course		—per square yard
Item 307-7	Reinforced Portland Cement Concrete Base	
Course		—per square yard

SECTION 308

OVERHAUL

DESCRIPTION

308-1. General. "Overhaul" shall consist of transporting specified material from the pit for a distance in excess of two (2) miles from that part of the project nearest the pit.

CONSTRUCTION METHODS

308-2. General. When acceptable material cannot be obtained within the free haul limit of two (2) miles, "Overhaul" shall be allowed on the amount of material hauled from the nearest acceptable source beyond the free haul limit, for items in which "Overhaul" is specified for payment.

If two or more projects or discontinuous sections of projects are combined in one contract, they shall be considered as one continuous project for the purpose of computing "Overhaul".

METHOD OF MEASUREMENT

308-3. 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 two (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 two (2) miles (measured to the nearest 1/10 mile) that the respective material is transported.

"Overhaul" computed on gravel used for stabilizing "Sand Base Course—In Place Measurement" shall be measured as stated above except that overhaul distance allowed shall not exceed that used for computing "Overhaul" for the sand base item.

BASIS OF PAYMENT

308-4. All work done under this item will be paid for at the contract unit price of ten (10) cents per "yard mile" for in place measured material, and eight (8) cents per "yard mile" for pit measured material, which payment shall be full compensation for transporting all material specified; for furnishing all labor, trucks, equipment, tools, and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 308-5	Overhaul (In Place Measure)	
		— 10 cents per yard mile
Item 308-6	Overhaul (Pit Measure)	
		— 8 cents per yard mile

SECTION 309

STRIPPING PITS

DESCRIPTION

309-1. General. "Stripping Pits" shall consist of the removal and disposal of all undesirable overburden, together with all trees, stumps, brush, bushes, roots, and debris found on pits from which material for "Granular Borrow", "Gravel Borrow", "Sand Base—In Place Measure", "Sand Base—Pit Measure", "Gravel Base—In Place Measure", "Gravel Base—Pit Measure", "Surface Treated Gravel", and "Bituminous Gravel Surface" is to be obtained. The removal of overburden from pits for purposes other than those enumerated above is not classified as stripping.

CONSTRUCTION METHODS

309-2. General. All undesirable material as specified above shall be stripped to the depth required before excavating of the acceptable pit material is begun.

The Contractor shall dispose of all stripped material at locations that will permit future development of the pit without re-handling the stripped material. The Contractor shall explore and sample prospective pit areas and ascertain that materials of satisfactory quality and sufficient quantity can be obtained without excessive stripping. No stripping shall be started until the Engineer has approved the location and has taken elevations and measurements of the existing ground surface. After stripping is completed the area shall be recross-sectioned before the excavating of the acceptable pit material is begun.

METHOD OF MEASUREMENT

309-3. The quantity of "Stripping Pits" to be measured for payment shall be the number of cubic yards of material removed and acceptably disposed of, measured in its original position by the method of cross-sectional elevations and the volume computed by the method of average end areas. No payment will be made for stripping areas beyond the limits from which material is taken and used on the project.

BASIS OF PAYMENT

309-4. All work done under this item will be paid for at the contract unit price per cubic yard for "Stripping Pits", which payment shall be full compensation for all exploration of pits; for all material removed and disposed of, in an acceptable manner, for furnishing all labor, equipment, tools, and all incidentals necessary to complete the work.

When no item for "Stripping Pits" is included in the contract, such work shall be considered incidental to other related items.

ITEM FOR PAYMENT

Item 309-5 Stripping Pits —per cubic yard

SECTION 310

SPRINKLING

DESCRIPTION

310-1. General. "Sprinkling" shall consist of applying water to the subgrade, base or surface courses.

MATERIALS

310-2. General. The water used shall not be salt or brackish, and shall be free from oil, acid and injurious alkali or vegetable matter.

CONSTRUCTION METHODS

310-3. General. Water shall be applied by approved methods and equipment under a minimum pressure of fifteen (15) pounds per square inch.

"Sprinkling" shall be used as authorized for controlling dust on subgrade, base and surface courses.

METHOD OF MEASUREMENT

310-4. The quantity of water to be measured for payment under "Sprinkling" shall be the number of one thousand

(1,000) gallon units satisfactorily applied as shown by "Delivery Slips," specified in Article 401-9.

BASIS OF PAYMENT

310-5. All work done under "Sprinkling" will be paid for at the contract unit price per unit, which payment shall be full compensation for loading, hauling, and applying the water; for furnishing all labor, equipment, material, tools, and all incidentals necessary to complete the work.

Water used for curing concrete, for washing stone or other material, for compacting embankment or for other similar work, will not be paid for under this item.

When no item for "Sprinkling" is included in the contract such work shall be considered incidental to other related items.

ITEM FOR PAYMENT

Item 310-6 Sprinkling —per unit

SECTION 311

CALCIUM CHLORIDE

DESCRIPTION

311-1. General. This item consists of furnishing and applying calcium chloride to the subgrade, base or surface courses.

MATERIAL

311-2. General. The calcium chloride shall conform to the latest revised Specification of the American Association of State Highway Officials, Designation M-144.

CONSTRUCTION METHODS

311-3. General. "Calcium Chloride" shall be applied by approved methods and equipment at the rate required to areas designated.

"Calcium Chloride" shall be used as authorized for controlling dust on subgrades, base and surface courses. In general, it shall not be used on surfaces to which bituminous material will be applied.

METHOD OF MEASUREMENT

311-4. The quantity of "Calcium Chloride" to be measured for payment under this item shall be the number of tons (2,000 pounds) satisfactorily applied.

BASIS OF PAYMENT

311-5. All work done under this item will be paid for at the contract unit price per ton, which payment shall be full compensation for hauling, applying, for furnishing all labor, equipment, tools, and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 311-6 Calcium Chloride — per ton

DIVISION IV

SURFACE COURSES AND PAVEMENTS

Surface courses and pavements shall consist of wearing courses, constructed on prepared base courses, for the purpose of carrying traffic.

SECTION 401

GRAVEL SURFACE COURSE

DESCRIPTION

401-1. General. "Gravel Surface Course" shall consist of a wearing course, or levelling course of screened aggregate constructed in conformity with the plans. When required, this course shall be treated with bituminous material of the type called for in the proposal or shown on the plans.

MATERIAL

401-2. Bituminous Material. This material shall meet the requirements for "Road Tar," Article 501-2, grades RT-3, RT-4, RT-5, RT-6; or "Cutback Asphalt," Article 505-2, grades MC-2 or MC-3.

401-3. Aggregate. The aggregate shall consist of hard, durable particles of granular material meeting the following requirements:

REQUIREMENTS FOR GRADATION

Screen Size	Gravel Surface	Cover Material
<i>Square Openings</i>	<i>Percent by Weight</i>	<i>Percent by Weight</i>
	<i>Passing</i>	<i>Passing</i>
1 1/4 inch	100	—
3/4 inch	70- 90	100
No. 4 mesh	30- 50	40-100
No. 200 mesh	0- 5	0- 5

Gravel aggregate shall be used only if its organic content is less than 2% as determined by an ignition test of a representative sample. The organic content shall be computed as:

$$\frac{\text{Weight loss by ignition}}{\text{Initial oven dry weight}} \times 100\%$$

401-4. Binder. Acceptable binder material shall include clay, marl, or other material having similar characteristics which will aid in obtaining compaction of the course.

CONSTRUCTION METHODS

401-5. General. The material for "Gravel Surface Course" shall be spread evenly in one layer upon the prepared base course to a depth that will insure the required thickness after being compacted. The gravel as spread shall be well graded with no pockets of fine or coarse material and shall be bladed and shaped with a power grader.

Rolling shall be done by means of a ten (10) ton power roller, a pneumatic-tired roller, 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 gravel 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 present in the mixture to exceed the limits specified for the material in the course. The binder material shall be uniformly incorporated in the surface course by means of harrowing or by other methods capable of procuring satisfactory results.

The entire surface area of the course shall be shaped and maintained to a tolerance of one-fourth ($\frac{1}{4}$) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one-fourth ($\frac{1}{4}$) inch under a ten (10) foot straight edge longitudinally.

401-6. Gravel Levelling Course. When "Gravel Levelling Course" for fine grading the gravel base course is called for on the plans, it shall conform to and be measured and paid for under the specification for "Gravel Surface Course."

401-7. Bituminous Treatment. Treatment for "Gravel Levelling Course" and the first treatment for "Gravel Surface Course" shall be as follows: Gravel to be treated shall have a clean dry surface. Glazed surfaces shall be broomed with a wire broom drag or bladed with a power grader in order to allow uniform penetration of bituminous material. No bituminous material shall be applied unless the atmospheric temperature is above 40° F. and rising and the weather is fair.

The bituminous material shall be applied with an approved type pressure distributor as called for under Article 501-3, "Distributor".

When tar is used, the first application shall be at the rate of from 0.4 to 0.5 gallons per square yard applied at a temperature of from 120° F. to 150° F. When cutback asphalt is used, the first application shall be at the rate of from 0.4 to 0.6 gallons per square yard. The application of MC-2 shall be at a temperature of from 100° F. to 200° F. and MC-3 shall be at a temperature of from 175° F. to 250° F. Treatment shall be applied in approximate one lane widths alternately to each side of the road; in lengths not exceeding three thousand (3000) feet.

Cover material shall be spread over the treated area in sufficient quantities to prevent traffic from picking up the bituminous material and shall be broomed or dragged until the cover material is uniformly spread over the entire treated area.

"Gravel Surface Course" shall have a second application of tar. The primary treatment shall be thoroughly set and shall be cleaned of all surplus cover material, before the second application of tar is applied, and in no case within twenty-four (24) hours of the time of the first application.

This second application of tar or cutback asphalt shall be at the rate of approximately 0.2 gallons per square yard and applied by the same methods as the first application. Cover material shall be spread over the treated area in the same manner as called for in the first application.

The Contractor shall take special care to protect all treated surface areas from picking up until thoroughly set and well cured; and, without extra compensation, he shall maintain traffic in such a manner that the treated areas shall not be damaged, nor shall traffic be unnecessarily inconvenienced or harmed by the operations.

METHOD OF MEASUREMENT

401-8. Gravel Surface Course. The quantity of "Gravel Surface Course" to be measured for payment shall be the number of cubic yards of material, forming this course and "Gravel Levelling Course," completed in accordance with the plans, accepted and measured in place. The quantity of "Cover Material" and "Binder" to be measured for payment shall be 80% of the number of cubic yards of material accepted and used, measured in vehicles at the point of delivery, as shown by "Delivery Slips" specified in Article 401-9.

401-9. Delivery Slips. The quantity of any material to be measured for payment in vehicles shall be determined on the basis of the amount of material in the vehicle as shown by

"Delivery Slips" which shall be made out in duplicate by the Contractor and signed by the Engineer at the point of delivery. One of these slips shall be retained by the Engineer and one by the Contractor. "Delivery Slips" shall be furnished by the Contractor and shall provide space for identifying the vehicle and the driver; for stating the volume of material carried, the source of the material, the date and the Engineer's signature.

Material included in the "Delivery Slips" and subsequently rejected shall be deducted from the amount being measured for payment.

Each day's "Delivery Slips" shall be reconciled by the Contractor and the Engineer within twenty-four (24) hours.

BASIS OF PAYMENT

401-10. "Gravel Surface Course," "Gravel Levelling Course," "Cover Material," and "Binder" will be paid for at the contract unit price per cubic yard for "Gravel Surface Course," which payment shall be full compensation for obtaining material, screening, hauling, spreading, rolling and shaping; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work; except that bituminous material will be paid for under Article 501-6, "Road Tar" or Article 505-7, "Cut-Back Asphalt" (M.C. Type). "Overhaul" will be paid for as specified in Section 308.

ITEM FOR PAYMENT

Item 401-11 Gravel Surface Course —per cubic yard

SECTION 402

BITUMINOUS GRAVEL SURFACE COURSE

DESCRIPTION

402-1. General. "Bituminous Gravel Surface Course" shall consist of a two (2) inch thick wearing course of graded aggregate and bituminous material constructed on a completed base course, or on a prepared subgrade, in conformity with the plans.

This work shall be done either by the "Mixed-In-Place" method or by the "Premixed" method, as called for in the Proposal. When the "Mixed-In-Place" method is called for, the Contractor may, if he prefers, construct the surface course in accordance with the specifications for the "Premixed" method.

MATERIALS

402-2. Bituminous Material. This material shall meet the requirements for "Road Tar," Article 501-2, grades RT-5,

RT-6, RT-7, RT-8, or RT-9; or for "Cutback Asphalt," Article 505-2, grades MC-2, MC-3 or MC-4, and "Cutback Asphalt," Article 504-2, grades RC-3 or RC-4 as called for in the Proposal or shown on the plans.

402-3. Aggregate. The aggregate shall consist of hard, durable particles of granular material meeting the following requirements. Gradation "A" shall be used unless otherwise called for in the Special Provisions.

REQUIREMENTS FOR GRADATION OF AGGREGATE

Screen Size Square Openings	"A"	"B"
	Percent by Weight Passing	Percent by Weight Passing
1 1/4 inch	100	100
3/4 inch	70- 90	45- 75
1/2 inch	—	25- 60
3/8 inch	—	10- 30
No. 4 mesh	30- 50	—
No. 10 mesh	—	8- 20
No. 200 mesh	0- 5	0- 3

This material shall be tested in accordance with the latest revision of the A.A.S.H.O. Designation T-96 and shall show a loss not greater than 40 per cent after 500 revolutions.

Cover Material. This material shall be either sand or stone chips. Sand shall be used unless "Stone Chips" is called for in the Proposal.

Sand cover shall consist of hard durable particles of granular material.

"Stone Chips" shall be tested in accordance with the latest revision of the A.A.S.H.O. Designation T-96 and shall show a loss not greater than 35% after 500 revolutions. They shall have not less than 75% fractured faces.

All cover material shall meet the following requirements for gradation:

REQUIREMENTS FOR GRADATION OF COVER MATERIAL

Screen Size Square Openings	Sand Cover	Stone Chips
	Percent by Weight Passing	Percent by Weight Passing
3/8 inch	100	100
No. 4 mesh	50- 80	20- 85
No. 8 mesh	—	0- 40
No. 16 mesh	—	0- 5
No. 200 mesh	0-5	—

Material shall be used only if its organic content is less than 2% as determined by an ignition test of a representative sample. The organic content shall be computed as:

$$\frac{\text{Weight loss by ignition}}{\text{Initial oven dry weight}} \times 100\%$$

EQUIPMENT

402-4. Mixed-In-Place Method. The following approved equipment in good working condition will be required:

A pressure type distributor as specified in Article 501-3, "Distributor."

At least one power grader weighing not less than 20,000 pounds and being powered by an engine developing not less than 75 horse power.

A pulvi-mixer of the self-propelled or pull type unit having a minimum mixing width of six (6) feet.

A spreader box, eight (8) feet in width, having an adjustable strike-off board. A two-axle tandem roller weighing from 6 to 10 tons. A rotary broom or sweeper.

402-5. Pre-Mixed Method. The following approved equipment in good working condition will be required:

A two-axle tandem roller weighing from 6 to 10 tons.

A power grader as specified in Article 402-4.

A spreader box as specified in Article 402-4.

A drum-type mixer having a capacity of at least one (1) cubic yard, or other approved types of equipment capable of producing equal or better results.

A blowtorch-type heater, or equivalent equipment capable of heating the material in the drums to at least 100° F.

A rotary broom or sweeper.

The pre-mixed material may be laid by means of an approved self-propelled paving machine having a screed or strike-off assembly and capable of placing the course to the required lines and grades; in which case the above-mentioned spreader box and power grader will not be required.

CONSTRUCTION METHODS

402-6. General. Construction methods common to both types of mix shall include the following:

The bituminous gravel surface shall be mixed and/or laid between May 1 and October 15, provided that the atmospheric temperature is above 50° F. and rising and the weath-

er fair. Bituminous material shall be applied only when the moisture content of the aggregate is 2% or less.

The material after mixing shall be placed upon the prepared base in one course of uniform depth such that after compaction it shall conform to the required thickness and cross section.

Bituminous materials shall be applied in accordance with the temperatures listed in the following table:

Material	RT 5, 6	RT 7, 8, 9	MC 2	MC 3	MC 4	RC 3	RC 4
Temp. in Deg. F.	100 to 150	150 to 225	100 to 200	175 to 250	200 to 275	150 to 200	175 to 250

402-7. Mixed-In-Place Method. Aggregate for the surface course shall be placed upon the prepared base course by means of an approved type spreader box, or other equipment capable of evenly depositing the required quantity of material. This material shall be bladed into a windrow at the side of the road to allow room for two-way traffic.

Preceding the application of bituminous material, about one-third (1/3) of the aggregate shall be bladed with a power grader from the windrow and laid out in approximate blade length widths on the base.

To the aggregate laid out on the base, shall be applied bituminous material at the rate of approximately 0.5 gallons per square yard. A power grader shall closely follow the distributor and blade the treated aggregate into a new windrow on the opposite edge of the treated base.

A second part of the dry windrow shall next be laid out across the base and treated as described above. This shall be bladed over into the new windrow. This procedure shall be continued until the entire dry windrow has been treated. Then the windrow shall be mixed by the power grader and the pulvi-mixer.

Alternate mixing with the power grader and the pulvi-mixer shall continue, with added applications of the bituminous material until a total of approximately 0.85 gallons of tar or approximately 1.00 gallons of cutback asphalt per square yard (of finished surface) has been applied and thoroughly mixed.

The material shall be considered to be thoroughly mixed when no lean or sandy streaks appear and no lumps containing an excessive amount of bituminous material remain. Road tar of a grade lower than RT-7 or cutback asphalt shall re-

quire additional mixing and curing until all detrimental volatile material is eliminated.

The mixed material shall be laid to the full width of the course and to the depth and cross section required, by means of a power grader. After the laying is completed the course shall be rolled, with longitudinal rolling, beginning on the lower edge and progressing to the higher part.

Care should be exercised to avoid excessive rolling. After the course has had time to set twenty-four (24) hours, the course should again be rolled.

When either RT-7, RT-8 or RT-9 is used, it shall not be applied beyond the limits where thorough mixing and laying can be completed before the end of the day's work.

When the mixing of the surface course is interrupted by wet weather, the material shall be left in a windrow, clear of traffic lanes, and shall be remixed and dried out before being finally laid.

402-8. Pre-Mixed Method. Aggregate for the surface course shall be deposited in the mixing drum in uniform batches accurately measured. Batches shall contain a minimum volume of one (1) cubic yard, loose measure.

Road tar of the grade specified in Article 501-4 or medium curing cutback asphalt of the grade specified in Article 505-4 shall be added to the aggregate at the rate of 10 to 14 gallons per cubic yard, loose measure, and at the required temperature.

The mixing drum shall be heated by an approved heater and mixing of each batch shall continue until all particles of aggregate are thoroughly coated with the bituminous material and no lean sandy streaks, or lumps containing excessive amounts of tar, remain.

Each batch shall be mixed for a minimum time of one and one-half (1½) minutes after the hot tar has been added to the aggregate.

After each batch has been satisfactorily mixed, the mixture shall be either stockpiled or transported to and placed on the prepared base course.

If a road tar of lighter grade than RT-7 or if medium curing cutback asphalt is used, the mixture shall be stockpiled and cured by handling over with a power shovel until all detrimental volatile matter has been dissipated, before placing on the road.

The mixture shall be deposited on the prepared base course by an approved type spreader box or other equipment capable of evenly depositing the required quantity of material for the full width of the course. After depositing on the base, the mixture shall be put into a windrow by means of a power grader.

When enough material has been windrowed to allow proper placing with the power grader, the mixed material shall be laid to the full width of the course and to the depth and cross section required.

After the laying is completed the course shall be rolled, with longitudinal rolling beginning on the lower edge and progressing to the higher part.

Care shall be exercised to avoid excessive rolling. After the course has had time to set for twenty-four (24) hours, it shall be rolled again.

If the Contractor wishes to place the mixture by means of an approved paving machine, the course shall be placed so that the two lanes will be completed to approximately the same station at the end of each day's work.

402-9. Cone Mixing. On projects where the amount of mixed-in-place or pre-mixed gravel surface course required is less than 300 cubic yards, the Contractor may mix the material by building up a cone of the aggregate and spraying the cone continuously with bituminous material during the time the power shovel adds aggregate to the pile.

Spraying shall be done by a two-man hand hose with extended multiple nozzles. Spraying shall be regulated to apply 10-14 gallons per cubic yard of loose aggregate as directed.

The material in the cone shall be handled and rehandled, by the power shovel, until the bituminous material and aggregate are thoroughly mixed and no lean sandy streaks, or lumps containing excessive amounts of bituminous material remain.

When the mixture in the cone is satisfactorily mixed and cured and free of volatile matter, it shall be placed and rolled as specified in Article 402-8.

402-10. Seal Coat. After the surface course has been compacted under traffic for at least three (3) days, the surface shall be broomed clean by use of a rotary broom or sweeper and a seal coat of bituminous material shall be ap-

plied at the rate of from 0.15 gallon to 0.25 gallon per square yard as directed.

Cover material in the amount of approximately twenty (20) pounds per square yard shall be uniformly spread upon the seal coat in sufficient quantity to absorb any excess bituminous material. Sand cover may be spread either by hand or by means of an approved mechanical spreader. "Stone Chips" shall be spread only by means of a roller (or "Birch") type mechanical spreader. Additional cover material shall be added to deficient areas whenever necessary to give a uniform covering; any ridges developed shall be removed by hand brooming and the entire surface shall be rolled once over.

METHOD OF MEASUREMENT

402-11. Bituminous Gravel Surface Course (Mixed-in-Place or Pre-mixed Method). The quantity of material to be measured for payment shall be the number of cubic yards of material forming this course, completed in accordance with the typical cross-sections, accepted and measured in place.

The quantity of Sand Cover Material to be measured for payment shall be 80% of the number of cubic yards of material accepted and used, measured in vehicles at the point of delivery as shown by "Delivery Slips" specified in Article 401-9.

402-12. Stone Chips. The quantity of stone chips to be measured for payment shall be the number of tons (2,000 pounds) of material accepted and used, and weighed as specified in Article 403-6.

BASIS OF PAYMENT

402-13. "Bituminous Gravel Surface Course" (Mixed-in-Place or Pre-mixed Method) and Sand Cover Material will be paid for at the contract unit price per cubic yard, which payment shall be full compensation for obtaining material, crushing, screening, hauling, mixing, spreading, shaping, rolling and brooming; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work; except that bituminous material will be paid for under Article 501-7, "Road Tar," Article 504-7, "Cutback Asphalt" (R. C. Type), or Article 505-7, "Cutback Asphalt," (M. C. Type). "Overhaul" will be paid for as specified in Section 308.

"Stone Chips" will be paid for at the contract unit price per ton (2,000 pounds), which payment shall be full compensation for obtaining material, crushing, screening, wash-

ing, hauling, spreading, rolling and brooming; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work.

ITEMS FOR PAYMENT

Item 402-14 Bituminous Gravel Surface Course, (Mixed-in-Place Method)	—per cubic yard
Item 402-15 Bituminous Gravel Surface Course, (Pre-mixed Method)	—per cubic yard
Item 402-16 Stone Chips	— per ton

SECTION 403

BITUMINOUS MACADAM SURFACE COURSE

DESCRIPTION

403-1. General. "Bituminous Macadam Surface Course" shall consist of a three (3) inch thick wearing course of crushed rock aggregate and bituminous binder, constructed on the prepared base course, in conformity with the plans.

MATERIALS

403-2. Bituminous Material. This material shall meet the requirements for "Emulsified Asphalt," Section 503.

403-3. Coarse Aggregate. This material shall consist of angular fragments of broken rock, having uniform quality and being free from thin or elongated pieces, soft or disintegrated rock. Washing of all stone (including keystone and chips) will be required. Any approved method of washing which will produce clean stone free from dirt or other matter occurring either free or as a coating on the rock may be used. Material shall be obtained from rock having a per cent of wear of not more than thirty-five (35), at 500 revolutions, as determined by A.A.S.H.O., Method T-96 (Los Angeles Test), except that in the case of native granite the per cent of wear obtained by the above method shall not exceed forty-five (45) at 500 revolutions.

"Stone Chips" shall have a per cent of wear of not more than thirty-five (35) at 500 revolutions when tested by the above method. The gradation of the stone shall meet the following requirements:

PER CENT PASSING SIEVES WITH SQUARE OPENINGS

Name	2½"	2"	1"	¾"	½"	¾"	No. 4
No. 2 Stone	100	95-100	100	0-15			..
Keystone	..	..	100	90-100	20-55	0-15	..
Chips	..	..	..	100	90-100	..	0-15

EQUIPMENT

403-4. General. The equipment to be used by the Contractor shall include: a power broom, a broom drag, an approved self-propelled spreader with mechanical screed, an approved pressure distributor as specified under Article 503-4, a three-axle tandem roller weighing not less than sixteen (16) tons, and an approved type mechanical chip spreader.

Approved platform truck scales as specified in Article 404-12, shall be furnished, installed and maintained by the Contractor at an approved location on or nearby the project, except when the aggregate is procured from a commercial plant having such scales available for weighing the aggregate.

CONSTRUCTION METHODS

403-5. General. The course upon which this surface is to be constructed shall be clean and free from foreign material. Shoulders shall be built with the side adjacent to the surface course as nearly vertical as the nature of the material will permit, and to such height that, after compaction, the shoulder will conform to the elevation of the compacted course.

The pavement shall be constructed only between May 15th and September 15th, and the application of bituminous material shall then be made only when the atmospheric temperature is above 50° F. and rising and the weather is fair.

Stockpiling of aggregate will be permitted if placed in such a manner as to avoid segregation. Piling the aggregate in cones will not be allowed.

403-6. Weighing Procedure. All weighing shall be done by an approved weigher, furnished by the Contractor. Stone, when weighed, shall be free from excess water. Each truck shall be weighed empty at least twice daily and the weight thus found shall be used to determine the net load until the next weighing of the empty truck.

Weigh slips in triplicate showing gross and net weight and truck number must be signed by the weigher. Two signed weigh slips must accompany each load of aggregate and be countersigned by the Engineer at the point of delivery. One of these slips shall be retained by the Engineer and one by the Contractor. Weigh slips shall be furnished by the Con-

tractor. Material included in the weigh slips and subsequently rejected shall be deducted from the amount being measured for payment. Each day's weigh slips shall be reconciled by the Contractor and the Engineer within twenty-four (24) hours.

403-7. Spreading and Rolling Stone. Upon the prepared base course the No. 2 stone shall be spread uniformly by means of approved self-propelled spreaders having a mechanical screed, and shall be rolled sufficiently to key the stone together. Longitudinal rolling shall begin at the lower edge and progress toward the higher part. If any irregularities appear during or after rolling, they shall be corrected by loosening, removing or adding stone, and the area shall again be rolled.

Any of the stone which has become coated or mixed with dirt or foreign substances shall be removed and replaced with clean stone; all segregation of stone shall be corrected.

403-8. First Application of Emulsified Asphalt. Emulsified asphalt shall be applied as soon as a section of crushed rock has been placed and satisfactorily rolled and keyed. If the stone shall have become dusty it must be thoroughly cleaned before the asphalt is applied. If in extremely hot weather the emulsion tends to break too rapidly, the Contractor may be required to sprinkle the stone with water immediately before the first application of asphalt.

The asphalt shall be applied at a temperature of 110° F. to 140° F. at the rate of approximately one (1.00) gallon per square yard by a distributor working at a pressure of not less than twenty (20) pounds per square inch. On widened areas, parking areas or such other areas that cannot be reached by the pressure distributor, the emulsion may be applied with pouring pots or by means of a hand spray nozzle.

Immediately after the emulsion has been applied and before it has had time to "break," clean keystone shall be uniformly spread over the surface in sufficient quantities to fill all voids and shall be hand broomed. The stone shall then be rolled once over. When necessary to prevent the roller from picking up the treated stone, water shall be applied to the rolls.

After rolling, more keystone shall be added to deficient areas, whenever necessary, to give a uniform covering. Then the entire surface of the course shall be broomed with a

broom drag. Any ridges developed by the broom shall be removed by hand brooming and the entire surface area again rolled once over.

403-9. Second Application of Emulsified Asphalt. After the first application has been completed for at least three (3) hours, a second application of emulsified asphalt shall be uniformly applied at a temperature of 110° F. to 140° F. and at the rate of approximately one (1.00) gallon per square yard. Immediately after the emulsion has been applied and before it has had time to "break," clean keystone shall be uniformly spread over the surface in sufficient but not excessive quantities to fill all voids. The surface shall then be thoroughly rolled. During this rolling, the surface shall be broomed with a broom drag to evenly distribute the keystone and more keystone shall be added to deficient areas, whenever necessary, to give a uniform covering. Prior to allowing traffic over the surface, it shall be thoroughly and systematically rolled, beginning at the lower edge and finishing at the higher part. At least twenty-four (24) hours shall elapse after the second application of emulsified asphalt before traffic shall be allowed over the surface. At least three (3) days shall elapse before applying the "Seal Coat."

403-10. Seal Coat.

(a) *First Seal Coat.* After the surface has been compacted as above it shall be swept clean and a "Seal Coat" of approximately three tenths (0.3) gallon of emulsified asphalt per square yard shall be uniformly applied. The bituminous material shall then be evenly covered with clean "Stone Chips" in a quantity sufficient to take up all excess asphalt, after which the course shall be well broomed with a broom drag. Any ridges developed by the broom drag shall be removed by hand brooming and the entire surface area again rolled once over. If the chips show excessive crushing under the roller, this rolling shall be omitted.

(b) *Second Seal Coat.* Before traffic is allowed over the first "Seal Coat" a second "Seal Coat" of approximately three tenths (0.3) gallon of emulsified asphalt per square yard shall be uniformly applied. The bituminous material shall then be evenly covered with clean "Stone Chips" in a quantity sufficient to take up all excess asphalt after which the course shall be well broomed with a broom drag, and the surface shall be thoroughly rolled.

Back rolling shall continue until thorough compaction of the course is obtained. The surface area of this course shall be shaped and maintained to a tolerance of three-sixteenths (3/16) inch above or below the required cross-sectional elevations and to a maximum irregularity not exceeding one-quarter (¼) inch under a ten (10) foot straight edge longitudinally.

METHOD OF MEASUREMENT

403-11. The quantity of "Bituminous Macadam Surface Course" to be measured for payment shall be the number of tons (of 2,000 pounds) of all stone forming this course, completed and accepted as computed from weigh slips required in Article 403-6.

BASIS OF PAYMENT

403-12. This work will be paid for at the contract unit price per ton for "Bituminous Macadam Surface Course," which payment shall be full compensation for obtaining, processing, washing, weighing, hauling, placing, spreading and rolling all stone required; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work, except that bituminous material will be paid for under Article 503-8, "Emulsified Asphalt."

ITEM FOR PAYMENT

Item 403-13 Bituminous Macadam Surface Course—per ton

SECTION 404

BITUMINOUS CONCRETE SURFACE COURSE

CLASS I

DESCRIPTION

404-1. General. "Bituminous Concrete Surface Course" shall consist of a course composed of one or more layers of a hot mixture of "Coarse Aggregate," "Fine Aggregate," "Mineral Filler," and "Bituminous Material" constructed on a prepared base or existing pavement in conformity with the plans.

MATERIALS

404-2. Bituminous Material. This material shall meet the requirements of "Asphalt Cement," Article 502-2, penetration grade 85-100.

404-3. Aggregate.

(a) The coarse aggregate (retained on the No. 10 sieve) shall be composed of either crushed rock or gravel (containing at least 50% of crushed particles) consisting of fragments of clean, durable stone, free from soft, thin, elongated pieces, disintegrated rock, dirt, vegetable and other foreign matter. The aggregate shall be tested for wear, in accordance with the latest revision of the A.A.S.H.O. Designation T-96. For Type "A" wearing course all the coarse aggregate shall be obtained from ledge rock and shall show a loss not greater than thirty (30) per cent after 500 revolutions; for Type "A" primary course and for Type "B" primary and wearing courses, the aggregate shall show a loss not greater than forty (40) per cent after 500 revolutions.

(b) The fine aggregate (passing the No. 10 sieve) shall be composed of sand or stone screenings or mixtures of them. The sand shall consist of hard, clean, durable grains free from clay, loam, or other foreign matter. The stone screenings shall be free from weathered or soft particles and shall be produced from stone equal in quality to the coarse aggregate specified for the surface type called for in the Proposal.

(c) The mineral filler shall consist of limestone dust, dolomite or trap rock dust, or Portland Cement and shall be free from foreign or other objectionable material. It shall be dry and free from lumps and when tested by means of laboratory sieves shall meet the following gradation requirements:

Passing No. 30 mesh sieve	100%
Passing No. 200 mesh sieve	65-100%

404-4. Composition of Mixtures. The several mineral constituents for the bituminous concrete surface course shall be so sized and graded, and combined in such proportions that the resulting composite blend will meet the grading requirements of the following table. To such composite blended aggregate (considered as one hundred (100) per cent) shall be added bitumen within the percentage limits set forth in the following table:

TYPES "A" AND "B"

<i>Screen Size Square Openings</i>	<i>Wearing Course per cent by Weight Passing</i>	<i>Primary Course per cent by Weight Passing</i>
¾ inch	—	100
½ inch	100	—
No. 4 mesh	35- 75	25- 44
No. 10 mesh	30- 55	18- 38
No. 20 mesh	24- 45	15- 35
No. 40 mesh	12- 40	8- 25
No. 80 mesh	7- 19	—
No. 200 mesh	3- 8	—
Bitumen (Sol. in CS ₂) %	5- 8	4- 6.5

The composition limits given above are master ranges of tolerance to govern mixtures made from any raw materials or combinations thereof, proposed for use under these specifications, and they are the maximum and minimum for all cases. A closer control within these ranges is intended for any specific project.

404-5. Job Mix. Before any surface is placed the Contractor shall submit to the Engineer in writing a balanced "Job Mix" which will conform to Article 404-4 stating the percentage of each ingredient to be used in the mixture and a resultant screen test and bitumen percentage from such combination. The product shall also conform to the requirements of Article 404-6, "Density and Stability." The mix shall not be used until approved, and no change shall be allowed unless authorized.

The mixture produced shall not vary from the approved "Job Mix" by more than the following allowable tolerances (and in all cases the grading requirements shall not exceed the limits specified in Article 404-4):

Total passing No. 4 sieve	—plus or minus 6 percentage points
Total passing No. 10 sieve	—plus or minus 5 percentage points
Total passing No. 20 sieve	—plus or minus 4 percentage points
Total passing No. 40 sieve	—plus or minus 4 percentage points
Total passing No. 80 sieve	—plus or minus 3 percentage points

Total passing No. 200 sieve

—plus or minus 2 percentage points

Bitumen

—plus or minus 0.5 percentage points

404-6. **Density and Stability.** The mixture forming the wearing course shall have a density when compacted of not less than ninety-three (93) per cent, nor more than ninety-seven (97) per cent of the calculated density of a voidless mixture composed of the same materials in like proportions.

The mixture forming the wearing course shall have a stability value, as measured on the Hveem Stabilometer of not less than 35. Tests for compacted density shall be made on cores taken as described in Article 404-22.

EQUIPMENT

404-7. **General.** The method employed in performing the work and all equipment, tools, machinery and other appliances used in handling materials and executing any part of the work shall be approved before the work is started. All equipment, tools, machinery, and plant used must be maintained in a satisfactory working condition.

The equipment furnished by the Contractor shall be made up of suitable units, including:

Bituminous Paving Plant

Bituminous Concrete Paver

Rollers

Platform Scales

404-8. **Paving Plant.** The "Paving Plant" shall be of sufficient capacity and coordinated to adequately handle the construction and shall comply with the following requirements:

(a) **Drier.** The drier shall be of the rotating cylindrical type suitably designed to heat and dry the aggregate to specification requirements and to continuously agitate the aggregate during heating. The drier shall be capable of preparing aggregate, to the full rated capacity of the paving plant, to meet the specification requirement. A dial thermometer or other approved thermometric instrument shall be so placed at the discharge chute of the drier as to automatically register or indicate the temperature of the heated aggregate.

(b) **Bins.** The plant shall have storage bins, protected from the weather, of sufficient capacity to furnish the necessary amounts of all aggregate when operating at the maximum rated capacity of the plant. The bins shall provide three or more compartments for hot aggregates so proportioned as to insure adequate storage of appropriate fractions of the aggregate. Each compartment shall be provided with an overflow pipe at least four (4) inches in diameter at such locations as to prevent backing up of material into other compartments. The bin shall have a "Tailing" pipe, at least six (6) inches in diameter, for rejections. Each compartment shall be provided with an individual outlet gate, designed and constructed so that when closed there will be no leakage.

A thermometer or other approved thermometric instrument shall be so placed in the fine aggregate bin as to automatically register or indicate the temperature of the heated aggregate immediately before it enters the mixer. The dial or other indicator shall be plainly visible from the mixing platform.

Adequate and dry storage for mineral filler shall be separately provided. Provisions shall be made for the weighing of filler.

(c) **Weigh Box or Hopper.** The plant shall have a batch weighing device of sufficient capacity to hold the maximum amount of the dried mineral aggregates for one batch. This equipment shall be constructed for easy adjustment of any working part so that it will function properly and accurately. The weigh box or hopper shall be supported on fulcrums and knife edges so made that they will not be easily thrown out of alignment or adjustment. The hopper must be free from contact on all edges, ends, or sides with any supporting rods or columns or other equipment that will in any way affect its proper functioning. In addition there must be sufficient clearance between the hopper and supporting devices so that foreign materials will not accumulate. The discharge gate of the weigh box or hopper shall be so hung that the aggregates will not be segregated when dumped in the mixer. If necessary to correct any such tendency, baffles shall be inserted or other means provided to discharge the materials in a blended condition.

The discharge gate of the weigh box or hopper shall close tightly when the hopper is empty so that no material will be allowed into a batch in the mixer during the weighing of the next batch.

(d) *Scales.* Scales for the weigh box may be either of the beam or springless dial type and shall be a standard make and design, sensitive to one-half ($\frac{1}{2}$) of one per cent of the maximum load that may be required. When of the beam type, there shall be a separate beam for each size of aggregate and there shall be a "telltale" dial scale attached. Each beam shall have a locking device designed and so located that the beam can easily be suspended or thrown into action. Beam scales shall be balanced on knife edges and fulcrums and be so constructed that they cannot be easily thrown out of alignment and adjustment. Dial scales shall be of a standard make and of sufficient size that the numerals on the dial can be read at a distance of not less than twenty-five (25) feet. All dial scales shall be so located that they will be in plain view of the operator at all times.

Scales for the weighing of bituminous material shall conform to the specifications for the aggregate scales except that beam scales shall be equipped with a tare beam and a full capacity beam. The value of the minimum graduation in any case shall not be greater than two (2) pounds. Dial scales for weighing the bituminous material shall have a capacity of at least twice the weight of the material to be weighed and shall read to the nearest pound.

All scales shall be approved before using. The Contractor shall have the scales tested and sealed as often as necessary to insure their accuracy.

The Contractor shall provide and have available the necessary number of standard test weights for frequent testing of all scales.

(e) *Bituminous Control Unit.* Satisfactory means, either by weighing or by metering, or the taking of volumetric measurements, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified for the "Job Mix." Suitable means shall be provided, either by steam-jacketed or other insulation, for maintaining the specified temperature of bituminous material in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

The bituminous material weigh bucket shall be supported on fulcrums and knife edges in the same manner as the weigh box and have a capacity equal to twelve (12) per cent by weight of the maximum capacity of the mixer.

(f) *Screens.* All plant screens shall be designed, constructed and operated so as to screen all aggregates to their

specified sizes and proportions and shall have a capacity when operated at normal speed, slightly in excess of the maximum production capacity of the mixing plant.

(g) *Mixer Unit-Batch Method.* The mixer shall be a standard twin pug mill type of sufficient size to maintain thorough uniform mixing at the rated plant capacity. The mixer shall be equipped with a sufficient number of paddles or blades set in the proper order and position to produce a satisfactory mixture of all material required. The mixer shall be constructed to prevent leakage of contents until the batch is to be discharged. The mixer shall be steam-jacketed or properly insulated to insure the required temperature control.

(h) *Control of Mixing Time.* The plant shall be equipped with positive means to govern the time of mixing and to maintain it constant unless changed by order of the Engineer. The time of mixing shall be considered as the interval between the time the bituminous material is spread on the aggregate and the time the same aggregate leaves the mixing unit.

(i) *Equipment for Preparation of Bituminous Material.* Equipment for heating bituminous material shall consist of kettles or tanks equipped with steam coils, electricity or other means capable of uniformly heating the material, under effective and positive control, to the required temperature. The circulating system for bituminous material shall be of adequate size to insure proper and continuous circulation during the entire operating period.

A non-detachable thermometer shall be provided on the storage tank, which will measure the temperature of the bituminous material.

(j) *Continuous Mixing Type Plant — Special Requirements.* A continuous mixing plant, conforming to the following requirements, may be used in place of a batching plant.

1. *Gradation Control Unit.* The plant shall include means for accurately proportioning aggregate from each bin, either by weighing or by volumetric measurement.

When gradation control is by volume, the unit shall include a feeder mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each bin compartment. The orifice shall be rectangular, its dimensions about eight (8) inches by nine (9)

inches. The size of the opening shall be adjustable by positive mechanical means, and, after being set to the required size, the gate shall be locked. Indicators shall be provided on each gate to show the size of gate opening in inches.

Mineral filler, if required, shall be proportioned separately from a small hopper.

2. *Weight Calibration of Aggregate Feed.* The plant shall include a means for calibration of gate openings with weight test samples. The material fed out of the bins through individual orifices shall be by-passed to a suitable test box, each compartment material being confined in a separate box section. The plant shall be equipped to handle conveniently such test samples weighing up to 800 pounds each and to weigh them on accurate platform scales.

3. *Synchronization of Aggregate Feed and Bitumen Feed.* Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source. This control shall be accomplished by interlocking mechanical means or by any positive method for accurate control.

4. *Mixer Unit for Continuous Method.* The plant shall include a continuous mixer of an approved twin pugmill type, steam-jacketed, and capable of producing a uniform mixture within the job-mix tolerance fixed by the contract. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge and also giving the rate of feed of aggregate per minute, at plant-operating speed.

Unless otherwise required, determination of mixing time shall be by weight method under the following formula:

$$\text{Mixing time in seconds} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second}}$$

The weights shall be determined for the job by tests made by the Engineer.

404-9. *Placing Equipment.* The "Placing Equipment" shall consist of an approved self-propelled mechanical paver for spreading and finishing. It shall be provided with a screed or strike off assembly capable of operating in such a manner that no supplemental spreading, shaping or finish-

ing will be required. The screed assembly shall be adjustable to give the cross-section shape required and shall be designed and operated so that it will leave the pavement course of the required thickness.

404-10. *Rolling Equipment.* The rolling shall be done with self-propelled tandem rollers designed for the construction of bituminous concrete pavement. The two-axle tandem type rollers shall weigh not less than eight (8) tons. The three-axle tandem type rollers shall weigh not less than sixteen (16) tons. The wheels on the rollers shall be equipped with adjustable scrapers which shall be used when necessary to clean the wheel surface. Rollers shall also be equipped with tanks and sprinkling apparatus and pads which shall be used to keep the wheels wet and prevent the surfacing material from sticking.

404-11. *Field Laboratory.* The Contractor shall provide a "Field Laboratory" building in which to house and use testing equipment. This building is in addition to the Engineer's Field Office and shall conform to the requirements of Article 105-13, and shall be maintained for the exclusive use of the Engineer. This building shall be placed, in an approved location, so that details of the batching and weighing section of the plant are plainly visible from at least one window.

404-12. *Platform Truck Scales.* An approved "Platform Truck Scale" having a minimum manufacturer's rated capacity at least ten (10) per cent in excess of the maximum gross load being weighed, and capable of accommodating the entire truck, shall be provided, installed and maintained by the Contractor. It shall conform to the specifications, tolerances and regulations of the National Bureau of Standards for commercial weighing devices and shall be accurate within a maximum tolerance of plus or minus 2 pounds per 1000 pounds of load. The value of the minimum graduation on the scale shall not be greater than ten (10) pounds. The scale shall be set on concrete or other approved foundation located at or near the mixing plant. The recording mechanism of the platform scale shall be suitably protected from the elements.

Twenty (20) standard fifty-pound weights shall be available on the project at all times for use in checking the accuracy of the scales. The Contractor shall have the scales checked and sealed as often as necessary to insure accuracy.

CONSTRUCTION METHODS

404-13. *General.* The pavement shall be constructed only

between May 1st and October 15th, and then only when the atmospheric temperature is above 40° F. and rising.

The wearing course shall have a compacted thickness of one (1) inch.

The surface upon which the bituminous concrete mixture is to be laid shall be clean and dry, except that authorization may be given for placing the mixture on a damp surface having no free water present. Placing during periods of precipitation will not be allowed except, the work of placing the binder course or wearing course may be permitted to continue when overtaken by local rain showers up to the amount of material which may be in transit at the time precipitation starts at the project, provided the Contractor assumes all responsibility, including replacement in kind for any failure which may develop in such areas.

Any material delivered to the project which, because of adverse weather or other limitations, cannot be placed shall be disposed of by the Contractor without compensation.

404-14. Preparation of Bituminous Material. The bituminous material shall be melted in tanks designed to heat the entire contents uniformly and to provide a continuous supply of bituminous material to the mixer at a temperature between 250° F. and 350° F.

404-15. Preparation of Mineral Aggregate. The aggregate for the mixture shall be dried and heated at the paving plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid injury to the aggregate. The aggregate shall be heated to a temperature between 275° F. and 350° F. as determined on the mixing platform.

When more than two ingredients enter into the composition of the mineral aggregate, they shall be combined as directed.

The aggregates, immediately after heating, shall be screened into three or more fractions and conveyed into separate bins ready for batching and mixing with bituminous material.

404-16. Preparation of Bituminous Concrete Mixture. The dried mineral aggregate shall be combined in the plant in the proportionate amounts of each fraction of aggregate required to meet the "Job Mix" formula. Where a batching plant is used, the Engineer shall determine the quantity of bituminous material for each batch. In any case, the bitu-

minous material shall be measured or gauged and introduced into the mixer in the proportionate amount determined for the particular material being used. Prior to adding bituminous material, the combined mineral aggregate shall be thoroughly mixed dry, after which the proper amount of bituminous material shall be distributed over the mineral aggregate and the whole thoroughly mixed for a period of at least forty-five (45) seconds, but longer if necessary, to produce a homogeneous mixture in which all particles of the mineral aggregate are coated uniformly. In any event, the mixing time shall be regulated and suitable locking means shall be provided for such regulation. For the continuous mixing plant, the mixing time may be regulated by fixing a minimum depth in the mixer unit and/or by other mixing unit adjustment.

The aggregate and the bituminous material shall be introduced into the mixer at the individual temperatures specified.

The ingredients shall be heated and combined in such a manner as to produce a mixture which, when discharged, shall be at a temperature of not less than 275° F., nor more than 350° F.

404-17. Weighing of Bituminous Concrete Mixture. Each load of the completed mixture shall be weighed as specified in Article 403-6 on platform scales as specified in Article 404-12.

404-18. Transportation and Delivery of Mixtures. The mixture shall be transported from the mixing plant to the point of use in vehicles having clean, tight bodies. The bodies of the vehicles may be thinly coated inside with soapy water, lime water, or a mixture of water and not more than 10 percent of lubricating oil. The use of kerosene, gasoline, or similar products will not be permitted. When directed, each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect the mixture from the weather. No loads shall be sent out so late in the day as to prevent completion of the spreading and compaction of the mixture during daylight, unless satisfactory artificial lighting is provided. The mixture shall be delivered at a temperature between 275° F. and 350° F.

404-19. Conditioning of Existing Base. Where no tack coat is to be applied prior to placing the bituminous concrete mixture, the existing base upon which the pavement is to be constructed shall be swept thoroughly and cleaned of all loose

dirt and other objectionable materials immediately before spreading the mixture.

Contact surfaces of curbs, gutters, manholes, and other structures shall be painted with a thin uniform coating of hot asphalt cement (or asphalt cement dissolved in naphtha) just before the bituminous concrete mixture is placed against them.

The pavement mixture shall be placed only on approved base areas.

404-20. Spreading and Finishing. The mixture shall be spread and struck off to the profile grade or to a predetermined parallel surface. For this purpose self-powered mechanical spreading and finishing equipment provided with a strike-off assembly, heated if required, shall be used, distributing the mixture either over the entire width or over such partial width lanes as may be practicable. Blade graders or drags shall not be used. The assembly shall be adjustable to give the cross-section shape required and shall be so designed and operated as to place the thickness of surface course material required after compaction.

If during construction it is found that the spreading and finishing equipment in operation leaves in the new surface course tracks or indented areas that are not satisfactorily corrected by the scheduled operations, or if it produces other permanent blemishes, the use of such equipment shall be discontinued and satisfactory spreading and finishing equipment shall be provided by the Contractor.

The term "strike-off assembly" includes any cutting, crowding, or other practical action which is effective on the mixture, at the workability specified and obtained, in producing without tearing, shoving, or gouging, a finished surface of the evenness and texture specified.

On areas where irregularities, inaccessibility, or unavoidable obstacles make the use of the self-powered spreading and finishing equipment impracticable, the mixture shall be spread and screeded by hand. On such areas the mixture shall be dumped on steel dump boards located outside the surface on which it is to be used and shall then be immediately placed and spread in a uniformly loose layer of such depth that when compacted the course shall have the thickness specified and will conform to the grade and surface elevations required.

The Contractor shall provide suitable means for keeping all small tools clean and free from accumulations of bitu-

minous material. He shall provide and have ready for use at all times enough tarpaulins, or covers, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may be dumped and not spread.

404-21. Compaction. After the spreading and strike-off and while still hot, the course shall be compacted to the required density by rolling.

For initial rolling 8 to 10-ton tandem power rollers will be required. All rollers shall be kept in good condition, and each shall weigh not less than 250 pounds to the inch width of tread.

Each roller shall be operated by a competent, experienced roller operator and, while the work is under way, must be kept as nearly as practicable in continuous operation. Rolling shall begin at the sides and progress gradually to the center, except that on superelevated curves rolling may progress from the lower to the upper edge parallel with the center line of the road and uniformly lapping each preceding track, until the entire surface has been rolled. The course shall be subjected to diagonal rolling in two directions, the second diagonal rolling shall cross the lines of the first. If the width of the course permits, it shall be rolled also at right angles to the center line. Rolling shall be continued until all roller marks are eliminated. The motion of the roller at all times shall be slow enough to avoid displacement of the hot mixture. Any displacement occurring as a result of the reversing of the direction of the roller, or from any other cause, shall be corrected at once by the use of rakes and of fresh mixture when required. To prevent adhesion of the mixture to the roller the wheels shall be kept properly moistened but excess water or oil will not be permitted.

Along forms, curbs, headers, and walls and at other places not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers or with mechanical tampers giving equivalent compression. Each hand tamper shall weigh not less than twenty-five (25) pounds and shall have a tamping face area of not more than fifty (50) square inches. On depressed areas, a trench roller may be employed, or cleated compression strips may be used under the roller, to transmit compression to the depressed area.

No surface course material shall be placed against the edge of a course or layer that has been rolled and has cooled,

unless such edge is vertical or has been cut back to a vertical face and in either case has received a brush coat of asphalt.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture that becomes loose and broken, mixed with dirt, or in any way defective prior to the acceptance of the work shall be removed and replaced with fresh hot mixture, which shall be immediately compacted to conform with the surrounding area. Any area of one (1) square foot or more showing an excess of bituminous material shall be removed and replaced.

404-22. Test Cores. The Contractor shall furnish the Engineer with undamaged test cores taken from designated locations in the wearing course placed during the previous day. These cores shall be four (4) inches in diameter and of the thickness of the depth of the course being tested. A minimum of three (3) undamaged cores, shall be taken from each preceding day's work with a maximum of one (1) additional core to be taken for each one hundred (100) tons of the course placed in excess of three hundred (300) tons.

Test cores shall be supplied to the Engineer during the first three (3) hours of the day's work.

The area from which the core is taken shall be painted with asphalt cement, filled with hot material similar to that removed and compacted by hand tamping or by rolling. This work shall be incidental to the cost of the pavement.

404-23. Joints. Placing of a course shall be as nearly continuous as possible and the roller shall pass over an unprotected end of freshly laid mixture only when the laying of the course is to be discontinued long enough to permit the mixture to become chilled. Unless construction of the adjoining lane follows immediately, the longitudinal joint shall be cut back. In all such cases, including the formation of joints as hereinafter specified, provision shall be made for proper bond with the new surface for the full specified depth of the course. Joints shall be formed by cutting back on the previous day's run so as to expose the full depth of the course.

When the laying of the course is resumed, the exposed edges of all transverse and longitudinal joints shall be painted with a coat of emulsified asphalt grade RS-1 or RS-2. The fresh mixture shall be raked against the joint, thoroughly tamped with hot tampers, and rolled.

When required, because of unsatisfactory longitudinal joints, the sealing of such joints shall be done by a strip of levelling mix using nine (9) per cent of asphalt. This strip shall be approximately ten (10) inches in width, about one-quarter ($\frac{1}{4}$) inch thick at the joint, and shall be feathered out at the sides. In compacting this strip a 3 to 5-ton power roller will be permitted. Work and materials used in sealing such joints will not be paid for directly, but shall be considered to be incidental to the work of constructing this course.

404-24. Surface Test of the Course. Before final acceptance, the finished course shall be tested by a crown template and by 3-foot and 10-foot straight edges applied at right angles and parallel, respectively, to the center line of the roadbed. The crown template shall conform to the typical cross-section shown on the plans. The variation of the surface from the testing edge of the crown template between any two contacts with the surface shall at no point exceed three-sixteenths ($\frac{3}{16}$) inch. The variation of the surface from the testing edges of the straight edges between any two contacts with the surface shall at no point exceed three-sixteenths ($\frac{3}{16}$) inch for the 10-foot straight edge, or one-eighth ($\frac{1}{8}$) inch for the 3-foot straight edge. In addition, any depression under a twenty (20) foot straight line longitudinally shall not exceed one-quarter ($\frac{1}{4}$) inch.

Tests for conformity with the specified crown and grade shall be made by the Contractor immediately after initial compression, and variations shall be corrected by removing or adding materials as may be necessary. Rolling shall then be continued as specified.

404-25. Protection of Pavement. Newly finished pavement shall be protected from traffic until it has become properly hardened. In no case shall power graders or other heavy construction equipment be allowed to work where it is necessary to come in contact with the pavement for at least forty-eight (48) hours after the section has been opened to traffic.

METHOD OF MEASUREMENT

404-26. The quantity of material to be measured for payment shall be the number of tons (of 2,000 pounds) as computed from "weigh slips" specified in Article 403-6, of material forming this course as specified, completed in accordance with the typical cross sections of the plans and accepted.

BASIS OF PAYMENT

404-27. "Bituminous Concrete Surface Course" will be paid for at the contract unit price per ton, which payment shall be full compensation for obtaining and furnishing all aggregate and bituminous material; for processing, heating, mixing, weighing, hauling, placing and painting joints; for shaping and rolling; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work.

ITEMS FOR PAYMENT

Item 404-28 Bituminous Concrete Surface Course,	
Type "A"	—per ton
Item 404-29 Bituminous Concrete Surface Course,	
Type "B"	— per ton

SECTION 405

PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

405-1. General. "Portland Cement Concrete Pavement" shall consist of a wearing course composed of portland cement concrete with or without steel reinforcement, as shown on the plans, constructed on the prepared base course or on an existing pavement in conformity with the plans.

Portland cement concrete shall consist of an intimate mixture of portland cement, fine and coarse aggregate, and water.

MATERIALS

405-2. Concrete. All concrete used in this work shall meet the general requirements of Section 701, "Portland Cement Concrete" and shall be Class "A" Concrete.

405-3. Steel. All steel used for this work shall meet the requirements of Section 705, "Reinforcing Steel".

405-4. Bituminous Material. Bituminous joint filler shall conform to the requirements of the A.A.S.H.O. Specification, Designation M-89 for "Mixed Asphalt and Mineral Filler" of penetration grade 50-60 or other approved joint filler.

EQUIPMENT

405-5. General. All equipment necessary for the placing of concrete pavement shall be on the site, available for inspection, testing and approval, before paving operations are

started. All equipment, tools and machinery shall be maintained in a satisfactory working condition.

The Contractor shall provide equipment of such capacity that the mixer will operate continuously or at a constant rate of production insofar as feasible. In the event that any piece of equipment does not have sufficient capacity to keep pace with the other operations, the Engineer may limit the size of the batch or otherwise limit the rate of production to prevent poor workmanship, overloading of equipment, or frequent delays.

Equipment for weighing materials, for batching and for mixing shall conform to the requirements of Section 701, "Portland Cement Concrete."

(a) *Finishing Machines.* Finishing machines for concrete pavement shall be self-propelled and capable of both spreading and compacting the concrete. The machine shall be equipped with two screeds, operating independently, or with one screed having a width of not less than eighteen (18) inches. The machine shall be fully and accurately adjustable to finish the concrete to the required pavement crown. The screeds shall be constructed with end wings to prevent spillage of concrete.

The finishing machine shall have sufficient power and traction to prevent slippage on the forms.

(b) *Lutes.* Two types of lutes are required, one shall be of wood and the other of steel. The blade of the wooden lute shall be constructed of a smoothly finished approved wood plank two (2) inches by seven (7) inches and ten (10) feet in length. Three (3) feet along the top from each end shall be tapered from the seven (7) inch dimension to four (4) inches at the ends. The handle for this blade shall be approximately fourteen (14) feet in length and attached at the center of the blade at an angle of 14° with the flat bottom face of the blade. It shall be securely braced to the blade.

The steel lute shall be of an approved type as is available commercially.

(c) *Forms.* Side forms shall be made of metal having a thickness of not less than three-sixteenths (3/16) inch. They shall have a depth equal to the required edge thickness of the concrete, without a horizontal joint and shall be not less than ten (10) feet in length.

The form base shall be not less than eight (8) inches wide. Forms shall be straight and free from warp; maximum deviation of the top and face surfaces of any section

from a straight line shall not exceed one-eighth ($\frac{1}{8}$) inch in any ten (10) feet. Maximum deviation of the base of the form from a right angle with the vertical face shall not exceed one-eighth ($\frac{1}{8}$) inch over or under a right angle at the back edge of the base. Form sections bent or warped beyond these allowed tolerances shall be removed from the project.

Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible springing or settlement, the impact and vibration of the consolidating and finishing equipment.

For curves of radius of less than two hundred (200) feet, flexible or curved forms may be used.

405-6. Forms. The forms shall be joined neatly and shall be set with exactness to the required grade and alignment in single lane widths and shall be supported in such a position during the entire operation of compacting and finishing that they will not at any time deviate more than one-eighth ($\frac{1}{8}$) inch from a straight edge ten (10) feet in length. Forms shall be set at least five hundred (500) feet in advance of the area where concrete is being placed. All forms shall be cleaned and oiled each time before they are used. The building of pedestals of earth or other materials to bring the forms to the required grade will not be permitted. The length and number of pins shall be such as to maintain the forms at the correct line and grade.

Forms shall remain in place for at least fifteen (15) hours after the concrete has been placed, except that in cold weather the Contractor may be required to leave the forms in place for a longer period of time.

CONSTRUCTION METHODS

405-7. Prepared Base Course. After the base course has been prepared and properly consolidated, the forms set and accepted and immediately before the concrete is to be placed, the surface of the prepared base course shall be tested as to crown and elevation by the use of an approved template. The template, resting on the side forms and having its lower edge at the elevation for the bottom of the concrete course, shall be operated along the forms between the mixer and the part of the prepared base course upon which the concrete is being deposited. Irregularities encountered shall be corrected and the surface rechecked. The surface of the prepared base course on widened curves, intersections, etc., shall be shaped by hand and checked with specially constructed templates.

If additional material is used to bring the gravel base course to the correct elevation, it shall be tamped and/or rolled until the fill material is thoroughly compacted.

The surface of the gravel base shall be in a moist condition at the time of placing the concrete so that it will not absorb moisture from the concrete, but not to the extent that free water will be standing thereon.

405-8. Batching and Mixing. All batching and mixing for "Portland Cement Concrete Pavement" shall conform to the requirements of Articles 701-14 and 701-15a, "Portland Cement Concrete".

405-9. Placing Concrete. The concrete shall be deposited on the subgrade in successive batches for the full width between forms in a manner requiring as little rehandling as possible. Additional spreading shall be done with hand shovels or by approved mechanical means in a manner that will prevent segregation and separation of materials. The amount of material deposited shall be sufficiently in excess of that amount necessary to form the pavement to provide a roll of concrete ahead of the front screed of the finishing machine for the full length of the screed.

If mesh or bar mat reinforcing is used, the concrete shall be deposited and struck off with a "strike-off" operating from the side forms to form a surface that will permit the reinforcement to be placed at the required elevation. The additional concrete necessary above the reinforcement to form the required cross section shall be placed within thirty (30) minutes after the concrete below the reinforcement has been deposited.

Along all joints and forms, the concrete shall be vibrated with approved vibrators as called for in Article 701-17. Over vibration shall be avoided.

Whenever the placing of concrete is to be suspended for more than thirty (30) minutes, due to an emergency, or at the end of the day's run, a transverse construction joint shall be formed as herein specified, providing that the section on which work has been suspended shall not be less than five (5) feet in length measured from the preceding joint; when less than five (5) feet in length, the Contractor shall remove the concrete to the joint previously formed and no payment will be made for placing or removal.

405-10. Placing Reinforcement. When steel reinforcing is called for and shown on the plans, all marginal bars, dowel

bars, and tie bars required shall be placed prior to depositing concrete on the subgrade and shall be held in proper position by sufficient approved metal bar supports or piers. If wire mesh or bar mat reinforcement is required it shall be placed on the freshly deposited concrete that has been struck off to the required elevation as hereinbefore provided. The reinforcement shall be placed so that it will lie in a plane parallel to the finished surface of the pavement and remain, after the pavement finishing operations are completed, at the elevation shown on the plans.

Laps in adjacent sheets or mats of reinforcement shall be as shown on the plans. Laps parallel to the center line of the pavement will be permitted only for unusual pavement widths or for irregular areas.

If dimensions for laps are not shown on the plans, the minimum lap shall be thirty (30) diameters of the steel used. The adjacent sheets shall be fastened or tied together with tie wires.

405-11. Joints. All transverse and longitudinal joints in concrete pavement shall conform to the details shown on the plans for the type of joints required.

(a) *Transverse Contraction Joints* shall be constructed with the longitudinal plane at right angles to the center line of the pavement and with the vertical plane perpendicular to the finished grade of the pavement. Where the concrete is laid continuously across a bridge or culvert whose deck is below grade, transverse contraction joints shall be formed at such distance from the abutment as to insure a bearing at the ends of the slab of not less than five (5) feet beyond the limits of the backfill area.

Where the concrete joins a bridge or culvert, whose deck is at grade, transverse contraction joints shall be formed at the back of each abutment and also at such distance from the abutment as to give a bearing at the end of the slab of not less than five (5) feet beyond the limits of the backfill area.

Groove type transverse contraction joints shall be constructed by inserting a solid metal plate in the concrete immediately after the finishing machine has passed over the pavement. The metal plate shall be of such shape and dimension to form a groove of the shape and dimension shown on the plans. Before removing the plate, the edges of the groove shall be rounded to form an edge having the radius shown on the plans. The metal plate shall remain in place

until the concrete has set sufficiently to allow the removal of the plate without causing slumping of the concrete.

(b) *Intermediate Transverse Contraction Joints* shall be spaced at intervals and to the depth shown on the plans. These joints shall be formed by sawing with an approved type concrete saw.

(c) *Transverse Construction Joints* shall be made at the close of each day's work or when an interruption occurs of more than thirty (30) minutes' duration. This joint shall be located at least five (5) feet from any other transverse joint and shall be perpendicular to the pavement center line.

A clean plank cut to conform with the cross section of the pavement shall be used. This plank shall be accurately set and held securely in place in a plane perpendicular to the profile and the center line of the pavement. When operations are resumed, the plank shall be carefully removed; all surplus concrete or materials on the subgrade shall be cleaned away; and the fresh concrete shall be deposited directly against the old concrete.

Dowel bars of the size, length and spacing shown on the plans shall be installed when construction joints are required.

(d) *Longitudinal Joints* shall be of the tongue and groove type and of the dimensions shown on the plans. These joints shall be provided with longitudinal joint supports or tie bars of the type, size and spacing as shown on the plans; and as required in Section 705, "Reinforcing Steel."

The face of the longitudinal joint shall be painted with approved bituminous material before the adjacent lane is constructed.

(e) *Bituminous Joint Filler*. Joints shall not be poured until the artificial curing of the pavement has been completed. The concrete surface shall be thoroughly dry and the sides and bottom of the joint shall be cleaned of all loose scale, dirt, laitance and other foreign matter before the joints are filled.

The joint filler specified in Article 405-4 shall have a temperature of not less than 225° F., nor more than 275° F., when poured into the joint. As the filler cools and subsides, additional material shall be added so that the joint will be flush full when the filler has cooled to air temperature.

The pouring shall be done by means of a device acceptable to the Engineer, and the pouring shall be manipulated

in such a manner that the bituminous material shall not spread over the surface on either side of the joint, nor spilled on exposed surfaces of curbs or structures.

405-12. Finishing Concrete. The sequence of operations after the placing of the concrete shall be: Striking off and consolidating, floating, scraping and testing surface with straight edge and preliminary finishing; then edging and final finishing with burlap drag.

(a) *Striking Off and Consolidating the Concrete* shall be accomplished by employing mechanical methods except that where the pavement width will not permit the use of a finishing machine, hand methods may be allowed.

(1) *Machine Methods:* After the concrete has been deposited it shall be struck off and consolidated by an approved finishing machine to such an elevation that when all finishing operations are completed, the surface will conform to the required finished grade. While striking off, a uniform ridge of concrete at least four (4) inches above the finished pavement grade shall be maintained ahead of the screed for its entire length. In consolidating, the finishing machine shall operate over each section of the pavement at least twice. Only sufficient mortar shall be worked to the surface to provide for a dense smooth finish. Excessive operation of the machine over a given area will not be permitted. Segregated particles of coarse aggregate, which may collect in front of the screed, shall be thoroughly mixed by hand with the mass of concrete already on the subgrade.

(2) *Hand Methods:* When striking off and consolidating by hand methods are permitted, the concrete shall be approximately levelled and then struck off to such elevation that when properly consolidated the surface will conform to the required finished grade. The entire area of the pavement shall be so consolidated as to insure a minimum of voids. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither end is raised from the side forms during the process. A slight excess of concrete shall be kept in front of the cutting edge at all times. When striking off and consolidating by hand methods, pours will be limited to single lane widths or less.

(b) *Longitudinal Floating of the Surface* shall follow the striking off and consolidating specified above to make the surface uniform. Longitudinal floating will be required except in places where this method is not feasible. In such

areas floating with the ten (10) foot float may be authorized.

(1) *Longitudinal Floating:* The mechanical longitudinal float shall be accurately adjusted and coordinated with the screed adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward travel shall be adjusted so that the float will pass over each section of pavement at least two times, or as otherwise directed. Excessive operation over a given area will not be permitted. Any excess water or soupy material shall be discharged over the form on each pass.

In the case of an emergency a wooden float board may be authorized for longitudinal floating. This shall be made of a flat board not less than sixteen (16) feet in length and eight (8) inches in width with conveniently placed handles at each end. It shall be operated by two (2) men, one at each end, each man standing on a bridge spanning the pavement. The entire surface shall be floated with the long dimension of the float parallel to the center line of the pavement. The float shall then be drawn back and forth in slow strokes about two (2) feet long, and shall advance slowly from one side of the pavement to the other in order to produce a uniform even surface free from transverse waves. Each section floated shall overlap the section previously floated by from three (3) to four (4) feet.

Where authorized, the ten (10) foot float shall be operated across the pavement by starting at the edge and slowly moving to the center and back again to the edge. The float shall then be moved forward one-half of its length and the above operations repeated. Care shall be taken to preserve the crown and cross section of the pavement.

(c) *Scraping with Lute, Testing Surface with Straight Edge and Finishing with Burlap Drag:* As soon as the preceding operations are completed, all laitance, surplus water and inert material shall be worked entirely off the pavement, and the surface made smooth by scraping or dragging with an approved hand operated wooden lute ten (10) feet in length. The wooden lute shall be placed on the form or edge of the adjacent concrete slab and shall be moved slowly over the surface of the concrete transversely from one side to the other and returned in such a manner that the cutting edge of the lute shall be parallel to the center line of the pavement at all times. Longitudinal movements of the lute shall be made by raising it completely above the surface and lift-

ing it ahead to its next position, allowing for adequate and proper lapping.

After the use of the wooden lute, the procedure specified above shall be repeated with a steel lute to remove any slight irregularities which might remain in the pavement surface. The steel lute shall be operated approximately twenty-five (25) feet behind the wooden lute or at such a distance therefrom as may be directed.

Lutes shall be checked on a master straight edge twice a day; once in the morning before use and again at noon. Any variation from a true plane must be corrected before further use.

The surface shall be tested for smoothness with an approved straight edge furnished by the Contractor. During this operation the contact of the straight edge with the concrete shall be uniform over the entire length tested. Should there appear on the concrete surface any unevenness amounting to more than one-eighth ($\frac{1}{8}$) inch in ten (10) feet, it shall be corrected in a satisfactory manner.

Final finishing operations shall be accomplished by the use of a burlap drag. A seamless strip of damp burlap or cotton fabric which will produce a uniform surface of gritty texture by dragging the fabric along the full width of the pavement shall be used for the final finishing of the pavement surface. The fabric drag shall be at least two (2) feet longer than the width of the pavement being finished and shall be dragged in a longitudinal direction. The fabric shall be cleaned or replaced as often as necessary to obtain the required surface texture. Dragging shall be completed before the concrete is in such condition that it will be torn or unduly roughened and before the concrete has attained its initial set.

(d) *Edging and Final Finishing with Burlap Drag:* Immediately after the initial finishing with burlap, the edges of the slab and all joints shall be finished with an edging tool to the radii shown on the plans. The pavement shall then be given a final finish by dragging the damp burlap or cotton fabric over the full width of the pavement for the second time.

405-13. *Curing Concrete.* As soon as the concrete has set sufficiently to prevent marring, the top surface shall be completely covered with wetted burlap. All new burlap and all burlap which has been used for purposes other than the curing of concrete shall be thoroughly washed before being used

for curing concrete pavement. The burlap shall be kept thoroughly wet and shall remain until after the final set, or in any case for twenty-four (24) hours after placing. The application of the final curing agent shall be made immediately after removal of the wet burlap. No concrete shall be left unprotected for more than one-half ($\frac{1}{2}$) hour. When the burlap is removed the pavement shall be treated by one of the following methods:

(a) *Straw or Hay Curing.* The entire surface of the pavement shall be covered with clean loose straw or hay at the rate of not less than four (4) pounds dry weight per square yard. This covering shall be thoroughly wetted as soon as placed and kept saturated for four (4) days unless otherwise directed. If the covering becomes displaced during the curing period it shall be immediately replaced to the amount specified. The covering shall be maintained on the pavement until the required time has elapsed. It may then be re-used when authorized or shall be disposed of in such a manner as to leave the right of way in a neat and presentable condition. The material shall not be disposed of by burning on, or adjacent to, the pavement.

(b) *Cotton Mat Curing.* The entire surface of the pavement shall be covered with standard cotton mats as required in the latest revised specifications of the A.A.S.H.O. Standard Specifications for Cotton Mats for Curing Concrete, Designation M-73.

The mats shall be thoroughly wetted as soon as placed and kept saturated for four (4) days.

(c) *Waterproof Paper Curing.* The entire surface of the pavement shall be covered with standard waterproof paper so that after shrinking it will completely cover the surface and both sides of the pavement. The waterproof paper shall meet the requirements of the latest revised specifications of the A.A.S.H.O. Standard Specification for Waterproof Paper for Curing Concrete, Designation M-139.

The pavement shall be thoroughly wetted prior to placing the waterproof paper, which shall be kept in place for four (4) days. Paper, not providing an air tight covering, shall be rejected and not reused unless repaired satisfactorily. The edges and laps shall be sealed to prevent the loss of moisture.

405-14. *Protection of Concrete.* The Contractor shall erect and maintain suitable barricades, and employ the number of watchmen necessary to exclude traffic from the newly

constructed pavement for the period required, but these 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, and necessary signs clearly indicating the lanes open to the public shall be maintained by the Contractor. When it is necessary to provide for traffic across the pavement the Contractor shall construct at his expense, immediately after the finishing of the concrete, the necessary bridges over the pavement clear of the forms and at least three (3) inches clear of the concrete, and sufficiently strong to carry the traffic. He shall maintain these bridges for a period of four (4) days after which time he may remove them and cover the concrete with a six (6) inch deep mat of earth which must be maintained for the full depth until the concrete is ready to be opened for traffic as specified in Article 405-15.

Newly laid pavement, threatened with damage by rain, shall be protected with a covering of canvas, burlap, cotton fabric, waterproof paper or by other approved means. Sufficient material for covering up to three hundred (300) linear feet of pavement slab shall be on hand at all times for emergency use.

No pavement shall be placed after October 15th. At any time when there is danger of freezing temperatures and in all cases after September 15 there shall be available a sufficient amount of clean, dry straw or hay to cover at least 1500 linear feet of pavement and as much more as may be necessary for the protection in accordance with these specifications.

When the temperature falls below 40° F. at any time during the first seven (7) days after the concrete is placed, the pavement shall be protected by the addition of not less than eight (8) pounds per square yard of loose dry straw or hay which shall remain in place as long as the temperature is below 40° F. during this period of seven (7) days.

405-15. Opening Pavement to Traffic. Traffic will ordinarily be excluded from the newly constructed pavement for a period of fourteen (14) days after the concrete has been placed, and may be excluded for a longer period, if cross-bending tests indicate that it is advisable to extend this time. Cross-bending test specimens, prepared at regular intervals from the mix as it comes from the mixer and cured under the same temperature, moisture, and climatic conditions as the corresponding slabs of pavement shall be employed as a means of fixing the time of opening the pavement to traffic.

These beams will be tested by standard laboratory methods and when these specimens as tested indicate that the corresponding pavement has attained a modulus of rupture of not less than 550 pounds per square inch the pavement shall be cleaned, the joints filled and trimmed, and the pavement opened to traffic. If this strength is attained in less than fourteen (14) days, the Engineer may open the pavement to traffic at his discretion. If it is not attained within fourteen (14) days, the pavement shall be kept closed until this strength is attained.

In all cases, before being opened to traffic, the pavement shall be cleaned and the joints shall be filled and trimmed or topped out as required. The joint or line of separation between adjacent strips or slabs of concrete, when the pavement is constructed in lanes or strips, shall be cleaned and filled with bituminous material required for this purpose.

METHOD OF MEASUREMENT

405-16. The quantity of "Portland Cement Concrete Pavement" to be measured for payment shall be the number of square yards of surface area of this course, completed, accepted and measured as follows:

The length shall be the actual surface length at the center of the roadway. The width shall be the width of the pavement shown on the plans. No deductions for areas occupied by drop inlets, catch basins, and manholes shall be made.

BASIS OF PAYMENT

405-17. All work done under plain or reinforced "Portland Cement Concrete Pavement" will be paid for at the contract unit price per square yard, which payment shall be full compensation for furnishing, processing, mixing, hauling, placing, finishing and curing; for furnishing all labor, equipment, materials (including cement, steel reinforcing, dowels, load transfers, longitudinal joint supports and bituminous joint material), tools and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 405-18	Plain Portland Cement Concrete Pavement	—per square yard
Item 405-19	Reinforced Portland Cement Concrete Pavement	—per square yard

DIVISION V

BITUMINOUS MATERIAL

Bituminous material consists of a mixture of hydrocarbons. It includes road tars; asphalt cements; asphalt emulsions of rapid curing, medium curing, and slow curing grades; and cut-back asphalts of rapid curing and medium curing types used in constructing base courses, surface courses and pavements.

SECTION 501

ROAD TAR

DESCRIPTION

501-1. General. "Road Tar" shall be bituminous material produced from coal tar, water gas tar, or from a combination of such tars with their constituents, and shall be used for treatment of gravel surfaces, for surface mixes and seal coats.

MATERIAL

501-2. General. Tar shall be homogeneous and shall conform to the requirements of the latest revised standard specification for "Tar for Use in Road Construction" of the A.A.S.H.O., Designation M-52. Test reports representing the bituminous material to be used shall be supplied by authorized agents to the Engineer prior to use of the material.

EQUIPMENT

501-3. Distributor. The distributor shall have a minimum capacity of 700 gallons, and shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface at readily determined and controlled rates within one-hundredth (1/100) gallon per square yard for any quantity from one-tenth (1/10) to one (1) gallon per square yard, and shall be capable of distributing a uniform and constant flow of bituminous material through all nozzles at a pressure of thirty (30) to sixty (60) pounds per square inch. The distributor shall be equipped with the following appliances and devices all in good working condition:

Tachometer

Pressure gauge

Adjustable length spray bars to sixteen (16) feet

Plugs for nozzle openings to permit adjustment of spray bars in increments of six (6) inches
Wind guard on end of spray bar
Separate power unit and pump on distributing system
Strainers at outlets to pumps
Heating coils and burner
Thermometer well and accurate thermometer
Calibrated measuring stick
Hand hose with nozzle
Manufacturer's tank capacity displayed
Pouring pot
Squeegee

CONSTRUCTION METHODS

501-4. General. The consistency limits of road tars are subdivided into grades RT-1 to RT-12, and grades RTCB-5 and RTCB-6, so that material may be chosen to meet the local conditions of temperature, road conditions and climate.

In general RT-4, RT-5, or RT-6 shall be used for treatment of gravel surface; RT-7, for bituminous gravel surface, both mixed-in-place and pre-mixed; RT-8 and RT-9, for crushed gravel or stone mixes. When necessary, because of weather or temperature conditions, other grades of tar may be used if authorized.

Under normal conditions, the same grade tar may be used for seal that is used for the treatment or mixture.

Road tar shall be used at the temperature and rate specified in the item under which it is to be used.

METHOD OF MEASUREMENT

501-5. The quantity of "Road Tar" to be measured for payment shall be the number of gallons (231 cubic inches) of the material satisfactorily applied, measured at a temperature of 60° F. or by converting the number of gallons measured at other temperatures to the number of gallons at 60° F., computed by using the coefficient of expansion of 0.00035 per degree Fahrenheit for Group 0 consisting of grades RT-1 to RT-4, inclusive; and the coefficient of expansion of 0.00030 per degree Fahrenheit for Group 00, consisting of grades RT-5 and heavier. "Delivery Slips" shall be required as specified in Article 401-9.

BASIS OF PAYMENT

501-6. This material will be paid for at the contract unit price per gallon for "Road Tar," which payment shall be full

compensation for obtaining the material, hauling, heating, applying and curing; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 501-7 Road Tar —per gallon

SECTION 502

ASPHALT CEMENT

DESCRIPTION

502-1. **General.** "Asphalt Cement" shall be a bituminous material produced from petroleum or from fluxing refined Trinidad Lake asphalt with a suitable petroleum flux and shall be used in the construction of bituminous macadam base course and in the manufacturing of bituminous concrete.

MATERIAL

502-2. **General.** Asphalt cement shall be homogeneous, of the penetration grade called for in the item under which it is to be used, and shall conform to the requirements of the latest revised standard specification for "Asphalt Cement" of the A.A.S.H.O., Designations M-20 or M-22.

Test reports representing the bituminous material to be used shall be supplied by authorized agents to the Engineer prior to use of the material.

EQUIPMENT

502-3. **Distributor.** The distributor shall conform to the requirements of Article 501-3, "Distributor," except that it shall be designed to apply the material at the rate of from one-tenth (1/10) gallon to two (2) gallons per square yard.

CONSTRUCTION METHODS

502-4. **General.** The penetration grade of asphalt cement shall be from 85-100 for bituminous concrete mixes and from 100-120 for bituminous macadam base courses.

Asphalt cement shall be applied at the temperature and rate specified in the item under which it is to be used.

METHOD OF MEASUREMENT

502-5. The quantity of "Asphalt Cement" to be measured for payment shall be the number of gallons (231 cubic inches)

of the material satisfactorily applied, measured at a temperature of 60° F. or by converting the number of gallons measured at other temperatures to the number of gallons at 60° F. computed by using the coefficient of expansion of 0.00035 per degree Fahrenheit. "Delivery Slips" shall be required as specified in Article 401-9.

BASIS OF PAYMENT

502-6. This material will be paid for at the contract unit price per gallon for "Asphalt Cement," which payment shall be full compensation for obtaining the material, hauling, heating and applying; for furnishing all labor, equipment, tools and all other incidentals necessary to complete the work, except that:

(a) Asphalt cement when used in bituminous concrete mixes shall not be paid for directly, but shall be considered incidental to the item involved.

ITEM FOR PAYMENT

Item 502-7 Asphalt Cement —per gallon

SECTION 503

EMULSIFIED ASPHALT

DESCRIPTION

503-1. **General.** "Emulsified Asphalt" shall be a water asphalt emulsion for use in penetration courses, surface mixtures, or seal coats.

MATERIAL

503-2. **General.** Emulsified asphalt shall be homogeneous, of the type called for, and shall conform to the requirements of the latest revised standard specification for "Emulsified Asphalt" of the A.A.S.H.O., Designation M-140, except for the following requirements:

Test reports representing the bituminous material to be used shall be supplied by authorized agents to the Engineer prior to use of the material.

For Type RS-1

(a) Viscosity, Saybolt Furol at 77° F., Sec. 35-100.

(b) Demulsibility, 35 ml. of 0.02 N, CaCl₂, shall be not less than fifty (50) per cent.

(c) The residue shall have a ductility at 25° C. (77° F.) of not less than 70 cms.

For Type RS-2

(a) Viscosity, Saybolt Furol at 122° F., Sec. 50-400.

For Type AES-2

This material shall pass the following requirements:

Furol Viscosity at 77° F.	20-120
Residue by Distillation	56
Settlement, 5 days	5—
Miscibility, 2 hours	Pass
Stone Coating (Modified*)	Pass
Old Distillate, %	5—
Tests on Residue:	
Float test, secs. at 140° F.	500+
Soluble in CS ₂ (Pet. Asphalt) %	97.5
Ash	2—

*The Modified Stone Coating Test shall be the A.A.S.H.O., Designation T-59, except the mixture of stone and asphalt emulsion shall be mixed vigorously for five (5) minutes, then allowed to stand for three (3) hours, after which the mixture shall be capable of being mixed for an additional five (5) minutes. The mixture of stone and asphalt shall then be rinsed twice with approximately its own volume of water without showing appreciable loss of bituminous film.

For All Types

When authorized, the emulsion may be used before the settlement test is completed, however, if the material fails to pass the settlement test, ownership of this material shall remain with the Contractor.

503-3. Adhesion. The Emulsified Asphalt shall firmly adhere to the surface of the mineral aggregate, even though of hydrophilic character.

EQUIPMENT

503-4. Distributor. The distributor shall conform to the requirements of Article 501-3, "Distributor," except that it shall be designed to apply the material at the rate of from one-tenth (1/10) gallon to two (2) gallons per square yard.

CONSTRUCTION METHODS

503-5. General. Emulsified asphalt Type RS-1 (quick setting, low viscosity) shall be used primarily for penetration of macadam construction and seal coat.

Emulsified asphalt Type RS-2 (quick setting, high viscosity) shall be used primarily for surface treatment or seal coat.

Emulsified asphalt Type MS-3 (medium setting, high viscosity) shall be used primarily for premixing coarse aggregate surface courses or patch.

Emulsified asphalt Type SS-1 (slow setting, medium viscosity) shall be used primarily for premixing of fine aggregate surface courses or patch.

Emulsified asphalt Type AES-2 (slow setting, mixing grade) shall be used for mulching and honing surface treatment.

Emulsified asphalt shall be applied at the temperature and rate specified in the item under which it is to be used.

METHOD OF MEASUREMENT

503-6. The quantity of "Emulsified Asphalt" to be measured for payment shall be the number of gallons (231 cubic inches) of the material satisfactorily applied, measured at a temperature of 60° F., or by converting the number of gallons measured at other temperatures to the number of gallons at 60° F., computed by using the coefficient of expansion of 0.00025 per degree Fahrenheit. "Delivery Slips" shall be required as specified in Article 401-9.

BASIS OF PAYMENT

503-7. This material will be paid for at the contract unit price per gallon for "Emulsified Asphalt (quick setting grade)" being Type RS-1 or Type RS-2; for "Emulsified Asphalt (mixing grade)", being Type MS-3 or Type SS-1; and for "Emulsified Asphalt (mulching grade)", being Type AES-2, as respectively used—which payment shall be full compensation for obtaining the material, hauling, heating, and applying; for furnishing all labor, equipment, tools and all other incidentals necessary to complete the work.

ITEMS FOR PAYMENT

Item 503-8	Emulsified Asphalt (quick setting grade)	—per gallon
Item 503-9	Emulsified Asphalt (mixing grade)	—per gallon
Item 503-10	Emulsified Asphalt (mulching grade)	—per gallon

SECTION 504
CUT-BACK ASPHALT
(Rapid Curing Type)

DESCRIPTION

504-1. General. "Cut-Back Asphalt (rapid curing type)" shall consist of liquid petroleum products produced by fluxing an asphaltic base with a suitable light volatile solvent, to be used in the treatment of road surfaces by seal coats, or for mixing or mulching surfaces during hot and dry weather.

MATERIAL

504-2. General. The "Cut-Back Asphalt" shall be free from water and shall show no separation or curdling prior to use; it shall be of the grade designated in the item under which it is to be used, and shall conform to the requirements of the latest revised standard specifications for "Cut-Back Asphalt" (Rapid Curing Type) of the A.A.S.H.O., Designation M-81.

Test reports representing the bituminous material to be used shall be supplied by authorized agents to the Engineer prior to use of the material.

EQUIPMENT

504-3. Distributor. The distributor shall conform to the requirements of Article 501-3, "Distributor."

CONSTRUCTION METHODS

504-4. General. Of the cut-back asphalts (rapid curing type), the Grade RC-0 shall be used primarily for tack coat; the Grades RC-1 or RC-2 shall be used primarily for seal coat and for mulching; the Grades RC-3 or RC-4 shall be used primarily for seal coat with stone chip cover.

Cut-back asphalt shall be applied at the temperature and rate specified in the item under which it is to be used.

METHOD OF MEASUREMENT

504-5. The quantity of "Cut-Back Asphalt" (Rapid Curing Type) to be measured for payment shall be the number of gallons (231 cubic inches) of the material satisfactorily applied, measured at a temperature of 60° F., or by converting the number of gallons measured at other temperatures to the number of gallons at 60° F., computed by using the co-

efficient of expansion of 0.00035 per degree Fahrenheit for Group 0, consisting of Grades RC-2, RC-3, RC-4, RC-5; and the coefficient of expansion of 0.00040 per degree Fahrenheit for Group 1, consisting of Grades RC-0 and RC-1. "Delivery Slips" shall be required, as specified in Article 401-9.

BASIS OF PAYMENT

504-6. This material will be paid for at the contract unit price per gallon for "Cut-Back Asphalt" (Rapid Curing Type), which payment shall be full compensation for obtaining the material, hauling, heating and applying; for furnishing all labor, equipment, tools, and all other incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 504-7 Cut-Back Asphalt (Rapid Curing Type) —per gallon

SECTION 505

CUT-BACK ASPHALT
(Medium Curing Type)

DESCRIPTION

505-1. General. "Cut-Back Asphalt" (Medium Curing Type) shall consist of liquid petroleum products produced by fluxing an asphaltic base with a suitable light volatile solvent, to be used in the treatment of road surfaces for general-purpose mixing or mulching.

MATERIAL

505-2. General. The "Cut-Back Asphalt" shall be free from water and shall show no separation or curdling prior to use; it shall be of the grade designated in the item under which it is to be used, and shall conform to the requirements of the latest revised standard specifications for "Cut-Back Asphalt" (Medium Curing Type) of the A.A.S.H.O., Designation M-82.

Test reports representing the bituminous material to be used shall be supplied by authorized agents to the Engineer prior to use of the material.

EQUIPMENT

505-3. Distributor. The distributor shall conform to the requirements of Article 501-3, "Distributor."

CONSTRUCTION METHODS

505-4. General. Of the "Cut-Back Asphalt" (Medium Curing Type), the Grades MC-2, MC-3 or MC-4 shall in general be used for mixing or for mulching in constructing gravel or stone surface courses.

"Cut-Back Asphalt" shall be applied at the temperature and rate specified in the item under which it is to be used.

METHOD OF MEASUREMENT

505-5. The quantity of "Cut-Back Asphalt" (Medium Curing Type) to be measured for payment shall be the number of gallons (231 cubic inches) of the material satisfactorily applied, measured at a temperature of 60° F., or by converting the number of gallons measured at other temperatures to the number of gallons at 60° F., computed by using the coefficient of expansion of 0.00035 per degree Fahrenheit for Group 0, consisting of Grades MC-2, MC-3, MC-4, MC-5; and the coefficient of expansion of 0.00040 per degree Fahrenheit for Group 1, consisting of Grades MC-0 and MC-1. "Delivery Slips" shall be required as specified in Article 401-9.

BASIS OF PAYMENT

505-6. This material will be paid for at the contract unit price per gallon for "Cut-Back Asphalt" (Medium Curing Type), which payment shall be full compensation for obtaining the material, hauling, heating and applying; for furnishing all labor, equipment, tools, and all other incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 505-7 Cut-Back Asphalt (Medium Curing Type) —per gallon

SECTION 506

TACK COAT

DESCRIPTION

506-1. General. "Tack Coat" is a bituminous material applied on an existing base or road surface.

MATERIAL

506-2. Bituminous Material. This material shall conform to the specifications for RC-0 or RC-1, "Cut-Back Asphalt," of the A.A.S.H.O., Designation M-81.

CONSTRUCTION METHODS

506-3. General. The surface area where the bituminous material is to be applied shall be cleaned of all dirt, sand, and loose material. Cleaning shall be accomplished by the use of revolving brooms or mechanical sweepers. Undesirable material not removed by the above means shall be cleaned by hand brooming. Small areas may be broomed with hand brooms. The asphalt shall be applied to this area at the rate of 0.10-0.15 gallons per square yard. Material shall be applied to dry areas only. When a total of less than one hundred (100) gallons of the bituminous material is required, it may be made by cutting back 85-100 penetration grade "Asphalt Cement" with an equal amount of hydrocarbon oil (gasoline, kerosene, or fuel oil).

METHOD OF MEASUREMENT

506-4. The quantity of "Tack Coat" to be measured for payment shall be the number of gallons (of 231 cubic inches) at 60° F., of this material acceptably applied. "Delivery Slips" shall be required as specified in Article 401-9.

BASIS OF PAYMENT

506-5. This work will be paid for at the contract unit price per gallon for "Tack Coat," which payment shall be full compensation for preparing and cleaning the surface area; for furnishing and satisfactorily applying all material; for furnishing all labor, equipment, tools and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 506-6 Tack Coat —per gallon

DIVISION VI

MINOR DRAINAGE STRUCTURES

Minor drainage structures shall consist of pipe culverts, storm sewers, underdrains and their appurtenances.

SECTION 601

CORRUGATED METAL PIPE

DESCRIPTION

601-1. General. This item shall consist of installing "Corrugated Metal Pipe" for culverts or storm sewers upon prepared foundations at locations and to lines and grades shown on the plans or as authorized.

MATERIALS

601-2. General. "Corrugated Metal Pipe" shall conform to the latest revised specification of the A.A.S.H.O., Specification M-36.

CONSTRUCTION METHODS

601-3. Bedding of Pipes. The pipes shall be bedded in a foundation of uniform density that is compacted and carefully shaped at the required grade to fit the lower part of the pipe exterior for at least ten (10) per cent of its overall height.

Bedding shall otherwise be in accordance with Section 204—"Structural Excavation."

601-4. Laying Pipe. Laying of pipe shall begin at the outlet; it shall be laid carefully in the prepared bed with the outside laps of circumferential joints pointing up grade. The longitudinal laps parallel to the center line of the pipe shall be placed on the sides of the culvert with outside laps pointing down. The ends of sections shall be fully and closely joined and true to the line and grade given. Each section or joint of pipe shall be securely attached to the adjoining section or joint of pipe with connecting bands, or other approved type of joint. The bands or other type of joints shall be tightly drawn or connected so that a rigid joint will be formed.

All metal, in joints, which is not thoroughly protected by galvanizing shall be coated with an approved asphaltic paint.

All pipe culverts forty-eight (48) inches in diameter and larger shall be elongated along the vertical diameter approx-

imately three (3) per cent by means of steel rods secured by nuts and washers, timber struts or other approved methods. Struts shall be left in place until the fill is thoroughly consolidated.

601-5. Backfilling. Before the pipes are covered the work shall be inspected to see that all joints are properly made and that the pipes are laid true to line and grade.

All backfilling shall be made in accordance with the requirements of Section 206—"Backfill and Special Backfill."

METHOD OF MEASUREMENT

601-6. The amount of pipe to be measured for payment shall be the actual length in linear feet measured along the center line of the pipe, complete in place and accepted.

Measurement for payment of connecting bands will be made at the rate of one linear foot of pipe for each band used, except that bands for pipe having a diameter greater than forty-eight (48) inches will be measured for payment at the rate of two (2) linear feet of pipe for each band.

BASIS OF PAYMENT

601-7. All work done under this section will be paid for at the contract unit price per linear foot for "Corrugated Metal Pipe" culverts of the various sizes, complete in place, which price shall be full compensation for furnishing, hauling and installing the pipe; for all equipment, tools, labor, backfilling and all incidentals necessary to complete the work, except that structural excavation and foundation preparation will be compensated for under Section 204—"Structural Excavation" and/or Article 6 (c) of Section 302—"Gravel Base Course."

SUMMARY OF ITEMS FOR PAYMENT

Item 601- 8	8 Inch Corrugated Metal Pipe	—per linear foot
Item 601- 9	10 Inch Corrugated Metal Pipe	—per linear foot
Item 601-10	12 Inch Corrugated Metal Pipe	—per linear foot
Item 601-11	15 Inch Corrugated Metal Pipe	—per linear foot
Item 601-12	18 Inch Corrugated Metal Pipe	—per linear foot
Item 601-13	21 Inch Corrugated Metal Pipe	—per linear foot
Item 601-14	24 Inch Corrugated Metal Pipe	—per linear foot
Item 601-15	30 Inch Corrugated Metal Pipe	—per linear foot
Item 601-16	36 Inch Corrugated Metal Pipe	—per linear foot
Item 601-17	42 Inch Corrugated Metal Pipe	—per linear foot
Item 601-18	48 Inch Corrugated Metal Pipe	—per linear foot
Item 601-19	54 Inch Corrugated Metal Pipe	—per linear foot

Item 601-20	60 Inch Corrugated Metal Pipe	—per linear foot
Item 601-21	72 Inch Corrugated Metal Pipe	—per linear foot
Item 601-22	84 Inch Corrugated Metal Pipe	—per linear foot

SECTION 602

ASPHALT COATED CORRUGATED METAL PIPE

DESCRIPTION

602-1. General. This item shall consist of installing "Asphalt Coated Corrugated Metal Pipe" for culverts and storm sewers upon prepared foundations at locations and to lines and grades shown on the plans or as authorized.

MATERIALS

602-2. General. "Asphalt Coated Corrugated Metal Pipe" shall conform to the latest revised specification of the A.A.S.H.O., Specification M-36 for "Corrugated Metal Pipe" and in addition shall be completely coated inside and out with an asphalt cement which shall meet the following requirements:

(a) The asphalt cement shall be 99.5% soluble in carbon disulphide and have a softening point between 200° F. and 208° F.

(b) The inside of the pipe shall be uniformly coated for three-fourths ($\frac{3}{4}$) of the circumference (top of pipe when installed) to a minimum thickness of 0.05 inch measured on the crests of the corrugations. The treatment on the bottom quarter of the circumference shall be either coated or paved (smooth pavement) or coated and paved (corrugated pavement):

1. *Coated and paved (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 one-eighth inch above the crests of the corrugations.

2. *Coated and paved (corrugated pavement).* In addition, a corrugated bituminous pavement shall be formed in the invert (bottom of pipe when installed), extending over one-quarter 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 three-eighths inch.

Both types shall meet the following performance requirements:

602-3. Performance Requirements. The asphalt cement shall adhere to the metal tenaciously; it shall not chip off in handling and shall pass the following performance tests:

(a) *Imperviousness Test:* The asphalt cement shall be impervious to liquids as indicated by the following test:

A twenty-five (25) per cent solution of sulphuric acid, a twenty-five (25) per cent solution of sodium hydroxide and a saturated salt solution (such as sodium chloride) shall be held respectively in the valleys of adjacent corrugations for a period of forty-eight (48) hours, during which time no loosening or separation of the bituminous material from the galvanizing shall have taken place.

(b) *Shock Test:* The ability of coated pipe to withstand handling in cold weather is indicated by successfully passing the shock test.

Four test specimens shall be prepared in the form of disks $\frac{3}{8}$ inch thick and 1 $\frac{1}{4}$ inches in diameter. Approximately four ounces of the material sample shall be heated over a low flame until it becomes fluid; then poured into a mold or molds. Care must be exercised to melt the sample at the lowest possible temperature. The sample shall be stirred thoroughly until it is homogenous and free from air bubbles when poured into the molds. The material may be poured in one 1 $\frac{1}{4}$ inch diameter cylinder of such length that the four test specimens may be cut from it, using a wire cutter.

The four specimens shall be cooled in a brine of ice and salt at a temperature of thirty (30) degrees F. for a period of at least one hour. The samples shall then be removed, one at a time, and quickly placed on the anvil of the test apparatus and centered under the plunger. The hammer is then tripped from a height of 5 $\frac{1}{2}$ inches. Not more than 8 seconds shall elapse from the time each specimen is removed from the brine until the hammer strikes the plunger.

For the material to be acceptable, not more than one of the four test specimens shall show a crack. If it is difficult to determine visually whether a specimen has cracked, remove it from the test apparatus and bend the specimen slightly.

The equipment for the shock test consists essentially of a rigid metal anvil or base plate not less than $\frac{1}{2}$ inch thick and resting on a solid foundation; a hammer weighing 2000 grams (4.4 pounds) arranged to fall freely in suitable guides against a plunger weighing 1000 grams (2.2 pounds) and

sliding freely in a vertical sleeve. The lower end of the plunger is spherical in shape with a radius of $\frac{1}{4}$ inch. The hammer is held in its guide by a trip mechanism at a distance of $5\frac{1}{8}$ inches above the plunger.

The split molds for preparing the specimens may be made of brass, with the surfaces amalgamated to prevent sticking, and held together by slip rings pressed on the slightly tapered outside surfaces.

(c) *Flow Test.* The ability of the coating on the pipe to remain in place and not flow or sag at summer temperatures is indicated by successfully meeting the flow test.

Two test specimens in the form of cylinders each $\frac{3}{8}$ inch in diameter and $\frac{1}{4}$ inch in length shall be prepared by pouring the excess molten bitumen from the preparation of the shock test specimens into amalgamated brass molds. Place each specimen in a corrugation of the corrugated slide (slide to be on a 45° slope), so that the lower end of each specimen will rest exactly along the line scribed 6 inches from the bottom edge of the slide. Place the test apparatus with the specimens in place in an oven maintained at 150° F., plus or minus two degrees. After 4 hours, remove from the oven and cool to room temperature. Measure the distance from the bottom of the corrugated plate to the lower edge of the test specimens. This distance subtracted from 6 inches determines the amount of sag or flow. To be acceptable, the flow must not exceed $\frac{1}{4}$ inch for either of the two specimens.

The apparatus for the flow test consists essentially of a corrugated brass plate 0.02 inch thick, 8 inches long, and 4 inches wide, with corrugations running the long way of the plate, and a metal support to hold the plate at a 45 degree angle with the horizontal. The corrugations shall have a crest to crest dimension of $\frac{5}{8}$ inch and a depth of $\frac{3}{16}$ inch. A line is scribed 6 inches from the lower edge. The split molds are similar to those used in the shock test.

CONSTRUCTION METHODS

602-4. *Bedding and Laying Pipes.* This work shall be in conformity with the requirements of Articles 3 and 4 of Section 601—"Corrugated Metal Pipe."

During the hauling, unloading, handling and laying of the pipe, care shall be used to avoid damage to the pipe and to the asphalt coating.

All "Asphalt Coated Corrugated Metal Pipe" culverts forty-eight (48) inches in diameter and larger shall have the

ends cut to the slope called for on the plans. The sloped ends shall be cut and properly treated in the shop before shipment.

602-5. *Backfilling.* Before the pipes are covered the work shall be inspected to see that all joints are properly made and that the pipes are laid true to line and grade.

All backfilling shall be made in accordance with the requirements of Section 206—"Backfill and Special Backfill."

METHOD OF MEASUREMENT

602-6. The amount of pipe to be measured for payment shall be the actual length in linear feet, measured along the center line of the pipe, complete in place and accepted.

When sloped-end pipe is used the amount to be measured for payment shall be the average of the top and bottom lengths measured parallel with the center line.

Measurement for payment of connecting bands will be made at the rate of one (1) linear foot of pipe for each band used, except that bands for pipe having a diameter greater than forty-eight (48) inches will be measured for payment at the rate of two (2) linear feet of pipe for each band.

BASIS OF PAYMENT

602-7. All work done under this section will be paid for at the contract unit price per linear foot for "Asphalt Coated Corrugated Metal Pipe" culverts of the various sizes, complete in place, which price shall be full compensation for furnishing, hauling and installing the pipe; for all equipment, tools, labor, backfilling and all incidentals necessary to complete the work, except that structural excavation and foundation preparation will be compensated for under Section 204—"Structural Excavation" and/or Article 6 (c) of Section 302—"Gravel Base Course."

SUMMARY OF ITEMS FOR PAYMENT

Item 602- 8	8 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602- 9	10 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-10	12 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-11	15 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-12	18 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot

Item 602-13	21 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-14	24 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-15	30 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-16	36 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-17	42 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-18	48 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-19	54 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-20	60 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-21	72 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot
Item 602-22	84 Inch Asphalt Coated Corrugated Metal Pipe	—per linear foot

SECTION 603

REINFORCED CONCRETE PIPE

DESCRIPTION

603-1. General. This item shall consist of installing "Reinforced Concrete Pipe" for culverts and storm sewers upon prepared foundations at locations and to lines and grades shown on the plans, or as authorized.

MATERIALS

603-2. General. "Reinforced Concrete Pipe" shall conform to the latest revised specification of the A.A.S.H.O., Specification M-41 for "Reinforced Concrete Culvert Pipe", Standard and Extra Strength, except as follows:

(a) Portland Cement used shall be Type II A.

(b) "Fine Aggregate" and "Coarse Aggregate" shall conform to the requirements of Articles 701-6 and 701-7—"Portland Cement Concrete," except that the gradation of "Coarse Aggregate" shall meet the following requirements:

	Per Cent
Passing $\frac{3}{4}$ inch sieve	100
Passing $\frac{1}{2}$ inch sieve	30- 75
Passing No. 4 Mesh sieve	0- 5

603-3. Mortar. Mortar for laying pipe and for pointing shall be composed of one (1) part portland cement and two (2) parts of sand.

The portland cement and the sand shall conform to the requirements of Article 603-2—"Reinforced Concrete Pipe."

603-4. Field Inspection. The following requirements for field inspection are a part of the Standard Specification for "Reinforced Concrete Culvert Pipe," A.A.S.H.O., Designation M-41; as required under Article 603-2.

1. Permissible Variations in Dimensions

(a) Variations in the internal diameter shall not exceed plus or minus one (1) per cent for pipe having an internal diameter of thirty-six (36) inches, or less, and shall not exceed plus or minus 0.75 per cent for larger pipe. The shell thickness shall not be less than that intended in the design by more than five (5) per cent at any point.

(b) Variations of the position of the reinforcement shall not exceed one-quarter ($\frac{1}{4}$) inch from the position provided in the design for pipe having an internal diameter of forty-eight (48) inches, or less, and shall not exceed one-half ($\frac{1}{2}$) inch for larger pipe; but the cover on the reinforcement shall not be less than three-quarters ($\frac{3}{4}$) inch at any point.

(c) The underrun in length of pipe from that specified shall be not more than one-eighth ($\frac{1}{8}$) inch per foot with a maximum of one-half ($\frac{1}{2}$) inch in any length of pipe.

2. Workmanship and Finish

Pipe shall be substantially free from fractures, large or deep cracks, and surface roughness. The planes of the ends of the pipe shall be perpendicular to the longitudinal axis.

3. Marking

The following shall be clearly stencilled on the pipe:

(a) The pipe class (by a "C" for Standard-Strength Pipe, and by an "XC" for Extra-Strength Pipe).

(b) The date of manufacture.

(c) The name or trademark of the manufacturer, and

(d) Elliptical pipe with circular reinforcing and circular pipe with elliptical reinforcing shall have the word "Top" or "Bottom" clearly stencilled on the inside of the pipe at the correct place to indicate the proper position when laid.

4. Rejection

Pipe shall be subject to rejection on account of any of the following:

(a) Fractures or cracks passing through the shell, except that a single end crack that does not exceed the depth of the joint shall not be cause for rejection. If a single end crack that does not exceed the depth of the joint exists in more than ten (10) per cent of the pipe inspected, however, the defective pipe shall be rejected.

(b) Defects that indicate imperfect mixing and molding.

(c) Surface defects indicating honeycombed or open texture.

(d) Spalls deeper than one-half ($\frac{1}{2}$) the depth of the joint or extending more than four (4) inches around the circumference. If spalls not deeper than one-half ($\frac{1}{2}$) the depth of the joint or extending not more than four (4) inches around the circumference exist in more than ten (10) per cent of the pipe, however, the defective pipe shall be rejected.

(e) Exposure of the circumferential reinforcement when such exposure would indicate that the reinforcement is misplaced.

(f) The complete absence of distinct web-like markings, which is indicative of a possible deficiency of water in the concrete mix, from the external surface of pipe made by any process in which the forms are removed immediately after the concrete has been placed.

CONSTRUCTION METHODS

603-5. Bedding Pipe. This work shall be in conformity with the requirements of Article 601-3—"Corrugated Metal Pipe."

603-6. Laying Pipe. The pipe shall be carefully laid true to lines and grades given, with hub, bell or groove ends upstream and with spigot or tongue ends fully entered into the adjacent section of pipe. Proper facilities shall be provided for lowering the sections of pipe into place when they are to be placed in a trench. All pipe shall be laid with mortared joints. Before each succeeding section of pipe is laid, the lower portion of the hub, bell or groove of the preceding pipe shall be filled on the inside with sufficient cement mortar to bring the inner surface of the abutting pipe flush and even. After the pipe is laid the remainder of the joint shall be filled with cement mortar, and sufficient additional mortar shall be used to form a bead around the joint. The inside of the joint shall be wiped and finished smooth. After the ini-

tial set, mortar on the outside shall be protected from the air and sun with earth or other covering.

603-7. Backfilling. Before the pipes are covered the work shall be inspected to see that all joints are properly made and that the pipes are laid true to line and grade.

All backfilling shall be made in accordance with the requirements of Section 206—"Backfill and Special Backfill."

METHOD OF MEASUREMENT

603-8. The amount of pipe to be measured for payment shall be the actual length in linear feet, measured along the center line of the pipe, complete in place and accepted.

When a section of "Reinforced Concrete Pipe" with a bell on each end is required, it shall be measured for payment as four (4) additional linear feet of the respective size pipe.

A "concrete collar" as shown on the plans may be substituted for the extra bell and measured for payment as four (4) additional linear feet of the respective size pipe.

BASIS OF PAYMENT

603-9. All work done under this section will be paid for at the contract unit price per linear foot for "Reinforced Concrete Pipe" culverts of the various sizes, complete in place, which price shall be full compensation for furnishing, hauling and installing the pipe (including wooden cradle when required); for all equipment, tools, labor, backfilling and all incidentals necessary to complete the work, except that structural excavation and foundation preparation will be compensated for under Section 204 "Structural Excavation" and/or Article 302-6 (c) "Gravel Base Course".

SUMMARY OF ITEMS FOR PAYMENT

Item 603-10	12 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-11	15 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-12	18 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-13	24 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-14	30 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-15	36 Inch Reinforced Concrete Pipe	—per linear foot

Item 603-16	42 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-17	48 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-18	54 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-19	60 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-20	66 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-21	72 Inch Reinforced Concrete Pipe	—per linear foot
Item 603-22	24 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-23	30 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-24	36 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-25	42 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-26	48 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-27	54 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-28	60 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-29	66 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot
Item 603-30	72 Inch Extra Strength Reinforced Concrete Pipe	—per linear foot

SECTION 604

VITRIFIED CLAY PIPE

DESCRIPTION

604-1. General. This item shall consist of installing "Vitrified Clay Pipe" for storm sewers or other work designated on the plans upon prepared foundations in conformity with the required lines and grades.

MATERIALS

604-2. General. "Vitrified Clay Pipe" shall conform to the latest revised specification of the A.A.S.H.O. Standard Specification M-65 for "Clay Pipe." Unless otherwise called for, Standard Strength shall be used.

604-3. Mortar. Mortar for laying pipe and for pointing shall be composed of one (1) part portland cement and two (2) parts of sand.

The portland cement and the sand shall conform to the requirements of Article 603-2 for "Reinforced Concrete Pipe."

604-4. Field Inspection. The following requirements for field inspection are a part of the standard specification for "Clay Pipe", A.A.S.H.O. Designation M-65, as required under Article 604-2.

1. Workmanship

(a) No blisters shall exceed three (3) inches in diameter and no blisters or pimples shall project more than one-eighth ($\frac{1}{8}$) inch above the surrounding surface of the pipe for sizes up to and including eighteen (18) inches in internal diameter. For sizes over eighteen (18) inches in internal diameter no blisters shall exceed in diameter more than two (2) inches per foot of the internal diameter of the pipe, nor project above the surrounding surface of the pipe more than one-eighth ($\frac{1}{8}$) inch per foot of the internal diameter of the pipe.

(b) The glaze shall consist of a continuous layer of salt glaze substantially free of large blisters or large pimples. Not more than ten (10) per cent of the inner surface of any pipe barrel shall be bare of glaze except the socket, where it may be entirely absent. Glazing shall not be required on the outer surface of the barrel at the spigot end for a distance from the end of the pipe equal to the specified depth of the socket. There shall be no well defined network of crazing line or hair cracks.

2. Rejection. Pipe shall be subject to rejection on account of any of the following:

(a) Fractures or cracks passing through the barrel or socket, except that a single crack at the spigot end of the pipe not exceeding seventy-five (75) per cent of the depth of the socket, or a single fracture in the socket not exceeding three (3) inches around the circumference nor two (2) inches lengthwise may be permitted.

(b) Chips or fractures on the interior of the pipe exceeding two (2) inches in length, one (1) inch in width, and of a depth more than one-fourth ($\frac{1}{4}$) of the thickness of the shell.

(c) Fire cracks or hair cracks sufficient to impair the strength, durability, or serviceability of the pipe.

(d) Variation of more than one-eighth ($\frac{1}{8}$) inch per linear foot in alignment of a pipe intended to be straight.

(e) Insecure attachment of spurs on branches.

CONSTRUCTION METHODS

604-5. **Bedding Pipe.** This work shall be in conformity with the requirements of Article 601-3, "Corrugated Metal Pipe."

604-6. **Laying Pipe.** This work shall be in conformity with the requirements of Article 603-6, "Reinforced Concrete Pipe."

604-7. **Backfilling.** Before the pipes are covered the work shall be inspected to see that all joints are properly made and that the pipes are laid true to line and grade.

All backfilling shall be made in accordance with the requirements of Section 206—"Backfill and Special Backfill."

METHOD OF MEASUREMENT

604-8. The amount of pipe to be measured for payment shall be the actual length in linear feet, measured along the center line of the pipe, complete in place and accepted.

BASIS OF PAYMENT

604-9. All work done under this section will be paid for at the contract unit price per linear foot for "Vitrified Clay Pipe" of various sizes, complete in place, which price shall be full compensation for furnishing, hauling and installing the pipe; for all equipment, tools, labor, backfilling, and all incidentals necessary to complete the work, except that structural excavation and foundation preparation will be compensated for under Section 204—"Structural Excavation" and/or Article 302-6 (c), "Gravel Base Course."

SUMMARY OF ITEMS FOR PAYMENT

Item 604-10	6 Inch Vitrified Clay Pipe	—per linear foot
Item 604-11	8 Inch Vitrified Clay Pipe	—per linear foot
Item 604-12	10 Inch Vitrified Clay Pipe	—per linear foot
Item 604-13	12 Inch Vitrified Clay Pipe	—per linear foot
Item 604-14	15 Inch Vitrified Clay Pipe	—per linear foot
Item 604-15	18 Inch Vitrified Clay Pipe	—per linear foot
Item 604-16	21 Inch Vitrified Clay Pipe	—per linear foot
Item 604-17	24 Inch Vitrified Clay Pipe	—per linear foot
Item 604-18	30 Inch Vitrified Clay Pipe	—per linear foot
Item 604-19	36 Inch Vitrified Clay Pipe	—per linear foot

SECTION 605

DROP INLETS, CATCH BASINS AND MANHOLES

DESCRIPTION

605-1. **General.** This item shall consist of constructing "Drop Inlets, Catch Basins and Manholes" where called for on and in conformity with the plans, and in accordance with the required locations and elevations.

MATERIALS

605-2. **General.** Catch basins and manholes shall be constructed of portland cement concrete, portland cement blocks, brick or stone masonry. Drop inlets shall be constructed of portland cement concrete.

(a) For catch basins, manholes or drop inlets being constructed of portland cement concrete, the concrete shall conform to the requirements of Section 701—"Portland Cement Concrete," Class "A".

(b) For catch basins and manholes being constructed of portland cement concrete blocks, the blocks shall be of an approved design and shall be made from materials conforming to the requirements of Section 701—"Portland Cement Concrete," and blocks shall be machine made solid segments not less than eight (8) inches in width. The blocks shall have a compressive strength of at least two thousand (2,000) pounds per square inch and the maximum average absorption as obtained by the A.A.S.H.O. Standard Method T-33 shall not exceed twelve (12) per cent.

(c) For catch basins and manholes being constructed of brick, the bricks shall conform to the requirements of the Standard Specifications of "Sewer Brick," A.A.S.H.O. Designation M-91, Grade "NA."

(d) For catch basins and manholes being constructed of stone, the stone shall consist of sound, hard granite blocks, rectangular in shape, six (6) inches to twelve (12) inches in length, three and one-half ($3\frac{1}{2}$) inches to six (6) inches wide and three and one-half ($3\frac{1}{2}$) inches to six (6) inches thick. The face of the block shall have no depression or point more than one-half ($\frac{1}{2}$) inch from the mean plane of the face.

(e) Mortar used in laying portland cement concrete blocks, bricks and stone blocks shall conform to the requirements of Article 603-3, "Mortar."

605-3. Granite Curb Inlets shall be made from sound, durable granite, free from seams and shall conform to the requirements of Section 901—"Granite Curb," and shall be shaped to provide an inlet to a Type "C" catch basin in accordance with the Standard Details of the plans.

605-4. Castings for frames, covers, gratings, traps, etc., shall be made from the best quality gray iron and shall conform to the latest specification for Gray Iron Castings of the A.S.T.M. Designation A-48. Class No. 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 position 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.

CONSTRUCTION METHODS

605-5. General. "Drop Inlets," "Catch Basins" and "Manholes" shall be constructed upon portland cement concrete bases in conformity with the plans.

(a) Concrete shall be proportioned, mixed and placed in accordance with the requirements of Section 701—"Portland Cement Concrete."

(b) Cement Concrete Blocks shall be laid on the prepared concrete base by a competent mason and in a workmanlike manner. The blocks shall be soaked in water before laying. All joints shall be completely filled with mortar. No joint shall be greater than one-half ($\frac{1}{2}$) inch in thickness. Joints shall be neatly pointed on the inside of the structure.

As the walls are laid up, they shall be plastered on the outside with mortar to a minimum thickness of one-quarter ($\frac{1}{4}$) inch.

(c) All brick and stone masonry shall be laid on the prepared concrete base by a competent mason and in a workmanlike manner. Bricks shall be well soaked in water before laying. Every fourth course shall consist of headers. The dome shall be wholly composed of headers. All joints shall be completely filled with mortar.

No joint on the face shall be greater than one-quarter ($\frac{1}{4}$) inch in thickness for brick masonry or more than one-half

($\frac{1}{2}$) inch in thickness for stone masonry. All joints shall be neatly pointed on the inside.

As the walls are laid up they shall be plastered on the outside with mortar to a minimum thickness of one-quarter ($\frac{1}{4}$) inch.

605-6. Castings for frames, covers, gratings and traps shall conform to the dimensions and details shown on the plans and shall be coated with coal tar pitch varnish. Castings shall be set in full mortar beds or otherwise secured as shown on the plans. Castings shall be set accurately to correct elevation so that no subsequent adjustment will be necessary.

605-7. Backfilling shall conform to the requirements of Section 206—"Backfill and Special Backfill."

605-8. Cleaning of all catch basins, manholes and drop inlets shall be thorough. All accumulations of silt, debris and foreign matter of any kind shall be removed before the time of final inspection.

605-9. Adjusting to Grade for any existing Drop Inlet, Catch Basin or Manhole shall consist of removing cover, grate and/or frame of the unit and in removing the necessary amount of the walls to allow rebuilding the unit in accordance with the plans, or as authorized, to meet the required finished grade. This work shall include replacement of the existing frame and/or grate or cover as well as the addition, when required, of new bricks, blocks or concrete to complete the walls and top all in accordance with the specifications for complete units under this section.

METHOD OF MEASUREMENT

605-10. The quantity to be measured for payment under this section shall be the number of completed units, or units plus fractions of a unit, measured as follows, in the completed and accepted structure.

Each unit having a depth of eight (8) feet or less, measured vertically from the top of the grating or cover to the top of the floor or base will be considered as one unit. When the depth of any unit exceeds eight (8) feet it will be considered as one unit plus one-eighth ($\frac{1}{8}$) unit for each foot of additional depth, measured as above, to the nearest foot.

The quantity of "Traps" to be measured for payment under this item will be the number of traps in the completed and accepted work. The quantity to be measured for payment of

"Adjusting Drop Inlets, Catch Basins or Manholes to Grade" shall be the number of units satisfactorily adjusted to grade as called for on the plans, or authorized, completed and accepted.

BASIS OF PAYMENT

605-11. All work done under this section will be paid for at the contract unit price each for the respective items listed below, which price shall be full compensation for furnishing all material, including grates, covers, frames, steps, steel eyebolts, granite curb inlets, and reinforcing; for all back-filling, equipment, tools, labor and all incidentals necessary to complete the work, except that structural excavation will be compensated for under Section 204—"Structural Excavation".

SUMMARY OF ITEMS FOR PAYMENT

Item 605-12	Drop Inlets—Type A	—per each
Item 605-13	Drop Inlets—Type B	—per each
Item 605-14	Catch Basins—Type A	—per each
Item 605-15	Catch Basins—Type B	—per each
Item 605-16	Catch Basins—Type C	—per each
Item 605-17	Catch Basins—Type D	—per each
Item 605-18	Catch Basins—Type E	—per each
Item 605-19	Manholes—Type A	—per each
Item 605-20	Manholes—Type B	—per each
Item 605-21	8" Traps	—per each
Item 605-22	12" Traps	—per each
Item 605-23	Adjusting Drop Inlets, Catch Basins or Manholes to Grade	—per each

SECTION 606

UNDERDRAIN

DESCRIPTION

606-1. General. This item shall consist of constructing underdrains and underdrain outlets in prepared trenches, to the lines and grades shown on the plans.

MATERIAL

606-2. General. Materials used in the construction of "Underdrains" and "Underdrain Outlets" shall meet the following requirements:

(a) Perforated Asphalt Coated Corrugated Metal Pipe shall conform to the latest requirements of the Standard

Specifications for Corrugated Metal Pipe Underdrains, A.A.S.H.O. Designation M-136. For pipe sizes greater than twenty-one (21) inch diameter, the pipe shall conform to the requirements of the Standard Specifications for Corrugated Metal Culvert Pipe, A.A.S.H.O. Designation M-36 and Perforations shall be as specified under Designation M-136.

All pipe shall be coated with asphalt cement which shall be 99.5% soluble in carbon disulphide. The entire pipe shall be coated to a minimum thickness of three hundredths (0.03) of an inch. The thickness shall be measured on the crest of the corrugations. Pipe used in underdrain outlets need not be perforated.

(b) Vitrified Clay Pipe used for underdrains shall conform to the specifications for Section 604—"Vitrified Clay Pipe."

(c) Plain cement concrete pipe used for underdrain shall conform to the requirements of the Standard Specifications for Concrete Sewer Pipe, A.A.S.H.O. Designation M-86.

(d) Granular material for backfill in Type "A" underdrain shall conform to the requirements of Section 302—"Gravel Base Course."

(e) Granular material for backfill in Type "B" underdrain shall be clean, fine material free from clay, silt or organic matter and shall conform to the following gradation requirements:

Sieve Size Square Mesh Openings	Per Cent By Weight Passing
1 inch	100
½ inch	75-100
No. 4 mesh	50-100
No. 20 mesh	15- 80
No. 50 mesh	0- 15

(f) For Type "C" Underdrain, crushed stone or granular material shall conform to the following gradation requirements:

GRADATION REQUIREMENTS FOR TYPE "C" UNDERDRAIN

Sieve Size Square Mesh Openings	Per Cent By Weight Passing
1 inch	100
No. 4 mesh	0- 5

CONSTRUCTION METHODS

606-3. For Type "A" Underdrain, the trench shall be excavated to the required width and depth shown on the plans.

The trench shall then be filled with the granular material specified in Article 606-2 (d). This material shall be placed in twelve (12) inch layers and each layer shall be thoroughly compacted.

606-4. For Type "B" Underdrain the trench shall be excavated to the required width and depth called for on the plans. A bed of the required granular material six (6) inches in depth shall be placed in the trench; on this prepared bed the six (6) inch perforated asphalt coated corrugated metal pipe shall be laid true to line and grade with the perforations on the bottom side of the pipe.

After the pipes have been firmly bedded and all joints securely connected and the pipe inspected, granular material meeting the requirements of Article 606-2 (e) shall be filled over and around the pipe in layers not exceeding twelve (12) inches in depth. Each layer shall be thoroughly compacted.

When authorized, six (6) inch Vitrified Clay Pipe or Plain Cement Concrete Pipe of the bell and spigot type meeting the requirements of Article 606-2 (b) and 606-2 (c) may be used. When this type of pipe is used it shall be laid true to line and grade on the six (6) inch granular bed, with the bell end upgrade. The joints shall be open, with the spigot end fully entered into the adjacent bell. All joints shall be tightly wrapped with a strip of burlap not less than one (1) foot in width having both ends securely tucked beneath the bell.

After inspection, backfilling as required above shall be placed in the trench.

606-5. For Type "C" Underdrain the trench shall be excavated to a width equal to the diameter of the pipe plus eighteen (18) inches and to the depth shown on the plans.

The perforated asphalt coated corrugated metal pipe of the size called for in the proposal shall be laid true to line and grade and centered on the bottom of the trench with the perforations uppermost. All pipe sections shall be securely connected by bands, and inspected before backfilling. The pipe shall be bedded and backfilled on each side to the level of the lower perforations with approved excavated material and thoroughly compacted. Care shall be taken to keep backfill material from entering the perforations.

Granular material or crushed stone conforming to the requirements of Article 606-2 (f) shall be placed to the full width of the trench and to a depth of six (6) inches above the pipe and shall be carefully and thoroughly compacted.

Upon this compacted backfill, granular material conforming to the requirements of Article 606-2 (e) shall be placed in layers not exceeding twelve (12) inches in depth. Each layer shall be thoroughly compacted.

606-6. Underdrain Outlets for Type "B" Underdrain shall be constructed where required to carry the water entirely away from the roadway. These outlets shall be constructed of the same type of pipe used in the underdrain itself, except that in the case of metal pipe the perforations may be omitted; and with vitrified clay or cement concrete pipe, the joints shall be mortared as required under Article 603-6—"Reinforced Concrete Pipe."

Trenches for "Underdrain Outlets," laying pipe and backfilling shall conform to the requirements of Section 601—"Corrugated Metal Pipe," or Section 603—"Reinforced Concrete Pipe," (for vitrified clay and cement concrete pipe outlets).

METHOD OF MEASUREMENT

606-7. The quantity to be measured for payment under this section shall be the length in linear feet of underdrains of the various types and sizes, and underdrain outlets, completed and accepted. Measurements shall be taken along the center line of the underdrain or center line of the outlet pipe.

When elbows, "Y's," "T's," or other special connections are required in underdrains, each connection shall be measured for payment as three (3) additional linear feet of underdrain of the respective type and size involved.

BASIS OF PAYMENT

606-8.

(a) All work done under this section for "Underdrain" will be paid for at the contract unit price per linear foot for the various types and sizes complete in place, which price shall include full compensation for all pipes, bands and materials; for hauling, laying pipe and backfilling; for all equipment, tools, labor and all incidentals necessary to complete the work, including connections with other drainage structures, except that structural excavation will be paid for under Section 204—"Structural Excavation."

(b) All work done under this section for "Underdrain Outlets" will be paid for at the contract unit price per linear foot complete in place, which price shall be full compensation for furnishing and installing the pipe, bands and ma-

terials; for backfilling; for all equipment, tools, labor, and all incidentals necessary to complete the work, including connections with other drainage structures, except structural excavation which will be paid for under Section 204—"Structural Excavation." For "Underdrain Outlets" requiring pipe larger than six (6) inches in diameter, payment will be made at the respective contract unit price for the size and type of pipe used.

SUMMARY OF ITEMS FOR PAYMENT

Item 606-9	Underdrain—Type A	—per linear foot
Item 606-10	Underdrain—Type B	—per linear foot
Item 606-11	12 Inch Underdrain—Type C	—per linear foot
Item 606-12	15 Inch Underdrain—Type C	—per linear foot
Item 606-13	18 Inch Underdrain—Type C	—per linear foot
Item 606-14	21 Inch Underdrain—Type C	—per linear foot
Item 606-15	24 Inch Underdrain—Type C	—per linear foot
Item 606-16	Underdrain Outlets	—per linear foot

DIVISION VII

MAJOR DRAINAGE STRUCTURES

Major drainage structures shall consist of bridges, structural plate culverts, portland cement concrete culverts, retaining walls and other related items.

SECTION 701

PORTLAND CEMENT CONCRETE

DESCRIPTION

701-1. General. This item shall consist of constructing all or portions of structures of the required class or classes of Portland Cement Concrete, with or without steel reinforcement, as called for on the plans.

(a) Concrete shall be composed 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 shown in detail on the plans.

(b) All concrete shall be air-entrained and, at the option of the Contractor, may be a concrete containing either an air-entraining admixture or an air-entraining portland cement.

1. Air-entrained concrete, in addition to conforming to the master limits shown in Tables No. 1 and No. 2 in Article 701-3 for the classes specified, shall contain not less than four (4) nor more than seven (7) per cent entrained air. Determination of the quantity of air entrained in concrete shall be made on the concrete as produced by the mixer and normal mixing methods used in producing concrete for the work.

2. If it is found impossible to produce concrete having the required air content with the materials and mixing methods being used, the materials or methods of mixing, or both, shall be changed in order to *secure the required air content*.

701-2. Classes of Concrete. The classes of concrete are A, B, Alt. B, S and Y. The class of concrete used in each part of the structure shall be that called for on the plans,

and in general shall conform with the following, unless changed by the Special Provisions:

Class A concrete is intended for use in all reinforced sections, except as noted below, in all work exposed to salt water and in concrete pavement.

Class B or (Alt. B) concrete is intended for use in massive sections, lightly reinforced, and in concrete base course.

Class S concrete is intended for use in concrete to be deposited under water.

Class Y concrete is intended for use in thin reinforced sections.

701-3. Composition of Concrete. The master limits shown in Table 1 and Table 2 govern the proportions for all classes of concrete throughout the progress of the work. The exact proportions of cement, fine aggregate, coarse aggregate, and water will be designated by the Engineer under the procedure prescribed in subsections (a) and (b), and shall be such as to require a water content and a consistency within the limits prescribed in Table 1 and Table 2. The Engineer also will designate the equivalent batch weights. The Contractor shall put into each batch the amount of cement and amount of water and shall weigh into each batch the respective weights of fine and coarse aggregates designated by the Engineer for the particular material being used and the class of concrete being made.

In batching aggregates for contracts having an estimated quantity of less than one hundred (100) cubic yards of concrete, the fine aggregate shall be weighed, as provided below. 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 less than twenty-five (25) cubic yards of concrete, the Contractor may use approved volumetric measuring devices for both fine and coarse aggregate.

(a) Determining the proportions and batch weights: The proportions and batch weights will be determined as prescribed in subsections 1 and 2. The determination will be made after the materials furnished by the Contractor have been accepted for the project.

1. The Engineer will designate the weights in pounds of fine and coarse aggregates in saturated surface-dry condition per bag (94 pounds) of cement, and the gallons of water per bag of cement which will be necessary to obtain the required slump for the given class of concrete, and these proportions shall not be changed during the progress of the work except as provided in (b).

2. Batch weights: The Engineer will also designate the batch amount of each ingredient in pounds, except, however, that the amount of water may be designated in gallons. Since the proportions are designated in terms of aggregates in saturated surface-dry condition, the equivalent batch weights of aggregates and water to be used by the Contractor will have to be corrected periodically to take into account the actual moisture content of the aggregate at time of use.

3. The coarse aggregate shall be supplied in, and kept separated into, at least two different sizes and the amount of each size to be used shall be that necessary to provide a well graded aggregate within the limits set forth in Table 3.

(b) Adjustments during the progress of the work: After the original proportions have been designated as prescribed under Article 701-3 (a), these proportions shall not be changed during the progress of the work except as provided in subsections 1, 2 and 3 which follow.

1. Adjustment for variation in workability: If it is found impossible to obtain concrete of the desired placeability and workability with the proportions originally designated by the Engineer, the Contractor shall make such changes in aggregate weights as may be authorized.

2. Adjustment for excess gross water content: If when using the designated cement content, it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable gross water content specified in Table 1 and Table 2, the cement content shall be increased so that the maximum water content will not be exceeded.

3. Adjustment for new materials: No change in the source or character of the materials shall be made without due 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.

**TABLE 1—MASTER LIMITS—UNCRUSHED GRAVEL
AGGREGATES**

Class of Concrete	A	B	B Alt.	S	Y
Max. size of coarse Aggregate—Square Mesh in inches	1½	2½	1½	1½	¾
Cement Content in Bags per Cubic Yard	6.0	5.0	5.25	6.5	7.0
Max. gross water content per bag of cement in gallons	5.75	6.50	6.25	5.50	5.50
Normal Basic Mix of Surface Dry Aggregate in pounds per bag of cement	Fine Aggregate	181	220	208	172
	Coarse Aggregate	322	409	386	282
Consistency Range Slump Inches	Non-Vibrated	3-5	2-3	2-3	3-6
	Vibrated	2-4	1-3	1-3	—

**TABLE 2—MASTER LIMITS—CRUSHED STONE
AGGREGATE**

Class of Concrete	A	B	B Alt.	S	Y
Max. size of coarse Aggregate—Square Mesh in inches	1½	2½	1½	1½	¾
Cement Content in Bags per Cubic Yard	6.0	5.0	5.25	6.5	7.0
Max. gross water content per bag of cement in gallons	6.00	6.75	6.50	5.75	5.75
Normal Basic Mix of Surface Dry Aggregate in pounds per bag of cement	Fine Aggregate	204	249	234	193
	Coarse Aggregate	293	374	353	255
Consistency Range Slump Inches	Non-Vibrated	3-5	2-3	2-3	3-6
	Vibrated	2-4	1-3	1-3	—

When requested by the Contractor, the Engineer may approve the substitution of Class B Alternate for Class B Concrete.

The "Slump" of mixed concrete shall be determined as follows:

A metal form in the shape of a frustrum of a cone four (4) inches and eight (8) inches in diameter, top and bottom respectively, and twelve (12) inches in height shall be placed on its base and filled with freshly mixed concrete, direct from the mixer, in three (3) equal layers by volume, each of which shall be puddled, using twenty-five (25) strokes of a bullet-pointed five-eighth (⅝) inch rod twenty-four (24) inches long, but in no case shall the rod pass through more than one layer. The concrete shall be struck off so that the

mold is entirely filled. The form shall be then immediately and slowly removed by steadily raising the same, using both handles, and the vertical settlement of the concrete measured and noted. The settlement is designated the "Slump."

The proportions are based on the use of aggregates having bulk specific gravities in a saturated surface-dry condition of 2.68. For other specific gravities, the weights shall be corrected by multiplying the weights shown in the table by the ratio of the specific gravities of the aggregates used and those used in computing the table (2.68).

The proportions are also based on an average air content of five and five-tenths (5.5) per cent.

MATERIALS

701-4. Cement and Admixtures. Only one brand and one type of cement shall be used on any one contract except by written permission of the Engineer. All cement shall be portland cement, Type IIA, or Type II, with the addition of an approved admixture.

(a) *Cement:* Portland cement shall conform to the requirements of A.A.S.H.O. Specifications M-85, Type II.

Air-entraining portland cement shall conform to the requirements of the A.S.T.M. Designation C-175 (A.A.S.H.O. Designation M-134), Type IIA, with the additional requirement that the autoclave expansion shall be limited to a maximum of two-tenths (0.20) per cent.

Storage facilities for cement shall be ample and afford protection from dampness. Bags of cement which for any reason have become partially set or which contain lumps of caked cement, shall be rejected. However, the cement from such bags which is not partially set, caked, or otherwise damaged, may be salvaged and used as bulk cement. Shipments of cement as received shall be separately stored in such a manner as to provide easy access for identification and inspection of each shipment.

(b) *Air-entraining Admixtures:* In the event the Contractor elects to use an air-entraining admixture, evidence based on tests made by an authorized agent shall be submitted to show that the material conforms to the requirements of the latest revision of A.A.S.H.O. M-154 (A.S.T.M. C-260) for 7- and 28-day compressive and flexural strengths and resistance to freezing and thawing, except as provided in the following paragraph. Tests for bleeding, bond strength and volume change will not be required. Tests may be made

upon samples taken from a quantity submitted by the Contractor for use on the project or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied.

An exception to the requirements in the preceding paragraph is the case of admixtures which are manufactured by neutralizing Vinsol resin with caustic soda (sodium hydroxide). When the Contractor proposes to use such an admixture he shall submit a certification concerning the admixture in the following form:

"This is to certify that the product (trade name) as manufactured and sold by the (company) is an aqueous solution of Vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to Vinsol resin is one part of sodium hydroxide to (number) parts of Vinsol resin. The percentage of solids based on the residue dried at 105° C. is (number). No other additive or chemical agent is present in this solution."

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to or at any time during construction the engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. When so tested, 7-day compressive strength of concrete made with the cement and aggregates in the proportions to be used in the work and containing the admixture under test in an amount sufficient to produce from four (4) to seven (7) percent entrained air in the plastic concrete shall be not less than 88 percent of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixture.

The percentage reduction in strength shall be calculated from the average strength of at least 5 standard 6" x 12" cylinders of each type of concrete. Specimens shall be made and cured in the laboratory in accordance with the requirements of the latest revision of A.A.S.H.O. T-126 (A.S.T.M. C-192) and shall be tested in accordance with the require-

ments of the latest revision of A.A.S.H.O. T-22 (A.S.T.M. C-39). The percentage of entrained air shall be determined in accordance with the requirements of the latest revision of A.A.S.H.O. T-152 (A.S.T.M. C-231).

Admixtures failing to meet the above requirements may be rejected.

The Contractor will be required to follow an approved procedure for adding the specified amount of air-entraining admixture to each batch and will be held responsible for its uniform operation during the progress of the work. The Contractor shall provide separate approved scales for such admixtures as are to be proportioned by weight and accurate measures for such admixtures as are to be proportioned by volume.

701-5. Water. All water used in concrete shall be subject to the Engineer's approval, shall be reasonably clear and free of oil, acid, alkali, and vegetable substance, and if required by the Engineer, 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 ten (10) per cent 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.

701-6. Fine Aggregate. The 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 fifty (50) per cent by volume of screenings. Screenings so used shall be obtained by crushing hard, durable rock having a per cent of wear not more than allowed for crushed stone. 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. The storage of fine aggregate shall be provided by stockpiling on planks not less than two (2) inches in thickness laid close together or on metal sheets of at least twelve (12) gauge. The stock piles shall be built in horizontal layers not more than four (4) feet in thickness.

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, A.A.S.H.O.

Method T-21*, produce a color darker than the reference standard color solution, it shall be rejected.

*The reference standard color solution shall be made by adding 2.5 ml. of a one (1) per cent solution of tannic acid in ten (10) per cent alcohol to 97.5 ml. of a three (3) per cent sodium hydroxide solution. This shall be placed in a twelve (12) ounce bottle, stoppered, shaken vigorously, and allowed to stand twenty-four (24) hours.

A twelve (12) ounce graduated clear glass bottle shall be filled to the four and one-half ($4\frac{1}{2}$) ounce mark with the sample of sand to be tested. To this shall be added a three (3) per cent solution of sodium hydroxide in water until the volume of the sand and liquid indicated after shaking is seven (7) liquid ounces. The bottle shall be stoppered, shaken vigorously and then allowed to stand for twenty-four (24) hours.

After standing twenty-four (24) hours the color of the clear liquid above the sample shall be compared with the color of the reference standard color solution prepared at the same time. If the color above the sample is darker than the reference color solution, the sand shall be considered unsatisfactory and subject to further test before used in the work.

The fine aggregate shall be well graded from coarse to fine, shall meet the following grading requirements when tested according to A.A.S.H.O., Method T-27, and shall meet the fineness modulus limits given below:

<i>Sieve Designation</i>	<i>Percentage by Weight Passing Square Mesh Sieve</i>
$\frac{3}{8}$ inch	100
No. 4	95-100
No. 16	50- 85
No. 50	10- 30
No. 100	2- 8

Fine aggregate failing to pass the minimum requirements for material passing the No. 50 and/or No. 100 sieves may be used, 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 of fine aggregate shall be not less than 2.3 and not greater than 3.1. Fine aggregate from any one source shall have sufficient uniformity of grading

that the fineness modulus as determined from representative samples shall not show a variation greater than 0.40.

The fineness modulus of fine aggregate shall be determined by adding the total percentages of material by weight retained on U. S. standard sieves Nos. 4, 8, 16, 30, 50, 100, and dividing by one hundred (100).

Mortar specimens containing the fine aggregate, when tested according to A.A.S.H.O. Method T-71 shall develop compressive strength at the age of seven (7) days when using cement conforming to A.A.S.H.O. Specification M-85, Type II, of not less than eighty-five (85) per cent 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.

Fine aggregate when tested for absorption as specified in A.A.S.H.O. Method T-84, shall show a per cent of absorption of not more than 2.30.

701-7. Coarse Aggregate. The coarse aggregate for concrete shall consist of crushed stone, or gravel, having hard, strong, durable pieces, free from adherent coatings.

The storage of coarse aggregate shall be provided by stock piling on planks not less than two (2) inches in thickness laid close together, or on metal sheets of at least twelve (12) gauge. The stock piles shall be built in horizontal layers not more than four (4) feet in thickness.

The coarse aggregate shall have a percentage of wear of not more than the following amounts as determined by A.A.S.H.O. Method T-96 (Los Angeles Abrasion Test).

	<i>Per Cent by Weight</i>
Crushed Stone (except native granite)	40
Crushed Stone (native granite)	45
Gravel	40

Gravel in which fifty (50) per cent or more, by weight, of the particles are crushed shall be tested and meet the requirements for crushed stone.

Coarse aggregate shall conform to the requirements of Table 3 for the size or sizes designated and shall be well graded between the limits specified.

TABLE 3—REQUIREMENTS FOR GRADING OF COARSE AGGREGATE

Class of Concrete	A.A.S.H.O. T-27 Percentages by Weight Passing Square Mesh Sieves								
	3"	2½"	2"	1½"	1"	¾"	⅝"	No. 4	No. 8
Y	—	—	—	—	100	90-100	15-50	0-10	0-5
S	—	—	100	95-100	—	40-75	20-35	0-5	—
A	—	—	100	95-100	—	30-60	5-25	0-5	—
B	100	95-100	—	55-85	—	25-55	10-20	0-5	—
B Alt.	—	—	100	90-100	—	15-45	5-20	0-5	—

701-8. Miscellaneous Materials.

(a) *Preformed Expansion Joint Filler* shall conform to the latest revised standard specification of the A.A.S.H.O. M-153.

(b) *Copper Baffle Strip* shall conform to the latest revised A.A.S.H.O. Standard Specifications, Designation M-138.

(c) *Galvanized Iron Baffle Strip* shall conform to the A.S.T.M. Standard Specifications for Zinc Coated (Galvanized) Iron or Steel Sheets, Class D, Serial Designation A-93.

(d) *Metal Drain Forms* shall conform to the A.S.T.M. Standard Specification for Zinc Coated (Galvanized) Iron or Steel Sheets, Class D, Serial Designation A-93.

(e) *Heavy Roofing*: Wherever "Heavy Roofing" is called for on the plans an approved standard brand of asphalt saturated roofing felt weighing about fifty-five (55) pounds per one hundred (100) square feet, shall be used.

(f) *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.

CONSTRUCTION METHODS

701-9. Form Construction. 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 amply strong to support safely, in addition to the weight of the concrete, all superimposed loads (run-ways, concrete buggy loads, workmen, scaffolding, etc.) placed upon them. In computing form load, falsework and centering, concrete shall be assumed to act as a liquid weighing one hundred and forty-four (144) pounds per cubic foot for vertical loads and seventy-two (72) pounds 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 twenty-five thirty-seconds (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 one and one-quarter (1¼) inches or plywood of an exterior ply-form grade, 5-ply, bonded with a water-proof glue and having a minimum thickness of five-eighths (⅝) inch.

Undressed lumber of uniform thickness and width, otherwise fulfilling the requirements for lumber dressed on one side, may be used for unexposed surface forms.

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 accurately 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 shall be permitted only in exceptional cases and 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. Chamfer strips shall have a width across the diagonal face between one-half (½) inch and one and one-quarter (1¼) 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 in the concrete plain flat surfaces.

Adhering mortar and other accumulations of foreign matter shall be carefully cleaned from form material or form sections used more than once.

The forms for beams, girders, columns, 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. Narrow forms may be built with removable sections to permit thorough cleaning.

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 two (2) inches from the exposed surface of the concrete without injury or damage to such surfaces.

Forms shall be inspected and approved before placing concrete within them.

701-10. 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. In general, cofferdams, caissons, cribs, or other devices used to exclude water from foundation excavations shall be constructed to provide free access to all exterior portions of the substructure forms, both for their construction and their inspection.

701-11. Preparing Form Surfaces. 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 carefully cleaned at each setting and recoated with oil or soap.

Whenever forms are constructed several days in advance of filling them with concrete, they shall be kept moist or otherwise protected against warping of the boards and other defects produced 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.

701-12. Falsework. All falsework used for supporting reinforced concrete superstructures shall be composed of timbers having ample cross-sectional areas to resist, without deformation or appreciable settlement, the loads imposed upon them. In addition to the weight of the superstructure, these loads shall include all forms, bracing, run-ways 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. It shall be well built, rigid and unyielding, securely braced, strutted and tied to prevent distortion and motion 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 with the under one. 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 two (2) tons per square foot.

2. For loose sand and gravel, and ordinary clay soils in confined thick beds one (1) ton per square foot.

3. For soft clay and firm alluvial soils one-half ($\frac{1}{2}$) ton per square foot.

All arch centering and false work shall be subject to the approval of the Engineer, 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.

False work shall be so constructed that the forms will have a slight 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.

701-13. Arch Centering. Detail plans of falsework and centering for concrete arch spans shall be supplied by the Contractor for the approval of the Engineer. The approval of such plans by the Engineer shall not relieve the Contractor of the responsibility for results obtained by the use of these plans.

Provision shall be made by means of suitable wedges, sand boxes or other devices for the gradual lowering of centers and rendering the arch self-supporting.

701-14. Batching. The weighing and batching equipment shall be of such design and construction that the materials for each batch can be quickly and accurately weighed. Storage bins with adequate separate compartments shall be provided for the fine aggregate and for each required size of coarse aggregate, and the equipment for delivery of materials to the bins shall not cause any intermingling of aggregates. Each compartment shall be designed to discharge efficiently and freely into the 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 of any one of the several materials from the hopper shall be provided. Weighing hoppers shall be constructed so that there will be no attachments that might affect the free movement of the weighing mechanism. Weighing hoppers shall discharge fully and there shall be no accumulation of materials. Weighing and batching equipment shall be supported on a firm foundation. If necessary, burlap or other suitable material shall be arranged about the weighing hopper to afford protection against the wind.

The scales for weighing aggregate or cement may be either the beam type or the springless-dial type. All scales shall be sensitive and accurate within four tenths (0.4) of one (1) per cent of the net load applied. All exposed fulcrums, clevises, and similar working parts of the scale shall be kept clean. When beam type scales are used, a separate beam for each type of material to be used shall be provided, and provisions shall be made for indicating to the operator that the required load in the weighing hopper is being approached; the device shall indicate at least the last five (5) per cent of the load weighed on any beam, except that in no case will this increment be required to be greater than two hundred (200) pounds. 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.

Standard test weights equivalent to twenty (20) per cent of the net load capacity, to the nearest greater fifty (50) pound increment, shall be available at all times for checking the accuracy.

The Contractor shall maintain the equipment in good condition and adjustment, and it shall be accurately operated when proportioning batches. All scales shall be so designed and constructed that they shall be sufficiently free from vibration to permit accurate weighing when the plant is in operation.

When cement is measured by weight, it shall be weighed on a scale separate from those used for other materials.

Water shall be measured accurately by volume or weight. The device for the measurement of water shall be readily adjustable, and under all operating conditions shall measure the required quantity within a tolerance of one (1) quart or one (1) per cent, whichever is greater. The device shall be so arranged that the flow of water will be automatically stopped when the required quantity has been delivered. The water measuring device on paving mixers shall be so designed that the quantity of water discharged is not affected by tilting the mixer in any direction.

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 authority to require all batch trucks used for transporting unmixed batches from the plant to the paver 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 must be adequate to handle the volume of material being hauled.

701-15. Mixing Concrete.

(a) *Pavement Concrete:* Concrete for pavements shall be mixed in a mixer of an approved type, having a power controlled boom and bucket. The use of a mixer having a chute delivery will not be permitted. Paving mixers having a manufacturer's rated capacity of less than twenty-seven

(27) cubic feet shall not be used. Dual drum mixers will be permitted, provided such mixers otherwise conform with the above requirements and are designed and built for synchronized operation.

The mixer shall be equipped with a batch-meter for counting the batches and also an approved timing device which will automatically lock the discharge mechanism during the full time of mixing and will release it at the end of the required mixing period. The equipment shall also include a bell which will ring each time the lock is released.

If the batch-meter and/or timing device becomes broken or otherwise out of order, the Contractor will be permitted to operate the mixer while repairs are being made, provided he furnishes a person approved by the Engineer, whose sole duty is to keep an accurate account of the number of batches mixed and/or to keep accurate timing, by means of an approved timepiece having a minute and a second hand and furnished by the Contractor, of all batches to insure each batch its full time of mixing. If the batch-meter and/or timing device are not repaired and in good operating condition within forty-eight (48) hours from the time of becoming unusable, further use of the mixer will be prohibited until repairs are made.

In charging the mixer, some of the water shall enter the drum in advance of the cement and aggregate and shall continue to flow uniformly for a period of time not to exceed twenty (20) seconds.

All of the ingredients, except water, shall stay in the drum not less than one and one-quarter ($1\frac{1}{4}$) minutes during which time the drum shall be revolved at a rate of not less than fourteen (14) nor more than twenty (20) revolutions per minute.

The entire contents of each batch shall be discharged from the drum before the next charge is made.

"Pick-up" and "throw-over" blades in the drum of the mixer, which at any point are worn down three-quarters ($\frac{3}{4}$) of an inch or more must be replaced by new blades.

Any concrete mixed less than the required time shall be rejected. The approved volume of material mixed per batch in the paving mixer shall not exceed the manufacturer's rated capacity of the drum.

Retempering of concrete by the addition of water shall not be permitted. The addition of water to the batch in the mixer, after ten (10) minutes have elapsed after the initial

charging or the addition of water at any time after the concrete has been removed from the mixer, shall be construed as "rettempering". Batches of concrete prepared contrary to these restrictions shall be rejected and immediately removed and disposed of.

(b) *All other concrete:* All concrete other than paving concrete shall be mixed in a mixer of an approved type. No mixers whose rated capacity is less than a one bag batch, of the class of concrete being placed, shall be used.

The mixer shall be equipped with batch-meter and timing devices as required under (a) "Pavement Concrete" above, which specification shall also govern the use and maintenance of such devices required in producing all other concrete.

A type of mixer shall be used that will insure uniform distribution of the materials throughout the mass until the mixture is uniform in color and smooth in appearance. The cement, aggregates, and not less than sixty (60) per cent of the water shall be mixed at least one and one-half ($1\frac{1}{2}$) minutes. The remaining water shall be introduced into the drum within not more than fifteen (15) seconds after all other materials for the batch are in the mixer. During the period of mixing, the drum or mixing blades shall operate at the speed for which they were designed. For mixers having a manufacturer's rated capacity of thirty-eight (38) cubic feet or less of mixed concrete per batch, this speed shall be between fourteen (14) and twenty (20) revolutions per minute. The drum or blades of mixers having a manufacturer's rated capacity of more than thirty-eight (38) cubic feet shall operate at a speed of not less than eleven (11) revolutions per minute. If such mixing of the concrete does not result in a uniform and smooth texture, a sufficient number of additional revolutions at the same rate shall be given until a thorough mixing of each batch of concrete is secured. Any concrete mixed less than one and one-half ($1\frac{1}{2}$) minutes shall be rejected. If a mixer having a manufacturer's rated capacity of more than thirty-eight (38) cubic feet of mixed concrete per batch is used, the mixing time shall be increased fifteen (15) seconds for each cubic yard, or fraction thereof, additional capacity. The approved volume of material mixed per batch in the paving mixers shall not exceed the manufacturer's rated capacity of the drum.

Material for a batch of concrete shall not be placed in the drum of the mixer until all of the previous batch has been discharged therefrom. Retempering, as defined under (a) above shall not be allowed.

701-16. **Central and Transit Mixed Concrete.** If central or transit mixed concrete is used, the Contractor shall meet the following additional requirements:

Unless storage facilities permit separate storage for aggregates and cement which have been approved at the source, the Contractor shall advise the Engineer of his plan to furnish central or transit mixed concrete sufficiently far in advance to permit inspection and approval of all materials and equipment.

Central mixed concrete shall be completely mixed in a stationary mixer in accordance with the requirements of Article 701-15 (b) and shall be transported to the point of delivery in a truck mixer operating at agitating speed or a truck agitator to prevent segregation while in transit to destination. Under certain conditions, specified herein, non-agitating equipment may be permitted.

Transit mixed concrete shall be produced by combining the aggregate, cement and water in a thoroughly mixed and uniform mass in a truck mixer.

The truck mixer shall consist of a closed watertight revolving drum fitted with adequate blades, or a watertight container suitably mounted and fitted with adequate revolving blades. When the mixer is equipped with a tail gate or a removable cover, the tail gate or cover shall have a one-half ($\frac{1}{2}$) inch diameter vent hole. Truck mixers shall be capable of combining aggregates, cement and water into a thoroughly mixed and uniform mass of concrete and of discharging the concrete without segregation. The truck agitator shall consist of a closed, watertight revolving drum or a watertight container suitably mounted and fitted with adequate revolving blades. Truck agitators shall be capable of transporting and discharging the concrete without segregation.

In order to check the uniformity of concrete from truck mixers or agitators, the Engineer may make slump tests of individual samples taken from a load; and if the slumps vary by more than two (2) inches, that mixer or agitator shall not be used unless the condition is corrected.

When used for truck mixing, the capacity of truck mixers shall be in accordance with the manufacturer's rating, but the volume of mixed concrete shall not exceed fifty-seven and five tenths (57.5) per cent of the gross volume of the drum or container. When used for agitating, the capacity of

the truck mixer or truck agitator shall be in accordance with the manufacturer's rating, but the volume of mixed concrete shall not exceed eighty (80) per cent of the gross volume of the drum or container.

Each truck mixer and agitator shall have attached thereto, in a prominent place, a metal plate or plates on which is plainly marked by the manufacturer 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. When capacities less than the limits indicated in this section are shown on the metal plates, it indicates the maximum capacities for which the equipment was designed to be operated under the conditions stated by the manufacturer, and such capacities shall govern.

Truck mixers and agitators shall be operated at the speed of rotation designed by the manufacturer of the equipment, provided such speeds are within the following limits: Mixing speed for the revolving drum type of mixer shall not be less than four (4) revolutions per minute of the drum nor greater than a speed which will produce a peripheral velocity of the drum of two hundred twenty-five (225) feet per minute; for the revolving blade type of mixer, mixing speeds shall not be less than four (4) nor more than sixteen (16) revolutions per minute of the mixing blades; agitating speed for both the revolving drum and revolving blade types shall be not less than two (2) nor more than six (6) revolutions per minute of the drum or of the mixing blade.

Transit mixed concrete shall be mixed not less than fifty (50) and not more than one hundred (100) revolutions of the drum or blades at mixing speed after all of the ingredients, including water, are in the mixer. When a truck mixer or truck agitator is used for transporting concrete that has been completely mixed, agitation of the concrete shall continue during transportation at the speed designated by the manufacturer of the equipment as agitating speed. Truck mixers shall be equipped with a means by which the number of revolutions of the drum or blades may be readily verified.

Water-measuring equipment shall meet the requirements of Article 701-14. If mixing water is to be added while the concrete materials are in transit the truck mixer shall be equipped with a tank for carrying mixing water, the water

to be measured and added to the tank at the proportioning plant unless the tank is equipped with an automatic measuring device. When wash water is used as a portion of the mixing water for succeeding batches, it shall be accurately measured and taken into account in determining the amount of additional mixing water required. If the mixer is not equipped with an automatic water-measuring device, a calibrated tank shall be installed either on the trucks or at the job site for measuring water. Twenty (20) revolutions of the drum or mixing blades shall be required after adding additional water. The water which is added to the mixed concrete at the site of the work shall be included in determining the net water. An ample quantity of cement and sand shall be kept at the job site to be added to the mixer in a ratio of one (1) bag of cement to two (2) cubic feet of sand in case the concrete is found to be too wet. Retempering, as defined under Article 701-15 (a) shall not be allowed.

Central or transit mixed concrete shall be delivered to the site of the work and discharge shall be complete within one (1) hour after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, a time less than one (1) hour may be specified by the Engineer. When a truck mixer is used for transit mixing of the concrete, the mixing operation shall begin within thirty (30) minutes after the cement has been added to the aggregates.

Watertight covers shall be used to cover the containers of open top mixers and agitators when the length of time from the addition of water to the cement and aggregates to the discharge of the concrete exceeds fifteen (15) minutes.

Central mixed concrete may be transported in non-agitating equipment at the discretion of the Engineer. The bodies of non-agitating equipment shall be smooth, watertight containers equipped with gates that will permit control of the discharge of the concrete. Watertight covers shall be provided for protection of the concrete. The concrete shall be delivered to the site of the work in a thoroughly mixed and uniform mass and discharged with a satisfactory degree of uniformity. Slump tests of individual samples taken during discharge shall fall within the requirements for the class of concrete being placed. The discharge of the concrete transported in non-agitating equipment shall be completed within fifteen (15) minutes after the introduction of the mixing water to the cement and aggregates.

701-17. Placing Concrete. All concrete shall be placed before it has taken its initial set and, in any case, within thirty (30) minutes after mixing, except as modified under Article 701-16 above. Concrete shall be placed in such manner as to avoid segregation of coarse or fine portions of the mixture, and shall be spread in horizontal layers when practicable. Comparatively rich mixes will be permitted initially in slabs and girders to facilitate the working of the concrete around nests of reinforcing steel, so as to eliminate rock pockets or air bubbles. Enough puddlers and tampers shall be provided to compact each batch before the succeeding one is dumped and to prevent the formation of joints between batches. Extra tamping shall be done along all faces to obtain smooth surfaces. Care shall be taken to prevent mortar from spattering on steel surfaces, forms and reinforcing steel, and from drying ahead of the final covering with concrete. Where spattering occurs, the forms and steel shall be cleaned with wire brushes or with scrapers. Following the placing of the concrete the metal surfaces shall be thoroughly cleaned without injuring the paint upon them.

Troughs, pipes and sectional drop chutes or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete do not become separated. Where steep slopes are required, troughs and chutes shall be equipped with baffle boards or shall be in short lengths that reverse the direction of movement. All chutes, troughs, sectional drop chutes, and pipes shall be kept clean and free of coatings of hardened concrete by flushing thoroughly with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Troughs and chutes shall be of metal or shall be lined with metal and shall extend as nearly as possible to the point of deposit.

When discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping the concrete a distance of more than five (5) feet or depositing a large quantity at any point and running it or working it along the forms will not be permitted.

The placing of the concrete shall be so regulated that the pressures caused by wet concrete shall not exceed those in the design of the forms.

Except as specified below concrete shall be deposited continuously for each monolithic section of the work. All floor slabs and similar thin sections of the work shall be placed

full thickness. In general, all concrete in piers, abutments, and retaining walls shall be deposited in horizontal layers of uniform thickness throughout. The thickness of layers shall not exceed eighteen (18) inches. An incomplete layer shall be left with a vertical construction joint. Horizontal layers, so located as to produce a construction joint at a location wherein a "feather edge" would normally be produced in the succeeding layer, shall be so formed by inset form work that the succeeding layer will end in a body of concrete having a thickness of not less than six (6) inches. Each layer of concrete shall generally be left somewhat rough to secure an efficient bonding with the next layer above. A succeeding layer placed before the underlying layer has become set shall be compacted in a manner that will entirely break up and obliterate the tendency to produce a construction joint between the layers.

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-beam spans 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 produced by embedding 2" x 4" wooden blocks having a length approximately four (4) inches less than the width of the stem in the top surface of the concrete when placed. 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 one-quarter ($\frac{1}{4}$) inch on the sides and ends and shall be firmly nailed upon a board at a distance of one (1) foot center to center. The blocks shall be thoroughly oiled to facilitate their ready removal from the concrete.

For the placing of concrete in arch spans, the order of construction or sequence of the work shall, in general, be shown upon the plans and shall include details of keyed construction joints in arch rings and their locations together with the details for the attachment of spandrel walls to the outer edge of arch rings. Sections shall be so arranged that initial stresses will not be created in the metal reinforcement, and to secure a proper loading of the centering shall involve symmetrical placing about the crown of the arch.

In no case shall the work on any section or layer be stopped or temporarily discontinued within eighteen (18) inches be-

low the top of any face, unless the details of the work provide for a coping having a thickness less than eighteen (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 two (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. Concrete in curbs of slab and T-beam spans, and similar construction shall be placed with the concrete in the slab. In placing concrete for curbs, rails, rail posts and other similar construction, the forms shall be overfilled one to two inches (1" to 2") and screeded off after waiting about one (1) hour.

Along the slope of abutment wings or retaining walls where a top form is usually required to hold the concrete, the following procedure shall be followed:

(a) A series of baffles shall be constructed along the slope of the wing to permit over filling the forms from one to two inches (1" to 2"). The spacing of the baffles shall depend upon the slope of the wing. The steeper the slope, the nearer the baffles need to be placed.

(b) As soon as the concrete will support itself, the baffles shall be removed.

(c) 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 chamfer strips.

Mechanical, high frequency internal vibrators shall be used for compacting concrete in all structures containing more than fifty (50) cubic yards of concrete and in both precast and cast-in-place piles. The vibrators shall be of an approved type, with a minimum frequency of five thousand (5,000) cycles per minute and shall be capable of visibly affecting a properly designed mixture with a one (1) inch slump for a distance of at least eighteen (18) inches from the vibrator. Sufficient vibrators shall be used to consolidate the incoming concrete within fifteen (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 con-

crete that is free of voids; of proper texture on exposed faces, and of maximum consolidation. Over-vibrating shall be avoided.

Concrete shall be placed continuously throughout each section of the structure or between indicated joints. If, in an emergency it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the Engineer may direct and the resulting joint shall be deemed a construction joint and treated as described under Article 701-19.

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 done in one (1) 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.

701-18. Depositing Concrete Under Water. Concrete shall be deposited under water by the method described in the following paragraphs.

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 ten (10) inches in diameter, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the seal and to permit its being lowered rapidly when necessary to choke off or retard the flow. The 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 concrete is placed with a bottom-dump bucket, the bucket shall have a capacity of not less than one-half ($\frac{1}{2}$) 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 possible, 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.

701-19. Forming Construction Joints. Construction joints shall be located where shown on the plans or permitted by the Engineer. Construction joints shall be perpendicular to the principal lines of stress and in general shall be located at points of minimum shear.

At horizontal construction joints, gauge strips having a minimum thickness of one and one-half ($1\frac{1}{2}$) inches shall be placed inside the forms along all exposed faces to give the joints straight lines. Before placing fresh concrete, the surfaces of construction joints shall be washed and scrubbed with a wire broom, drenched with water until saturated, and kept saturated until the new concrete is placed. Immediately prior to placing new concrete the forms shall be drawn tight against the concrete already in place and the old surface shall be coated thoroughly with a very thin coating of neat cement mortar. Concrete in substructures shall be placed in such manner that all horizontal 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 panelled wing walls or other large surfaces which are to be treated architecturally.

The construction joints produced between layers of concrete placed intermittently in piers, abutments and retaining walls, shall be bonded to prevent displacement by sliding or by overturning. Approved hard, sound and durable stones weighing from fifty (50) to seventy-five (75) pounds each may be used in structures having a width of four (4) feet or more, while in narrower structures, metal dowels or a mechanical bond secured by producing a "mortise and tenon" interlock shall be used. When the concreting of the lower layer is complete, its surface shall be prepared for bonding the layer to be superimposed upon it before the concrete has taken its set. When "bond" or "dowel" stones are to be used

they shall be handplaced, not cast nor thrown into the concrete, and in general, shall be staggered and their distance center to center shall not exceed three (3) feet. Stones shall not be placed nearer than one (1) foot to the form. Stones having a distinct stratified structure shall be set with the "grain" vertical to the construction joint. Metal dowels shall consist, in general, of rods having a diameter of not less than one-half ($\frac{1}{2}$) inch and a length of not less than one (1) foot. However, when approved by the Engineer, metal secured from scrap bar, pipe, castings, etc., may be used, provided such metal has ample cross section and is free from detrimental rust, scale and grease. In general, dowels shall be staggered and their distance center to center shall not exceed three (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 six (6) to eight (8) inches in width to a height of from three (3) inches to four (4) inches above the surface of the layer.

Construction joints in abutments, piers, and 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 exposed surfaces, shall contain water baffles consisting of a sheet of zinc or galvanized iron six (6) inches in width, set vertically at a distance of six (6) inches to eight (8) inches from the rear surface of the concrete and embedded one-half of its width in the concrete below the joint with the remaining width in the concrete above. The sections or strips of metal shall overlap not less than six (6) inches at their ends. Thickness of the metal used shall be not less than twenty-six (26) gauge unless otherwise called for on the plans.

701-20. Installation of Expansion Joints. Expansion joints shall be located and formed as required on the plans.

In filled expansion joints the thickness of the filler as installed shall be as required on the plans. The joint filler shall be cut to the same shape and size as that of the surfaces being jointed. 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. 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 covered with a layer of asphalt-saturated roofing felt of not less than fifty-five (55)

pound grade, one side of which shall be covered with hot asphalt to insure proper retention. Immediately after the forms are removed, the expansion joints shall be inspected carefully. Any concrete or mortar that has sealed across the joint shall be cut neatly and removed. When, during construction, an opening of one-eighth ($\frac{1}{8}$) inch or more appears in any joint over which any traffic occurs, the opening shall be completely filled with hot tar or asphalt as directed.

Where sliding joints are to be provided at the ends of slab, T-beam, and girder spans having a length less than thirty (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 provided upon 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 each sheet in only sufficient quantity to hold the sheets in position.

The thickness of layers shall vary as follows:

<i>Span lengths</i>	<i>Layer thickness</i>
10 ft. and less	$\frac{1}{8}$ inch
11 ft. to 20 ft.	$\frac{1}{4}$ inch
21 ft. to 30 ft.	$\frac{3}{8}$ inch

Reinforced concrete T-beam and girder spans of lengths over thirty (30) feet shall, in general, be provided with bronze expansion plates or other approved devices for permitting free expansion and contraction movements. Unless especially provided otherwise upon the plans, no reinforcement shall extend across an expansion joint.

Necessary dowels, load transfer devices and other devices shall be placed as shown on the plans or as directed.

All metal flashings and expansion joint fillers shall be placed in such manner as to be free of kinks. The resulting joints shall be water tight and so formed and placed as to lead all drainage water to a point of discharge so located as to prevent the staining of exposed concrete surfaces. Sectional lengths of the prepared metal expansion filler or flashing shall be riveted together and/or soldered.

701-21. Cold Weather Concreting. Unless authorized by the Engineer, the mixing and placing of concrete shall be dis-

continued when the atmospheric temperature is below 40° F. in the shade and is descending and shall not be resumed until the atmospheric temperature is as high as 35° F. in the shade and ascending. 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 between 130° F. and 150° F. If the atmospheric temperature is below 30° F. the aggregate shall also be heated either by steam or dry heat to a temperature between 70° F. and 150° F. The heating apparatus shall be capable of heating the mass uniformly and preventing the occurrence of spots of overheated material. The temperature of the mixed concrete shall be between 50° F. and 75° F. when it is placed in the forms. Neither salt nor other chemical shall be added to the concrete to prevent its freezing, except by special permission of the Engineer.

When concrete is placed under the above special conditions or where concrete has been in place less than the minimum curing period specified under Article 701-24, and the temperature drops below 35° F., the Contractor shall furnish sufficient canvas and framework, or other type of housing, to enclose and protect the structure. Sufficient heating apparatus, such as stoves, salamanders, or steam equipment, and fuel to furnish all required heat, shall be supplied. When dry heat is used, means of preventing loss of moisture from the concrete shall be provided. The temperature of the air surrounding the fresh concrete shall be kept above 50° F. for the minimum curing period specified under Article 701-24 and then gradually decreased at the rate of approximately 1° F. per hour.

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 air surrounding the concrete shall be controlled as above specified. Submersion shall proceed slowly and steam shall be admitted to the water freely so that, by the time the concrete is completely submerged, the temperature of the water will be above 40° F. and it shall be so maintained for a period of five (5) days after the concrete has been placed.

Before placing the concrete under water, the temperature of the water in the cofferdam shall be raised to above 40° F. and it shall be so maintained for a period of five (5) days after the concrete has been placed.

Permission given to place concrete under the conditions mentioned above shall not relieve the Contractor of responsibility for obtaining satisfactory results. Unsatisfactory concrete placed under such conditions shall be removed and replaced at the Contractor's expense.

701-22. Curb and Sidewalk Finish. Unless otherwise provided the finishing of curb and sidewalk areas upon bridge structures shall consist essentially of the following treatment:

The top surfaces of curbs and sidewalks shall generally be "struck" with a straight edge and floated after the stone aggregate has been forced below the finished elevation of the concrete. A margin six (6) inches in width shall be defined and finished smooth upon the curb side or edge of the sidewalk. Similarly on bridges with concrete posts a margin of three (3) inches in width shall be outlined adjacent to the base of the posts and parallel to the curb line. On bridges with a steel rail a margin of six (6) inches in width shall be outlined adjacent to the outside edge of the sidewalk. The margin shall be outlined by tautly stretching a cord upon the freshly screeded surface, following which this margin or strip shall be finished smooth by the use of a plaster mason's trowel and in this operation the cord shall be pressed firmly into the concrete to produce a clearly defined margin.

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 with a margin of four (4) inches in width to conform with the finish along the curb. Otherwise, the finish at the ends shall be such as to match the margins used upon the slab of the approach sidewalk.

Following the finishing of the margins as above specified the entire mid-area of the sidewalk slab shall be finished with a short wooden float which shall be moved in small circles to produce a shell-like pattern upon the surface of the concrete. Care shall be exercised not to "float" beyond the cord marks upon either margin. Unless otherwise provided upon the plans, the sidewalk area shall not be divided into longitudinal sections by transverse grooves.

701-23. Concrete Floor and Wearing Surface Finish. Immediately after being placed, concrete floors or wearing surfaces shall be struck off with templates to provide proper crowns and shall be hand finished to smooth, even surfaces by both longitudinal and transverse movement of wooden floats, or by other suitable means.

A concrete wearing surface, unless monolithic with the floor slab, shall not be placed until the inside curb forms are removed to permit screeding to the face of the curb. The portion of the curb to be covered by the concrete wearing surface shall be painted with tar, or some bituminous product that will effectively break the bond between the wearing surface and the curb.

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 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 of 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 the screeding has been completed, the surface of the concrete shall be inspected and any irregularities shall be corrected at once in order to maintain the surface to a tolerance of one-eighth ($\frac{1}{8}$) inch above or below the required cross sectional elevations and to a maximum irregularity not exceeding one-eighth ($\frac{1}{8}$) inch under a ten (10) foot straight edge longitudinally.

Just before the concrete takes its initial set the surface shall be lightly broomed uniformly and at right angles to the center line with a steel or barn broom, or finished with a wooden float as described for "Sidewalk Finish."

701-24. Curing Concrete.

(a) *Water Curing:* All concrete surface shall be kept wet for at least seven (7) days after placing. Roadway and sidewalk slabs shall be covered with wet burlap, cotton mats, or other suitable fabric immediately after final finishing of the surface. 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 either 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.

(b) *Special Curing:* Special attention shall be given by the Contractor to the proper curing of concrete handrails and all surfaces requiring rubbed finishes.

(c) *Filling on and Opening to Traffic:* Traffic and/or fill material shall not be allowed on superstructures of concrete bridges or culverts for a period of from fourteen (14) to twenty-one (21) days after placing of concrete has been completed.

When a separate portland cement concrete wearing surface is required, the time after placing and prior to opening the surface to traffic shall be not less than ten (10) days, provided the superstructure on which the wearing surface is placed shall have cured for the required period as stated above.

701-25. Removal of Forms and Falsework.

(a) 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 "stoney ring" when struck with a small hammer. In general, forms for vertical surfaces shall not be removed for at least seven (7) days; and supporting forms for a period of fourteen (14) to twenty-one (21) days, depending upon conditions, except forms for slabs having clear spans less than ten (10) feet may be removed after seven (7) days.

(b) In cold weather, the Engineer may require that the length of time that forms and falsework are to remain in place shall be increased.

(c) Falsework and centering for spandrel-filled arches shall not be struck until fills back of abutments have been placed up to the spring line. Falsework supporting the deck of rigid frame structures shall not be removed until fills have been placed back of the vertical legs.

(d) 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. As soon as the forms are removed, all projecting wire or metal devices which have

been used for holding the forms in place, and which pass through the body of the concrete, shall be removed or cut back at least two (2) inches from the exposed surface of the concrete.

701-26. Repairing Defects. As soon as the forms are removed, all porous areas, stone pockets, open or porous construction joints and foreign matter shall be removed and the areas patched.

In patching holes or porous spots, all coarse or broken material shall be chipped away until a dense uniform surface of concrete, exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form faces perpendicular to the surface having a minimum depth of one (1) inch. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with thick, dry mortar composed of the same material and of the same mix as that used in the concrete containing the defects. 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 five (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.

701-27. Finishing Concrete Surfaces. The character of the materials used and the care with which forms are constructed and concrete placed are factors in determining the amount of rubbing required. If, through the use of first class form materials and the exercise of special care, concrete surfaces are obtained that are satisfactory to the Engineer, the Contractor may be relieved in part from the requirement of rubbing.

All concrete surfaces exposed in the completed work shall comply with the requirements of "Ordinary Finish," except where the plans or specifications indicate "Rubbed Finish," "Curb and Sidewalk Finish," "Concrete Floor," and "Wearing Surface."

Surfaces not exposed to general view shall be given an "Ordinary Finish" as described in the following paragraph. In general such surfaces shall in regard to bridges, overpasses and culverts, consist of sides and bottoms of girders and stringers, bottom surfaces of superstructure slabs, breast

and wing walls of abutments, piers, columns, and retaining walls.

(a) *Ordinary Finish:* An "Ordinary Finish" is defined as the finish left on a surface after the removal of the forms, the filling of all holes left by form ties, and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections and of uniform texture. 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. The concrete in bridge seats, caps, and tops of walls shall be struck off with a straight edge and floated to true grade. The use of mortar topping for concrete surfaces shall in no case be permitted.

(b) *Rubbed Finish:* Surfaces exposed to general view shall be given a "Rubbed Finish". In general such surfaces shall consist of interior and exterior surfaces of handrails and curbs on bridges and overpasses; the breast and wing walls of abutments, retaining walls, piers, columns and the exterior face of girders and fascia curbs on underpasses. Other surfaces as may be indicated on the plans or specified shall have a "Rubbed Finish".

A "Rubbed Finish" shall be produced in three steps as follows:

(1) All holes left by form ties, honeycomb spots and other defects shall be carefully filled.

(2) As soon as the mortar used in filling surface defects has taken a firm set, the surface to be finished shall be moistened and thoroughly rubbed or ground with a carborundum brick or similar tool to remove from such surfaces all inert sand or cement materials and to eradicate all impressions of form work.

(3) When the surface under treatment has been rubbed to a smooth and even surface, it shall be again wet rubbed until a small accumulation of fine-grained paste is produced. This paste shall not be removed but it shall be carefully spread with a moist whitewash brush to form a very thin uniform coating upon the surface of the concrete. This finish shall result in a surface of smooth texture and uniform color.

Final surface finishing shall not be done in freezing weather nor when the concrete contains frost. In cold weather the preliminary rubbing necessary to remove the inert sand and cement materials and surface inequalities may be done without the application of water to the concrete surfaces.

701-28. Incidental Drainage. Metal drain forms and drains through abutments and retaining walls shall conform to the requirements of Article 701-8. They shall be installed at locations shown on the plans or as authorized.

All drains shall be accurately placed and adequate means provided for securely holding them in the required position during the placing of the concrete.

Care shall be taken to insure that the drain forms shall retain their designed size and shape. The details of drains shall be such as to prevent the discharge of drainage water against any part of the structure.

701-29. Cast Iron Roadway Drains. Material for castings for "Cast Iron Roadway Drains" shall conform to the requirements of Article 702-26.

Drains shall conform to the details and shall be installed at locations shown on the plans or as authorized. They shall be accurately placed and adequate means shall be provided for securely holding them in the required position during the placing of the concrete.

701-30. Expansion Bearings. Expansion bearings shall consist of steel and bronze plates, or steel and rolled copper alloy plates placed between the substructure and superstructure in conformity with the dimensions and details shown on the plans.

Material and workmanship of structural steel used in "Expansion Bearings" shall conform to the requirements of Section 702, "Structural Steel."

Material and workmanship of bronze and copper alloy plates used in "Expansion Bearings" shall conform to the requirements of Section 703, "Bronze or Copper Alloy Bearing and Expansion Plates." When Lubrite expansion plates are called for on the plans, they shall be Lubrite Bronze Self-Lubricating Expansion Plates, with trepanned inserts, manufactured by Merriman Brothers Inc. of Boston, Mass., or an approved equal. Just prior to erection, the Contractor shall thoroughly rub the steel bearing plates, which rest on the bronze, with stick lubricant.

Expansion bearings shall be anchored in correct position according to the details shown on the plans, and all sliding surfaces shall be planed true and smooth. The bronze plates shall be so placed that the direction of the planing of the two surfaces in contact are parallel to the movement of the span.

Special care shall be taken in the placing of the expansion bearings so that in the finished structure they will conform to the exact lines and grades shown on the plans.

METHOD OF MEASUREMENT

701-31. The quantity of "Portland Cement Concrete" to be measured for payment shall be the number of cubic yards satisfactorily placed within the neat lines of the structure as shown on the plans, or on authorized changes in the plans. No deduction from this volume shall be made for the volume of embedded structural steel, reinforcing steel, pile heads or drains.

The quantity of "Concrete Rail" to be measured for payment shall be the number of linear feet measured horizontally from out to out of end-posts of each continuous section of rail.

The quantity of "Cement" to be measured for payment shall be the number of barrels (of four (4) ninety-four (94) pound bags) incorporated in the structure as authorized.

The quantity of "Cast Iron Roadway Drains" to be measured for payment shall be the number of drains satisfactorily installed in accordance with the details on the plans or as authorized.

The quantity of "Expansion Bearings" to be measured for payment shall be the number of sets satisfactorily installed in accordance with the details on the plans or as authorized. An expansion bearing "set" shall consist of a complete unit at the expansion end of the beam.

BASIS OF PAYMENT

701-32. All work done under "Portland Cement Concrete" of the various types required will be paid for at the contract unit price per cubic yard, except that "Concrete Rail" shall be paid for at the contract unit price per linear foot. Payment shall be full compensation for furnishing and processing all aggregates; for furnishing water; for mixing, hauling, placing, finishing and curing; for furnishing all labor, equipment, forms and falsework, tools and all incidentals neces-

sary to complete the work, except cement which will be paid for under a separate item.

Unless otherwise provided, payment for "Portland Cement Concrete" shall include full compensation for metal drain forms, baffles, expansion joint filler, cast iron or tile drains, roofing felt and burlap.

For "Portland Cement Concrete" and "Concrete Rail" all reinforcing steel or wire mesh, cement, structural steel, cast iron roadway drains and expansion bearings will be paid for under their respective items.

"Portland Cement" will be paid for at the contract unit price per barrel, which payment shall be full compensation for furnishing the cement, for hauling, storing, handling and for all incidentals necessary to complete the work.

All work done under "Cast Iron Roadway Drains" will be paid for at the contract unit price each, which payment shall include full compensation for furnishing all material; for fabricating and placing; for all labor, tools, equipment and all incidentals necessary to complete the work.

All work done under "Expansion Bearings" will be paid for at the contract unit price per set, which payment shall include full compensation for furnishing all material; for fabricating and placing; for all labor, tools, equipment and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item

701-33 Portland Cement Concrete, Abutments and Retaining Walls	—per cubic yard
701-34 Portland Cement Concrete, Abutments and Retaining Walls (placed under water)	—per cubic yard
701-35 Portland Cement Concrete, Piers	—per cubic yard
701-36 Portland Cement Concrete, Piers (placed under water)	—per cubic yard
701-37 Portland Cement Concrete, Sub- structure columns, Column bases, Bents, Collision Walls, Girders, Struts, etc.	—per cubic yard
701-38 Portland Cement Concrete, Floor Slabs	—per cubic yard
701-39 Portland Cement Concrete, Superstructure Slabs	—per cubic yard
701-40 Portland Cement Concrete, Road- way and Sidewalk Slabs on Steel Bridges	—per cubic yard

701-41 Portland Cement Concrete, Superstructure T-beam Type	—per cubic yard
701-42 Portland Cement Concrete, Superstructure Arch Type	—per cubic yard
701-43 Portland Cement Concrete, Rigid Frame Structures including Sidewalks, Curbs, and Frame Footings	—per cubic yard
701-44 Portland Cement Concrete, Wear- ing Surface on Bridges	—per cubic yard
701-45 Portland Cement Concrete, Cul- vert Endwalls	—per cubic yard
701-46 Portland Cement Concrete Rail	—per linear foot
701-47 Portland Cement	—per barrel
701-48 Cast Iron Roadway Drains	—each
701-49 Expansion Bearings	—per set

SECTION 702 STRUCTURAL STEEL

DESCRIPTION

702-1. General. This item shall consist of detailing, fabricating, erecting and painting the structural steel portions of bridges, as required under this contract.

702-2. 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 may at his option supply correct copies on tracing cloth, and these plans shall be the property of the Commission.

All plans shall be thirty-six (36) inches in length by twenty-two (22) inches in width measured upon a trimming line located one-eighth ($\frac{1}{8}$) inch outside the border line. The inner border line shall be located one-half ($\frac{1}{2}$) inch inside the outer border line upon the top, bottom and right end of the plan and two (2) inches from that line upon 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. If the plans and specifications differ, the plans shall govern.

702-3. Design. Design, detail and load requirements shall conform to the latest revised A.A.S.H.O. Standard Specifications for Highway Bridges.

702-4. Name Plates. Unless otherwise specified there shall be a name plate, showing in raised letters and figures the name of the manufacturer and the year of construction, bolted to the bridge near each end at a point convenient for inspection.

MATERIALS

702-5. General. Except where otherwise provided, all members shall be of structural carbon steel and rivets shall be of structural rivet steel. Castings and bearing details shall be as shown on the plans.

702-6. Structural Carbon Steel and Eye Bar Steel. Structural carbon steel and steel for eye bars shall conform to the latest revised Specification for Steel for Bridges and Buildings of the A.S.T.M. Designation A-7.

702-7. Structural Silicon Steel. Structural silicon steel shall conform to the latest revised Specification for Structural Silicon Steel of the A.S.T.M. Designation A-94.

702-8. Structural Nickel Steel. Structural nickel steel shall conform to the latest revised Specification for Structural Nickel Steel of the A.S.T.M. Designation A-8.

702-9. Structural Rivet Steel. Structural rivet steel shall conform to the latest revised Specification for Structural Rivet Steel of the A.S.T.M. Designation A-141.

702-10. High-Strength Structural Rivet Steel. High-strength rivet steel shall conform to the latest revised Specification for High-Strength Structural Rivet Steel of the A.S.T.M. Designation A-195.

702-11. Structural Low-Alloy Steel. Structural low-alloy steel shall conform to the latest revised specification for Low-Alloy Steel of the A.S.T.M. Designation A-242.

702-12. Structural Weldable Steel. Structural steel for welding shall conform to the latest revised specifications for Structural Weldable Steel of the A.S.T.M. Designation A-373.

702-13. High - Tensile - Strength Bolts. Bolts, nuts and washers shall conform to the requirements of the current specifications for quenched and tempered steel bolts and studs with suitable nuts and plain washers of the A.S.T.M. Designation A-325. Bolts manufactured to this specification are identified by marking on the top of the head with three radial lines.

Bolt dimensions shall conform to the current requirements for regular semifinished hexagon bolts of the American Standards Association Designation B-18.2.

Nut dimensions shall conform to the current requirements for heavy semifinished hexagon nuts of the American Standards Association Designation B-18.2.

Washer dimensions shall not be less than would conform to the current requirements of the American Standards Association Designation B-27.2.

702-14. Canvas. The canvas used under masonry bearing plates shall be 12 to 14 ounce duck and shall conform to the latest revised specification for Numbered Cotton and Army Duck of the A.S.T.M. Designation D-230.

702-15. Sheet Lead. Sheet lead shall conform to the requirement for Common Desilverized Lead A, of the specification for Pig Lead of the A.S.T.M. Designation B-29.

702-16. Copper Bearing Steels. When copper bearing steel is specified, the steel shall contain not less than two-tenths (0.2) per cent of copper.

702-17. Full Size Tests. When full-size tests of built-up structural members and eye bars are required by the contract, the Contractor shall supply testing machines of the proper type and capacity and shall provide all facilities and labor incidental to the making of tests. In all tests involving the determination of tensile and compressive strengths, the ultimate strength, deformation and other pertinent data shall be recorded.

702-18. Number and Size of Test Bars. When tests of full-sized eye bars are required, the number and size of the bars to be tested shall be designated by the Engineer before the mill order is placed. The number shall not exceed five (5)

per cent of the total number of bars ordered, with a minimum of two (2) bars on small orders.

702-19. Selection of Test Bars. Test bars shall be of the same section as the bars to be used in the structure and of the same length if within the capacity of the testing machine. They shall be selected by the Inspector from the finished bars, preferably after annealing. Test bars representing bars too long for the testing machine shall be selected from the full length bar material after the heads on one end have been formed and shall have the second head formed upon them after being cut to the greatest length which can be tested.

702-20. Failure to Meet Requirements. If an eye bar fails to fulfill the specified requirements, two additional bars of the same size and from the same melt shall be tested. The bars represented by the test may be re-annealed before the additional bars are tested.

If two of the three test bars fail to give satisfactory results, the bars of that size and melt shall be rejected.

702-21. Record of Annealing. A record of the annealing charges shall be furnished the Engineer showing the bars included in each charge and the treatment they received.

702-22. Wrought Iron. Wrought iron shall conform to the following latest revised A.S.T.M. specifications:

Plates: A.S.T.M. Designation A-42

Rolled shapes and bars: A.S.T.M. Designation A-207

Welded pipe: A.S.T.M. Designation A-72

702-23. Steel Forgings. Steel forgings shall conform to the latest revised specification for Carbon-Steel Forgings for General Industrial Use of the A.S.T.M. Designation A-235. Class C-1 forgings shall be furnished unless otherwise specified.

702-24. Carbon Steel Castings. Carbon steel castings shall conform to the specifications for mild to medium strength Carbon Steel Castings for general application of the latest revised A.S.T.M. Designation A-27. Grade 65-35 shall be furnished unless otherwise specified.

702-25. Chromium Alloy-Steel Castings. Chromium alloy-steel castings shall conform to the latest revised specification for Chromium Alloy-Steel Castings, A.S.T.M. Designation A-296. Grade 10 shall be furnished unless otherwise specified.

702-26. Gray Iron Castings. Gray iron castings shall conform to the latest revised specification for Gray Iron Castings of the A.S.T.M. Designation A-48. Class No. 30 shall be furnished unless otherwise specified.

Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

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.

702-27. Malleable Castings. Malleable castings shall conform to the latest revised Specification for Malleable Iron Castings of the A.S.T.M. Designation A-47, Grade No. 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.

FABRICATION

702-28. General.

(a) Riveted construction is intended, unless otherwise shown on the plans or called for in the Special Provisions.

(b) Workmanship and finish shall be equal to the best general practice in modern bridge shops.

702-29. Storage of Materials. Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease and other foreign matter, and shall be protected as far as practicable from corrosion.

702-30. 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.

702-31. Finish. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately.

702-32. Rivet Holes. All holes for rivets shall be either punched or drilled. Material forming parts of a member composed of not more than five (5) thicknesses of metal may be punched one-sixteenth (1/16) inch larger than the nominal diameter of the rivets whenever the thickness of the metal is not greater than three-fourths (¾) inch for structural steel or five-eighths (⅝) inch for alloy steel. When there are more than five (5) thicknesses, or when any of the main material is thicker than three-fourths (¾) inch in carbon steel, or five-eighth (⅝) inch in alloy steel, or when required under Article 702-35, all the holes shall be subpunched or subdrilled three-sixteenths (3/16) inch smaller and, after assembling, reamed one-sixteenth (1/16) inch larger, or drilled from the solid to one-sixteenth (1/16) inch larger, than the nominal diameter of the rivets.

702-33. Punched Holes. The diameter of the die shall not exceed the diameter of the punch by more than one-sixteenth (1/16) inch. If any holes must be enlarged to admit the rivets, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching of holes will be cause for rejection.

702-34. Reamed or Drilled Holes. Reamed holes shall be cylindrical, perpendicular to the member and not more than one-sixteenth (1/16) inch larger than the nominal diameter of the rivets. Where practicable, reamers shall be directed by mechanical means. Drilled holes shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed. Poor matching of holes 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 drilled and shall be match marked before disassembling.

702-35. Subpunching, Reaming and Shop Assembly. Unless otherwise specified, holes in all field connections and field splices of main truss or arch members, continuous

beams, plate girders and rigid frames shall be subpunched (or subdrilled if subdrilling is required according to Article 702-32) and reamed while assembled in the shop. The assembly including camber, alignment, accuracy of holes and milled joints, shall be approved before reaming is commenced.

Unless otherwise authorized, each individual (full length) truss, arch, continuous beam or girder shall be assembled in the shop before reaming is commenced.

All holes for floor beam and stringer field end connections shall be subpunched and reamed to a steel template or reamed while assembled.

If additional subpunching and reaming is required it shall be specified in the Special Provisions or on the plans.

702-36. 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 one-eighth (⅛) 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 seventy-five (75) per cent 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 three-sixteenths (3/16) inch smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

702-37. Accuracy of Reamed and Drilled Holes. When holes are reamed or drilled, eighty-five (85) per cent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than one-thirty-second (1/32) inch between adjacent thicknesses of metal.

702-38. Shop Assembling. Shop assembly of trusses, arches, continuous beam spans, and plate girders shall be according to Article 702-35.

Complete shop assembly of an entire structure, including floor system, which may be necessary in the case of complicated designs, shall be done when shown on the plans or when stipulated in the Special Provisions.

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 one-sixteenth (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 riveted in the shop shall be secured by bolts, insofar as practicable, to prevent damage in shipment and handling.

702-39. Camber Diagram. A camber diagram shall be furnished the Engineer, showing the camber at each panel point for each truss, taken from actual measurements while the truss is assembled.

702-40. 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.

702-41. 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.

702-42. 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.

702-43. 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.

702-44. Bolts and Bolted Connections. The Specifications of this article do not pertain to the use of high tensile strength bolts.

(a) *General:* Bolted connections shall not be used unless shown on the plans. Where bolted connections are permitted, the bolts furnished shall be unfinished bolts (ordinary rough

or machine bolts). Turned bolts shall be provided if shown on the plans or if required by the special provisions. Special ribbed drive fit bolts may be substituted for turned bolts upon written approval of the Engineer.

The holes for ribbed bolts shall be truly cylindrical and the size of holes shall be one-sixteenth (1/16) inch greater than the nominal diameter of the bolts and shall make a driving fit with the bolts. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread. A snap shall be used to prevent damaging the heads.

The heads and nuts shall be drawn tight against the work with a suitable wrench. Bolt heads shall be tapped with a hammer while nut is being tightened. Where bolts are to be used in beveled surfaces, beveled washers shall be provided to give full bearing to the head or nut. Ribbed bolts shall be furnished in the same number and in nominal sizes not smaller than the rivets for which they are substituted. They shall be furnished in sufficient variety of lengths that when drawn tight the fluted shank will fill the hole in the work and the thread will completely fill the nut with not more than one thread protruding. All bolts shall have cut threads neatly and accurately finished.

If for any reason the bolts twist before drawing tight, the hole shall be carefully reamed and the bolt replaced with a new bolt of diameter to fit properly in the hole.

The Contractor shall provide and supply himself with over-size bolts for this replacement in an amount not less than ten (10) per cent of the number of ribbed bolts specified.

The nuts of all bolts shall be effectually locked after they have been finally tightened.

(b) *Unfinished Bolts:* Unfinished bolts shall be standard bolts with hexagonal heads and nuts. The diameter of the bolt holes shall be one-sixteenth (1/16) inch greater than the diameter of the bolts used. Bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal. The bolts shall be of such length that they will extend entirely through their nuts, but not more than one-quarter ($\frac{1}{4}$) inch beyond them. The number of bolts furnished shall be five (5) per cent more than the actual number shown on the plans for each size and length.

(c) *Turned Bolts:* Holes for turned bolts shall be carefully reamed and the bolts turned to a driving fit with the threads entirely outside of the holes and a washer shall be used. The heads and nuts shall be hexagonal.

One-fourth ($\frac{1}{4}$) inch nut locks shall be used on all turned bolts unless otherwise specified on the plans. Turned bolts shall be finished by a finishing cut.

(d) *Special Ribbed Bolts:* Ribbed bolts, with drive fit, shall be used only where called for on the plans. Ribbed bolts may be substituted for field rivets in locations where, in the opinion of the Engineer, it is impracticable to drive rivets.

702-45. Connections Using High-Tensile-Strength Bolts.

(a) *General.* This specification covers the assembly of structural connections using high-tensile-strength bolts and nuts with hardened washers where the initial tension in the bolt produces friction on the contact surfaces of the connected pieces sufficient in magnitude to resist shear.

High-tensile-strength bolts may be substituted for rivets as indicated by the plans or Special Provisions.

Except as otherwise provided in this article, construction shall conform to applicable specifications for riveted structures.

All bolts, nuts, and washers shall conform to the requirements of Article 702-13 with regard to materials, dimensions, and identification marking.

(b) *Dimensions of Bolts, Nuts, and Washers.* Bolt lengths shall be determined by adding the values given in Table I to the total thickness of connected material. The values in Table I compensate for thickness of nut, two flat washers, and bolt point. The total length shall be adjusted to the next $\frac{1}{4}$ -inch increment up to 5-inch length and to the next longer $\frac{1}{2}$ -inch increment for lengths over 5 inches.

TABLE I—BOLT LENGTHS

Bolt Size (In.)	Add to Grip (In.)
$\frac{1}{2}$	1
$\frac{3}{4}$	$1\frac{1}{8}$
$\frac{7}{8}$	$1\frac{1}{4}$
1	$1\frac{1}{2}$
$1\frac{1}{4}$	$1\frac{3}{4}$
$1\frac{1}{2}$	$1\frac{7}{8}$

When circular washers having a thickness greater than given in Table II for standard washers are used, the necessary bolt length shall be adjusted accordingly. Where beveled washers of the dimensions given in Table II are used,

an additional $\frac{1}{8}$ inch shall be added for each such beveled washer.

TABLE II—WASHER DIMENSIONS

Bolt Size (In.)	Circular Washers			Squared Beveled Washers For American Standard Beams and Channels		
	Inside Diameter (In.)	Outside Diameter (In.)	Thickness Gage No.	Mean Width	Mean Thickness	Slope
$\frac{1}{2}$	9/16	$1\frac{1}{8}$	12	$1\frac{1}{4}$	5/16	1:6
$\frac{3}{4}$	11/16	$1\frac{1}{4}$	10	$1\frac{3}{8}$	5/16	1:6
$\frac{7}{8}$	13/16	2	9	$1\frac{1}{2}$	5/16	1:6
1	15/16	$2\frac{1}{4}$	8	$1\frac{3}{4}$	5/16	1:6
$1\frac{1}{8}$	17/16	$2\frac{1}{2}$	8	$1\frac{7}{8}$	5/16	1:6
$1\frac{1}{4}$	$1\frac{1}{4}$	$2\frac{3}{4}$	8	$2\frac{1}{4}$	5/16	1:6
$1\frac{1}{2}$	$1\frac{3}{4}$	3	8	$2\frac{1}{2}$	5/16	1:6

Circular washers shall be flat and smooth. Where clearance is necessary, washers may be clipped on one side to a point not closer than $\frac{1}{8}$ of the bolt diameter from the center of the washer. Where bearing faces of the bolted parts have a slope of more than 1:20 with respect to a plane normal to the bolt axis, smooth beveled washers shall be used to compensate for lack of parallelism.

(c) *Bolted Parts and Assembly.* Holes may be punched, subpunched and reamed or drilled, as required by the applicable specification for riveted construction, and shall be of a diameter not more than $1/16$ inch in excess of the nominal bolt diameter.

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be descaled or carry the normal tight mill scale. Contact surfaces shall be free of dirt, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts.

Contact surfaces of joints shall be free of paint or lacquer unless otherwise indicated by the plans or Special Provisions.

Connections shall be assembled with a hardened washer under the bolt head and nut. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel, except flat washers may be used on surfaces having a slope not greater than 1:20 with respect to a plane normal to the bolt axis, providing the nut is torqued against a non-sloping surface. For slopes greater than 1:20, smooth beveled washers shall be used to produce parallelism.

All nuts shall be tightened to give at least the required minimum bolt tension values given in Table III upon completion of the joint.

TABLE III—BOLT TENSION AND TORQUE VALUES

Bolt Size (In.)	Recommended Bolt Tension For Cal- ibrating Wrenches (Lb.)	Required Minimum Bolt Tension (Lb.)	Approximate Equivalent Torque For Required Minimum Bolt Tension (Lb. Ft.)
$\frac{1}{8}$	12,500	10,850	90
$\frac{3}{16}$	20,000	17,250	180
$\frac{1}{4}$	29,000	25,600	320
$\frac{5}{16}$	37,000	32,400	470
$\frac{3}{8}$	49,000	42,500	710
$\frac{1}{2}$	58,000	50,800	960
$\frac{5}{8}$	74,000	64,500	1,350

702-46. 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.

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, recupping 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 three-eighths ($\frac{3}{8}$) inch.

702-47. Edge Planing. Sheared edges of plates more than five-eighths ($\frac{5}{8}$) inch in thickness and carrying calculated stresses shall be planed to a depth of one-quarter ($\frac{1}{4}$) inch. Re-entrant cuts shall be filleted before cutting.

702-48. Flame Cutting. Steel or wrought iron may be flame-cut, provided a smooth surface is secured by the use of a mechanical guide. Flame-cutting, by hand, shall be done only where approved by the Engineer, and the surface shall be made smooth by planing, chipping or grinding. The cut-

ting flame shall be so adjusted and manipulated as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted to a radius of not less than one-half ($\frac{1}{2}$) inch.

In the case of silicon steel, flame-cut edges shall be removed to a depth of at least one-quarter ($\frac{1}{4}$) inch, by milling, chipping 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° F. to 1,250° F.) to a depth of at least one-sixteenth ($\frac{1}{16}$) inch; or, (b) by means of a post-heating torch attached to and following the cutting torch; the tips, gas pressure, speed of travel and the distance of post-heating torch from kerf regulated to the thickness of the steel. Bend test specimens so cut and flame-softened shall meet the bend test requirements for that thickness in Specification A.S.T.M. A-94.

702-49. 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 B46.1, Surface Roughness, Waviness and Lay, Part 1:

Steel slabs, ...	ASA 2000
Heavy plates in contact in shoes to be welded, ..	ASA 1000
Mill ends of compression members, stiffeners, and fillers, ...	ASA 500
Bridge rollers and rockers, ...	ASA 250
Pins and pin holes, ...	ASA 125
Sliding bearings, ...	ASA 125

702-50. Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed one-quarter ($\frac{1}{4}$) inch.

702-51. End Connection Angles. Floor beams, stringers and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall not be less than that shown on the detail drawings.

702-52. Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

702-53. Finished Members. Finished members shall be true to line and free from twists, bends and open joints.

702-54. Web Plates. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than one-eighth ($\frac{1}{8}$) 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 one-half ($\frac{1}{2}$) inch less in width than the distance back to back of flange angles.

Splices in webs of girders without cover plates shall be sealed on the top by welding.

At web splices, the clearance between the ends of the web plates shall not exceed three-eighths ($\frac{3}{8}$) inch. The clearance at the top and bottom ends of the web splices shall not exceed one-quarter ($\frac{1}{4}$) inch.

702-55. Fit of Stiffeners. End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within one-quarter ($\frac{1}{4}$) inch at each end.

Welding will be permitted, as provided in Article 702-3, in lieu of milling or grinding, if noted on the plans or specified in the special provisions. Welding transversely across the tension flanges of beams or girders which have a flange stress of more than seventy-five (75) per cent of their designed capacity, will not be permitted.

702-56. 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, measured to the concave face of the metal, shall not be less and preferably shall be greater than shown in the following table in which "T" is the thickness of the plate:

<i>Angle through which plate is bent</i>	<i>Minimum Radius</i>
61 degrees to 90 degrees	1.0 T
91 degrees to 120 degrees	1.5 T
121 degrees to 150 degrees	2.0 T

(c) If a shorter radius is essential, the plates shall be bent hot. Hot-bent plates shall conform to the requirement of (a) above. Before bending, the corners of the plate shall be rounded to a radius of one-sixteenth ($\frac{1}{16}$) inch throughout that portion of the plate at which the bending is to occur.

702-57. Eye Bars. Eye bars shall be straight, true to size, and free from twists, folds in the neck and head, and other defects. The heads shall be made by upsetting and rolling or forging, and not by welding. The form of the heads will be determined by the dies in use at the works where the eye bars are made, if they are satisfactory to the Engineer. The thickness of the head and neck shall not overrun more than one-sixteenth ($\frac{1}{16}$) inch.

Eye bars that are to be placed side by side in the structure shall be bored so accurately that upon being placed together, pins one thirty-second ($\frac{1}{32}$) inch less in diameter than the pin holes will pass through the holes at both ends at the same time without driving.

702-58. Annealing and Stress Relieving. Before boring, eye bars shall be annealed to produce the required physical qualities and shall be straightened. Proper instruments shall be provided for determining at any time the temperature of the bars.

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 provisions of the American Welding Society.

702-59. 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 more than seven (7) inches in diameter shall be forged and annealed.

In pins larger than nine (9) inches in diameter, a hole not less than two (2) inches in diameter shall be bored full length along the 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.

702-60. 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 one thirty-second ($1/32$) inch. Boring of holes in builtup members shall be done after the riveting is completed.

702-61. Pin Clearance. The diameter of the pin hole shall not exceed that of the pin by more than one-fiftieth ($1/50$) inch for pins five (5) inches or less in diameter, or one thirty-second ($1/32$) inch for larger pins.

702-62. Screw Threads. Threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that the pin ends having a diameter of one and three-eighths ($1\frac{3}{8}$) inches or more shall be threaded six (6) threads to the inch.

702-63. Pilot and Driving Nuts. Two (2) pilot nuts and two (2) driving nuts for each size of pin shall be furnished, unless otherwise specified.

702-64. Welding. All welding shall conform to the current Specifications for Welded Highway and Railway Bridge, Design, Construction, and Repair, of the American Welding Society.

This specification provides for welding (and gas cutting) of base metal consisting of Structural Carbon Steel, Article 702-6, or similar low carbon steel or wrought iron approved by the Engineer. Wrought iron shall conform to the requirements of Article 702-22.

Structural members which carry primary stress and are assembled or fabricated by welding, including rolled beams with flange plates, shall conform to the requirements of Article 702-12, "Structural Weldable Steel". Structural Carbon Steel, Article 702-6, may be used where welding is used to connect or fabricate secondary members, railing assemblies and miscellaneous details.

Where a definite amount of riveting is specified as a minimum for connections, the welded connection shall develop an equivalent strength.

If a fabricating shop prequalifies its metal-arc welding operators according to the standard qualification procedure of the American Welding Society and certifies to the Engineer that an operator working on the structure has been prequalified within twelve (12) months previous to the be-

ginning of work on the subject structure, the Engineer may consider such operator qualified. The certificate shall state that such operator shall have been doing satisfactory welding of the required type within the three-month period previous to the subject work. A certification shall be submitted for each operator and for each project, stating the name of the 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. Such a certification of prequalification may also be accepted as proof that an operator on field welding is qualified, if the Contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose.

MILL AND SHOP INSPECTION

702-65. 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.

702-66. 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.

702-67. Inspector's Authority. The inspector shall have the authority to reject any material or work which does not meet the requirements of these specifications. In case of dispute the Contractor may appeal to the Engineer, whose decision shall be final.

702-68. Mill Orders. The Contractor shall furnish the Engineer with as many copies of the mill orders as the Engineer may direct.

702-69. Rejections. The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

702-70. Mill Tests. If requested by the Engineer, 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.

WEIGHING, MARKING AND SHIPPING

702-71. Weighing of Members. In case it is specified that any part of the material is to be paid for by actual weight, finished work shall be weighed in the presence of the inspector, if practicable. In such case, the Contractor shall supply satisfactory scales and shall perform all work involved in handling and weighing the various parts.

702-72. Marking and Shipping. 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. The weights of individual members shall be shown on the statements. Members weighing more than three (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 one length and diameter and loose nuts or 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 three hundred (300) pounds. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

ERECTION

702-73. 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 com-

plete the bridge or bridges as covered by the agreement, all in accordance with the plans and these specifications.

702-74. 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 copy of shipping statements showing a list of parts and their weights.

702-75. 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.

702-76. 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.

702-77. Handling and Storing Materials. Material to be stored 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. If the contract is for erection only, 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.

702-78. 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.

702-79. 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.

702-80. Bearings and Anchorage. Masonry bearing plates shall not be placed upon bridge-seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the Engineer, they shall be placed on a sheet of lead, a built up layer of canvas and red lead, or a firmly compressed pad of cotton duck impregnated with rubber or equivalent waterproof binder.

The lead shall be a single $\frac{1}{8}$ inch sheet the same size as the bearing plate, with holes accurately punched to accommodate the anchor bolts.

Canvas and red lead shall be applied as follows: thoroughly swab the bridge seat bearing area with red lead paint of a type approved for painting structural steel, and place upon it three layers of canvas (Article 702-14), each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic.

The preformed fabric pads shall be composed of multiple layers of 8 ounce cotton duck impregnated and bound with high quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of a uniform thickness. The number of plies shall be such as to produce the specified thickness (of one-eighth inch unless otherwise called for) after compressing and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 pounds per square inch without detrimental reductions in thickness or extrusion.

Preformed pads shall be cleanly cut to dimensions with holes for anchor bolts accurately prepared before setting. 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.

702-81. 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 that producing a "dark cherry-red color." After heating, the metal shall be cooled as slowly as possible.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

702-82. Assembling Steel. The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets in railings shall not be driven until the span has been swung. Splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have three-fourths of the holes so filled.

Fitting up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be one thirty-second ($1/32$) inch larger.

702-83. Riveting. Pneumatic hammers shall be used for field riveting, except when the use of hand tools is permitted by the Engineer. Rivets larger than seven-eighths ($\frac{7}{8}$) 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 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.

702-84. 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.

702-85. Misfits. The correction of minor misfits involving non-harmful 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 within thirty (30) days an itemized bill for the approval of the Engineer.

702-86. 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 false work placed in the stream channel during con-

struction shall be removed by the Contractor before final acceptance.

PAINT MATERIALS

702-87. Shop Coat. The shop or prime coat of paint for metal shall be a red lead paint and shall conform to the latest revised Specification for Red Lead (Dry and Paste in Oil) and Paint Made Therefrom, Designation M-71, or for Red Lead Ready-Mixed Paint, Designation M-72, Type I or Type II, of the A.A.S.H.O. Specification for Highway Materials. The oil shall be raw linseed oil unless otherwise specified. The paint preferably shall be factory mixed. As an alternative the pigment shall be furnished in the form of red lead paste.

702-88. Factory Inspection and Testing. The Engineer or his authorized representative shall have free access afforded to him for sampling the ingredients entering into the paint and for observing the processes of its manufacture. Samples will be subject to chemical analysis and, if found of unsatisfactory quality, the materials they represent will be rejected.

The methods of test shall, in general, be those approved by the A.A.S.H.O.

PAINTING

702-89. General Conditions. The painting of metal structures shall include, unless otherwise provided in the contract, the preparation of the metal surfaces, the application, protection, and drying of the paint coatings, and the supplying of all tools, tackle, scaffolding, labor, and materials necessary for the entire work.

702-90. Mixing of Paint. Paint shall be thoroughly mixed before applying, and the pigments shall be kept in uniform suspension.

702-91. Weather Conditions. Paint shall not be applied when the air temperature is below 40° F., or when the air is misty, or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work. It shall not be applied upon damp or frosted surfaces.

Material painted under cover in damp or cold weather shall remain under cover until dry or until weather conditions permit its exposure in the open. Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

702-92. Application. Painting shall be done in a neat and workmanlike manner. Paint may be applied with hand brushes or 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 the 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 the addition of any thinner. In cool weather, the paint may be warmed to reduce the viscosity for use. Such warming shall be accomplished by heating the paint containers in water or by placing them on steam radiators.

Paint when applied with spray equipment shall be immediately followed by brushing when necessary to secure uniform coverage and to eliminate wrinkling, blistering and air holes.

On all surfaces which are inaccessible for paint brushes, the paint shall be applied by spraying or with sheepskin daubers to insure thorough covering.

702-93. Removal of Paint. If the painting is unsatisfactory, the paint shall be removed and the metal thoroughly cleaned and repainted.

702-94. Cleaning of Surfaces. Surfaces of metal to be painted shall be thoroughly cleaned, removing rust, loose mill scale, dirt, oil or grease and other foreign substances. All weld areas, before cleaning is begun, shall be neutralized with a proper chemical, after which it shall be thoroughly rinsed with water.

The removal of rust, scale and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers or other effective means. Oil and grease shall be removed by the use of gasoline or benzine. Bristle or wood fiber brushes shall be used for removing loose dust.

702-95. Painting Galvanized Surfaces. For the purpose of conditioning the surface of galvanized surfaces for painting, the painting shall be deferred as long as possible in order that the surface may weather.

Before painting galvanized surfaces which are required to be painted they shall be treated as follows:

In one (1) gallon of soft water dissolve two (2) ounces each of copper chloride, copper nitrate, and sal ammoniac, then add two (2) ounces of commercial muriatic acid. This should be done in an earthen or glass vessel, never in tin or other metal receptacle. Apply the solution with a wide flat brush to the galvanized surface, which will assume a dark, almost black color. The solution upon drying becomes a grayish film.

702-96. Shop Painting. Unless otherwise specified, steel work shall be given one (1) coat of shop coat paint after it has been accepted by the inspector and before it is shipped from the plant.

Surfaces not in contact but inaccessible after assembly or erection shall be painted two (2) coats. The shop contact surfaces shall not be painted. Field contact surfaces shall receive a shop coat of paint, except main truss connection and girder splices involving multiple thicknesses of material where a shop coat 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 (1) coat of shop paint after shop welding is finished. Steel which is to be field welded shall be given one (1) 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 (1) coat of paint.

With the exception of abutting joints and base plates, machine-finished surfaces shall be coated as soon as practicable after being accepted with a hot mixture of white lead and tallow, or other approved coating, before removal from the shop.

Erection marks for the field identification of members and weight marks shall be painted upon surface areas previously painted with the shop coat.

Material shall not be loaded for shipment until it is thoroughly dry, and in any case not less than twenty-four (24) hours after the paint has been applied.

702-97. Field Painting. Unless specifically provided, field painting by the Contractor will not be required. However, as soon as the inspector has examined and approved all field rivets driven, the heads of such rivets and field bolts, all welds and any surfaces from which the shop or first coat of paint has become worn off or has otherwise become defective, shall be cleaned and thoroughly covered with one (1) coat of shop coat paint.

Surfaces to be riveted in contact and surfaces which will be in contact with concrete shall not be painted.

Surfaces which will be inaccessible after erection shall be painted with one (1) coat of shop coat paint.

To secure a maximum coating on edges of plates or shapes, rivet heads and other parts subjected to special wear and attack, the edges shall first be painted with a longitudinal motion and the rivet heads with a rotary motion of the brush, followed immediately by the general painting of the whole surface, including the edges and rivet heads.

If field painting is required, it shall be done in accordance with the preceding sections and the following requirements:

When the paint applied for retouching the shop coat has thoroughly dried, and the field cleaning has been satisfactorily completed, such field coats as are called for in the Special Provisions shall be applied. In no case shall a succeeding coat be applied until 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.

The Contractor shall protect pedestrians, vehicular and other traffic upon or underneath the bridge, and also all portions of the bridge superstructure and substructure against damage or disfigurement by spatters, splashes and smirches of paint or paint materials.

702-98. Number of Coats. Field painting shall consist of three coats applied after erection, one coat of priming coat paint, one coat of intermediate paint, and one coat of finish-coat paint, as provided in the Special Provisions.

METHOD OF MEASUREMENT

702-99. General. The quantity of material to be measured for payment shall be, unless otherwise specified, the computed net weight, in pounds, of metal in the fabricated and erected structure completed and accepted.

702-100. Computed Weight. The weight shall be computed on the following basis:

(a) Unit weights, per cubic foot	Pounds
Aluminum, cast or wrought	173.0
Bronze, cast or copper-alloy	536.0
Copper sheet	558.0
Iron, cast	445.0
Iron, malleable	470.0
Iron, wrought	487.0
Lead, sheet	707.0
Steel, rolled, cast, copper bearing, carbon, silicon, nickel and stainless	490.0
Zinc	450.0

(b) The weights of rolled shapes shall be computed on the basis of their nominal weights per foot as shown on the drawings, or listed in the hand books.

The weights of plates shall be computed on the basis of the nominal weight for their width and thickness as shown on the drawings, plus an estimated over-run computed as one-half the "Permissible Variation in Thickness and Weight," as tabulated in Specification A-6, "General Requirements for Delivery of Rolled Steel Plates, Shapes and Bars for Structural Use" of the American Society for Testing Materials, current edition.

(c) The weight of castings shall be computed from the dimensions shown on the approved shop drawings, deducting for open holes. To this weight shall be added five (5) per cent allowance for fillets and over-run. Scale weights may be substituted for computed weights in the case of castings or of small complex parts for which accurate computations of weight would be difficult.

(d) For members comprising both carbon steel and other special steel or material, when separate unit prices are provided for same, the weight of each class of steel in each such member shall be separately computed.

(e) The weight of all rivet heads, both field and shop, shall be included on the basis of the following weights:

<i>Diameter of Rivet in Inches</i>	<i>Weight per 100 heads, in Pounds</i>
$\frac{1}{2}$	4
$\frac{5}{8}$	7
$\frac{3}{4}$	12
$\frac{7}{8}$	18
1	26
$1\frac{1}{8}$	36
$1\frac{1}{4}$	48

(f) The weight of weld metal shall be computed on the basis of the theoretical volume from dimensions of the welds.

(g) The weights shall be computed on the basis of the net finished dimensions of the parts as shown on the approved shop drawing, deducting for copes, cuts, clips and all open holes, except rivet holes.

(h) The weight of erection bolts, shop and field paint, boxes, crates and other containers used for shipping, and materials used for supporting members during transportation and erection, shall not be included.

702-101. Scale Weights. When scale weights are specified in the Special Provisions the quantity to be measured for payment shall be determined as follows:

(a) Any weight in excess of one and one-half ($1\frac{1}{2}$) per cent above the computed net weight for the whole structure shall not be included.

(b) The quantity of structural steel shall be the shop scale weight of the fabricated members which shall be weighed on satisfactory scales in the presence of the inspector. If the shop paint has been applied to the completed member when weighed, four-tenths (0.4) of one (1) per cent of the weight of the member shall be deducted from the scale weights to compensate for weight of the shop paint. The weight of field rivets shall be based on the approved shipping list.

(c) Any member whose weight is less than ninety-seven and one-half ($97\frac{1}{2}$) per cent of the computed weight may be rejected.

(d) The weight of erection bolts, shop and field paint, boxes, crates and other containers used for shipping, and materials used for supporting members during transportation and erection, shall not be included.

BASIS OF PAYMENT

702-102. All work done under the items in this section will be paid for at the respective contract unit price per pound for "Structural Steel." For the purpose of payment such metal parts as anchor bolts and nuts, shoes, rockers, rollers, bearing and slab plates, pins and nuts, expansion dams, weld metal, bolts embedded in concrete, cradles and brackets, railing and railing posts, blast plates and water spouts shall be considered, unless otherwise provided, as "Structural Steel."

Furnishing and placing canvas, preformed pads or sheet lead required under Article 702-80 will be paid for at the respective contract bid prices per pound for "Structural Steel."

Full size eye bars which are tested and meet the requirements of these specifications shall be paid for at the same rate as for bars accepted for the structure. Bars which fail to meet these requirements, and all bars rejected as a result of tests, shall not be paid for.

Payment for "Structural Steel" shall be made as follows:

(a) The payment for material delivered shall be full compensation for all labor, materials and transportation necessary for fabrication, shop painting, shipping and delivery to the place designated, which shall mean the bridge site unless otherwise specified and for storing and all incidental work.

(b) The payment for erection of material shall be full compensation for all labor, materials, equipment, tools, and all incidental work necessary for erection, including field painting, if required in the contract.

SUMMARY OF ITEMS FOR PAYMENT

Item 702-103	Structural Steel, Fabricated and	
	Delivered	—per pound
Item 702-104	Structural Steel, Erection	—per pound

SECTION 703

BRONZE OR COPPER-ALLOY BEARING AND EXPANSION PLATES

DESCRIPTION

703-1. General. This item shall consist of fabrication and erection of bronze or copper-alloy bearing and expansion plates for bridges.

MATERIALS

703-2. Bronze Bearing and Expansion Plates shall conform to the requirements of the latest required specification for Bronze Castings for Turntables and Movable Bridges and for Bearing and Expansion Plates of Fixed Bridges of the A.S.T.M. Designation B-22. Alloy B shall be furnished unless otherwise specified.

703-3. Copper-Alloy Bearing and Expansion Plates shall conform to the latest revised specification for Rolled Copper-Alloy Bearing and Expansion Plates for Bridge and Other Structural Uses of the A.S.T.M. Designation B-100. Alloy No. 1 shall be furnished unless otherwise specified.

CONSTRUCTION METHODS

703-4. Bronze Plates shall be cast according to details shown on the plans. Sliding surfaces shall be planed parallel to the movement of the spans and polished unless detailed otherwise.

703-5. Copper-Alloy Plates shall be furnished according to details shown on the plans. Finishing of the rolled plates will not be required provided they have a plane, true and smooth surface.

703-6. Placing. All bearing plates shall be accurately set in correct position as shown on the plans and shall have a uniform bearing over the whole area. Provision shall be made to keep the plates in correct position as the concrete is being placed.

METHOD OF MEASUREMENT

703-7. The quantity of this material to be measured for payment shall be the computed weight in pounds as determined by Article 702-100, "Computed Weight."

BASIS OF PAYMENT

703-8. All work done under the items in this section will be paid for at their respective contract unit prices per pound. Payment shall be made as follows:

(a) For material delivered, the payment shall be full compensation for all labor, materials and transportation necessary for fabrication, shipping and delivery to the site designated and for storing and all incidental work.

(b) For placing material, payment shall include full compensation for all labor, materials and all incidental work necessary for placing.

SUMMARY OF ITEMS FOR PAYMENT

Item	
703- 9 Bronze or Copper-Alloy Bearing and Expansion Plates, Delivered	—per pound
703-10 Bronze or Copper-Alloy Bearing and Expansion Plates, Placing	—per pound

SECTION 704

STRUCTURAL PLATE PIPE, ARCHES AND PIPE ARCHES

DESCRIPTION

704-1. General. This item shall consist of furnishing and installing structural plate pipe, arches or pipe arches in accordance with the sizes, dimensions and locations shown on the plans and in conformity with the lines and grades required.

704-2. Design:

(a) *Elliptical Pipe.* When called for on the plans, pipes shall be fabricated elliptically so as to increase the vertical diameter five (5) per cent, and decrease the horizontal diameter five (5) per cent. These dimensions shall be subject to manufacturing tolerances.

(b) *Pipe Arch.* Pipe arch design shall require plates to form a cross-section made up of four (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 between sixteen (16) and twenty-one (21) inches, and of not more than 87½ degrees nor less than 75 degrees.

MATERIALS

704-3. General. All material, including bolts and nuts, manufacture, galvanizing, corrugations, and incidental items shall conform to the latest revised edition of the A.A.S.H.O. Standard Specifications for Highway Bridges Division IV.

FABRICATION

704-4. Description of Plates. Plates shall consist of structural units of galvanized corrugated metal. Single plates shall weigh not more than seven hundred fifty (750) pounds and shall be furnished in standard sizes to permit structure length increments of two (2) feet.

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three (3) plates come together at one point. Each plate shall be curved to one or more circular arcs.

704-5. Forming and Punching Plates. Plates shall be formed to provide lap joints. The bolt holes shall be so punched 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 to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the plans or as specified.

Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows two (2) inches apart, with one (1) row in the valley and one (1) in the crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than twelve (12) inches. The minimum distance from the center of a hole to the edge of the plate shall be not less than $1\frac{1}{4}$ times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than one-eighth ($\frac{1}{8}$) inch.

Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burnt edges shall be free from oxide and burrs; shall present a workmanlike finish, and legible identification numerals shall be placed on each part plate to designate its proper position in the finished structure.

704-6. Workmanship. In addition to compliance with the details of construction the completed structure shall show careful, finished workmanship in all particulars. Plates on which the spelter coating has been bruised or broken either in the shop or in shipping and erecting, or which shows defective workmanship, shall be rejected. This requirement applies not only to the individual plates but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any of them in any individual culvert plate shall constitute sufficient cause for rejection:

1. Uneven laps.
2. Elliptical shaping (unless specified).
3. Variation from a straight center line.
4. Ragged edges.

5. Loose, unevenly lined or spaced bolts.
6. Illegible brand.
7. Bruised, scaled, or broken spelter coating.
8. Dents or bends in the metal itself.

CONSTRUCTION METHODS

704-7. Field Erection — Pipe and Pipe Arch Structures. Excavation of material shall conform to the requirements of Section 204, "Structural Excavation."

The pipe shall be bedded in a foundation of uniform density. Backfilling shall conform to the requirements of Section 206, "Backfill and Special Backfill."

Structural plate structures shall be assembled in conformity with the manufacturers' shop details showing location, laps and sequence of placing plates.

In general the structure shall be assembled in place on the prepared foundation bed. When authorized, because of adverse water conditions, the structure may be partially or fully assembled near the site before being placed in final position. When the structure is erected in the latter manner, extreme care shall be exercised in moving and placing the pipe.

When underwater bedding becomes necessary, structural excavation of the trench or bed shall extend at least six (6) inches below the pipe flow line and this depth shall be back-filled with granular material. This gravel bed shall be built to the required line and grade of the pipe and shall be shaped to the cross-section of the bottom of the bed plates.

"Structural Plate Pipes" shall be assembled in two stages as follows: (a) bottom plates, (b) side and top plates.

The unsupported edges of plates shall be held in position by the use of temporary props. Each row of side plates shall extend far enough to support the plate above until after the first complete arc has been made, the side plates being lapped one corrugation and a sufficient number of bolts placed in position, but not tightened closer than three rings behind the plates being assembled. During the erection of the plates drift pins and pry bars shall be used to align the holes. Special care shall be used to prevent injury to the galvanizing on the plates by the use of these or other methods of assembling.

The specified length of bolt called for shall be used in its proper location and all bolts shall be effectively tightened.

Unless called for on the plans or in the Special Provisions, field strutting will not be required. When strutting of elliptical pipes is specified, deformation by jacking will not be required.

"Structural Plate Pipe Arches" shall be assembled in three stages as follows: (a) bottom plates, (b) corner plates, and (c) top plates.

All bottom plate bolts shall be inserted and tightened as the bottom is assembled. Then the remainder of the pipe shall be assembled as required under "Sectional Plate Pipes."

704-8. Strutting "Structural Plate Pipes." This shall be accomplished by strutting vertically between two and one-half (2½) per cent and three and one-half (3½) per cent out of round before placement of the backfill. The strutting shall be accomplished by use of a longitudinal timber at the bottom as a sill and one at the top of the pipe as a cap, with timber posts between the longitudinal members.

The longitudinal timbers shall have minimum dimensions of four (4) inches by six (6) inches for use where pipe diameters do not exceed one hundred twenty (120) inches. For pipe diameters over one hundred twenty (120) inches the minimum dimensions of the longitudinal timbers shall be six (6) inches by six (6) inches. The minimum length of longitudinal timbers shall be twelve (12) feet.

Vertical posts shall conform to the requirements of the following table as to cross-sectional dimensions and spacing:

Size (In Inches) and Spacing (In Feet) of Vertical Struts

Pipe Diam. Inches	Strut Size Inches	Fill Over Top of Pipe in Feet					
		1-5	6-10	11-15	16-20	21-30	31-40
60	4x4	6.0	6.0	6.0	6.0	4.5	3.5
	4x6	...	...	...	...	6.0	5.0
72	4x4	6.0	6.0	6.0	5.5	3.5	...
	4x6	...	...	...	6.0	5.5	4.0
84	6x6	...	...	...	...	...	6.0
	4x4	6.0	6.0	5.5	4.5	3.0	...
	4x6	...	...	...	6.0	4.5	3.5
96	6x6	...	...	...	...	6.0	5.0
	4x4	6.0	6.0	4.5	3.5	...	...
	4x6	...	...	6.0	5.5	4.0	...
108	6x6	...	...	...	...	6.0	4.5
	4x4	6.0	4.5	3.5	...	...	...
	4x6	...	6.0	5.5	4.5	3.0	...

Pipe Diam. Inches	Strut Size Inches	Fill Over Top of Pipe in Feet					
		1-5	6-10	11-15	16-20	21-30	31-40
120	6x6	...	...	...	6.0	5.0	4.0
	6x8	...	...	...	...	6.0	5.5
	4x4	6.0	4.0	...	...	...	...
	4x6	...	5.5	4.5	...	...	...
	6x6	...	...	6.0	6.0	4.5	3.5
132	6x8	...	...	...	...	6.0	4.5
	4x6	6.0	5.0	4.0	3.5	...	...
	6x6	...	...	6.0	5.0	4.0	3.0
	6x8	...	...	...	6.0	5.5	4.0
	4x6	6.0	4.5	3.5	...	...	...
144	6x6	...	6.0	5.5	4.5	3.5	...
	6x8	...	...	...	6.0	5.0	4.0
	8x8	...	...	...	...	6.0	5.0
	4x6	5.0	4.0	3.0	...	...	...
	6x6	...	6.0	5.0	4.0	...	...
156	6x8	...	...	...	5.5	4.5	3.5
	8x8	...	...	...	...	6.0	4.5
	4x6	4.5	3.5	...	...	...	...
	6x6	6.0	5.5	4.5	3.5	...	...
	6x8	...	...	6.0	5.0	4.0	3.0
168	8x8	...	...	...	6.0	5.0	4.5
	6x6	6.0	5.0	4.0	...	...	...
	6x8	...	6.0	5.5	4.5	3.5	3.0
	8x8	...	...	...	6.0	5.0	4.5
	6x6	6.0	5.0	4.0	...	...	...
180	6x8	...	6.0	5.5	4.5	3.5	3.0
	8x8	...	...	...	6.0	5.0	4.0

The pipe shall be deformed the required amount by means of suitable jacks and by an approved method. Strutting shall be carried uniformly from end to end of the pipe, when without headwalls. When headwalls are used the strutting shall not be used nearer than ten (10) feet to the end of the pipe. All struts shall be left in place until the backfill and roadway fill (if any) are complete and thoroughly compacted, unless otherwise directed.

704-9. Field Erection—Arches. Excavation of material shall conform to the requirements of Section 204, "Structural Excavation."

Each side of each arch shall rest on a galvanized angle or channel securely anchored to or embedded in the substructure.

When the substructure called for is to be constructed of portland cement concrete it shall conform to the requirements of Section 701, "Portland Cement Concrete."

When the substructure is to be constructed of log or timber grillage or of other type construction it shall conform to the details shown on the plans and the applicable specifications.

Structural plate arch structures shall be assembled in conformity with the manufacturers' shop details showing location, laps and sequence of placing plates.

The structure shall be erected in place upon the prepared substructure.

Assembly shall be started by placing a side plate of a full ring upon the abutment near the end of the arch. Next place a side plate of the same ring upon the other abutment. Make certain that the holes of the plates are as shown on the detail plans so that the holes will match at the top.

The unsupported edges of plates shall be held in position by the use of temporary props. In general, one ring of plates shall be completed before another ring is started, using as few bolts as possible to hold the ring. Drift pins and pry bars shall be used to align the holes. Special care shall be used to prevent injury to the galvanizing on the plates by the use of these or any other method of assembling.

About three rings behind the plates being assembled, the remaining bolts may be inserted and tightened. The specified length of bolt called for shall be used in its proper location and all bolts shall be effectively tightened.

704-10. Backfilling of Arches shall conform to the requirements of Section 206, "Backfill and Special Backfill" except for the following additional provisions:

When backfilling arches before headwalls are placed, the first material shall be placed midway between the ends of the arch forming as narrow a ramp as possible until the top of the arch is reached. The ramp shall be built evenly from both sides, and the backfilling material shall be thoroughly compacted as it is placed. After the two ramps have been built to the top of the arch, the remainder of the backfill shall be deposited from the top of the arch both ways from the center to the ends, and evenly on both sides of the arch.

If the headwalls are built before the arch is backfilled, the filling material shall first be placed adjacent to one headwall, until the top of the arch is reached, after which the fill shall be dumped from the top of the arch toward the other headwall, with care being taken to deposit the material evenly on both sides of the arch.

In multiple installations the procedure above specified shall be followed, but extreme care shall be used to bring the backfill up evenly on each side of each arch so that unequal pressure will be avoided.

In all cases the filling material shall be thoroughly but not excessively tamped. Puddling the backfill will not be permitted.

METHOD OF MEASUREMENT

704-11. The quantity to be measured for payment shall be the completed and accepted length of the structure in linear feet.

In general the pay length will be designated on the plans. When the pay length is not shown on the plans, measurement shall be as follows:

(a) For "Structural Plate Pipes," the number of linear feet shall be the average of the top and bottom center line lengths.

(b) For "Structural Plate Pipe Arches," the number of linear feet shall be the bottom center line length.

(c) For "Structural Plate Arches," the number of linear feet shall be the average of the springing line lengths.

BASIS OF PAYMENT

704-12. All work done under this section will be paid for at the contract unit price per linear foot for the respective size and type of structure listed, complete in place, which price shall be full compensation for furnishing, hauling and erecting the structure; for all equipment, tools, labor and all incidentals necessary to complete the work, except that structural excavation and foundation preparation will be compensated for under Section 204, "Structural Excavation" and/or Article 302-6 (c), "Gravel Base Course."

Material for backfilling will be paid for under the respective item covering the type of backfill material used.

SUMMARY OF ITEMS FOR PAYMENT

Item		
704-13	—Inch Structural Plate Pipe	—per linear foot
704-14	—Inch Structural Plate Pipe	—per linear foot
704-15	—Inch Structural Plate Pipe	—per linear foot
704-16	—Span, —Rise, Structural Plate Pipe Arch	—per linear foot
704-17	—Span, —Rise, Structural Plate Pipe Arch	—per linear foot

704-18	—Span, —Rise, Structural Plate Arch	—per linear foot
704-19	—Span, —Rise, Structural Plate Arch	—per linear foot

SECTION 705

REINFORCING STEEL

DESCRIPTION

705-1. General. This item shall consist of furnishing and placing reinforcing steel of the quality, type, size, shape and quantity designated for concrete structures.

705-2. Steel Schedule. When steel schedules are not furnished by the Commission, the Contractor shall supply order lists and bending diagrams for approval. No material shall be ordered until such lists and diagrams have been approved. The Contractor shall be responsible for such lists and diagrams, although they may have been approved.

MATERIALS

705-3. General.

(a) Bar Reinforcement shall conform to the requirements of the latest revised Standard Specifications for Billet Steel Bars for Concrete Reinforcement of the A.A.S.H.O. Designation M-31 with the following modifications:

1. All bars shall be of the deformed type unless otherwise specified and shall be intermediate grade.
2. The use of cold twisted bars is not permitted.
3. Steel for all bars shall be made by the open hearth process, unless otherwise called for in the special provisions or on the plans.
4. The type of deformation shall be subject to the approval of the Engineer. In addition to the above requirements the deformation of deformed bars shall conform to the latest revision of the Minimum Requirements for the Deformation of Deformed Steel Bars for Concrete Reinforcement of the A.A.S.H.O. Designation M-137.

5. Deformed bars shall not be used for Spiral Reinforcement.

(b) Wire mesh, when used for reinforcement in concrete, shall conform to the latest revised Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement of the A.A.S.H.O. Designation M-55. The type of mesh shall be approved by the Engineer.

(c) Bar mat reinforcement for concrete shall conform to the latest revised Specifications for Fabricated Steel Bar or Rod Mats for Concrete Reinforcement of the A.A.S.H.O. Specifications, Designation M-54.

(d) Structural shapes used as reinforcement in concrete shall conform to the requirements for structural steel as provided in Section 702, "Structural Steel."

CONSTRUCTION METHODS

705-4. General. All steel reinforcement shall be stored on skids or other supports at a satisfactory height above the ground and it shall be protected at all times from injury. When placed the steel shall be free from dirt, detrimental scale, paint, oil or other foreign substances. When steel has on its surface detrimental rust, loose scale or other foreign matter it shall be cleaned by an approved method.

705-5. Fabrication. Bent bar reinforcement shall be cold bent to the shapes shown on the plans.

Stirrups and tie bars shall be bent around a pin having a diameter not greater than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness except for bars larger than one (1) inch, in which case the bends shall be made around a pin of eight bar diameters.

705-6. Placing and Fastening. All steel reinforcement shall be accurately placed in the position shown on the plans and firmly held during the placing and setting of the concrete. Bars shall be tied at all intersections except where spacing is less than one (1) foot in each direction. Where bars are spaced less than one (1) foot in each direction, tying of alternate intersections will be permitted if this will produce satisfactory results.

The welding of the spirals to be the beams is to be done after the structural steel is erected and the forms for the concrete floor slab are in place. The size and location of the welds shall be as shown on the plans. All welding shall conform to the specifications for welding, Article 702-64 of the Standard Specifications.

Distances from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shape and dimension or approved metal chairs. Layers of bars shall be

separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks will not be permitted.

After the reinforcement has been placed, it shall be inspected and approved before the placing of the concrete begins. The placing of the reinforcement as the concrete placing progresses, without definite means of holding the steel in its correct location, will not be permitted.

705-7. Splicing. All reinforcement shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans will not be permitted without written approval of the Engineer. Splices shall be staggered as far as possible. Unless otherwise shown on the plans, bars in the bottom of beams and girders, and in walls, columns and haunches shall be lapped twenty (20) diameters, and bars near the top of beams and girders, having more than twelve (12) inches of concrete under the bars, shall be lapped thirty-five (35) diameters, to make the splice.

In lapped splices, the bars shall be placed in contact and wired together in such a manner as to maintain a clearance of not less than the minimum clear distance to other bars. Welding of reinforcing steel shall be done only if detailed on the plans or if authorized by the Engineer in writing.

705-8. Lapping. Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one (1) mesh in width.

705-9. Substitutions. Substitution of different size bars will be permitted only with specific authorization by the Engineer.

METHOD OF MEASUREMENT

705-10. General. The quantity of material to be measured for payment shall be the computed net weight, in pounds, of steel reinforcing mesh or mats in the structure, completed and accepted.

705-11. Computed Weight. The weight shall be computed on the following basis:

(a) For reinforcing bars:

Bar Size	#2	#3	#4	#5	#6	#7	8#	#9	#10	#11
Weight per foot in pounds	.167	.376	.668	1.043	1.502	2.044	2.670	3.400	4.303	5.313

(b) For wire mesh the weight will be computed from the theoretical weight of plain wire.

No measurement will be allowed for clips, wire, separators, wire chairs, welds, or other material used in fastening or welding the reinforcing in place.

If bars are substituted upon the Contractor's request and as a result more steel is used than is specified, only the amount specified shall be included for measurement.

When laps are made for splices, other than those shown on the plans, for the convenience of the Contractor the extra steel required for the splice shall not be included for measurement.

BASIS OF PAYMENT

705-12. All work done under the items in this section will be paid for at the respective contract unit price per pound for "Reinforcing Steel," "Steel Wire Mesh," or "Spiral Reinforcing."

(a) The payment for material delivered shall be full compensation for all labor, materials and transportation necessary for fabrication, shipping and delivery to the place designated, and for storing and all incidental work.

(b) The payment for placing of material shall be full compensation for all labor and materials necessary for placing and for all incidental work.

SUMMARY OF ITEMS FOR PAYMENT

Item

705-13	Reinforcing Steel, Delivered	—per pound
705-14	Reinforcing Steel, Placing	—per pound
705-15	Steel Wire Mesh, Delivered and Placed	—per pound
705-16	Spiral Reinforcing, Delivered and Placed	—per pound

SECTION 706

STEEL GRID FLOORING

DESCRIPTION

706-1. General. This item shall consist of detailing, fabricating, erecting and painting "Steel Grid Flooring" for bridge structures.

706-2. Drawings. Unless previously prepared and supplied by the Commission, the Contractor shall prepare shop detail, erection and other working plans as required in Article 702-2, "Drawings."

706-3. **Design.** Detail and load requirements shall conform to the latest revised A.A.S.H.O. Standard Specifications for Highway Bridges.

MATERIALS

706-4. **General.** All steel shall conform to the latest revised Standard Specifications of Steel for Bridges and Buildings, A.S.T.M. Designation A-7, except the material shall have a copper content of not less than two tenths (0.2) per cent.

CONSTRUCTION METHODS

706-5. **Arrangement of Sections.** Where the main elements are normal to center line of roadway, the units generally shall be of such length as to extend over the full width of the roadway, for roadways up to forty (40) feet, but in every case the units shall extend over at least three (3) panels. Where joints are required, the ends of the main floor members shall be welded at the joints over their full cross-sectional area or otherwise connected to provide full continuity.

Where the main elements are parallel to center line of roadway, the sections shall extend over not less than three (3) panels, and the ends of abutting units shall be welded over their full cross-sectional area or otherwise connected to provide full continuity in accordance with the design.

706-6. **Provision for Camber.** Unless otherwise provided on the plans, provision for camber shall be made as follows:

Steel units so rigid that they will not readily follow the camber required shall be cambered in the shop. To provide a bearing surface parallel to the crown of the roadway, the stringers shall be canted or provided with shop welded beveled bearing bars. If beveled bars are used they shall be placed along the center line of the stringer flange, in which case the design span length shall be governed by the width of the bearing bar instead of by the width of the stringer flange.

Longitudinal stringers shall be mill cambered or provided with bearing strips so that the completed floor after dead load deflection shall conform to the longitudinal camber shown on the plans.

706-7. **Field Assembly.** Areas of considerable size shall be assembled before the floor is welded to its supports. The main elements shall be made continuous, and sections shall be connected together along their edges by welding bars or

by riveting them. The connections shall meet with the approval of the Engineer. The rivets may be cold driven.

706-8. **Connection to Supports.** The floor shall be connected to its steel supports by welding. Before any welding is done the floor either shall be loaded to make a tight joint with full bearing, or it shall be clamped down. The location, length and size of the welds shall be subject to the approval of the Engineer, but in no case shall they be less than the manufacturer's standard.

The ends of all main steel members of the slab shall be securely fastened together at the sides of the roadway for the full length of the span by means of steel plates or angles welded to the ends of the main members, or by securely encasing the ends with concrete.

706-9. **Welding.** All shop and field welding shall be done in accordance with the latest revised specifications of the American Welding Society for Welded Highway and Railway Bridges.

Surfaces to be welded shall be free from paint, grease, loose scale, rust and other material that will prevent a proper weld. A thin coating of linseed oil, without pigment, need not be removed. Any clinkers or slag caused by flame cutting or other causes shall be removed before welding.

706-10. **Concrete Filler.** Floor types with bottom flanges not in contact shall be provided with bottom forms of metal or wood to retain the concrete filler without excessive leakage.

If metal form strips are used they shall fit tightly on the bottom flanges of the floor members and be placed in short lengths so as to extend only about one (1) inch onto the edge of each support, but in all cases the forms shall be such as will result in adequate bearing of slab on the support.

The concrete used for filling the grid flooring shall conform to the requirements of Section 701, "Portland Cement Concrete." Class "Y" concrete shall be used.

The concrete shall be thoroughly compacted by vibrating the steel grid floor, and shall be screeded off true and smooth, flush with the top surface of the metal grid with a final rough finish secured by brooming, except when the plans call for the metal grid to be overfilled, the concrete surface shall be finished as required in Article 701-23.

706-11. Painting. Steel grid floor shall be given a shop coat of paint in accordance with the requirements of Articles 702-87 to 702-97 inclusive.

METHOD OF MEASUREMENT

706-12. The quantity of "Steel Grid Floor," either open or concrete filled type, shall be measured for payment complete and in place per square foot.

BASIS OF PAYMENT

706-13. Work under this item will be paid for at the contract unit price per square foot, which payment shall be full compensation for furnishing drawings and all material; for fabricating, delivering, assembling, welding, shop painting, concrete filling when specified; for all labor, equipment and incidentals needed to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

<i>Item</i>	
706-14 Steel Grid Flooring—Open Type	—per square foot
706-15 Steel Grid Flooring—Concrete Filled Type	—per square foot

SECTION 707

COURSED STONE MASONRY

DESCRIPTION

707-1. General. This work shall consist of furnishing and laying stone for masonry of the class specified in accordance with the details shown on the plans or called for in the specifications.

MATERIALS

707-2. Stone. Stone for masonry shall be granite or other approved rock material. Stone shall be tough, dense, sound and durable; resistant to weathering action, reasonably fine grained, uniform in color, and free from seams, cracks, pyrite inclusions or other structural defects. Stone shall be of such character that it can be wrought to lines and surfaces, whether curved or plain, that may be required.

707-3. Mortar. Sand, cement and water for use in mortar shall conform with the requirements of Section 701, "Portland Cement Concrete."

The mortar shall be composed of one (1) part portland cement and two (2) parts of sand and shall be machine

mixed, in an approved mixer for not less than one and one-half (1½) minutes after all ingredients are in the mixer.

When ready for use, the mortar shall be of an approved consistency which will support the stone. Mortar shall be used within forty-five (45) minutes after mixing and the re-tempering of mortar will not be permitted.

707-4. Lead Wool. This material shall be the product of standard commercial manufacturers and shall be of an approved quality.

CONSTRUCTION METHODS

707-5. General. The surface of the stone shall be clean and free from dirt, oil, or other injurious material which may prevent the proper adhesion of mortar.

707-6. Surface Finishes of Stone. For the purpose of this specification the surface finishes of stone are defined as follows:

Smooth-finished: Having a surface in which the variations from the pitch line do not exceed one-sixteenth (1/16) inch.

Fine-finished: Having a surface in which the variations from the pitch line do not exceed one-fourth (¼) inch.

Rough-finished: Having a surface in which the variations from the pitch line do not exceed one-half (½) inch.

Rock-faced: Having an irregular projecting face without indications of tool marks. The projections beyond the pitch line shall not exceed three (3) inches and no part of the face shall recede back of the pitch line.

707-7. Ashlar Masonry.

(a) *Size of Stone:* The height of courses shall not be more than eighteen (18) inches nor less than twelve (12) inches. In all cases the thickness of the courses shall be uniform or shall decrease from the bottom to the top of the exposed face, and each course shall be uniform in thickness throughout.

(b) *Dressing Stone:* Stones shall be dressed to exact size and shapes before being laid and shall be cut to lie on their natural beds with top and bottom truly parallel. Hollow beds will not be permitted. The bottom bed shall be the full size of the stone and no stone shall have an overhanging top. In rock-face construction, the face side of any stone

shall not present an undercut contour adjacent to its bottom arris giving a top-heavy, unstable appearance when laid.

Beds of face stone shall be fine-finished for a depth not less than six (6) inches. Vertical joints of face stones shall be fine-finished and full to the square for a depth of not less than six (6) inches.

The faces of the stones laid in abutment breast walls and wing walls and in the sides and ends of piers, except in ice breakers, shall be rock-faced with the edges pitched to true lines and exact batter. The faces of stones forming the ice-breakers of piers shall be rough-finished unless otherwise specified.

Exposed corners of the structure shall be fine-finished with a one and one-half ($1\frac{1}{2}$) inch chisel draft on each face with edges pitched to true lines and exact batter.

Drill holes used for engaging stone hooks in lifting and laying stones shall not be permitted to show in the face surfaces of the finished stone work.

(c) *Stretchers*: In general, stretchers shall have a bed width of fifteen (15) inches. However, in battered walls the bottom bed of the stone may be fifteen (15) inches plus the face batter of the stone. The bed joint shall not be less than six (6) inches at any place. The minimum length of stretchers shall be three (3) feet and the maximum length shall be six (6) feet.

(d) *Headers*: In each course headers shall alternate with stretchers and the headers shall show a minimum face length of eighteen (18) inches. Headers shall have a minimum bed length of two (2) feet. Headers shall not diminish in cross-section for their entire length.

(e) *Bond*: The vertical joints in each course shall be so arranged as to overlap those in the course below at least nine (9) inches. In no case shall a vertical joint be so located as to occur directly above or below a header.

(f) *Wing Wall Steps*: Where the top of the wing wall is stepped each step shall be formed of a single stone and shall overlap the stone forming the step immediately below it at least nine (9) inches. If required, a one and one-half ($1\frac{1}{2}$) inch margin shall be cut around the exposed faces of the steps, and their top surfaces shall be rough-finished.

(g) *Laying Stones*: Whenever stones are laid in cold weather the stones shall be freed from snow, ice and frost by warming and the conditions involved in laying shall con-

form to the requirement for placing concrete in cold weather, as specified under Section 701, "Portland Cement Concrete."

Each stone shall be cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be cleaned and well moistened. All stones shall be well bedded in freshly made mortar and settled in place with a suitable wooden maul to produce the specified joint thickness before the setting of the mortar. The face surfaces of stone shall not be smeared with mortar forced or raked out of the joints. No pinning up of stones with spalls will be permitted and no spalls will be permitted in beds, except the projecting ends of headers shall be held up by small stones or spalls laid in mortar in order to prevent any movement of the stone upon its bed.

In the area to be lead calked, joints and beds shall be not less than three-eighths ($\frac{3}{8}$) inch nor more than one-half ($\frac{1}{2}$) inch in thickness and the thickness of the joint or bed shall be uniform throughout.

Stones shall not be dropped upon or slid over the wall, nor will hammering, rolling or turning of stones on the wall be allowed; they shall be carefully set without jarring the stone already laid and shall be handled with lewis or other appliance which will not cause disfigurement. In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.

In preparation for lead calking joints, the mortar shall be raked out to the depth of not less than one and one-half ($1\frac{1}{2}$) inches before the mortar of the joint becomes set, and its front surface shall be compacted and rendered roughly even and smooth by being hand-rammed with either a wooden or metal tool applied with a small amount of pressure. The vertical joints, except for the one and one-half ($1\frac{1}{2}$) inch face or front portion, shall be completely filled with mortar and the front surface of the mortar smoothed for lead calking.

(h) *Concrete Core and Backing*: The concrete used for the cores of piers and the backing of abutments shall conform to the requirements of Section 701, "Portland Cement Concrete."

The operations involved in the handling and placing of the concrete shall, in general, comply with the requirements of the above specifications. However, the puddling and compacting of concrete adjacent to the ashlar masonry facing

shall be done in a manner that will assure the filling of all spaces between the stones and secure full contact and efficient bond upon the stone surfaces.

The construction joints produced by the intermittent placing of concrete in cores and backing shall be located, in general, not less than four (4) to six (6) inches below the top bed of any course of masonry.

(i) *Lead Pointing Joints*: The pointing of the horizontal and vertical face joints of the stone courses shall consist of calking the raked-out joints with lead wool. The lead wool shall be driven into the joint to form a well compacted mass which shall provide a water-tight protection, and its exposed surface shall be finished with an approved pointing tool to form a surface in which the overlying stone projects slightly beyond the lead and the underlying one is flush.

After the pointing is completed the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.

(j) *Dowels, Cramps and Anchors*: Where required, stones shall be secured with wrought iron cramps or dowels as indicated on the plans. Dowel holes shall be drilled through each stone before the stone is placed; after it is in place, dowel holes shall be extended by drilling into the underlying course not less than six (6) inches. Holes for cramps shall be drilled before the stone is set. Cramps shall be of the shape and dimension shown on the plans or approved by the Engineer, and they shall be inset in the stone so as to be flush with the surface.

Dowels or cramps shall be set in mortar except when they are exposed; when exposed they shall be set in lead, care being taken to completely fill the surrounding spaces with molten metal.

707-8. Coursed Mortar Masonry—Second Class.

(a) *Size of Stone*: Individual stones shall have a thickness of not less than ten (10) inches nor more than twenty-four (24) inches. The thickness of courses, if varied, shall decrease from bottom to top of wall.

(b) *Dressing Stone*: Stones shall be dressed to sizes and shapes before being laid and shall be cut to lie on their natural beds with top and bottom parallel.

Beds of face stone shall be rough-finished for a depth of not less than six (6) inches. The remainder of the beds shall not contain depressions greater than one and one-half ($1\frac{1}{2}$) inches in depth, measured from the pitch line.

Vertical joints of face stone shall be rough-finished and full to the square for a depth of not less than four (4) inches. Exposed surfaces of the face stones shall be rock-faced with edges pitched to within one-half ($\frac{1}{2}$) inch of true line and batter. Holes for stone hooks shall not show in exposed surfaces.

(c) *Stretchers*: Stretchers shall have a width of bed of not less than one and one-half ($1\frac{1}{2}$) times their thickness unless this width is greater than the thickness of wall. They shall have a length of not less than twice their width, nor less than three (3) feet, and not more than four (4) times their thickness.

(d) *Headers*: Headers shall be placed in each course and shall have a width of not less than their thickness. In walls having a thickness of three (3) feet or less, the headers shall extend entirely through the wall. In walls of greater thickness, the headers shall extend not less than twelve (12) inches into the core or backing. Headers shall hold in the heart of the wall the same size shown in the face and shall be spaced not farther apart than eight (8) feet center to center.

(e) *Laying Stones*: Whenever stones are laid in cold weather the stones shall be freed from snow, ice and frost by warming and the conditions involved in laying shall conform to the requirements for placing concrete in cold weather, as specified under Section 701, "Portland Cement Concrete."

Face stone shall not be dropped or slid over the wall, but shall be carefully set without jarring the stone already laid, and shall be handled with a lewis or other appliance which will not cause disfigurement.

Each stone shall be cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be cleaned and well moistened. All stones shall be well bedded in freshly made mortar and settled in place before the setting of the mortar. Whenever possible, the face joints shall be properly pointed before the mortar sets. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of two (2) inches before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joints or that used in pointing. No hammering, rolling or turning of stones will be permitted on the wall.

No spalls will be permitted in the beds. Joints and beds shall be not less than one-half ($\frac{1}{2}$) inch nor more than one

and one-half (1½) inches in thickness. The vertical joints in each course shall break joints with those in adjoining courses at least nine (9) inches. In no case shall a vertical joint be so located as to occur directly above or below a header. In case any stone is moved or joint broken the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.

(f) *Backing and Cores:* Stone backing and cores shall consist of stones roughly squared, not less than eight (8) inches thick, laid with headers interlocking with face headers when the thickness of the wall will permit, and breaking joints at least six (6) inches with the face stones and with each other. Bed joints in cores and backing shall not exceed two (2) inches and vertical joints shall not exceed four (4) inches in thickness. Stone in backing and cores shall be laid in full mortar beds as provided above for face stone.

The backing and cores shall be constructed so that a wall entirely free from voids shall be produced.

Stone backing and cores shall be carried up to the approximate level of the face course before the succeeding course is started.

Concrete backing and cores, when required, shall conform to the requirements of Article 707-7 (h) of this specification.

(g) *Dowels:* Where required, stone shall be secured with dowels as indicated on the plans. Dowel holes shall be drilled through each stone before the stone is placed, after it is in place dowel holes shall be extended by drilling into the underlying course not less than six (6) inches. The dowels shall be set in mortar.

(h) *Pointing:* Pointing shall not be done when the stone contains frost. If pointing is done in cold weather the condition specified under laying stone, paragraph (e) above, shall apply.

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done and in hot or dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least three (3) days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.

707-9. Coursed Dry Rubble Masonry.

(a) *Size of Stone:* Individual stones shall have a thickness of not less than twelve (12) inches nor greater than twenty-four (24) inches. When courses of different thickness are used the thicker courses shall be at the base of the wall. All stones shall extend into the wall not less than twelve (12) inches. Headers shall show a minimum face width equal to the thickness of the course.

(b) *Dressing Stone:* Stones shall be roughly squared on joints, beds and faces. Headers shall show in the heart of the wall the general shape shown in the face and shall extend not less than twelve (12) inches into the backing. The headers shall occupy not less than one-fourth (¼) the face area of the wall and shall be uniformly distributed.

All shaping of stone shall be done before the stone is laid in the wall and no dressing or hammering which will loosen the stone shall be permitted after it is placed in position.

(c) *Laying Stone:* Stone shall be laid on their natural beds, in courses, and shall conform to the lines indicated on the plans.

All joints, either horizontal or vertical, shall not exceed three (3) inches in thickness or width. Joints shall be broken by at least six (6) inches, measured edge to edge of stone, but no vertical joint shall be located directly above or below a header.

Care shall be taken that each stone takes a firm bearing in at least one point upon the underlying stone and upon two or more fitted spalls so placed that the stone takes a well distributed bearing on the wall. Open horizontal joints, both front and rear, shall be "chinked" with spalls fitted to take firm bearing upon their top and bottom surfaces, for the purpose of securing firm bearing throughout the length of the stone. Vertical joints shall be "chinked" with spalls. All spalls shall be from stone similar to that being used in the wall.

(d) *Stone Backing:* Stone backing shall be laid in the same manner as specified above, with headers interlocking with face headers when the thickness of the wall permits and breaking joints with the face stone. Joints shall conform to those specified for face stone. Sizes of stone may vary, providing the backing levels up with each course of face stone, and providing all stones have good bearing and interlock with each other in a manner which does not detract from the strength of the wall.

METHOD OF MEASUREMENT

707-10. The quantity of masonry to be measured for payment shall be the number of cubic yards of this material completed and accepted, measured in place, including joints; and the limiting dimensions shall not exceed those shown on the plans or specified.

(a) For Ashlar Masonry, the limiting dimensions shall be as follows:

1. For headers, the maximum allowable length for payment shall be two (2) feet plus one-half ($\frac{1}{2}$) the front batter of the course. When the lengths of headers exceed this maximum allowable length, the excess shall be measured for payment as concrete backing.

2. For stretchers, the maximum allowable width for payment shall be fifteen (15) inches plus one-half ($\frac{1}{2}$) the front batter of the course. When the widths of the stretchers exceed this maximum allowable width, the excess shall be measured for payment as concrete backing.

BASIS OF PAYMENT

707-11. Work under these items will be paid for at the contract unit price per cubic yard, which payment shall be full compensation for furnishing, and laying stone masonry; for all materials, all mortar and lead for pointed joints; for furnishing and installing cramps and dowels; for all labor, equipment and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 707-12	Ashlar Masonry	—per cubic yard
Item 707-13	Coursed Mortar Masonry, Second Class	—per cubic yard
Item 707-14	Coursed Dry Rubble Masonry	—per cubic yard

SECTION 708

PILES

DESCRIPTION

708-1. General. This item shall consist of furnishing and driving piles of the size and type called for on the plans for foundations and/or bents.

MATERIAL

708-2. Timber Piles—General.

(a) *Untreated Pile:* In general, 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.

(b) *Pressure Treated Pile:* In general, treated timber piles shall be southern yellow pine, Norway pine or Douglas fir.

Preservative oil used shall be Creosote Oil, conforming to the latest revised Standard Specifications, Designation M-133 of the American Association of State Highway Officials.

All piles shall be treated by the empty cell process and the minimum amount of preservative retained shall be twelve (12) pounds per cubic foot for southern yellow pine or Norway pine and ten (10) pounds per cubic foot for Douglas fir, unless otherwise indicated on the plans.

Quality.

(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 $1\frac{1}{2}$ 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 three quarters of the length from the butt of piles longer than 50 feet, shall be no larger than 4 inches, or one-third the diameter of the pile at the point where they occur, whichever is the smaller. Sound knots in the remaining one quarter of the length of piles longer than 50 feet shall be no larger than 5 inches, or one-half 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 two 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 one-half 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 one-third the circumference of the butt of the pile.

(e) *Treated Piles, Sapwood*: Piles for preservative treatment shall have not less than one inch of sapwood at the butt end.

(f) *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 one-half inch shall remain.

(g) *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 knot.

(h) *Straightness*: A straight line from the center of the butt to the center of the tip shall lie entirely within the body of the pile.

(i) *Taper*: Piles shall be cut above the butt swell and shall have a continuous taper from the point of butt measurement to the tip.

(j) *Twist of Grain*: Twist of grain in any 20 feet of length shall not exceed one-half of the circumference at the mid-point of length measured.

Dimensions.

(a) *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 not more than 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.

TABLE I. CIRCUMFERENCES AND DIAMETERS OF
TIMBER PILES

Length Feet	3 Feet From Butt				At Tip	
	Minimum		Maximum		Minimum	
	Circumference Inches	Diameter Approx. Inches	Circumference Inches	Diameter Approx. Inches	Circumference Inches	Diameter Approx. Inches
Under 40	38	12	63	20	25	8
40 to 50	38	12	63	20	22	7
51 to 70	41	13	63	20	22	7
71 to 90	41	13	63	20	19	6

WHITE OR RED OAK AND OTHER HARDWOODS						
Under 30	38	12	57	18	25	8
30 to 40	41	13	63	20	22	7
Over 40	41	13	63	20	19	6

(b) *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 one 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.

708-3. *Steel Piles*. All steel used for steel piles and caps for steel pile shall be structural grade and shall conform to the requirements of the latest revised Standard Specifications for Steel for Bridges and Buildings, A.S.T.M., Designation A-7. Mill test reports will be required as specified under Article 702-70.

CONSTRUCTION METHODS

708-4. *Determination of Pile Lengths*. Except in special cases, the length of piles to be ordered shall be determined after construction work is in progress. The Contractor shall drive test piles of the lengths and at the location designated by the Engineer. These piles shall have a greater length than the length estimated in order to provide for any variation in soil conditions and to insure that the proper penetration is obtained. From data obtained in this manner, the Engineer shall instruct the Contractor concerning the proper length of piling to be furnished. This length must be ade-

quate for the location concerned, but excessive cut-offs should be avoided.

708-5. Preparation for Driving.

(a) *Excavation*: In general, piles shall not be driven until after the excavation is complete. Any material forced up between the piles shall be removed to the correct elevation before masonry for the foundation is placed.

(b) *Caps*: The heads of timber piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design, preferably having a suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block.

For steel piling the heads shall be cut squarely and a driving cap shall be provided to hold the axis of the pile in line with the axis of the hammer.

(c) *Collars*: Collars, bands, or other devices, to protect timber piles against splitting and brooming shall be provided where necessary.

(d) *Pointing*: Timber piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes of a satisfactory design, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.

(e) *Splicing Piles*: Full length piles shall be used where practicable. In exceptional circumstances splicing of piles may be permitted. The method of splicing shall be as shown on the plans or as approved. When the splicing of a steel pile is done by welding, the arc method shall be given the preference.

708-6. Methods of Driving.

(a) *General*: Timber piles may be driven with a gravity hammer, a steam hammer, or a water jet and hammer combination, but a steam hammer is preferred. Steel piles shall be driven with a steam hammer, except that under favorable driving conditions the use of a drop hammer may be approved.

(b) *Hammers*: Gravity hammers for driving timber and steel piles shall weigh not less than two thousand (2,000) pounds, preferably not less than three thousand (3,000) pounds and in no case shall the weight of the hammer be less than the combined weight of driving head and pile. The fall shall be regulated to avoid injury to the piles and in no case shall exceed fifteen (15) feet. When a steam hammer

is used, the total energy developed by the hammer shall be not less than six thousand (6,000) foot pounds per blow.

(c) *Additional Equipment*: In case the required penetration is not obtained by the use of a hammer complying with the above minimum requirements, the Contractor shall provide a heavier hammer, or a water jet and hammer combination.

(d) *Leads*: Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer and they shall be held in position by guys or stiff braces to insure support to the pile during driving. Except where piles are driven through water, the leads preferably shall be of sufficient length so that the use of a follower will not be necessary.

Preferably, inclined leads shall be used in driving batter piles.

(e) *Followers*: The driving of piling with followers shall be avoided and shall be done only under written permission of the Engineer. When followers are used, one pile from every group of ten (10) shall be a long pile driven without a follower, and shall be used as a test pile to determine the average bearing power of the group.

(f) *Water Jets*: When water jets are used, the number of jets and the volume and pressure of the water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least one hundred (100) pounds per square inch pressure at two (2) three-quarter ($\frac{3}{4}$) inch jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration.

(g) *Accuracy of Driving*: Piles shall be driven with a variation of not more than one-quarter ($\frac{1}{4}$) inch per foot from the vertical or from the batter shown on the plans, except that piles for trestle bents shall be so driven that the cap may be placed in its proper location without inducing excessive stresses in the piles, and foundation piles shall not be out of the position shown on the plan more than six (6) inches after driving.

708-7. *Defective Piles*. The procedure incident to the driving of piles shall not subject them to excessive and undue abuse producing splintering and brooming of the wood or deformation of the steel. Excessive manipulation of piles to force them into proper location will not be permitted. Any

pile damaged by reason of internal defects; by improper driving; by being driven out of its proper location or below the required elevation, shall be corrected at the Contractor's expense by one of the following approved methods:

1. The pile shall be withdrawn and replaced by a new and, if necessary, a longer pile.

2. A second pile shall be driven adjacent to the defective or low pile.

3. The pile shall be spliced or built up as otherwise provided herein or a sufficient portion of the footing extended to properly embed the pile. Timber pile shall not be spliced without specific permission of the Engineer. All piles pushed up by driving of adjacent piles or by any other cause shall be driven down again.

708-8. Determination of Bearing Values.

(a) *Loading Tests:* When required, the size and number of piles shall be determined by actual loading test. In general, these tests shall consist of the application of a test load placed upon a suitable platform supported by the pile, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. The safe allowable load shall be considered as fifty (50) per cent of that load which, after a continuous application of forty-eight (48) hours, produces a permanent settlement, measured at the top of the pile, of not more than one-fourth ($\frac{1}{4}$) inch. This maximum settlement shall not be increased by a continuous application of the test load for a period of sixty (60) hours or longer. At least one pile for each group of one hundred (100) piles shall be tested.

(b) *Timber Pile Formulas:* When not driven to practical refusal, the bearing values of the piles preferably shall be determined by loading tests as specified above. In the absence of loading tests or substantiated adequate pile formulas, safe bearing values for timber piles may be determined by the following formulas:

$$P = \frac{2WH}{S + 1.0} \quad \text{for gravity hammers}$$

$$P = \frac{2WH}{S + 0.1} \quad \text{for single-acting steam hammers}$$

$$P = \frac{2H(W + Ap)}{S + 0.1} \quad \text{for double-acting steam hammers}$$

where P = safe bearing capacity in pounds.

W = weight, in pounds, of striking parts of hammer.

H = height of fall in feet.

A = area of piston in square inches.

p = steam pressure in pounds per square inch at the hammer.

S = the average penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam hammers.

The above formulas are applicable only when

1. The hammer has a free fall.
2. The head of the pile is not broomed or crushed.
3. The penetration is at a reasonably quick and uniform rate.
4. There is no sensible bounce after the blow.
5. A follower is not used.
6. The hammer is operated at a speed not less than that recommended by the manufacturer.

Twice the height of the bounce shall be deducted from "H" to determine its value in the formula.

In case water jets are used in connection with the driving, the bearing capacity shall be determined by the above formulas from the results of driving after the jets have been withdrawn, or a loading test may be applied.

(c) *Steel Piles:* When not driven to practical refusal the bearing value for steel piles preferably shall be determined by means of loading tests specified in (a) above. In the absence of loading tests, their safe bearing values may be approximated by substantiated adequate pile formulas, or those specified for timber piles. However, the character of the soil penetrated, conditions of driving, distributions, sizes, lengths and weights of the piles, and the computed load per pile shall be given due consideration in determining the probable safe bearing value of steel piles.

708-9. *Storage and Handling of Timber Piles.* The method of storing and handling shall be such as to avoid injury to the piles. Special care shall be taken to avoid breaking the surface of treated piles and cant-hooks, dogs or pike poles shall not be used. Cuts or breaks in the surface of treated piling shall be given three (3) brush coats of hot creosote oil of approved quality, and hot creosote oil shall be poured into all bolt holes.

708-10. Cutting Off Timber Piles. The tops of all piling shall be sawed to a true plane at the elevation shown on the plans. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the superimposed structure. In general, the length of piles above the elevation of the cut-off shall be sufficient to permit the complete removal of all material injured by driving, but piles driven to very nearly the cut-off elevation shall be carefully adzed or otherwise freed from all "broomed," splintered or otherwise injured material.

The pile cut-off is defined as the difference in length of the pile authorized to be driven and the length of pile remaining in place in the completed structure.

708-11. Cutting Off Steel Piles. Piles shall be cut off at the required elevation. If capping is required, the connection shall be made according to details shown on the plans.

METHOD OF MEASUREMENT

708-12. The quantity of piles to be measured for payment shall be the actual number of linear feet of all piles remaining in the finished structure.

All pile cut-offs having an individual length of three (3) feet or more shall be measured for payment and shall become the property of the Commission. Cut-offs less than three (3) feet in length shall not be measured for payment and shall remain the property of the Contractor.

The quantity of test piles to be measured for payment shall be the actual number of linear feet of all test piles furnished and driven as authorized. No deduction for cut-offs shall be made from test pile measurement.

Steel caps for steel piles when actually used shall be measured for payment as three (3) linear feet of steel pile.

Steel pile splices that are required and authorized, when the piles supplied by the Contractor are in accordance with an approved pile schedule, shall be measured for payment as one splice each.

The quantity of "Loading Tests," which are called for or authorized to be measured for payment under this item shall be the number of loading tests completed and accepted.

BASIS OF PAYMENT

708-13. All work done under this section will be paid for at the contract unit price for the respective items listed below:

(a) Timber untreated or treated piles and steel H-beam piles will be paid for at the contract unit price per linear foot, which payment shall be full compensation for furnishing and driving the piling; for all bracing, temporary caps and collars; for cutting off piling and for jetting piles; for all equipment, labor, tools and all incidentals necessary to complete the work.

Pile cut-offs, three (3) feet or more in length, will be paid for on the basis of the actual cost of the material delivered at the bridge site and shall become the property of the Commission. The Contractor shall submit receipted bills, pay rolls and other satisfactory vouchers required for determining the cost per foot of the pile.

(b) Piles and pile caps ordered as authorized by the Engineer and not used, will be paid for on the basis of actual cost plus five (5) per cent and shall become the property of the Commission. The Contractor shall submit receipted bills, pay rolls and other satisfactory vouchers required for determining the cost.

(c) "Test Piles" conforming to the size and type of the piles used in the finished work will be paid for as specified under (a) above. When "Test Piles" not conforming to these requirements are driven, or when there is no unit price for piling in the contract, they shall be paid for on the basis of "Extra Work," as provided in Article 108-4.

(d) "Pile Splices" for steel H-beam piles, when conforming to splices required and authorized in an approved pile schedule, will be paid for at the contract unit price each, which payment shall be full compensation for all material, labor, equipment, and tools required to satisfactorily complete this work.

When pile splices are made for the Contractor's convenience, they shall be made without compensation. Only one splice per pile will be permitted.

(e) "Pile Loading Tests" will be paid for at the contract unit price each, which payment shall be full compensation for all material, bracing, loading, and measuring apparatus required; for all equipment, labor, tools and all incidentals necessary for the work.

If no item for "Pile Loading Tests" is included in the Proposal, this work will be paid for on the basis of "Extra Work" as provided in Article 108-4.

SUMMARY OF ITEMS FOR PAYMENT

Item 708-14	Timber Piles, Untreated	—per linear foot
Item 708-15	Timber Piles, Treated	—per linear foot
Item 708-16	Steel H-beam Piles lbs./foot	—per linear foot
Item 708-17	Steel H-beam Piles lbs./foot	—per linear foot
Item 708-18	Splices, Steel H-beam Piles lbs./foot	—each
Item 708-19	Splices, Steel H-beam Piles lbs./foot	—each
Item 708-20	Pile Loading Test	—each

DIVISION VIII

INCIDENTAL CONSTRUCTION—BRIDGE ITEMS

"Incidental Construction—Bridge Items" shall include the removal of existing superstructure, maintenance of traffic, cofferdams, and other miscellaneous items.

SECTION 801

REMOVAL OF EXISTING SUPERSTRUCTURE

DESCRIPTION

801-1. **General.** This item shall consist of the removal and disposal of existing superstructures and pile or trestle bents at sites where new structures are located and/or at other sites shown on the plans.

CONSTRUCTION METHODS

801-2. **Removal of Existing Superstructure and Pile or Trestle Bents (Material Retained by Commission).** When the material from an existing structure is to be retained by the Commission, it shall be carefully wrecked by the Contractor, and all materials except those to be re-used in the new structure, are to be loaded on trucks, or carefully piled or stored, adjacent to the bridge site, in such manner and in such location as the Engineer may direct. The use of any portion of the salvaged material in connection with the new or temporary construction shall not be anticipated by the Contractor. The wrecking of metal structures shall, when especially provided, involve the removal of all bolts and rivets necessary to disconnect the members and the match-marking of these members for future reassembling.

801-3. **Removal of Existing Superstructure and Pile or Trestle Bents (Material to Become Property of Contractor).** When the material from an existing structure is 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.

METHOD OF MEASUREMENT

801-4. The quantity of "Removal of Existing Superstructure" to be measured for payment shall be one unit which shall consist of all superstructures, pile or trestle bents on the project, requiring removal and disposal in a satisfactory manner.

BASIS OF PAYMENT

801-5. "Removal of Existing Superstructure" will be paid for at the contract lump sum price for removal and disposal of all superstructures, pile or trestle bents required, which payment shall be full compensation for all equipment, hauling, tools, labor and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 801-6 Removal of Existing Superstructure (Retained by Commission)	—lump sum
Item 801-7 Removal of Existing Superstructure (Property of Contractor)	—lump sum

SECTION 802

MAINTENANCE OF TRAFFIC

DESCRIPTION

802-1. **General.** The item "Maintenance of Traffic" shall mean the construction, maintenance in good condition, and removal of temporary structures and approach roads required for the maintenance of vehicular and pedestrian traffic. When no item for "Maintenance of Traffic" is included in the Proposal, traffic shall be maintained as specified in Article 104-4, "Maintenance of Traffic."

CONSTRUCTION METHODS

802-2. **Maintenance of Traffic.** In general, and unless otherwise specified or permitted by the Engineer, temporary structures and approach roads provided for traffic shall be located as close as possible to the new work; shall be sufficiently strong to safely carry the legal load permitted on the highways; shall be provided with a suitable curb and rail for the protection of traffic; shall have a clear roadway width of at least that indicated in Item 802-8 of the Proposal; and the elevation of the floor shall be above the high water elevation which may be expected during the construction period. The approach grades shall not exceed ten (10) per cent, and the curves shall be such as will not inconvenience traffic.

This item shall mean the maintenance of both vehicular and pedestrian traffic over one roadway of the width specified in Item 802-8 of the Proposal.

802-3. **Maintenance of Pedestrian Traffic.** Temporary structures and approaches provided for pedestrian traffic shall be sufficiently strong to safely carry a live load of seventy-five (75) pounds per square foot; shall have a clear width of at least five (5) feet; shall be adequately lighted; and shall have a curb and rail, satisfactory to the Engineer, for the protection of pedestrians; shall fulfill the requirement of Article 802-2, above, as to location and height above high water; and shall be constructed in such a manner as to provide safe and easy passage at all times.

This item shall mean the maintenance of pedestrian traffic only.

802-4. **Maintenance of Combined Vehicular and Pedestrian Traffic—Separate Ways.** This item shall mean the maintenance of separate ways for vehicular and pedestrian traffic, conforming to all of the requirements for the separate structures specified above. If both roadways are maintained on the same structure, the roadway width for vehicular traffic shall be at least the width specified in Item 802-10 of the Proposal; and the pedestrian portion shall have a clear width of at least five (5) feet and shall be protected from vehicular traffic by being at least nine (9) inches above the roadway, or suitably protected by means of an adequate curb having a height of at least nine (9) inches above the roadway surface.

802-5. **Contractor's Responsibility.** The Contractor shall be held responsible for the protection against loss of or damage to any temporary structure, including its approaches, from any cause whatsoever, and shall maintain the same in a satisfactory manner, until the new structure is opened to traffic. If any temporary structure, or its approaches, is damaged due to high water or any other reasons, it shall be replaced by the Contractor, in accordance with the requirements for "Maintenance of Traffic" under this contract, without extra compensation.

METHOD OF MEASUREMENT

802-6. "Maintenance of Traffic" to be measured for payment shall be the respective units (consisting of structure and approaches) required, constructed and maintained in a satisfactory manner.

BASIS OF PAYMENT

802-7. "Maintenance of Traffic" will be paid for at the contract lump sum price for the respective items listed below,

as called for in the Proposal, which payment shall be full compensation for constructing, maintaining and removing all temporary structures and approaches required; for all materials, equipment, tools, labor, barricades, lighting and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 802- 8 Maintenance of Traffic—foot Road-way width	—lump sum
Item 802- 9 Maintenance of Pedestrian Traffic	—lump sum
Item 802-10 Maintenance of Traffic, Separate Ways—foot, Vehicular Roadway width	—lump sum

SECTION 803

COFFERDAMS

DESCRIPTION

803-1. General. This item includes 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 the excavation of foundation pits; and to permit and protect the construction of structural units.

CONSTRUCTION METHODS

803-2. Drawings. If requested by the Engineer, the Contractor shall submit for approval plans showing his proposed method of protecting the foundation construction; and construction shall not be started until such plans are approved. However, approval of these plans shall not relieve the Contractor of the responsibility for the cofferdam.

803-3. General. 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 performance of the foundation construction. 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 construction of forms and to permit pumping outside of forms. Except for seal concrete, cofferdams shall be so constructed that sea water shall not come in contact with concrete during placing and for at least seventy-two (72) hours thereafter.

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 left in cofferdams or cribs in such a way as to extend into the substructure masonry, without written permission of the Engineer.

Cofferdams shall be constructed so as to protect green 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, all sheeting and bracing 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.

803-4. 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. In no case will pumping be permitted within seven (7) days.

METHOD OF MEASUREMENT

803-5. "Cofferdams" to be measured for payment shall be the respective cofferdam unit or units indicated on the plans or called for in the Proposal.

BASIS OF PAYMENT

803-6. "Cofferdam" items will be paid for at the contract lump sum price for the respective cofferdam items in the Proposal, which payment shall be full compensation for all materials, equipment, pumping, tools, labor and all incidental work.

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 twenty-five (25) per cent of the area of the excavation is more than three (3) feet below the elevation shown on the plans, at the Contractor's request, the entire cost of the cofferdam will be paid for in accordance with Article 108-4, "Extra Work," instead of at the contract lump sum price.

SUMMARY OF ITEMS FOR PAYMENT

Item 803- 7	Cofferdams	—lump sum
Item 803- 8	Cofferdams	—lump sum
Item 803- 9	Cofferdams	—lump sum
Item 803-10	Cofferdams	—lump sum

SECTION 804

FRENCH DRAINS

DESCRIPTION

804-1. General. This item shall consist of furnishing and placing stone and gravel for "French Drains" where called for on the plans or authorized.

MATERIAL

804-2. General.

(a) Stones for "French Drains" shall consist of hard, durable rock, meeting the following gradation requirements:

<u>Screen Size</u> <u>Square Openings</u>	<u>Per Cent by</u> <u>Weight Passing</u>
6 Inch	90-100
2 Inch	0- 5

(b) Gravel for "French Drains" shall consist of hard, durable particles of granular material meeting the following gradation requirements:

<u>Screen Size</u> <u>Square Openings</u>	<u>Per Cent by</u> <u>Weight Passing</u>
6 inch	100
¼ inch	25- 70
#200 mesh	0- 5

CONSTRUCTION METHODS

804-3. General. "French Drains" shall be constructed behind abutments, wing walls and retaining walls to drain the approach fill through the weep holes in the wall.

The drains shall be placed with the bottom at the elevation of the flow line of the weeper openings through the wall. They shall be two (2) feet in width for the entire length of the section and shall extend in height from the bottom of the weepers to the subgrade of the road or to within six (6) inches of embankment slopes. The space from the bottom of the drains to a height of two (2) feet above the weeper flow

lines shall be filled with stone and the remainder of the drain above the stone shall be filled with gravel. The stone and gravel shall conform to the requirements of Article 804-2.

"French Drains" shall be compacted as required in Article 207-4, "Embankment Construction."

METHOD OF MEASUREMENT

804-4. The quantity of "French Drains" to be measured for payment shall be the number of cubic yards of material measured in place, completed and accepted. Measurement limits shall be as shown on the plans or as authorized.

BASIS OF PAYMENT

804-5. This item will be paid for at the contract unit price per cubic yard, which payment shall be full compensation for furnishing all material, loading, hauling, placing and compacting; for all labor, tools, equipment and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 804-6 French Drains —per cubic yard

SECTION 805

WROUGHT IRON RAIL

DESCRIPTION

805-1. This item shall consist of furnishing and erecting "Wrought Iron Rail" where called for on the plans or authorized.

DRAWINGS

805-2. Drawings shall conform to the requirements of Article 702-2, "Drawings."

MATERIALS

805-3. Wrought Iron shall conform to the requirements of Article 702-22, "Wrought Iron."

Materials for Concrete Posts when required shall conform to the requirements of Section 701, "Portland Cement Concrete."

Reinforcing steel for concrete posts shall conform to the requirements of Section 705, "Reinforcing Steel."

CONSTRUCTION METHODS

805-4. Fabrication, welding, mill and shop inspection, erection, and shop painting shall conform to the respective requirements of Section 702, "Structural Steel." Reinforced concrete posts, when required, shall conform to the requirements of Section 701, "Portland Cement Concrete," and Section 705, "Reinforcing Steel."

METHOD OF MEASUREMENT

805-5. The quantity of "Wrought Iron Rail" to be measured for payment shall be the number of linear feet measured horizontally from out to out of end posts of each continuous section of rail. Except when the wrought iron rail extends beyond the end post, measurement shall be made from out to out of the rail.

BASIS OF PAYMENT

805-6. All work done under "Wrought Iron Rail" will be paid for at the contract unit price per linear foot, which payment shall include full compensation for furnishing all material, fabrication, transportation, shop painting, erection, labor, tools and all incidental work necessary to complete the item, except cement and reinforcing steel for concrete posts will be paid for under their respective items and/or structural steel posts will be paid for under "Structural Steel."

ITEM FOR PAYMENT

Item 805-7 Wrought Iron Rail, Delivered
and Erected —per linear foot

DIVISION IX

INCIDENTAL CONSTRUCTION ITEMS

Incidental Construction Items shall consist of curbing, guard rail, slope treatment and other miscellaneous items.

SECTION 901

GRANITE CURB AND EDGING

DESCRIPTION

901-1. General. This item shall consist of furnishing and placing granite curb and granite edging as called for on the plans or as required.

MATERIAL

901-2. General. Stone shall be of tough, dense, sound and durable granite, of a uniform color, reasonably fine grained, and free from seams, cracks, pyrite inclusion or other structural defects.

901-3. Dimensions.

(a) *Granite Curb—Type I.* The curbstone shall have a minimum length of four (4) feet, shall be six (6) inches wide at the top, seventeen (17) inches to nineteen (19) inches in depth and shall have a minimum width at the bottom of four (4) inches for at least two-thirds ($\frac{2}{3}$) of its length. When curbstone having a radius of from thirty (30) to one hundred sixty (160) feet is required, the curbstone length shall be from four (4) to six (6) feet; and curbstone having a radius of thirty (30) feet or less shall be cut to the curve required. Granite curb corners shall have their front arris line extend through one-quarter ($\frac{1}{4}$) of a circle two (2) feet in radius. The back arris line shall be straight. The plane of the back shall be normal to the top.

(b) *Granite Curb—Type II.* The four (4) inch type curbstone shall have a length between fifteen (15) inches and six (6) feet and at least 80% shall be in excess of twenty (20) inches in length. The width of the top of the curbstone shall be at least three (3) inches and not more than five (5) inches and the width of the bottom shall be at least three (3) inches for two-thirds ($\frac{2}{3}$) of its length. The curbstone shall have a depth from fourteen (14) to eighteen (18) inches.

Granite curb corners shall have their front arris line extend through one-quarter ($\frac{1}{4}$) of a circle of radius two (2)

feet or three (3) feet as required. The back arris line shall be straight with the plane of the back normal to the top surface.

(c) *Sloped Granite Curb*. Curbstone for "Sloped Granite Curb" shall conform to (a) above, except that the face and top shall be sloped or beveled as shown on the plans.

(d) *Granite Edging*. Edging shall have a length from three (3) to six (6) feet; a thickness of from five (5) to eight (8) inches; and a width or face of twelve (12) inches plus or minus one-half ($\frac{1}{2}$) inch. Except when edging is used on a radius of less than one hundred sixty (160) feet, shorter lengths shall be authorized. Edging for curves having a radius of thirty (30) feet or less shall have its edges cut on approximate radial lines.

901-4. Finish.

(a) *Granite Curb—Type I*. The curbstone shall have a top free from wind; shall be peen hammered or sawed to an approximately true plane; and shall have no projections or depressions greater than one-eighth ($\frac{1}{8}$) of an inch. The front and back arris lines shall be pitched straight and true and there shall be no projection on the back surface for three (3) inches down from the top which would exceed a batter of four (4) inches in one (1) foot.

The front face shall be at right angles to the planes of the top and ends and shall be smooth quarry split, free from drill holes and with no projection of more than one (1) inch and no depression of more than one-half ($\frac{1}{2}$) inch measured from the vertical plane of the face through the arris or pitch line for a minimum distance down from the top of eight (8) inches. Except that when the curb height shown on the plans exceeds $7\frac{1}{2}$ inches this distance shall be one (1) inch greater than the curb height shown. For the remaining distance there shall be no projection or depression greater than one (1) inch measured in the same manner.

The ends of all stones shall be square with the planes of the top and face so that when the stones are placed end to end as closely as possible no space shall show in the joint at the top and face of more than five-eighths ($\frac{5}{8}$) inch for the full width of the top and for a minimum of eight (8) inches (or the clear height of the curb whichever is greater) down on the face, after which the end may break back not over eight (8) inches from the plane of the joint.

If sawed, the curbing shall be thoroughly cleaned of any iron rust, or iron particles, by sand blasting or other ap-

proved methods and any conspicuous saw marks shall be removed with the peen hammer.

(b) *Granite Curb—Type II*. The curbstone shall have a top surface free from drill holes, and shall be scabble dressed to an approximately true plane having no projections or depressions over one-half ($\frac{1}{2}$) inch under a two (2) foot straightedge or over one (1) inch under a four (4) foot straightedge.

The front face shall be at right angles to the top and shall be smooth quarry split, free from drill holes in the top six (6) inches of exposed face and with no projections or depressions exceeding one (1) inch. The arris at the intersection of the top and face shall be pitched so that when a straightedge is applied to the full length of the stone, there shall be no depression under the straightedge greater than one-half ($\frac{1}{2}$) inch.

The ends shall be square to the length at the face, and so finished that when the stones are placed end to end as closely as possible no space more than three-quarters ($\frac{3}{4}$) of an inch shall show in the joint for the full width of the top or down the front face for at least six (6) inches after which the end may break back not more than one-fourth ($\frac{1}{4}$) the length of the stone.

(c) *Sloped Granite Curb*. Curbstones for "Sloped Granite Curb" shall conform to (a) above, except that the face and top shall be sloped or beveled as called for on the plans. This sloped top shall be finished as required for the top surface under (a) above.

(d) *Granite Edging*. The exposed face of stones for "Granite Edging" shall be smooth quarry split to an approximately true plane having no projections or depressions over one (1) inch under a two (2) foot straightedge. If projections on the face are more than that specified, they shall be dressed off. The top arris line at the face shall be pitched, with no variation from a straight line greater than one-eighth ($\frac{1}{8}$) inch. The bottom arris line at the face shall be pitched so that not over one (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 as closely as possible, no space more than one and one-half ($1\frac{1}{2}$) inches shall show in the joint for the full width of the face. The arris lines at the ends shall be pitched with no variation more than one-quarter ($\frac{1}{4}$) inch from the plane of the face. Drill holes may show on the exposed face, but only

along the bottom edge. The sides shall not be under the square more than four (4) inches or over the square at the back more than one (1) inch.

CONSTRUCTION METHODS

901-5. General. All curbstones and edging shall be laid to conform with the line and grade called for on the plans. They shall be set on a compact gravel base and shall be fitted together so as to form an open joint not exceeding five-eighths ($\frac{5}{8}$) inch in width. The curb shall be placed on the prepared gravel foundation and all voids under the curb filled with gravel and firmly tamped so that when finally placed the curb shall have its top at the required line and grade and it shall have a full and uniform bearing on the gravel foundation for its entire length and width.

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 rejected.

Long and short lengths of curb shall be laid alternately unless otherwise directed.

METHOD OF MEASUREMENT

901-6. The quantity of curbstone to be measured for payment shall be the length in linear feet actually laid, complete and accepted, as measured in place along the front arris line of the curb.

The quantity of edging to be measured for payment shall be the length in linear feet actually laid, complete and accepted, as measured in place along the bottom line of the face slope of the edging.

BASIS OF PAYMENT

901-7. All work done under this section will be paid for at the contract unit price per linear foot for the respective items listed below, which payment shall be full compensation for furnishing all materials, equipment, tools, labor and all incidentals necessary to complete the work.

Curb and edging required to be placed on a radius of thirty (30) feet or less, shall be paid for as circular curb or edging.

SUMMARY OF ITEMS FOR PAYMENT

Item 901- 8	Granite Curb—Type I	—per linear foot
Item 901- 9	Granite Curb—Type I	
	Circular	—per linear foot

Item 901-10	Granite Curb—Type II	—per linear foot
Item 901-11	Granite Curb—Type II	
	Circular	—per linear foot
Item 901-12	Sloped Granite Curb	—per linear foot
Item 901-13	Sloped Granite Curb—Circular	
		—per linear foot
Item 901-14	Granite Edging	—per linear foot
Item 901-15	Granite Edging—Circular	—per linear foot

SECTION 902

PORTLAND CEMENT CONCRETE CURB INTEGRAL CURB, CURB AND GUTTER

DESCRIPTION

902-1. General. This item shall consist of constructing curb, integral curb, or curb and gutter all of portland cement concrete as called for on and in conformity with the plans.

MATERIALS

902-2. Materials for Concrete: Concrete used in this work shall conform to the requirements of Section 701, "Portland Cement Concrete," Class "A".

902-3. Steel Reinforcement shall conform to the requirements of Section 705, "Reinforcing Steel."

902-4. Joint Filler shall consist of one-quarter ($\frac{1}{4}$) inch thick plywood of good quality cut to the required cross-section of the joint.

CONSTRUCTION METHODS

902-5. General. When concrete curb is placed in conjunction with the construction of portland cement concrete pavement, it shall conform with the requirements of Section 405 "Portland Cement Concrete Pavement" except that the forms shall remain in place at least seventy-two (72) hours.

All other concrete curb shall conform to the requirements of Section 701 "Portland Cement Concrete".

Backfill behind the curb shall be of granular material conforming to the requirements of Section 302 "Gravel Base Course", and shall be compacted by tamping.

902-6. Curb. All forms shall be set true to line and grade and held rigidly in position. The top edges of the curb shall be uniformly rounded with an approved edging tool or beveled by the use of wood bevel strips.

902-7. Integral Curb. The curb is to be an integral part of the supporting concrete pavement and shall be placed as a separate operation after the pavement has been completed. Dowel bars shall be set in the pavement, before the concrete is set, in accordance with the plans.

Forms shall be of either metal or wood or an approved combination of them, and shall be set true to line and grade and held rigidly in place.

The top edges of the curb shall be uniformly rounded with an approved edging tool. Joints shall be located in the same vertical plane with joints in the pavement, and shall be formed by the use of the wooden filler required in Article 902-4, "Joint Filler."

902-8. Curb and Gutter shall be constructed in conformity with the plans. The curb and gutter shall be placed in one operation. Sections twenty (20) feet in length shall be required except when placed adjacent to portland cement concrete pavement, or when local conditions necessitate sections less than twenty (20) feet in length. When placed adjacent to portland cement concrete pavement the joints shall be located in the same transverse plane as the joint in the pavement. Joints shall be formed by the use of the wooden filler required in Article 902-4, "Joint Filler."

Forms shall conform to the requirements of Article 902-7, "Integral Curb."

The top edges of the curb shall be uniformly rounded with an approved edging tool.

METHOD OF MEASUREMENT

902-9. The quantity to be measured for payment shall be the length in linear feet, completed and accepted, measured in place along the front line of the curb.

BASIS OF PAYMENT

902-10. All work done under this section will be paid for at the contract unit price per linear foot for the respective items listed below, which price shall be full compensation for furnishing all materials including reinforcing steel, dowels and cement; for all equipment, tools, forms, labor and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 902-11	Concrete Curb	—per linear foot
Item 902-12	Integral Concrete Curb	—per linear foot
Item 902-13	Concrete Curb and Gutter	—per linear foot

SECTION 903

FIELD STONE CURB

DESCRIPTION

903-1. General. This item shall consist of constructing field stone curb as called for on and in conformity with the plans, or as required.

MATERIAL

903-2. General. The stones shall be field stones or other approved rock material. The stone shall be sound and durable, from five (5) inches to seven (7) inches thick, at least six (6) inches wide, and at least fifteen (15) inches in length.

CONSTRUCTION METHODS

903-3. General. The stones shall be placed on a compacted gravel base with the fifteen (15) inch dimension vertical, and the largest end in the ground. They shall be fitted closely together and the face of the stone laid to the line of the face of the curb. The backfill in front and back of the curb shall be granular material conforming to the requirements of Section 302, "Gravel Base Course," and shall be compacted by tamping.

METHOD OF MEASUREMENT

903-4. The quantity of "Field Stone Curb" to be measured for payment shall be the length in linear feet, completed and accepted, measured in place along the front line of the curb.

BASIS OF PAYMENT

903-5. All work done under this section will be paid for at the contract unit price per linear foot for "Field Stone Curb" which price shall be full compensation for furnishing all material, equipment, tools, labor and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 903-6 Field Stone Curb —per linear foot

SECTION 904

PORTLAND CEMENT CONCRETE—SIDEWALK AND STEPS

DESCRIPTION

904-1. General. This item shall consist of constructing portland cement concrete sidewalk and/or steps where called

for on and in conformity with the plans, or as required. This item does not include concrete sidewalks on bridges.

MATERIAL

904-2. **General.** Materials used for concrete in this work shall conform to the requirements of Section 701, "Portland Cement Concrete," Class A.

Steel reinforcement shall conform to the requirements of Section 705, "Reinforcing Steel".

CONSTRUCTION METHODS

904-3. **General.** Concrete shall conform with the requirements of Section 701, "Portland Cement Concrete". Vibrating will not be required when spaded and tamped satisfactorily.

904-4. **Sidewalk Joints** shall be located at intervals not exceeding six (6) feet, and in general the distance between joints shall be the same as the width of the sidewalk. Slabs shall be placed alternately, and joints shall be coated with approved bituminous material before placing the adjacent slab.

Where a concrete sidewalk is constructed adjacent to a curb, building, retaining wall or other fixed structure, a pre-fabricated joint filler as required in Article 902-4 shall be placed between the sidewalk and the adjacent structure.

904-5. **Finishing.** The top surface of the sidewalk shall be generally "struck" with a straight edge and floated after the stone aggregate has been forced below the finished elevation of the concrete. A margin two (2) inches in width shall be defined and finished smooth along the joint of each slab, and all edges shall be rounded to a radius of one-quarter ($\frac{1}{4}$) inch with an approved edging tool. Following the finishing of margins and edges, as required above, the entire area of the slab shall be finished with a short wooden float which shall be moved in small circles to produce a shell-like pattern upon the surface of the concrete.

All exposed surfaces of concrete steps shall have a "Rubbed Finish" as specified in Article 701-27 (b).

904-6. **Opening to Traffic.** Concrete sidewalks and steps shall be protected for a period of not less than seventy-two (72) hours, after which they may be opened to pedestrian traffic. After seventy-two (72) hours, sidewalk crossings for vehicular traffic shall be protected by a layer of earth as specified in Article 405-14.

METHOD OF MEASUREMENT

904-7. The quantity of concrete sidewalk to be measured for payment shall be the area in square yards, completed and accepted, measured in place.

The quantity of concrete steps to be measured for payment shall be the volume in cubic yards, completed and accepted, measured in place.

BASIS OF PAYMENT

904-8. All work done under "Cement Concrete Sidewalk" will be paid for at the contract unit price per square yard, which payment shall be full compensation for furnishing all materials (except reinforcing steel and cement); for all equipment, tools, forms, labor and all incidentals necessary to complete the work.

All work done under "Cement Concrete Steps" will be paid for at the contract unit price per cubic yard, which payment shall be full compensation for furnishing all materials (except reinforcing steel and cement); for all equipment, tools, forms, labor and all incidentals necessary to complete the work.

Payment for reinforcing steel will be made under Items 705-13 and 705-14.

Payment for cement will be made under Item 701-47 "Portland Cement".

SUMMARY OF ITEMS FOR PAYMENT

Item 904-9	Plain Concrete Sidewalk	—per square yard
Item 904-10	Reinforced Concrete Sidewalk	
		—per square yard
Item 904-11	Reinforced Concrete Steps	—per cubic yard

SECTION 905

GUARD RAIL

DESCRIPTION

905-1. **General.** This item shall consist of installing guard rail of the type required as called for and in conformity with the plans.

MATERIALS

905-2. **Wood Posts.** 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 shall be trimmed flush with the

surface of the post. Unsound, loose or hollow knots, plugged or open holes will not be permitted. Sound knots will be permitted if the diameter of any one knot or the combined diameter or two or more knots occurring in the same cross section is not greater than one-third (1/3) of the diameter 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 and of the length shown on the plans.

Rectangular wood posts shall be of well seasoned, straight and sound timber, cut from live growing trees, free from loose knots or other defects and shall be dressed on all sides. The dimensions before dressing shall be six (6) inches by eight (8) inches, and the length shall be as shown on the plans.

Wood posts for guard rail shall conform to the requirements listed in the following table:

Type	Line Posts Diameter Top Cut Off		Anchor Posts Diameter Top Cut Off		Specie*	Shape	Treatment
	Min.	Max.	Min.	Max.			
"A"	6"	10"	10"	15"	Group 1	Round	Creosote Oil and Paint
"B"	6"	10"	10"	15"	Group 2	Round	Pressure Treated
"D"	8"	11"	11"	15"	Group 2	Round	Pressure Treated
"F"	8"	11"	—	—	Group 2	Round	Pressure Treated
"H"	8"	11"	—	—	Group 1	Round	Creosote Oil and Paint
"G"	6"x8" Full length	—	—	—	Group 1	Rectangular	Creosote Oil and Paint

Type "C" and "E" guard rail shall have steel posts.

*Line posts in Group 1 shall be of cedar, oak or hackmatack, anchor posts shall be oak.

Line posts in Group 2 shall be of Norway pine, southern yellow pine, pitch pine or Douglas fir; anchor posts shall be Norway pine or southern yellow pine.

Butts shall be pointed and the top cut shall be sawed on the bevel shown on the plans. If the top bevel is made with a saw leaving a rough or fuzzy cut, the top shall be trimmed smooth with a draw shave or other suitable tool.

905-3. Preservative Oil used for posts shall be Creosote Oil, conforming to the latest revised Standard Specifications, Designation M-133 of the American Association of State Highway Officials. When pressure treatment is required, all posts shall be treated by the empty cell process and the minimum amount of preservative retained shall be eight (8)

pounds per cubic foot. Oil borne preservatives meeting the requirements of the A.A.S.H.O. specifications may be used when authorized.

905-4. Steel Posts shall conform to the latest revised Specification for Steel for Bridges and Buildings of the A.S.T.M., Designation A-7.

The dimensions and details shall be as shown on the plans. The posts shall be given a shop or prime coat of red lead paint conforming to the latest revised Specification for Red Lead (Dry and Paste-in-oil) and Paint made therefrom, Designation M-71 or to the Specification for Red Lead Ready-Mixed Paint, Designation M-72, Type I or Type II, of the A.A.S.H.O. Specification for Highway Materials. The shop or prime coat may be a zinc chromate-iron oxide paint conforming to the latest revised Specification for Zinc Chromate-Iron Oxide Ready-Mixed Paint Designation M-142 of the A.A.S.H.O. Specification for Highway Materials.

905-5. Field Coat Paint for guard rail posts shall be a white lead paint conforming to the latest revised Specification for White and Tinted Ready-Mixed Paint (Lead and Zinc Base) Designation M-70 of the A.A.S.H.O. Specification for Highway Materials.

905-6. Cable. The cable shall be of galvanized three-quarter (¾) inch wire rope having a tensile strength of not less than 25,000 pounds and conforming to the latest revised Standard Specifications for Wire Rope and Fittings for Highway Guard Rail, Designation M-30 of the A.A.S.H.O.

905-7. Offset Brackets shall be fabricated from spring steel conforming to the requirements of the latest revised Standard Specification for Carbon Steel Bars for Springs, Designation A-14 of the A.S.T.M. The brackets shall be machined and formed as shown on the plans with one-eighth (⅛) inch tolerance in height and width, and shall be tempered, drawn and galvanized after forming. The completed bracket shall meet strength requirements as follows:

The load shall be applied through three-quarter (¾) inch wire cables laid in the slots. Measured out to out, front to back, a load of 15,000 pounds shall cause a minimum deflection of one (1) inch. After the load has been held for one (1) minute and released, the bracket shall show a permanent set of not greater than one-half (½) inch.

905-8. Fittings. All fittings and fastenings including bolts, nuts and washers shall be of the dimensions shown on

the plans and shall be galvanized. Cable fittings shall be of drop forged steel or malleable iron castings. Anchor rods, bolts, nuts, washers and bearing plates shall be structural grade steel. Cable fasteners, splices, and end bolts when assembled shall develop an ultimate tensile strength of not less than 25,000 pounds.

Where wedge type fittings are used, the wedge may be of cast iron and shall be of the larger size.

The anchor rod assembly shall have a tensile strength of at least 40,000 pounds for Type "A" and Type "B" guard rail and of at least 60,000 pounds for Type "C" and Type "D" guard rail.

The anchor block used shall conform to the details shown on the plan. When made of concrete it shall conform to the requirements of Section 701, "Portland Cement Concrete."

905-9. Steel Beam. Sections for steel beam guard rail shall be of ten (10) gauge carbon steel and of the proper length to erect on posts set twelve (12) feet six (6) inches, center to center. The beams shall be made of shop fabricated steel plates of either the corrugated or channel type, having a minimum over-all width of finished beam of twelve (12) inches. A two (2) inch test specimen of the material shall elongate not less than twelve (12) per cent.

The steel beam shall develop a minimum tensile strength of not less than 70,000 pounds, for rail element and joints. It shall have a section modulus greater than 1.35 inches cubed, based on full section, and meet the following beam strength test: A section of rail freely supported at each end on twelve (12) foot centers shall support a concentrated load, at the center, of 2,000 pounds with a maximum deflection of three (3) inches. All bolts used for steel beam guard rail shall have a minimum diameter of five-eighths ($\frac{5}{8}$) inch and shall be made from high-strength steel and heat treated to give the proper strength and toughness. These bolts shall be made from steels that have an ultimate strength of 120,000 p.s.i. after heat treating. End wings shall be designed to be attached to the straight beam section at the end post. They shall be of the same material and construction as required for the beam section and shall be designed in accordance with the manufacturer's standards.

All fittings and fastenings shall be galvanized. Beams, end wings and butt plates shall be either galvanized or shop painted with one coat of fast-drying, rust inhibitive primer. The primer shall be thoroughly dry before the parts are handled or packed for shipment.

Formulas used for primers shall have been demonstrated as capable of withstanding at least 200 hours exposure in a weatherometer test conducted in accordance with "Recommended Practice for Light and Water Exposure Apparatus (Carbon Arc Type) for Testing Paint, Varnish, Lacquer and Related Products," A.S.T.M. D-822-46T, with no evidence of cracking, blistering, rusting, checking, peeling, scaling or loss of adhesion.

905-10. Galvanizing. All material required to be galvanized shall be galvanized in accordance with the requirements of the Standard Specifications for Wire Rope and Fittings for Highway Guard Rail, Designation M-30 of the A.A.S.H.O. Bolts used in assembling the beam guard rail shall be galvanized by the hot dipped process to conform to A.S.T.M. Specification A-153-42T.

905-11. Wood Rails shall be of well seasoned, straight and sound spruce, southern yellow pine or Douglas fir, cut from live growing timber, free from loose knots or other defects and shall be dressed on all sides. The dimensions before dressing shall be six (6) inches by eight (8) inches by sixteen (16) feet.

CONSTRUCTION METHODS

905-12. General. All metal work shall be fabricated in the shop. No punching, cutting or welding shall be done in the field.

905-13. Setting Posts. The post holes shall be dug to the depth and in the location shown on the plans and the bottoms shall be thoroughly rammed so that the post will have a stable foundation. Wood posts shall be selected with respect to size so they will present a pleasing appearance after placing. The posts shall be set plumb, with the smaller diameter at the top and the holes around the posts shall be back-filled with suitable material thoroughly tamped in layers not exceeding nine (9) inches.

After wood posts are set the tops shall be cut and beveled and the required holes shall be bored at the proper locations, except that pressure treated posts shall be framed, bored and beveled before being treated.

Wood posts not required to be pressure treated, shall be given two coats of creosote oil on the lower part to a line which will be six (6) inches above the finished shoulder line when the post is set. Posts may be immersed to the specified depth in a tank or barrel of creosote oil instead of paint-

ing two coats, in which case the posts must remain in the oil for a minimum of sixty (60) minutes. After being treated the posts shall be piled in a manner to permit thorough drying before being set in the ground and to prevent the creosote oil from flowing onto the upper portion of the post. Creosote stains existing above the top of the creosoted section shall be removed by draw shaving or planing the post surface. Steel posts may be driven if suitable driving caps and equipment are provided to prevent battering or injury to the posts. Before driving these posts, holes about eight (8) inches deep and one (1) foot in diameter shall be dug at post locations to facilitate painting. Posts shall then be driven to the proper depth and alignment. After driving each anchor post an underground steel channel shall be bolted to the post as shown on the plans. The posts shall be painted below the bottom of the bracket to six (6) inches below the ground line with one coat of black asphalt varnish of such quality as to give a tough flexible film, free from tackiness, and which will not chip or flake off in handling. After the varnish has thoroughly dried the space around the posts shall be filled with suitable material which shall be thoroughly tamped.

905-14. Erecting Cable. For Type "A" and Type "B" guard rail, the two wire cables shall be securely attached to the posts by means of tightly fastened hook bolts. For Type "C" and Type "D" guard rail the three wire cables shall be positioned and confined by stay pins into the offset brackets which are securely bolted to the posts, and the stay pins shall be held in place so that they cannot be removed without the use of tools.

The cables shall be drawn to take up all sag between the posts. Both ends of each section of cable shall be anchored as shown on the plan. At all cable ends the rods shall be screwed against the wedges so as to hold them tightly in place. The cables shall be stretched as the Engineer may direct and all cables shall have approximately the same tension.

Splicing of the cable will be permitted when necessary, but no single piece of cable shall be less than fifty (50) feet in length and not more than one (1) splice shall occur in any one space between posts. Continuous stretches of cable more than five hundred (500) feet long shall have intermediate turnbuckles. The anchor rods shall be adjusted to equalize the strain on the cables and anchors.

905-15. Erecting Beam Guard. The rail elements and fittings shall be placed and fastened as shown on the plans. The rail elements shall be erected to provide a smooth taut rail closely conforming to the line and grade of the pavement. All bolts shall be drawn tight and shall extend at least one-quarter ($\frac{1}{4}$) inch beyond the nuts. Except where required for adjustment the bolts shall not extend more than one-half ($\frac{1}{2}$) inch beyond the nuts.

End wings shall be erected as shown on the plans and shall be securely and rigidly attached to the beam section and end post.

905-16. Erecting Wood Rail. The wood rails shall be placed as shown on the plans. Each rail shall be securely fastened to the posts by two (2) ten (10) inch spikes at each end and at the intermediate post. The rails shall be drilled for the spikes to prevent splitting.

905-17. Field Painting. All surfaces to be painted shall be cleaned and shall be dry when the paint is applied. Each coat shall be thoroughly brushed out and allowed to dry before the succeeding coat is applied. No painting shall be done in damp weather nor when the air temperature is below 40° F.

(a) Wooden Posts and Rails, not pressure treated, shall be painted on all exposed surfaces, with two (2) coats of white paint as specified herein. The posts shall also be painted from the ground line to a height of six (6) inches with two (2) coats of best quality black paint.

(b) Steel Posts shall be painted with two (2) coats of the specified white paint from the bottom of the bracket to the top of the post.

The posts shall be painted below the bottom of the bracket to six (6) inches below the ground line with one (1) coat of black asphalt varnish of such quality as to give a tough flexible film, free from tackiness, and which will not chip off or flake off in handling.

(c) Beam Sections not galvanized shall be painted with two (2) coats of white paint as specified above.

905-18. Anchors for wire cable guard rail shall be installed as shown on the plans. All backfill shall be of satisfactory material and shall be placed in layers not exceeding nine (9) inches, and each layer shall be thoroughly tamped. All fittings shall be properly adjusted.

905-19. Guard Posts shall be installed as required in Article 905-13, "Setting Posts." Guard posts shall be designated Type "A" or Type "B" and shall conform respectively to the posts for Type "A" and Type "B" guard rail of the table in Article 905-2, "Wood Posts."

METHOD OF MEASUREMENT

905-20. The quantity of guard rail to be measured for payment shall be the length in linear feet of the respective types listed below. Measurement shall extend from end post to end post of each section measured along the rail. When guard rail is attached to the end post of a bridge, measurement shall not include the distance from the end guard rail post to the end post of the bridge rail. The quantity of anchorages to be measured for payment shall be the number of units installed. The measurement shall include all the material beyond the end post and, in the case of anchorage to a bridge rail, shall include all work in the space between the end guard rail post and the bridge rail end post.

The quantity of "End Wings" for beam guard rail to be measured for payment shall be the total number of individual end wings used.

The quantity of "Guard Posts" to be measured for payment shall be the number of individual wood guard posts set as required.

BASIS OF PAYMENT

905-21. Classification. Guard Rail shall be classified for payment in the following types:

Type "A" shall consist of a two (2) cable rail on wood posts having the lower portion brush-treated with creosote oil and the upper portion field painted.

Type "B" shall consist of a two (2) cable rail on pressure treated wood posts.

Type "C" shall consist of a three (3) cable rail attached by brackets to steel posts.

Type "D" shall consist of a three (3) cable rail attached by brackets to pressure treated wood posts.

Type "E" shall consist of a beam type rail with steel posts.

Type "F" shall consist of a beam type rail with pressure treated wood posts.

Type "G" shall consist of a beam type rail with rectangular wood posts having the lower portion brush treated with creosote oil and the upper portion field painted.

Type "H" shall consist of a wood rail with wood posts having the lower portion brush treated with creosote oil; and the upper portion, including the rail, field painted.

905-22. All work done under the respective guard rail items classified above will be paid for at the contract unit price per linear foot complete in place, which payment shall include full compensation for furnishing all materials, including wire cable, fittings, posts, creosote oil, paint, excavation (except solid ledge rock), backfilling, equipment, labor, tools and all incidental work necessary to complete the item, except:

(a) "Anchorages" will be paid for at the contract unit price each, which payment shall include full compensation for furnishing all materials, including fittings, dead men, excavation (except solid ledge rock), backfilling, equipment, labor, tools and all incidental work necessary to complete the item.

(b) "End Wings" will be paid for at the contract unit price each, which payment shall include full compensation for furnishing all materials, equipment, labor, tools and all incidental work necessary to complete the item.

(c) "Guard Posts" will be paid for at the contract unit price each, which payment shall include full compensation for furnishing and setting posts; for excavation (except solid ledge rock) and backfillings; for all labor, tools and all incidental work necessary to complete the item.

(d) Excavation for posts or anchorages in solid ledge rock will be paid for under Item 204-11, "Structural Rock Excavation-Drainage" and allowance for post holes will be made for holes two (2) feet in diameter for the depth of ledge rock actually removed; for anchorages, the allowance will be made for ledge rock actually required to be removed.

SUMMARY OF ITEMS FOR PAYMENT

Item 905-23	Guard Rail—Type "A"	—per linear foot
Item 905-24	Guard Rail—Type "B"	—per linear foot
Item 905-25	Guard Rail—Type "C"	—per linear foot
Item 905-26	Guard Rail—Type "D"	—per linear foot
Item 905-27	Guard Rail—Type "E"	—per linear foot
Item 905-28	Guard Rail—Type "F"	—per linear foot
Item 905-29	Guard Rail—Type "G"	—per linear foot
Item 905-30	Guard Rail—Type "H"	—per linear foot
Item 905-31	Anchorages for Types "A" and "B" Guard Rail	—per each

Item 905-32	Anchorage for Type "C"	
Guard Rail		—per each
Item 905-33	Anchorage for Type "D"	
Guard Rail		—per each
Item 905-34	End Wings	—per each
Item 905-35	Guard Posts—Type "A"	—per each
Item 905-36	Guard Posts—Type "B"	—per each

SECTION 906

FENCING

DESCRIPTION

906-1. **General.** This item shall consist of furnishing and erecting woven wire stock fence on metal or wood posts at locations shown on the plans or as required.

MATERIALS

906-2. **Posts.** The posts shall be of either wood or steel. When wood posts are called for in the contract, the Engineer may approve a request in writing from the Contractor for substituting "Fencing—Metal Posts" and "Barways—Metal Posts" for "Fencing—Wood Posts" and "Barways—Wood Posts". Such change shall apply to all fencing on the project, not a fractional part thereof.

(a) Wood posts shall conform to the requirements for wood posts, for Type A Guard Rail, Section 905, except that the minimum diameter at the top cut-off line shall be four (4) inches for line posts and six (6) inches for end, corner, gate, and barway posts. The length of all posts shall be at least seven and one-half (7½) feet; the upper part of the post above the creosote line need not be shaved or painted.

(b) Metal posts shall be hot rolled from new billet steel. Line posts shall be either of a "T" or "U" shaped section of standard manufacturers' design, seven (7) feet long, and shall weigh not less than 1.33 pounds per linear foot. Each post shall be provided with a suitable anchor plate about one-eighth (⅛) inch thick and weighing at least six-tenths (0.6) pound.

End, corner, gate and intermediate posts shall be an angle section 2½"x2½"x¼", and shall be seven and one-half (7½) feet long; or other approved post sections weighing not less than four (4) pounds per linear foot may be used if authorized. These posts shall be furnished complete with the required fittings and braces. Braces shall be of an angle section 1¾"x1¾"x¼", and of sufficient length to adequately

support the posts; or other approved brace sections weighing not less than two and three-fourths (2¾) pounds per linear foot (exclusive of fittings) may be used, if authorized. Each end or gate post shall be furnished with at least one (1) brace and each corner or intermediate post shall have at least two (2) braces.

All posts, braces and fittings shall have a heavy shop coat of red lead, zinc chromate primer or shall be galvanized. As an alternate, posts may be painted with a shop coat of red or green enamel.

906-3. **Woven Wire Fencing.** The wire fencing shall conform to the latest revised Standard Specifications for Zinc Coated (Galvanized) Iron or Steel Farm-Field and Railroad Right-of-Way Fencing, A.S.T.M. Designation A-116 Class 1, Design Number 1047-12-11. This shall mean the wire shall be forty-seven (47) inches high, having ten (10) horizontal wires of which the top and bottom wires shall be of nine (9) gauge and the intermediate wires of eleven (11) gauge; and the vertical stay wires of eleven (11) gauge spaced at twelve (12) inches.

906-4. **Fasteners.** Staples shall be not less than one and one-half (1½) inches long and shall be made of galvanized wire of not less than nine (9) gauge. Wire fasteners or clamps shall be galvanized wire of not less than eleven (11) gauge.

906-5. **Bars.** Bars for barways shall be cedar or spruce poles equal in quality to the posts, with the bark removed and all knots hewn flush with the face. They shall be at least three (3) inches in diameter at the top and at least two (2) feet longer than the clear width of the barway.

906-6. **Braces.** Braces for wood posts shall be spruce or hemlock timbers, four (4) inches by four (4) inches or spruce or cedar posts having a minimum diameter of four (4) inches and of sufficient length to make a diagonal brace between adjacent posts. They shall be equal in quality to wood rails, as specified in Article 905-11, "Wood Rails".

906-7. **Gates.** Wood gates shall be of spruce or hemlock timbers with bracing and woven wire fencing as shown on the plans.

906-8. **Concrete Blocks** for anchoring metal posts, metal braces and wooden gate posts shall conform to the requirements of Class "B" "Portland Cement Concrete", Section 701.

CONSTRUCTION METHODS

906-9. Setting Posts. All posts shall be spaced ten (10) feet center to center. All wood posts shall be set three (3) feet and three (3) inches in the ground. Metal line posts shall be set two (2) feet and nine (9) inches in the ground; and metal end, corner, gate and intermediate posts shall be set three (3) feet and three (3) inches in the ground.

When the distance between end, corner, gate or barway posts exceeds five hundred (500) feet, intermediate posts, with bracing, spaced not more than five hundred (500) feet apart shall be placed to relieve the strain.

Holes for wood posts shall be dug to full depth.

Wood posts shall be set plumb and to the required line and grade with the large end down. Backfill around the posts shall be made with sound earth placed in nine (9) inch layers. Each layer shall be well tamped.

Metal line posts shall be driven plumb and to the required line and grade by means of an approved post driver. Posts which are bent or otherwise damaged shall be removed and replaced.

906-10. Anchoring and Bracing Posts. End, corner, gate, barway and intermediate posts shall be braced and/or anchored as specified below:

(a) *Wood Posts:* Line posts set in depressions where tension in the fencing may cause lifting of the post shall be considered to be intermediate posts and shall require bracing in reverse to adjoining posts.

Bracing shall be done by use of timber braces gained into the posts about twelve (12) inches from the top and into the adjacent line post about twelve (12) inches above the ground line and securely spiked.

(b) *Metal Posts:* End, corner, gate, barway or intermediate posts and braces shall be set in blocks of concrete. The posts shall be set in blocks of concrete three (3) feet deep and either twelve (12) inches square or fourteen (14) inches in diameter. The bottom of the block shall be at the same elevation as the bottom of the post.

Braces shall be set in blocks of concrete set flush with the ground. These blocks shall be eighteen (18) inches deep and either twelve (12) inches square or fourteen (14) inches in diameter. At least ten (10) inches of the end of the brace shall be embedded in the concrete block. One brace shall be

used on end and gate posts; two (2) braces shall be used on corner and intermediate posts. The braces shall be securely fastened to the post near the top.

At depressions where stresses tending to pull the posts from the ground or where an angle of from three (3°) degrees to ten (10°) degrees in alignment occurs, the line posts shall be anchored in place by casting a block of concrete eighteen (18) inches deep and either twelve (12) inches square or fourteen (14) inches in diameter. The bottom of these blocks shall be set level with the bottom of the post.

At points where alignment angles from ten (10°) degrees to thirty (30°) degrees occur, line posts with two (2) braces and anchors shall be placed. Alignment angles exceeding thirty (30°) degrees shall be considered to be corners.

906-11. Barways. Where barways are required they shall be constructed of two (2) wood or metal posts on each side of the barway to correspond with the type of posts used in the fence. The metal posts shall be set in concrete anchors and tied together with slats all as shown on the plan details. Wood bars as specified in Article 906-5, and as shown on the plans, shall be supplied for all barways.

906-12. Erecting Fencing. Woven wire fencing shall be stretched taut by means of a block and tackle or other satisfactory equipment. It shall be securely fastened to each post with the bottom wire not over four (4) inches above the ground. Splicing the wire will be permitted at posts only and each horizontal strand of wire shall be wrapped completely around the post. This type of fastening shall be used at each end, corner or gate post and at the barway post set in the line of the fence. The wire strand wrapped around the post shall be securely fastened by winding the end of the wire about the same strand where it leads up to the post.

The wire fencing shall be attached to each wood post by at least one (1) staple for each horizontal strand of wire. All staples shall be fully driven into the post. When attaching wire fencing to metal posts a galvanized iron clamp shall be used for securely attaching top and bottom strands and alternate interior horizontal strands to the post.

906-13. Gates. Driveway and/or walk gates as required shall be erected in an approved manner in accordance with the plans and at locations shown on the plans or authorized.

906-14. The Completed Fence shall have the tops of all wood posts cut to a uniform height not exceeding four (4)

inches above the top strand of wire. The cut-off line of the top of each wood post shall be horizontal. All surplus excavated material and all other debris from this work shall be removed and disposed of to leave a neat and workmanlike appearance.

METHOD OF MEASUREMENT

906-15. The quantity of fencing to be measured for payment shall be the length in linear feet actually erected, complete and accepted as measured in place from end post to end post (not including barways and gateways) along the top of the fence.

The quantity of barways and gates to be measured for payment shall be the number of the respective unit installed completed and accepted.

BASIS OF PAYMENT

906-16. All work done under this section for fencing will be paid for at the contract unit price per linear foot for the respective items listed below, which payment shall be full compensation for furnishing all materials, including woven wire fencing, posts, concrete for anchors and bracings, for excavating for postholes and anchorages, for all equipment, tools, labor and all incidentals necessary to complete the work except that solid ledge rock of the required depth and up to two (2) feet in diameter, excavated to allow setting posts, shall be paid for under Item 204-11, "Structural Rock Excavation—Drainage." Barways and gateways will be paid for at the respective contract unit price each for the item required, which payment shall be full compensation for all materials including posts, anchorages, slats or gates, bars, braces and attachments; for excavation of post holes (except solid ledge rock) and anchorages; for all equipment, tools, labor and all incidentals necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 906-17	Fencing—Wood Posts	—per linear foot
Item 906-18	Fencing—Metal Posts	—per linear foot
Item 906-19	Barways—Wood Posts	—per each
Item 906-20	Barways—Metal Posts	—per each
Item 906-21	Drive Gateways—12 Feet	—per each
Item 906-22	Walk Gateways—4 Feet	—per each

SECTION 907

STONE FILL, RIPRAP AND STONE BLANKET

DESCRIPTION

907-1. General. This item shall consist of constructing stone fill, riprap and stone blanket as a fill or a protective slope covering, as called for on the plans, or as required.

MATERIALS

907-2. General. The stone to be used for stone fill, riprap or stone blanket shall consist of sound, durable rock which will not become disintegrated by the action of water or by exposure to the action of atmospheric elements. Either field stone or quarried rock suitable in all respects for the purpose intended, shall be used.

(a) Material for stone fill shall be stones which may vary in size from ten (10) pound stones upward to a maximum of five hundred (500) pounds.

(b) Material for riprap shall consist of stones weighing from ten (10) pounds to one hundred fifty (150) pounds, except that when available, suitable split stone weighing in excess of one hundred fifty (150) pounds may be used. At least fifty (50) per cent of the stones shall exceed fifty (50) pounds each.

(c) Stones for stone blanket shall all weigh more than three hundred (300) pounds each.

CONSTRUCTION METHODS

907-3. Stone Fill. Material for "Stone Fill" shall be deposited to make a compact mass. The exposed slopes shall be finished to line and grade without special handling or hand work except, when hand-laid riprap face or slope is required such finishing of the slope will be in accordance with the item involved.

907-4. Riprap. Material for "Riprap" shall be placed upon a slope not steeper than the natural angle of repose of the filling material. When required, the bottom of the riprap shall be placed in a trench at the toe of the slope. When "Plain Riprap" is required, it shall be placed without special hand work and shall be approximately true to the required slope line and grade, and shall be uniform in appearance.

When "Hand Laid Riprap" is required, the face or outer course of the slope or embankment, to the depth indicated on the plans, shall be of random rubble hand laid to secure

interlocking of all face stones and stones placed as backing. The larger stones shall be laid at the base of the slope. The stones shall be laid in close contact and so as to break joints, and their longer axis shall be perpendicular to the face of the slope. After the slopes are completed, joints shall be filled with spall or gravel and rock securely rammed into place.

907-5. Stone Blanket shall in general be placed for protection purposes around piers or abutments, as shown on the plans. The stones shall be placed individually by a derrick or other approved means. They shall be placed in such manner as to form a reasonably compact mass. Spaces between the larger stones shall be filled with stone of suitable size or spall firmly rammed to leave an even surface conforming to the contour required.

METHOD OF MEASUREMENT

907-6. The quantity of the items in this section to be measured for payment shall be the number of cubic yards of material, measured in place in accordance with the plans, completed and accepted.

BASIS OF PAYMENT

907-7. All work done under this section will be paid for at the contract unit price per cubic yard, which payment shall be full compensation for furnishing all materials, for loading, hauling, and placing; for all equipment, tools, labor and all incidental work necessary to complete the item, except that earth excavation required for the trench at the toe of the slope will be paid for under Item 204-10, "Structural Earth Excavation—Drainage". When this item does not appear in the contract, such earth excavation will be paid for under Item 204-12, "Structural Earth Excavation—Abutments and Retaining Walls".

SUMMARY OF ITEMS FOR PAYMENT

Item 907- 8	Stone Fill	—per cubic yard
Item 907- 9	Plain Riprap	—per cubic yard
Item 907-10	Hand Laid Riprap	—per cubic yard
Item 907-11	Stone Blanket	—per cubic yard

SECTION 908

LOAM

DESCRIPTION

908-1. General. This item shall consist of placing loam, or topsoil, for seeding or sodding as called for on the plans, or as authorized.

MATERIAL

908-2. General. The loam shall be of an approved quality topsoil. It shall be free from gravel, roots, clods, stones or other material which would tend to form air pockets in the soil. The use of sour loam or muck will not be permitted. Prior to stripping the loam, the Contractor shall remove grass, briars, stumps or roots by mowing, grubbing or other satisfactory means.

CONSTRUCTION METHODS

908-3. General. Loam shall be classified as either "Loam Borrow" which shall be obtained from approved sources outside the highway right of way limits, or "Loam Excavation" which shall be obtained from approved areas within the limits of improvement.

908-4. Preparing Areas. All slopes and other areas where loam is required, shall be trimmed and shaped to the required sub-grade of the area. Before placing the loam, the prepared areas shall be scarified or loosened to a depth of at least two (2) inches by harrows, pulverizers or other means.

908-5. Placing Loam. Loam shall be spread on the prepared areas to the uniform depth shown on the plans or as directed. After spreading, all existing lumps or clods shall be broken up and all rocks over two (2) inches in diameter, and roots, litter or foreign matter shall be raked up and disposed of. When the loamed area is to be seeded and is also adjacent to an existing lawn all rocks over one (1) inch in size shall be removed by raking or by other approved methods, and the material shall be compacted by rolling with a suitable lawn roller. All compacted loamed surfaces shall conform to the required lines, grades and cross sections.

When loam is spread, upon which sod is to be placed, the material shall be spread to the required depth, rocks exceeding two (2) inches shall be raked up, together with undesirable roots and debris and disposed of. The loam need be only

roughly shaped since in placing sod the material shall be adjusted to give the desired finished elevation and cross section of the sod surface. Any excess of loam remaining in stock piles, after completion of loaming all required areas, shall be trimmed or levelled to present a neat appearance as directed.

METHOD OF MEASUREMENT

908-6. The quantity of loam to be measured for payment shall be the number of cubic yards of acceptable material actually used as required. This shall be measured in its original position, before and after stripping the topsoil, by the cross-sectional method and the volume computed by average end areas. When small quantities of "Loam Borrow", not exceeding one hundred (100) cubic yards for a single project, are involved, and it is impracticable to measure the amount by the above method, the quantity may be measured in vehicles at the point of delivery, or measured in place. When measured in vehicles, the amount to be measured for payment shall be 90% of the quantity as determined from amounts shown on "Delivery Slips", specified in Article 401-9; when measured in place, the amount to be measured for payment shall be 100% of the quantity.

BASIS OF PAYMENT

908-7. All work done under this item will be paid for at the contract unit price per cubic yard, which payment shall be full compensation for all material; for loading, hauling, and placing; for all equipment, labor, tools and all incidentals necessary to complete the work.

For "Loam Excavation", payment shall also include full compensation for stockpiling, reloading and all incidental work.

SUMMARY OF ITEMS FOR PAYMENT

Item 908-8	Loam Excavation	—per cubic yard
Item 908-9	Loam Borrow	—per cubic yard

SECTION 909

SODDING

DESCRIPTION

909-1. General. This item shall consist of furnishing and placing approved live sod on a bed of suitable soil for the protection of slopes and ditches as called for on the plans or authorized.

MATERIALS

909-2. General. Sod shall, in general, be obtained from sources having soils of the same type as the base soil over which it is to be placed, except that sod from light sandy soils will not be acceptable. The sod to be placed upon sandy soils shall be taken from a sandy loam soil source. Further, the sod soil shall be of such character and moisture content that the sod will not break up or crumble during the operations of cutting, transporting or laying. All sod shall be approved in its original location before cutting.

The sod shall consist of a dense, well-rooted growth of perennial and desirable grasses, indigenous to the general locality where it is to be used and shall be free from noxious weeds.

Wooden pegs shall have a minimum cross section area of one (1) square inch and a minimum length of twelve (12) inches.

CONSTRUCTION METHODS

909-3. Cutting and Transporting Sod. The sod bed or area from which the sod is to be cut shall be mowed at least twice before the sod cutting begins. Mowing shall be by means of lawn mowers or other approved equipment at intervals of one week between mowings. Cutting of sod shall not be started until at least one week after the second mowing. The sod shall be cut in strips having a minimum width of twelve (12) inches and length of not less than eighteen (18) inches. The sod shall be cut to a uniform thickness of not less than two (2) inches.

The sod shall be freshly cut by means of an acceptable sod cutter and transported to the area to be sodded in an unbroken condition.

Storage of sod will not be permitted and it shall be placed in final position immediately after cutting. Sod shall be loaded and unloaded by hand.

909-4. Laying Sod. The sod shall be moist and shall be laid on a moist soil bed of loose loam. The sod shall be carefully placed by hand in rows at right angles to the slopes, commencing at the base of the area to be sodded and working upward.

The bottom edges of sodded areas shall extend at least two (2) inches into the ground or ditch bottom. All other edges of sodded areas shall be turned into the ground and covered with a layer of topsoil at least two (2) inches in depth, which

shall be thoroughly compacted to conduct the surface water over the edge of the sod.

The transverse joints of sod strips shall be broken and the sod carefully laid to produce tight joints. Any spaces left between sod strips shall be filled with loam. Where the sod may be displaced during sodding operations, the workmen shall work from ladders or treaded planks.

The sod shall be firmly compacted by tamping with an approved tamper immediately after a workable area has been placed.

After tamping, the sod surface shall present a smooth, even surface free from bumps and depressions and true to line, grade and cross-section. On slopes steeper than three (3) horizontal to one (1) vertical, the sod shall be pegged with wooden pegs. The pegs shall be spaced not over two (2) feet apart in any direction and 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 satisfactorily 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.

METHOD OF MEASUREMENT

909-5. The quantity of sodding to be measured for payment shall be the area in square yards measured along the slope, satisfactorily sodded as required and accepted.

BASIS OF PAYMENT

909-6. All work done under this item will be paid for at the contract unit price per square yard, which payment shall be full compensation for all material; for cutting, loading, hauling and placing; for all equipment, tools, labor and all incidentals necessary to complete the work.

ITEMS FOR PAYMENT

Item 909-7 Sodding —per square yard

SECTION 910

SEEDING

DESCRIPTION

910-1. General. This item shall consist of applying fertilizer and grass seed to unsodded loamed areas shown on the plans or authorized.

MATERIALS

910-2. Fertilizer. Commercial fertilizer for seeding shall be 10-10-10 grade containing at least ten (10) per cent available nitrogen, ten (10) per cent readily available phosphoric acid and ten (10) per cent total available potash. The fertilizer shall be supplied in unopened bags with the weight, contents and guaranteed analysis shown thereon or on a securely attached tag.

910-3. Seed. There shall be two classes of seed mixture, "Roadside Mixture" and "Park Mixture".

All seed shall be certified as to mixture, germination and purity, as being in conformity with the following requirements: All seed shall be from the previous year's crop, each type of seed shall have a percentage of germination not less than eighty (80), a percentage of purity of not less than eighty-five (85) and shall have not more than one (1) per cent weed content.

The seed mixtures shall consist of seeds proportioned by weight as follows:

Roadside Mixture		Park Mixture	
Canada Blue Grass	20%	Kentucky Blue Grass	50%
Red Top	15%	Red Top	25%
Orchard Grass	15%	Canada Blue Grass	10%
Alsike Clover	5%	Dwarf White Clover	10%
Domestic Rye Grass	20%	English Rye Grass	5%
Sheeps Fescue	25%		

CONSTRUCTION METHODS

910-4. Preparing the Soil. After the areas to be seeded have been loamed and brought to grade under Section 908, "Loam", the soil shall be brought to a friable condition by harrowing or otherwise loosening and mixing it to a depth of at least four (4) inches before fertilizing.

910-5. Fertilizing. The commercial fertilizer shall be applied to the soil by means of a mechanical spreader or other approved method which is capable of maintaining a uniform

rate of application. The fertilizer (10-10-10) shall be applied at the rate of twenty-five (25) pounds per one thousand (1,000) square feet of area. When other commercial fertilizers are used as authorized above, the application shall provide a minimum amount of the basic ingredients as specified for the 10-10-10 fertilizer. Fertilizer shall be thoroughly harrowed, raked or otherwise mixed satisfactorily with the soil to a depth of not less than one (1) inch. Fertilizing shall be done when the soil is in a moist condition and at least twenty-four (24) hours before sowing the seed.

910-6. Sowing Seed. Grass seed of the required mixture and quality shall be sown by a mechanical seeder or other method which will sow a uniform quantity as required over the whole area to be seeded. The mechanical seeder shall be capable of being operated to avoid the growth of grass in rows. The application of the seed shall be in the amount of three (3) pounds per one thousand (1,000) square feet.

Seeding shall be done when the air is calm and between the dates of April 15 and June 15 or August 15 and October 1. Seeding between June 15 and August 15 shall be avoided.

After seeding all areas shall be lightly raked by hand to mix the seed and loam and to smooth the surface. Lawn areas shall then be rolled with a light lawn roller.

When dry periods occur during the allowable dates for seeding, the Contractor shall apply sufficient water to the area to satisfactorily maintain the moisture content of the soil to allow proper germination of the seed and growth of the grass.

METHOD OF MEASUREMENT

910-7. The quantity of seeding to be measured for payment shall be the area measured along the slope of the ground, in units of one thousand (1,000) square feet of area satisfactorily seeded as required.

BASIS OF PAYMENT

910-8. All work done under this item will be paid for at the contract unit price per unit, which payment shall be full compensation for furnishing fertilizer, seed and all materials; for planting, raking, rolling and for all labor, equipment and all incidental work necessary to complete the work.

SUMMARY OF ITEMS FOR PAYMENT

Item 910- 9	Seeding—Roadside Mixture	—per unit
Item 910-10	Seeding—Parkway Mixture	—per unit

SECTION 911

SLOPE CHECKS

DESCRIPTION

911-1. General. This item shall consist of installing boards on slopes supported by stakes to hold loam and/or sod from sliding until a bond is formed with the subsoil sufficient to hold the slope as called for on the plans or required.

MATERIAL

911-2. General. The boards shall be one (1) inch by six (6) inch sound, undressed Pine, Hemlock or Spruce free from large knots or cracks.

The stakes shall be of sound, soft or hard wood, undressed to size two (2) inches by two (2) inches by thirty (30) inches long and shall be pointed. Nails shall be at least eight (8) penny common wire.

CONSTRUCTION METHODS

911-3. General. The boards shall be placed on edge with the faces at right angles to the slope and at the location required. The top edge of the board shall be at an elevation flush with the slope surface after loam or sod has been placed and compacted.

Wooden stakes shall be placed along the lower side of the board at intervals not exceeding four (4) feet. Boards shall be long enough to extend by two spaces, and splices in the boards shall occur at locations where stakes are driven. Each stake shall be driven flush with the top of the board and nailed securely to each board by at least two (2) nails.

METHOD OF MEASUREMENT

911-4. The quantity of "Slope Checks" to be measured for payment shall be the length in linear feet actually placed, completed and accepted, measured continuously along the top, or surface, line of the boards.

BASIS OF PAYMENT

911-5. All work done under this section will be paid for at the contract unit price per linear foot, which payment shall be full compensation for furnishing all material, equipment, tools, labor and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 911-6 Slope Checks —per linear foot

SECTION 912

HAY MULCH

DESCRIPTION

912-1. General. This item shall consist of covering slopes and other designated areas with a mulch of hay conforming to the requirements of this section.

MATERIALS

912-2. General. Acceptable mulch material shall be low-grade hay or straw. Better-grade hay or straw may be used if approved.

CONSTRUCTION METHODS

912-3. General. Upon the prepared areas to be mulched as shown on the plans, or as required, the hay mulch shall be spread to the required depth. The loose depth of this layer shall be from four (4) to six (6) inches as directed. The layer shall uniformly cover the entire area and shall be spread by hand. Hay mulch shall be anchored in place by means of a light covering of loam, except other means that will keep the hay in place, without being objectionable to the appearance and future development and maintenance of the area may be used if approved.

METHOD OF MEASUREMENT

912-4. The quantity of "Hay Mulch" to be measured for payment shall be the number of tons (2,000 pounds) of dry material required and acceptably placed.

BASIS OF PAYMENT

912-5. All work done under this item will be paid for at the contract unit price per ton, which payment shall be full compensation for furnishing and spreading the material, for all equipment, labor, anchoring material, tools and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 912-6 Hay Mulch —per ton

SECTION 913

BITUMINOUS SLOPE STABILIZATION

DESCRIPTION

913-1. General. The work to be done under this section shall consist of applying bituminous material to previously seeded slopes where indicated on the plans or where required.

MATERIAL

913-2. The bituminous material shall meet the requirements for "Emulsified Asphalt", Section 503, and shall be diluted with additional water in the ratio of one (1) part water to two (2) parts emulsified asphalt.

CONSTRUCTION METHODS

913-3. General. Upon the prepared slopes the diluted mixture of emulsified asphalt shall be applied at the rate of approximately twenty-five hundredths (0.25) gallon per square yard with an approved pressure distributor as required in Section 503.

The application of asphalt shall be made not later than the third day after the slope has been seeded.

METHOD OF MEASUREMENT

913-4. The quantity of "Bituminous Slope Stabilization" to be measured for payment shall be the number of gallons of undiluted emulsified asphalt as shown by "Delivery Slips", Article 401-9.

BASIS OF PAYMENT

913-5. This work will be paid for at the contract unit price per gallon for "Bituminous Slope Stabilization", which payment shall be full compensation for obtaining the material, hauling, mixing, heating, and applying; for furnishing all labor, equipment, tools and all other incidentals, including the addition of water, necessary to complete the work.

ITEM FOR PAYMENT

Item 913-6 Bituminous Slope Stabilization —per gallon

SECTION 914

PROJECT MARKERS

DESCRIPTION

914-1. General. This item shall consist of constructing and placing, or placing only, project markers as required on

the plans and/or called for in the Proposal in conformity with the plans and these specifications.

MATERIAL

914-2. **General.** The portland cement concrete for project markers shall conform to the requirements of Section 701, "Portland Cement Concrete", Class "Y". The concrete shall be satisfactorily rubbed.

The steel used shall comply with the requirements of Section 705, "Reinforcing Steel".

CONSTRUCTION METHODS

914-3. **General.** The project markers shall be of precast portland cement concrete with steel reinforcing, all in conformity with the dimensions shown on the plans.

The letters and numerals designating the project shall be placed on the face authorized by the Engineer and shall be indented into the concrete by beveled castings attached to the forms before pouring the concrete. Such indented markings shall have a minimum depth of one-quarter ($\frac{1}{4}$) inch below the face of the marker. All letters and numerals shall be painted with 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, with the project markings facing toward the project. They shall be set in a vertical position extending four (4) feet into the ground and shall be securely tamped in place.

METHOD OF MEASUREMENT

914-4. The quantity of "Project Markers" to be measured for payment shall be the number of markers complete in place and accepted.

BASIS OF PAYMENT

914-5. All work done under this section will be paid for at the contract unit price each, complete in place, or setting only as called for in the Proposal as follows:

(a) When "Project Markers" is required in the Proposal, payment shall be full compensation for supplying the marker, placing at the required location, and for all materials, excavation (except solid ledge rock), backfilling, equipment, labor, tools and all incidental work.

(b) When "Project Markers—Setting Only" is required in the Proposal the marker shall be supplied by the State at the project site, and payment shall be full compensation for

placing at the required location, and for all materials, excavation (except solid ledge rock), backfilling, equipment, labor, tools, and all incidental work.

Excavation for placing project markers in solid ledge rock will be paid for under Item 204-11, "Structural Rock Excavation—Drainage" and allowance for marker holes will be made for holes two (2) feet in diameter for the depth of rock actually removed.

SUMMARY OF ITEMS FOR PAYMENT

Item 914-6	Project Markers	—each
Item 914-7	Project Markers—Setting Only	—each

SECTION 915

RIGHT OF WAY MONUMENTS

DESCRIPTION

915-1. **General.** This item shall consist of furnishing and placing "Right of Way Monuments" at locations shown on the plans or required in conformity with the plans and these specifications.

MATERIALS

915-2. **General.** Monuments shall be of granite or of reinforced portland cement concrete. When of granite, they shall be of a quality conforming to the requirements of Section 901, "Granite Curb and Edging". When of portland cement concrete, they shall be of Class "Y" Concrete as specified in Section 701, "Portland Cement Concrete". The steel used shall conform with the requirements of Section 705, "Reinforcing Steel".

Monuments shall be not less than five and one-half ($5\frac{1}{2}$) inches square and at least five (5) feet in length. The tops of the monuments shall have the letter "H" cut or cast into them together with a center hole, all as shown on the plans.

CONSTRUCTION METHODS

915-3. **General.** Monuments shall be placed in vertical positions and the backfill shall be firmly tamped around the monument in layers not exceeding one (1) foot in depth, loose measure.

Monuments shall be set with two sides parallel with the roadway centerline and at depths determined by the Engineer to meet local conditions of the usage of the ground into which the monument is to be set.

When a monument is set in ledge rock, a hole shall be excavated to the depth of one (1) foot in the ledge, and the hole around the monument to the top of the ledge shall be grouted with portland cement mortar as specified in Section 701, "Portland Cement Concrete". A monument set in ledge may be shortened as required.

METHOD OF MEASUREMENT

915-4. The quantity of "Right of Way Monuments" to be measured for payment shall be the number of individual monuments complete in place and accepted.

BASIS OF PAYMENT

915-5. All work done under this section will be paid for at the contract unit price per each, which payment shall be full compensation for all excavation (except solid ledge rock), material, equipment, labor, tools and all incidental work necessary to complete the item.

Excavation in solid ledge rock will be paid for under Item 204-11, "Structural Rock Excavation—Drainage" and allowance will be made for holes two (2) feet in diameter for the depth of rock actually removed.

ITEM FOR PAYMENT

Item 915-6 Right of Way Monuments —each

SECTION 916

UNDERDRAIN OUTLET MARKERS

DESCRIPTION

916-1. General. This item shall consist of furnishing and placing wood posts in the ground beside the outlet end of underdrains when required.

MATERIAL

916-2. General. Posts shall be of wood conforming to the requirements of Article 905-2, "Wood Posts" for Guard Rail. Round posts having a six (6) inch minimum diameter shall be used.

CONSTRUCTION METHODS

916-3. General. Marker posts shall be erected, treated, and painted as required for guard rail posts used on the same project and shall conform in appearance.

The length of marker posts shall be the same as required for guard rail posts, and they shall be set into the ground a minimum depth, as required in Section 905, "Guard Rail".

METHOD OF MEASUREMENT

916-4. The quantity of "Outlet Markers" to be measured for payment shall be the number of individual posts furnished and erected as required and accepted.

BASIS OF PAYMENT

916-5. All work done under this item will be paid for at the contract unit price each for "Underdrain Outlet Markers" which payment shall be full compensation for all material, labor, equipment, tools and all incidentals necessary to complete the work.

ITEM FOR PAYMENT

Item 916-6 Underdrain Outlet Markers —each

SECTION 917

TRAFFIC OFFICERS

DESCRIPTION

917-1. General. This item consists of furnishing sworn traffic officers, when authorized, where one-way traffic is required during the construction of the following items: Crushed Stone Base, Bituminous Macadam Base, Bituminous Concrete Base, Cement Concrete Base, Bituminous Gravel Surface, Bituminous Macadam Surface, Bituminous Concrete Surface, or Portland Cement Concrete Pavement.

SPECIAL REQUIREMENTS

917-2. Officers. All traffic officers working under the requirements of this section shall be sworn officers and shall have police powers granted by the proper authorities. Officers shall be supplied with suitable badges, which shall be worn in a conspicuous place on their person. They shall be acceptably attired, preferably in uniform.

917-3. Traffic Control. Suitable facilities to best expedite the flow of traffic shall be furnished the Traffic Officers by the Contractor. Methods used shall be authorized for individual projects and special situations.

When portland cement concrete base or pavement is being constructed, officers shall control traffic with the aid of a

telephone system or by radio field sets furnished by the Contractor.

METHOD OF MEASUREMENT

917-4. The quantity of "Traffic Officers" to be measured for payment shall be the number of man hours of this item, authorized as required, and accepted.

BASIS OF PAYMENT

917-5. This item will be paid for at the contract unit price per man hour, which payment shall be full compensation for furnishing all equipment, labor, and all incidentals necessary for this item.

ITEM FOR PAYMENT

Item 917-6 Traffic Officers —per man hour

SECTION 918

PLANK CURB

DESCRIPTION

918-1. General. This item consists of constructing a plank curb, with outlets as required, along guard rail sections where called for on the plans or as authorized.

MATERIALS

918-2. Plank. The plank curb shall be constructed of two (2) inches thick by ten (10) inches wide, sound, seasoned spruce or hemlock plank.

918-3. Preservative Oil. This material shall conform to the requirements of Article 905-3, "Preservative Oil", for Guard Rail.

CONSTRUCTION METHODS

918-4. Curb. Plank shall be placed on the inside of the guard rail posts in accordance with the design shown on the plans, or as directed by the Engineer. The planks shall be fastened together at the ends with splices ten (10) inches wide by two (2) inches thick by eighteen (18) inches long. The splice shall be placed on the back side of the curb and shall be secured to each curb plank by five (5) spikes sufficiently long to extend through both plank and splice and be clinched on the back. The plank shall bear on the posts but shall not be fastened to them.

918-5. Baffle Wall. At curb outlets a baffle wall shall be constructed of plank of the dimensions and design shown on

the plans. This wall shall be securely fastened to the curb by splices as specified for the plank curb. There shall be no space between the curb and the baffle wall.

918-6. Shoulder. The surface of the shoulder from the inside of the plank curb to the edge of the pavement shall be finished with a course of bituminous gravel surfacing or bituminous concrete surfacing, as called for on the plans or as authorized. This surface material shall be placed against the plank curb in a sloped section to cause the water to run along the shoulder at a distance of at least six (6) inches from the curb as shown on the plans. This shoulder shall be satisfactorily rolled or tamped to obtain the required degree of compaction, and shall be depressed at outlets to match the cut sections in the curb and outlet sluice.

METHOD OF MEASUREMENT

918-7. The quantity of this item to be measured for payment shall be the length in linear feet of curb placed, plus the length of baffle walls actually placed.

BASIS OF PAYMENT

918-8. All work done under this item will be paid for at the contract unit price per linear foot complete in place, which payment shall include full compensation for furnishing all materials, equipment, tools, labor and all incidental work necessary to complete this item. Payment for surfacing on the shoulder will be made under the respective surface item.

ITEM FOR PAYMENT

Item 918-9 Plank Curb —per linear foot

SECTION 919

METAL SLUICE

DESCRIPTION

919-1. General. This item shall consist of furnishing and installing half-circle bituminous coated metal sluice in conformity with these specifications, and as shown on the plans or as authorized.

MATERIALS

919-2. Metal Sluice. The sluice shall be composed of sixteen (16) gauge corrugated metal shaped to a half-circle

having a diameter of eighteen (18) inches. The corrugated metal and bituminous coating shall comply with the foregoing specifications for "Asphalt Coated Corrugated Metal Pipe". Two (2) inch wide flanges at the sides of the sluice shall be made either from the sluice material or of 2"x2"x $\frac{1}{8}$ " steel angles bolted to the sluice with three-eighths ($\frac{3}{8}$) inch bolts spaced approximately twelve (12) inches. Both flanges shall be punched with two (2) three-eighths ($\frac{3}{8}$) inch holes, three (3) inches center to center in the center of each two (2) foot length of sluice.

919-3. Stakes. The stakes shall be of spruce or hemlock 2"x6"x2'-6" and pointed on one end. They shall receive the same preservative treatment as specified for wood posts for guard rail.

CONSTRUCTION METHODS

919-4. General. A trench shall be excavated to provide a uniform firm bed, shaped to conform to the bottom of the sluice. Each metal sluice flange shall rest, for its full length, on 2"x4" Spruce or Hemlock rails and shall be attached to the rails by means of four (4) inch long spikes. Splices in the rails shall occur at the location of stakes and shall not occur opposite a splice in the rail on the other side of the sluice.

Stakes shall be driven, on each side, approximately six (6) feet apart measured on the axis of the sluice. The stakes shall be fastened to each rail with two four (4) inch long spikes.

The upper end of the sluice shall be fitted to the plank curb and the joint shall be tightly caulked with oakum. Excavated material shall be tamped firmly around the sluice. Excess material shall be disposed of as directed.

METHOD OF MEASUREMENT

919-5. The quantity of this item to be measured for payment shall be the length in linear feet of "Metal Sluice" measured along the center line of the sluice installed in place and accepted as specified.

BASIS OF PAYMENT

919-6. All work done under this item will be paid for at the contract unit price per linear foot, which payment shall be full compensation for all materials, labor, excavation, tools and all incidental work necessary to complete the item.

ITEM FOR PAYMENT

Item 919-7 Metal Sluice

—per linear foot

SECTION 920

CONCRETE BLOCK MASONRY

DESCRIPTION

920-1. General. "Concrete Block Masonry" shall consist of approved concrete blocks laid up in portland cement mortar, and shall be constructed in accordance with these specifications and in conformity with the dimensions and designs shown on the plans.

MATERIALS

920-2. Mortar. Sand, cement and water for use in mortar shall conform to the requirements of Section 701, "Portland Cement Concrete".

The mortar shall be composed of one (1) part portland cement and two (2) parts of sand and shall be machine mixed in an approved mixer for not less than one and one-half ($1\frac{1}{2}$) minutes after all ingredients are in the mixer.

Hydrated lime, conforming to the A.S.T.M. latest revised Standard Specifications C-6, to the extent of ten (10) percent, by volume of the cement, may be added to the mortar if directed. When used, hydrated lime shall be treated as an addition and not as replacing any of the cement. Mortar for pointing shall be composed of one (1) part of portland cement, ten (10) percent hydrated lime, and one (1) part sand.

When ready for use, the mortar shall be of an approved consistency which will support the block. Mortar shall be used within forty-five (45) minutes after mixing and retémpering of the mortar will not be permitted.

920-3. Concrete Blocks. The blocks shall be portland cement concrete hollow masonry units for wall construction.

The blocks shall be made from a mixture of portland cement and sand, gravel and/or crushed stone in such proportions and with such a process of manufacture that units meeting the requirements of this specification will be produced.

All units shall be sound and free from cracks or other defects that would interfere with the proper setting of the units or impair the strength or permanence of the construction.

920-4. General Requirements:

(a) Dimensions of the blocks shall be 8"x8"x16" with allowable tolerance of plus or minus three (3) percent.

(b) The thickness of all shells and webs shall be at least three-quarters ($\frac{3}{4}$) inch.

Load bearing units shall meet the following compressive strength requirements when tested:

Minimum thickness of shells*	Compressive strength, pounds per square inch of gross area	
	Average of 5 or more units	Individual minimum
1 $\frac{1}{4}$ inches or more.....	700	600
$\frac{3}{4}$ to 1 $\frac{1}{4}$ inches.....	1,000	800

*In determining the minimum thickness of the shells, only the outer shells of the units that will be parallel to the exposed surface of the wall shall be considered.

The absorption shall not exceed sixteen (16) pounds per cubic foot of concrete when tested. This requirement shall be waived when the units are used in construction not exposed to soil or weather and is so stated in the "Special Provisions".

The average percentage of moisture in the units at time of delivery shall not exceed forty (40) percent of the total absorption of the units when tested.

The tests shall be made in accordance with the requirements of The Standard Methods of Sampling and Testing Concrete Masonry Units (A.S.T.M. Designation C-140).

CONSTRUCTION METHODS

920-5. General. Concrete Block Masonry shall be laid by a competent mason and in a workmanlike manner. The blocks shall be laid with all horizontal joints being level and vertical joints truly plumb. Joints shall not exceed one-half ($\frac{1}{2}$) of an inch in thickness. Each course shall break joints with the courses above and below it by one-half the length of the block; half block to be used at ends as required. All blocks shall be cleaned and wetted just before being set. They shall be carefully laid in full beds of mortar and the vertical joints shall be completely filled with mortar at the time the block is set.

No blocks shall be cut or otherwise worked on the wall. In case any block is moved or the joint broken, the block

shall be taken up, the mortar cleaned from the bed and joints and the block reset in fresh mortar. All joints shall be pointed and neatly smoothed before initial set of the mortar shall have occurred.

Whenever blocks are laid in cold weather they shall be freed from snow, ice and frost by warming and the conditions involved in laying shall conform to the requirements for placing concrete in cold weather, as specified under Section 701, "Portland Cement Concrete".

Masonry laid in hot or dry weather shall be protected from the sun and kept moist for at least three (3) days after laying.

METHOD OF MEASUREMENT

920-6. The quantity of "Concrete Block Masonry" to be measured for payment shall be the number of concrete blocks required and remaining in the masonry structure.

BASIS OF PAYMENT

920-7. "Concrete Block Masonry" will be paid for at the contract unit price per unit of one thousand blocks, which payment shall be full compensation for all blocks, mortar, equipment, tools, labor and all incidentals necessary to complete the work except that excavation required by this work shall be paid for under Section 204, "Structural Earth Excavation—Drainage".

ITEM FOR PAYMENT

Item 920-8 Concrete Block Masonry —per unit

SECTION 921

BRICK MASONRY

DESCRIPTION

921-1. General. "Brick Masonry" shall be composed of approved brick laid up in portland cement mortar and shall be constructed in accordance with these specifications and in conformity with the dimensions and designs shown on the plans.

MATERIALS

921-2. Mortar shall conform to the requirements of Article 920-2, "Mortar" except that Brixment or similar approved patented brick cement may be substituted for portland cement and Hydrated Lime if approved by the Engineer.

921-3. Brick. The brick shall be new, well formed whole brick of the best quality, burned hard entirely through, free from injurious cracks and flaws, tough and strong, and shall have a clear ring when struck together. No salmon colored, light burned, soft or twisted brick shall be used.

CONSTRUCTION METHODS

921-4. General. Unless otherwise specified all brick work shall be laid up "Common Bond" for walls and "Chimney Bond" for chimneys, with all horizontal joints truly level and all vertical joints truly plumb. Joints shall not exceed one-half ($\frac{1}{2}$) inch in thickness if portland cement and Hydrated Lime Mortar is used, nor more than three-eighths ($\frac{3}{8}$) inch in thickness if "Brixment" Mortar is permitted. All brick shall be wetted before laying. They shall be laid in a full bed of mortar on the foundation or brickwork already in place and all vertical joints completely filled at the time the brick is set. Struck weather joints shall be used unless otherwise specified. Every fifth course shall consist of alternate header and stretcher brick. All walls shall be a solid mass of brick and mortar, walls of a thickness greater than eight (8) inches shall have the space between inside and outside rows of brick completely filled with whole or broken brick slushed into place with mortar.

Exterior faces of walls shall be plumb and all corners and openings square. Interior faces may be battered as deemed proper to meet existing conditions. Bottom thickness of wall to be full width of foundation or of a width specified by the Engineer. Top thickness to be such as to provide full bearing for the sill or other structural member to rest upon it.

No structure shall be set nor any weight placed upon brick masonry until at least forty-eight (48) hours has elapsed after its completion.

METHOD OF MEASUREMENT

921-5. The quantity of "Brick Masonry" to be measured for payment shall be the number of bricks required and remaining in the masonry structure.

BASIS OF PAYMENT

921-6. "Brick Masonry" will be paid for at the contract unit price per unit of one thousand bricks, which payment shall be full compensation for all brick, mortar, equipment, tools, labor, and all incidentals necessary to complete the work, except that excavation required by this work shall be

paid for under Section 204, "Structural Earth Excavation—Drainage".

ITEM FOR PAYMENT

Item 921-7 Brick Masonry —per unit

SECTION 922

MOLDED FIBER SANITARY PIPE

DESCRIPTION

922-1. General. This item shall consist of furnishing molded fiber pipe of standard make of the sizes and dimensions required, and installing such pipe at places designated on the plans or by the Engineer and in conformity with the lines and grades given.

MATERIALS

922-2. General. Molded fiber sanitary pipe shall consist of sound, heavy weight double thick or double strength pipe free from any defects, or flaws, including all necessary couplings and joint cement.

CONSTRUCTION METHODS

922-3. General. All trenches and beds shall be prepared true to the lines and grades shown on the plans or given by the Engineer. Recesses shall be excavated to receive the couplings at each joint. The inside of the coupling shall be painted with the joint cement specified by the manufacturer of the pipe and the section of pipe to be added shall be immediately driven to a full, tight bearing, care being taken not to crack or damage the pipe or coupling in so doing.

The filling around the pipe shall be made in nine (9) inch layers with approved material free from large stones, sods, or other material which would prevent the backfill from being thoroughly compacted, and each layer shall be tamped thoroughly around and over the pipe.

The first layer of filling shall contain no stones or other material which might puncture or otherwise injure the pipe and care shall be taken in the tamping to prevent damage to the pipe of any nature whatsoever.

METHOD OF MEASUREMENT

922-4. The amount of "Molded Fiber Sanitary Pipe" to be measured for payment shall be the actual length of pipe laid in place and accepted.

BASIS OF PAYMENT

922-5. All work done under "Molded Fiber Sanitary Pipe" will be paid for at the contract unit price per linear foot for the respective size of pipe installed, which payment shall include full compensation for all materials, equipment, pipes, joints, labor, hauling and placing and all incidentals necessary to complete the work, except that excavation, including backfilling, shall be paid for under Section 204, "Structural Earth Excavation—Drainage".

ITEM FOR PAYMENT

Item 922-6 4" Molded Fiber Sanitary Pipe—per linear foot
Item 922-7 6" Molded Fiber Sanitary Pipe—per linear foot

SECTION 923

SEPTIC TANK AND DISPOSAL BED

DESCRIPTION

923-1. General. This item shall consist of furnishing an asphalt coated septic tank conforming to these specifications and of the size specified, and installing the same at such place as may be designated on the plans or by the Engineer, together with the construction of a disposal bed as herein-after described and located as shown on the plans or as directed.

In addition to these specifications this work shall conform to State or Local Laws or Ordinances.

MATERIALS

923-2. Septic Tank. The Septic Tank shall be of steel with properly designed inlet and outlet connections and baffles, with a tight fitting cover, and completely coated both inside and outside with asphalt after all welding of joints has been completed.

923-3. Vitrified Clay or Molded Fiber Pipe.

(a) Vitrified Clay Pipe shall conform to the requirements of "Vitrified Clay Pipe", Section 604.

(b) Molded Fiber Pipe shall conform to the requirements of "Molded Fiber Sanitary Pipe", Section 921.

CONSTRUCTION METHODS

923-4. General.

(a) *Installing Septic Tank.* The specified Septic Tank shall be installed at the location and grade shown on the

plan or given by the Engineer. The bed on which the tank is set shall be smooth and level. The tank shall be lowered into place by such method as to prevent scarring, scratching, or otherwise disturbing the asphalt coating. If the asphalt coating is disturbed all damaged portions shall be painted with an approved asphaltic paint which shall be allowed to dry before any backfill shall be placed. Before inlet or outlet pipes are connected the excavation for the tank shall be backfilled in accordance with the requirements for "Backfill", Section 206, to the level of the inlet and outlet. After inlet and outlet pipes have been installed and approved the remainder of the backfill shall be placed in a similar manner.

(b) *Connecting Inlet with Sanitary System of Structure and Installing Outlet.* This shall consist of furnishing and installing the specified amount of the type and size of pipe called for, in accordance with the requirements for the pipe called for, and in the locations and grades as required by the plans or given by the Engineer.

(c) *Disposal Bed.* This work shall consist of furnishing and installing at the location and grades shown on the plans, or as given by the Engineer, of the necessary length of Absorption Trench fully conforming to the Standard Design, Maine Department of Health and Welfare, Division of Sanitary Engineering. Length of Absorption Trench to be determined by the size of septic tank to be served and the type of soil encountered. All lumber in Absorption Trench is to be completely coated with creosote oil or asphaltic paint after being cut and fitted and outlet notches have been made and before being fastened together.

METHOD OF MEASUREMENT

923-5. Septic Tanks shall be considered as a unit for each tank supplied and placed. Inlet and outlet pipe will be measured according to the provisions of the sections covering the type of pipe used. Absorption Trench shall be measured by the lineal foot of completed and accepted Trench.

BASIS OF PAYMENT

923-6.

(a) *Septic Tank:* When called for in the Contract on a Unit Price basis, a lump sum payment in the amount bid shall be paid for furnishing and installing the Septic Tank. This shall include the tank itself and all transportation, equipment, labor, materials and all incidental work to complete the installation of the tank.

(b) *Inlet and Outlet Pipes and Absorption Trench:* When called for in the contract on a unit price basis, pipe will be paid for at the unit prices for the type and size of pipe specified or used; Absorption Trench will be paid for at the unit price per lineal foot for Absorption Trench, complete in place, which price shall be full compensation for furnishing gravel, all materials, equipment, tools, labor and incidentals necessary to complete the work (including excavation and disposal of surplus material).

ITEM FOR PAYMENT

Item 923-7	Septic Tank	—per lump sum
Item 923-8	Absorption Trench	—per linear foot

SECTION 924

WOOD POST FOUNDATIONS

DESCRIPTION

924-1. *General.* This work shall include furnishing and installing the wood posts for foundation of buildings as shown on the plans in conformity with these specifications.

MATERIALS

924-2. *General.* Wood posts shall be of peeled cedar or hackmatack of the length specified and shall have a minimum diameter of six (6) inches at the small end. All posts shall be sound and straight, well seasoned and free from any defects or weakening knots. All knots shall be trimmed flush. Square sawed posts not less than six (6) inches on a side may be used at the option of the Contractor.

CONSTRUCTION METHODS

924-3. *General.* The posts shall be placed at the locations shown on the plans or as otherwise specified and shall be plumb. The tops and bottoms shall be sawed square to provide full bearing. Where called for the posts shall be set upon flat bearing stones or blocks. The tops shall be firmly spiked to the bearing timber which they support with not less than two twenty penny (20d) spikes. The posts shall be given a full coat of asphalt paint or creosote oil for such length that such coating shall extend from the bottom to at least six (6) inches above the finished ground grade. Wood post foundations may be required to be cross-braced to insure stability.

METHOD OF MEASUREMENT

924-4. "Wood Posts" for foundations shall be measured for payment for each post satisfactorily supplied and placed as required.

BASIS OF PAYMENT

924-5. "Wood Posts" will be paid for at the contract unit price each, which price shall be full compensation for all excavation, materials, equipment, bracing, tools, labor, and all incidental work necessary to complete this item.

ITEM FOR PAYMENT

Item 924-6	Wood Posts	—per each
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SECTION 925

MOVING, RAISING OR ALTERING BUILDINGS

DESCRIPTION

925-1. *General.* This item shall consist of moving (including altering), raising (including altering) or altering buildings in accordance with the plans and specifications and as directed.

MATERIALS

925-2. *General.* All materials not covered by the requirements of other Sections or by the Special Provisions shall be new first quality, standard products made by a reputable manufacturer and shall fully meet commonly accepted standards or specifications for such materials.

925-3. *Timbers.* When called for on the plans, or specified, timbers shall be new or used spruce or hemlock, sound and well seasoned, free from defects and excessively large, loose, or weakening knots, without warp or twist, square sawed and of full dimensions throughout their length. Timbers to be placed under bending stress shall be straight grained and free from knots larger than one (1) inch in diameter.

925-4. Doors, Windows, and Frames.

(a) *Doors:* All doors shall conform to the Commercial Standard Specification CS 120-46 of the National Door Manufacturers Association. The doors shall be of the size, thickness and grade specified and shall be of the pattern specified or which matches existing doors in the building in which they are to be installed. Hardware shall be standard make and as specified. All hinges shall be loose pin Butt Hinges

unless otherwise specified. 3" x 3" Butts for interior doors, 4"x4" Butts for exterior doors. Locks to be of type specified.

(b) *Windows and Sash:* All windows and sash shall conform to the National Door Manufacturer's Association Standards for Ponderosa Pine Stock Windows, Sash and Screens of the size and grade specified. Design of sash shall be as specified or conform to the type of sash existing in the building in which it is to be installed. All necessary hardware and weights of standard manufacture shall be furnished. Hardware shall match existing hardware in the building.

(c) For both doors and windows there shall be furnished all necessary frames, exterior and interior finish, flashing and all incidental materials necessary for proper installation. Exterior and interior finish and trim shall match existing finish and trim.

(d) All glass in doors and windows shall be bed puttied unless otherwise specified.

(e) Paint or varnish finish shall match existing paint or varnish finish of existing doors and windows and shall be of a first quality product of a recognized manufacturer. A particular brand and type of paint or varnish may be specified to conform to the finish existing.

(f) All hardware to be equal to that manufactured by Yale & Towne or Corbin.

925-5. Rollway Doors and Frames.

(a) *Lumber:* All lumber shall be straight, sound, well-seasoned spruce or pine (unless otherwise specified or allowed by the Engineer), dressed four sides, free from loose knots, shakes, or large pitch pockets and of the dimensions and types shown on plans.

(b) *Hardware:* All hinges, hooks, catches and locks to be equal to products by Yale and Towne or Corbin and of the sizes and types specified on the plans or in the Special Provisions. Nails, spikes and screws shall be of sizes and type specified on the plans.

(c) *Flashing:* Shall be as specified on the plans.

(d) *Paint:* Shall be a standard make, first quality exterior oil paint, of the color specified.

CONSTRUCTION METHODS

925-6. *General.* The methods used by the Contractor to perform this work shall be of his own choice but shall fulfill the following requirements:

(a) *Use and occupancy* shall be maintained to the owner or occupants at all times throughout the work. Ingress and egress shall be maintained by as reasonably convenient means as possible and shall be interrupted only as absolutely necessary. Use of lighting, cooking, heating, water, and sanitary facilities shall be maintained; interruption of their use to be only as absolutely necessary. The owner or occupants shall be given sufficient advance notice of such interruption and be informed of its probable duration. All such facilities as it may be necessary to disconnect shall be re-connected as speedily as possible. The Contractor shall make all necessary arrangements with public utility companies for any changes required in their facilities and shall pay all bills for work performed by such companies in making such changes.

(b) *The Safety and Stability* of the structure shall be maintained at all times. The Contractor shall be responsible to the owner for any and all damage to any portion of the structure caused by the performance of the work under this contract and shall restore such damaged portions to the full satisfaction of the owner. The work shall be performed in such manner that no undue strain shall be placed upon any portion of the building. Only screw type or hydraulic jacks will be permitted for the purpose of jacking or lifting operations and unless permission is given to move and/or raise portions of the building separately, the entire structure shall be lifted and/or moved as a unit.

Chimneys and any other appurtenances shall be safely supported throughout the operation and shall be set on proper foundations at the new location and shall be extended as necessary with proper materials. Extended chimneys shall be provided with a standard cleanout, suitably located and properly installed.

(c) *Sanitary Facilities* shall be provided as called for on the plans or in the Special Provisions and shall conform to all State and Local Laws and Ordinances.

(d) *Water Supply.* Where a public water supply exists the Contractor shall connect the piping in the house to said water supply. He shall make all arrangements and pay all bills as required under (a) above. This work shall include the furnishing of all materials called for or necessary, equipment, tools, labor and all incidental work necessary to complete this portion of the work satisfactorily and in full compliance with all State or Local Laws, Ordinances, Rules or Regulations. If the supply of water is to be from a drilled

or dug well and to be carried to the building in pipes the Contractor shall furnish proper size pipe sleeves and install them in the cellar wall at the location shown on the plan or specified by the Engineer.

(e) *Drains.* Cellar, sink, or other drains shall be installed as shown on the plans or as specified in the Special Provisions. Materials shall conform to the various Specifications contained herein, in the Special Provisions or to commonly accepted specifications for the material required.

925-7. Replacement of Timbers. All rotted or unsafe sills or bearing timbers shall be replaced in accordance with Article 925-3, "Timbers". Sound timbers shall be installed in a workmanlike manner and fastened with a sufficient number of spikes of a size to insure proper bearing strength. Drift pins or bolts shall be used if required. All vertical studding, corner posts, etc., shall be securely toenailed to the new timbers with not less than two ten-penny (10d) common nails.

925-8. Installation of Doors, Windows, Frames, Etc. When called for on the plans or in the Special Provisions these items shall be installed where required.

All doors and windows and frames shall be installed by competent workmen. The frames shall be provided with sufficient backing or bucks and sufficiently nailed and shimmed to prevent movement, warping or twisting out of position. Nails shall be the proper size finish nail set approximately one-eighth ($\frac{1}{8}$) inch below the finished surface. All frames shall be plumb throughout the entire height with all heads, thresholds and sills truly level. Care shall be taken to provide as close a fit of doors and windows as possible and still allow for opening and closing without binding or sticking. Two hinges shall be installed on interior doors and three hinges on exterior doors. Doors, windows, or frames to be varnished shall be sealed with a full coat of varnish cut down with an equal amount of pure gum spirits of turpentine. The second coat shall be clear varnish, flat or gloss as specified on interior work and first grade spar varnish on exterior work. Painted doors or windows shall first be sealed with pure raw linseed oil and then receive either two or three coats as specified or directed by the Engineer, paint to be thinned for prime and second coats according to the manufacturer's directions. Enameled doors or windows shall be sealed with pure raw linseed oil then prime coated with a mixture of half flat oil paint and half enamel. Final coat to be a full coat of unthinned enamel.

925-9. Installation of Rollway Doors and Frames.

(a) *Carpentry.* All work shall be performed by competent carpenters in strict accordance with the plans. Doors shall be built up as shown with all joints tight, edges square and true, battens and diagonal bracing screw fastened as shown. Timber sub-frame members shall be securely bolted as indicated on the plans. Top frame and drip members shall be solidly nailed to the timber sub-frame with ten penny (10-d) common nails of sufficient number to assure a tight fit and top frame shall be nailed at the outside edge to the drip member with six penny (6-d) common nails at approximately one (1) foot centers. Hardware shall be installed with the proper screws in a workmanlike manner.

(b) *Painting.* All work shall be painted two coats with the specified paint. Prime coat to be thinned according to the manufacturer's directions. Only pure Raw Linseed Oil and Gum Spirits of Turpentine shall be used as thinners. Knots and pitch streaks to be coated with orange shellac before any painting is done.

METHOD OF MEASUREMENT

925-10. "Moving (Including Altering) Buildings"; "Raising (Including Altering) Buildings"; and "Altering Buildings" to be measured for payment shall be the respective unit or units shown on the plans and called for in the Proposal.

BASIS OF PAYMENT

925-11. All work under "Moving, Raising, or Altering Buildings", will be paid for at the contract lump sum price, which payment shall be full compensation for all equipment, materials, tools, labor, and all incidentals necessary to complete the item in a satisfactory manner, compensation to include full payment for:

(a) Replacement of rotted or unsafe timbers.

(b) Installation of doors, windows, frames, etc.

(c) Installation of Rollway Doors and frames, all when specifically included as indicated on the plans or in the Special Provisions.

ITEMS FOR PAYMENT

Item 925-12 Moving (including altering)
Buildings No. —

—lump sum

Item 925-13 Moving (including altering)
Buildings No. —

—lump sum

Item 925-14 Raising (including altering)	
Buildings No. —	—lump sum
Item 925-15 Raising (including altering)	
Buildings No. —	—lump sum
Item 925-16 Altering Buildings No. —	—lump sum
Item 925-17 Altering Buildings No. —	—lump sum

SECTION 926

REMOVAL OR RAZING BUILDINGS

DESCRIPTION

926-1. General. This work shall consist of the complete removal of the building from the property or the razing of the building and the removal of all materials, equipment, and debris from the premises. The Contractor may perform the work in either manner as he may elect.

OPERATING METHODS

926-2. Ownership of Building and Materials and Equipment Therein. 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, shall be vested in the Contractor upon execution and acceptance of the Contract. If the building covered by the Contract is to be occupied after the date of execution of the Contract, this fact will be stated in the Special Provisions and the date at which it is to be vacated will be given. When occupant is to continue in occupancy to a specified date, such occupancy shall be free of all rent and the Contractor shall take whatever steps he deems necessary to protect his interests from damage by fire or other so-called "Acts of God". The occupants shall be responsible to the Contractor for all other forms of damage to the premises if caused by said occupants during such occupancy, reasonable wear and tear excepted.

926-3. Foundations. Unless otherwise provided in the Special Provisions the Contractor will be required to raze the foundations, clean up all debris and leave the premises in a neat and workmanlike condition.

926-4. Removal of Materials. All debris and unusable materials shall be removed from the site as it accumulates so no fire hazard will arise. All material so removed shall be transported to a public dump if such exists in the community;

if not, to an approved place of disposal. No material shall be disposed of on the premises by burning unless special written permission of the Engineer is obtained as well as a permit from the local Fire Department.

METHOD OF MEASUREMENT

926-5. "Removal or Razing Buildings" to be measured for payment shall be the respective unit or units shown on the plans and called for in the Proposal.

BASIS OF PAYMENT

926-6. All work under "Removing or Razing Buildings" will be paid for at the contract lump sum price, which payment shall be full compensation for all equipment, materials, tools, labor, and all incidentals necessary to complete the work, including any soil or gravel used to cover debris.

ITEMS FOR PAYMENT

Item 926-7 Removal or Razing Buildings	
No. —	—per each
Item 926-8. Removal or Razing Buildings	
No. —	—per each

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