

NEW JERSEY STATE HIGHWAY  
DEPARTMENT



STANDARD  
SPECIFICATIONS

WITH ADDENDA - Page 237

*for*

ROAD AND BRIDGE CONSTRUCTION

1941

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# **DIVISION 1**

## **General Provisions**

### **SECTION 1**

#### **General Information**

##### **1.1.1. Headings.**

The headings of the articles herein are intended for convenience of reference only and shall not be considered as having any bearing on their interpretation.

##### **1.1.2. Numbering of Articles.**

The articles herein are numbered, and the numbers are in 3 parts. The first part denotes the division number in which the article is found, the second part the section number of the division, and the third part the article number of the section.

##### **1.1.3. Definition.**

Whenever in this Contract the following terms, or pronouns in place of them are used, their intent and meaning shall be interpreted as follows:

COMMISSIONER, the State Highway Commissioner of New Jersey, as established by and defined in Chapter 1, Title 27, of Revised Statutes.

STATE, State of New Jersey, as represented by the Commissioner.

DEPARTMENT, the State Highway Department of New Jersey, as established by and defined in Chapter 1, Title 27, of Revised Statutes.

PUBLIC ROADS ADMINISTRATION, the Public Roads Administration, Federal Works Agency, Washington, D. C., acting through its representatives on work in which the Federal Government participates.

ENGINEER, The State Highway Engineer, or his duly authorized representative.

INSPECTOR, authorized representative of the Engineer assigned to inspection of work and materials.

LABORATORY, the testing laboratory of the Department.

## GENERAL INFORMATION

**CONTRACT**, the agreement covering the performance of the Project, hereinafter defined, and payments therefor including **Advertisement for Proposal, Proposal, Certification as to Publication and Notice, Resolution of Award of Contract, Executed Contract, Contract Bond, Standard Specifications, Supplementary Specifications, Plans and supplementary agreements which may be entered into**, all of which documents are to be treated as one instrument whether or not set forth at length in the form of Contract.

**PROJECT**, the entire work to be performed under the Contract.

**PLANS**, drawings or reproductions thereof furnished by the Engineer, pertaining to the Project.

**STANDARD SPECIFICATIONS**, this document of Standard Specifications.

**SUPPLEMENTARY SPECIFICATIONS**, additions to or amendments of the Standard Specifications pertaining to the Project.

**SPECIFICATIONS**, the Standard Specifications, the Supplementary Specifications and all written agreements made or to be made, pertaining to the method or manner of performing the Project or to the quantities or qualities of materials to be furnished for the Project.

**PROPOSAL**, the prepared form furnished by the Department, properly filled in and executed and submitted as a bid for the performance of the Project.

**BIDDER**, an individual, firm, partnership or corporation, acting directly or through a duly authorized representative, legally submitting a Proposal.

**CONTRACTOR**, party of the second part to this Contract, acting directly or through agents or employees, and primarily liable for the acceptable performance of the Project and for the payment of all debts pertaining to the Project.

**SURETY**, the corporate body which is bound with and for the Contractor, and which engages to be responsible for his acceptable performance of the Project and for his payment of all debts pertaining to the Project.

**WORKING DAY**, a calendar day, exclusive of Sundays and legal holidays, on which weather and working conditions permit the Contractor to make effective use of not less than 50 per cent of the usual daily man hours during regular working hours. Saturday, subject to the above, shall be considered one-half a working day, unless according to prevailing practice at the location of the Project no work is done on Saturdays, in which case Saturday shall not be counted as a Working Day.

**MATERIALS**, all raw or prepared materials and manufactured or fabricated products entering into the finished Project.

## SECTION 2

### Information for Bidders

#### 1.2.1. Invitation to Bid.

In accordance with advertisement, Proposals will be received for the performance of the Project, the designation of which is stated in the advertisement. Bids are requested on the items stated in the form of proposal for the Project. The prices bid shall cover all costs of any nature, incident to and growing out of the work. In explanation but not in limitation thereof, these costs shall include the cost of all work, labor, material, equipment, transportation and all else necessary to perform and complete the Project in the manner and within the time required, all incidental expenses in connection therewith, all costs on account of loss by damage or destruction of the Project, and any additional expenses, for unforeseen difficulties encountered, for settlement of damages, and for replacement of defective work and materials. Conditions, limitations or provisos attached by the Bidder to the Proposal may cause its rejection. If the statements described in Art. 1.2.7 (p. 5), are not submitted with the Proposal, it may be rejected.

Before submitting his Proposal, the Bidder shall be familiar with the Plans, Specifications and other documents that will form parts of the Contract, shall have investigated in detail the site of the Project and shall have made such examination thereof as may be necessary to satisfy himself in regard to the character and amount of work involved.

He shall have satisfied himself also that he can secure the necessary labor and equipment, and that the materials he proposes to use will comply with the requirements therefor and can be obtained by him in the quantities and at the time required.

### 1.2.2. Prequalification of Bidders.

Proposals will be received only from Bidders who, prior to the delivery of the Proposal, have submitted statements under oath on forms furnished by the Department relating to their financial ability, adequacy of plant and equipment, organization and prior experience and other matters; who have been classified in accordance with **Regulations Covering the Classification of Prospective Bidders**, issued in accordance with Chapter 35, Title 52, of Revised Statutes; and who are qualified to bid in accordance with the qualification attained.

### 1.2.3. Plans and Specifications.

The Project shall be performed in accordance with the requirements of the Plans and Specifications, subject to modifications as provided in Art. 1.8.4 (p. 32). The Plans and Specifications are intended to complement and supplement each other. Any work required by either of them and not by the other shall be performed as if denoted both ways. Should any work be required, which is not denoted in the Specifications or on the Plans because of an obvious omission, but which is nevertheless necessary for the proper performance of the Project, such work shall be performed as fully as if it were described and delineated.

### 1.2.4. Proposal.

Proposals shall be submitted on the form of proposal furnished by the Department properly filled out, and shall be duly executed. The Bidder shall state in the form of proposal the price per unit of measure for each scheduled item of work, for which he will agree to carry out the work, as well as the **Total Price** for the performance of the Project, as determined by multiplying each estimated quantity by the price per unit of measure bid therefor and adding together the resulting amounts. For the purpose of comparison of bids received the Total Price stated in the Proposal will be considered to be the amount bid for the Project and award will be made on that Total Price. When award is made as provided in Art. 1.3.1 (p. 6), and the

Total Price is found to have been incorrectly computed, changes will be made in any or all unit prices so as to attain conformity with the Total Price before the Contract is executed.

When the Proposal is made by an individual, his post-office address shall be stated, and he shall sign the Proposal; when made by a firm or partnership, its name and post-office address shall be stated, and the Proposal shall be signed by one or more of the partners; when made by a corporation, its name and principal post-office address shall be stated, and the Proposal shall be signed by an authorized official of the corporation. Before award is made to a Bidder not a resident of the State of New Jersey, such Bidder shall designate a proper agent in the State of New Jersey on whom service can be made in event of litigation.

#### 1.2.5. Estimate of Quantities.

The estimated quantities of the several scheduled items of work involved in the performance of the Project and stated in the form of proposal are to be used for comparison of Proposals received. The actual quantities may be greater or less. Payment will be made only for the actual quantity of authorized work done under each scheduled item.

#### 1.2.6. Proposal Guaranty.

The Proposal when submitted shall be accompanied by a Proposal Guaranty in the form of a certified check, made payable to the **State Treasurer of New Jersey** in the sum of not less than 10 per cent of the amount of the Proposal, except that the amount of the check needs not exceed \$20,000 and shall be not less than \$500.

#### 1.2.7. Submitting Proposal.

The Proposal shall be enclosed in a sealed envelope, furnished by the Department for this purpose, and shall bear on the outside the name and address of the Bidder as well as the designation of the Project as named in the form of proposal. Proposals will be received at the place and time stated in the advertisement. Enclosed with the Proposal shall be submitted the following documents: (a) the **Proposal Guaranty**, as described in Art. 1.2.6 (p. 5); (b) a **Financial Statement** on form furnished by the Department, as submitted for prequalification but revised to

show conditions at the time of bidding; and (c) **Plant and Equipment Statement** on form furnished by the Department, enumerating plant and equipment available for the Project.

#### 1.2.8. **Withdrawing Proposal.**

A Proposal after being submitted may be withdrawn, when request therefor is made in writing by the Bidder before the time designated in the advertisement for opening of the Proposals. The low bidder on a project may, subject to the approval of the Commissioner, withdraw any and all other proposals he has submitted for other projects scheduled to be opened the same day, if the withdrawal be made before any proposals for such other projects have been opened.

#### 1.2.9. **Causes for Rejection.**

The Commissioner is required by law to reject proposals from bidders not qualified to bid according to the provisions of Art. 1.2.2 (p. 4). In addition, any or all Proposals may be rejected (a) if the prices are obviously unbalanced, (b) if competition obviously has been suppressed, (c) if received from Bidders who have previously performed work for the State in an unsatisfactory manner, and (d) if it is deemed advisable to do so in the interest of the State.

#### 1.2.10. **Laws and other Requirements.**

Attention is called to Arts. 1.6.3 to 1.6.5 (p. 23), relating to Observance of Laws, Federal Aid and Permits, and to Arts. 1.4.7 to 1.4.9 (p. 14), relating to Materials, Superintendence and Workmen, and Equipment.

## SECTION 3

### Award of Contract

#### 1.3.1. **Awarding Contract.**

Award, if made, will be to the lowest responsible Bidder, whose Proposal complies in all respects with the requirements stated herein. The award shall not be binding upon the State until the Contract has been executed by the Commissioner, nor shall any work be performed on account of the proposed Contract until the Contract has been fully executed and delivered.

**1.3.2. Return of Proposal Guaranty.**

All proposal guaranties will be returned immediately after the Proposals have been opened, read and tabulated, except those of the two or more Bidders who have bid the lowest Total Prices for performing the Project, and whose Proposals and other documents submitted therewith in all respects comply with the requirements stated herein. The proposal guaranties of these Bidders will be returned when the Contract is executed or, if not executed, when the matter has been disposed of by the Commissioner, except, however, when the proposal guaranty has been forfeited as liquidated damages in accordance with the requirements of Chapter 7 of Title 27 of Revised Statutes.

**1.3.3. Contract Bond.**

The Bidder, to whom the Contract has been awarded, shall furnish and deliver, within ten days of the date of the award, a Surety Corporation Bond, satisfactory to the Commissioner, in the following form:

“KNOW ALL MEN BY THESE PRESENTS, That we, the undersigned ..... as principal, and ..... a corporation organized and existing under the laws of the State of ..... and duly authorized to do business in the State of New Jersey, as surety, are held and firmly bound unto the State of New Jersey in the penal sum of ..... dollars, for the payment of which well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns. Signed this ..... day of ..... A. D. nineteen hundred and .....

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, That whereas the above named principal did on the ..... day of ..... 19.... enter into a contract with the State Highway Commissioner of the State of New Jersey, which said contract is made a part of this the bond the same as though set forth herein;

Now, if the said ..... shall well and faithfully do and perform the things agreed by ..... to be done and performed according to the terms of said contract, or any changes or modifications therein made as therein provided, and shall pay all lawful claims of sub-

contractors, materialmen, laborers, persons, firms or corporations, for labor performed or materials, provisions, provender or other supplies, or teams, fuels, oils, implements or machinery furnished, used or consumed in the carrying forward, performing or completing of said contract; we agreeing and assenting that this undertaking shall be for the benefit of any subcontractor, materialman, laborer, person, firm or corporation having a just claim, as well as for the obligee herein; and shall indemnify and save harmless the party of the first part mentioned in the contract aforesaid, its officers, agents and servants, and each and every one of them against and from all suits and costs of every kind and description, and from all damages to which the said party of the first part in said contract mentioned, or any of its officers, agents or servants may be put by reason of injury to the person or property of others resulting from the performance of said work, or through the negligence of the said party of the second part to said contract, or through any improper or defective machinery, implements or appliances used by the said party of the second part in the aforesaid work, or through any act or omission on the part of the said party of the second part, or his agents, employees or servants, and shall further indemnify and save harmless the party of the first part mentioned in the contract aforesaid, its officers, agents and servants from all suits and actions of any kind or character whatsoever, which may be brought or instituted by any subcontractor, materialman or laborer who has performed work or furnished materials in or about the work required to be done pursuant to the said contract or by, or on account of, any claims or amount recovered for any infringement of patent, trade-mark or copyright; then this obligation shall be void, otherwise the same shall remain in full force and effect; it being expressly understood and agreed that the liability of the surety for any and all claims hereunder shall in no event exceed the penal amount of this obligation as herein stated. The said surety hereby stipulates and agrees that no modifications, omissions, or additions in or to the terms of the said contract or in or to the plans or specifications therefor, shall in anywise affect the obligations of said surety on its bond."

The bond shall be for a sum of not less than the Total Price bid for the Project and shall be maintained by the Contractor until the final payment is made, and in the event of insolvency of the Surety, the Contractor shall forthwith furnish and maintain, as above provided, other surety satisfactory to the Commissioner.

#### 1.3.4. Execution of Contract.

The Bidder to whom the Contract is awarded shall, within 10 days of the date of the award, execute and deliver the necessary documents entering into the Contract with the State, as provided in Sec. 27:7-31 of Revised Statutes. The Contract Bond shall have been furnished, executed and delivered before the Contract will be executed by the Commissioner.

#### 1.3.5. Statements of Material Sources and Progress.

Within 10 days after the date of execution of the Contract the Contractor shall inform the Engineer in writing from whom and where he proposes to obtain the materials required for the Project, except that for such items of materials which need not be ordered by the Contractor for a period of not less than 6 months after said date of execution, and for such items which, in the opinion of the Engineer, are not of primary importance, the Contractor may delay furnishing said information until 1 calendar month prior to the date that such items need to be ordered to be available for the Project at the proper time. Within 10 days after the date of execution of the Contract, the Contractor shall furnish also a progress schedule, satisfactory to the Engineer, showing in general the times intended by the Contractor for commencing and completing the principal items of work included in the Project, as well as the quantity and kind of equipment and the labor force which he intends to use therefor.

#### 1.3.6. Failure to Execute Contract.

Failure upon the part of the Bidder, to whom the Contract has been awarded, to execute and deliver the Contract as provided in Art. 1.3.4 (p. 9), and the Surety Corporation Bond as provided in Art. 1.3.3 (p. 7), in the manner and within the time provided shall be just cause for annulment of the award. It is understood and agreed by said Bidder that if the award is annulled for the above reasons, the Proposal Guaranty, as described in

Art. 1.2.6 (p. 5), shall become the property of the State, not as a penalty but as liquidated damages.

### 1.3.7. Subletting and Assigning Contract.

The Contractor shall not sell, transfer, assign or otherwise dispose of the Contract to any third party. The Contractor shall perform with his own organization and with the assistance of workmen under his immediate superintendence work amounting to not less than 80 per cent of the Total Price bid for the Project, exclusive of items not commonly found in contracts for similar work or which require highly specialized knowledge, craftsmanship or equipment, not ordinarily available in the organizations of contractors performing work of the character embraced in this Contract. Subject to the above provision and to the consent of the Commissioner work may be sublet, but said consent shall be effective only after a surety bond in the form described in Art. 1.3.3 (p. 7), and satisfactory to the Commissioner, has been furnished by the subcontractor to cover the work to be performed and the materials to be used in that particular subcontract. Said bond shall be drawn in favor of the Contractor and the State as joint obligees and shall recite the fact that the Contract has been entered into as well as the subcontract which the bond immediately covers. It is understood however, that any consent of the Commissioner for the subletting of any of the work under the Contract in no way relieves the Contractor from his full obligations under the Contract. The consent to sublet any part of the work and the acceptance by the Commissioner of the said surety bond shall not be construed to be an approval of the said subcontract or of any of its terms, but shall operate only as an approval of the making of a subcontract between the Contractor and subcontractor. The subcontractor shall look only to the Contractor for the payment of any claims of any nature whatsoever arising out of the said subcontract, and said subcontractor agrees, as a condition of the granting by the Commissioner of the consent to the making of said subcontract, that he shall make no claim whatsoever against the Commissioner or his agents or employees for any work performed or thing done by reason of said subcontract, or for any other cause whatsoever that may arise by reason of the relationship created between the Contractor and subcontractor by the subcontract. The Commissioner will not consent to the making of any

subcontract unless the proposed subcontractor furnishes a statement to the effect that said subcontractor is acquainted with all the provisions of the Contract and agrees thereto.

### 1.3.8. Familiarity with Work.

It is the obligation of the Bidder to ascertain for himself all the facts concerning conditions to be found at the location of the Project, including all physical characteristics above, on and below the surface of the ground, to fully examine the Plans and read the Specifications, to consider fully these and all other matters which can in any way affect the work under this Contract and to make the necessary investigations relating thereto, and he agrees to this obligation in signing the Contract. The State assumes no responsibility whatsoever with respect to ascertaining for the Contractor such facts concerning physical characteristics at the site of the Project. The Contractor agrees that he will make no claim for, and has no right to, additional payment or extension of time for completion of the work or any other concession because of any misinterpretation or misunderstanding on his part of this Contract or because of any failure on his part to fully acquaint himself with all conditions relating to the work.

### 1.3.9. Subsurface Conditions.

It is the obligation of the Bidder to make his own investigations of subsurface conditions prior to submitting his Proposal. Borings, test excavations and other subsurface investigations, if any, made by the Engineer prior to the construction of the Project, the records of which may be shown on the Plans, are made for design purposes. Said borings, test excavations and other subsurface investigations are not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, if in carrying out the Project he finds that the actual conditions encountered do not conform to those indicated by said borings, test excavations and other subsurface investigations.

Any estimate or estimates of quantities shown on the Plans or in the form of proposal, based on said borings, test excavations and other subsurface investigations or otherwise, are in no way warranted to indicate the true quantities or distribution of quantities. The Contractor agrees that he will make no claims against the State, if the actual quantity or quantities do not conform to the estimated quantity or quantities.

**SECTION 4****Scope of the Work****1.4.1. Work to be Performed.**

The work under this Contract comprises the performance and completion of the Project, including the furnishing of all materials, equipment, transportation, labor and all else necessary therefor and incidental thereto, the final cleaning up as provided in Art. 1.4.4 (p. 13), the payment of all due obligations as provided in Art. 1.8.5 (p. 34), and the replacing of defective work and materials as provided in Art. 1.8.7 (p. 35), all in accordance with the Plans and Specifications.

**1.4.2. Other Contractors.**

The right is reserved by the State to do work by other contractors or by State forces and to permit public utility companies and others to do work during the progress and within the limits of or adjacent to the Project, and the Contractor shall conduct his work and cooperate with such other parties so as to cause as little interference as possible with such other work and as the Engineer may direct. The Contractor shall agree, and hereby does agree, to make no claims against the State for additional payment due to delays or other conditions created by the operations of such other parties. If there be a difference of opinion as to the respective rights of the Contractor and others doing work within the limits of or adjacent to the Project, the Engineer will decide as to the respective rights of the various parties involved in order to secure the completion of the State's work in general harmony and in a satisfactory manner, and his decision shall be final and binding on the Contractor.

**1.4.3. Maintenance of Traffic.**

When traffic is to be maintained over existing highways within the scope of the Project, the Contractor shall plan and carry out his work accordingly. When temporary means are required for the maintenance of traffic and provisions therefor are made in the Specifications, the Contractor shall provide such means. Unless otherwise required the temporary means for maintaining traffic shall be removed at the completion of the work and any damage done to public or private property shall be made good.

Unless otherwise specifically provided the cost of maintenance of traffic will not be paid for under any specific scheduled item but shall be included in the prices bid for the various items scheduled in the Proposal.

Where the Project is over or adjacent to railroad tracks, the Contractor shall safeguard the tracks, traffic and appurtenances of the railroad. He shall comply with the regulations of the railroad company relating to the work, shall keep the tracks clear of obstructions and shall provide watchmen, flagmen, lights, signals, warnings and other means of protection as may be required by the railroad company or the Engineer. The Contractor shall arrange with the railroad company for direct payment to the company for watchmen, flagmen and other service which may be required by the railroad company. Payment for protection of traffic on the railroad as above described will be made at the lump sum price bid for the item PROTECTION OF RAILROAD TRAFFIC in the Proposal, which price shall include the cost of safeguarding tracks, traffic and appurtenances of the railroad, watchmen, flagmen, lights, signals, warnings and all other services.

#### 1.4.4. Final Cleaning Up.

Before the final acceptance of the Project the Contractor shall remove all equipment, temporary work, unused and useless materials, rubbish and temporary buildings, shall repair or replace in an acceptable manner fences or other private or public property which may have been damaged or destroyed on account of the prosecution of the work, shall fill in all depressions and water pockets on public and private property caused by his operations, shall remove all obstructions from waterways caused by his work, shall clean all drains and ditches within and adjacent to the site of the Project which have been obstructed by his operations, and shall leave the site of the Project and adjacent public and private property in a neat and presentable condition wherever his operations have disturbed conditions existing at the time of starting work. Payment for final cleaning up and restoration of property as above provided will be made at the lump sum price bid for the item FINAL CLEANING UP in the Proposal; provided, however, that when this item is not scheduled in the Proposal the cost of this work shall be included in the prices bid for the various scheduled items.

#### 1.4.5. Field Offices.

The Contractor shall provide for the use of the Engineer a substantial, weatherproof, heated and lighted office with lock and keys and a floor space of not less than 200 square feet, and furnished with long tables with drawers and cupboards. When the Project includes both road and bridge work and the bridge items amount to not less than \$6,000, two such offices shall be provided. The offices shall be ready for use not later than 10 days after execution of the Contract and before any other work is started, shall be maintained until the final certificate of cost has been approved, and shall then be removed, except that when the Project is closed down entirely for a reason authorized by the Contract for a continuous period of not less than 6 weeks the offices may be closed during that period, providing the Contractor gives written notices to the Engineer about his intent to close and subsequently reopen not less than 5 days prior to the respective dates set therefor. The cost of providing and maintaining offices shall be included in the prices bid for the various scheduled items.

#### 1.4.6. Sanitary Provisions.

The Contractor shall provide and maintain in a neat and sanitary condition accommodations for his employees, complying with the regulations of the State Department of Health and other bodies having jurisdiction. Necessary conveniences, properly secluded, shall be provided and maintained for the use of the Contractor and the Engineer, satisfactory to the Engineer and sanitary authorities. The cost thereof shall be included in the prices bid for the various scheduled items.

#### 1.4.7. Materials.

All materials for the Project shall be furnished by the Contractor, unless otherwise specifically provided, and shall be from approved sources. Request for approval of source shall state the name and address of the proposed source, the method of shipment, the proposed date of the first shipment and the intended use of the material. Materials shall be inspected at their source and approved before being shipped. Shipment before approval shall be sufficient cause for rejection. Materials shall not be used until approved by the Engineer. Approval by samples applies only so long as the material conforms to the samples approved and it can be furnished at the time and in the

quantity required by a producer equipped to furnish it in uniform quality and composition. Approval for a specific case or use does not imply approval for other cases or uses. Approved materials which appear defective when received, or which may have become damaged in storage, shall not be used until retested and reapproved. Orders for materials shall give detailed description of them and their intended use, and shall state the official designation of the Project on which they are to be used. Duplicates of orders shall be furnished the Engineer at the time the order is placed.

Unless otherwise specifically provided, materials will be tested at the expense of the State. The Contractor, however, shall provide the necessary facilities for taking samples, shall furnish samples and shall deliver them to the Laboratory or elsewhere as the Engineer may direct, and samples shall be prepared by the Contractor for testing if so required. The cost to the Contractor in connection with tests as above described shall be included in the prices bid for the various items scheduled in the Proposal. Unless otherwise specifically provided, materials will be tested in accordance with the methods of the American Association of State Highway Officials.

Vehicles and receptacles used for transport of materials shall be strong, clean and in good repair; otherwise the materials therein may be rejected. The receptacles shall be plainly marked with name of producer, net weight, grade, lot number of approved material from which the content is taken, and date of approval. Materials liable to damage by the elements shall be stored in proper structures or in such other manner as may be necessary to protect them from damage. Materials shall be kept clean and free from foreign matter of any kind before, while and after being placed in the finished work, and provisions necessary therefor, in the opinion of the Engineer, shall be made by the Contractor. Materials when placed in the finished work shall be undamaged and conform in every respect to the Specification requirements. Unclean, damaged or otherwise defective materials shall not be used in the work, even though they have previously been accepted.

#### 1.4.8. Superintendence and Workmen.

The Contractor shall attend to the work personally or through a competent, English speaking superintendent on

the work, authorized to receive and carry out instructions. The superintendent shall be a citizen of the United States. The workmen shall be competent and shall perform their work in a neat and workmanlike manner. Any man not properly qualified for his work or who is doing it in an unsatisfactory manner or contrary to the Specifications or the Engineer's instructions, or who is disorderly, shall be discharged, if so requested by the Engineer, and shall not be employed again on the Project except with the approval of the Engineer. The superintendence and the number of workmen shall be sufficient, in the opinion of the Engineer, to insure the completion of the Project within the time stipulated therefor.

#### 1.4.9. Equipment.

Good equipment only shall be used, and it shall be in proper working condition. Sufficient equipment shall be used to insure the completion of the Project within the time specified. The equipment shall be operated so as not to damage public or private property. When a specific type or character of equipment is called for it shall be provided and used. All equipment is subject to the approval of the Engineer.

If the Contractor or his subcontractors do not own all or part of the equipment required, a written statement shall be submitted by the Contractor or his subcontractors, respectively, of the name and address of the owner or owners and shall be accompanied by a certificate from said owner or owners stating that an agreement has been made to lease or loan the equipment and that in event of default, as set forth in Art. 1.7.6 (p. 30), the Commissioner has the right to take over and use such equipment or cause it to be used for completing the Project.

#### 1.4.10. Working Site.

Any space that the Contractor may require for plant, equipment, storage or other purposes, in addition to that available therefor at the site of the Project, shall be procured by the Contractor and the cost thereof shall be included in the prices bid for the various scheduled items. In event of default as set forth in Art. 1.7.6 (p. 30), the Commissioner has the right to take over and occupy such space or cause it to be occupied for the purpose of completing the Project. If leased, the lease shall contain a provision that in event of default by the Contractor the

lease may be assigned to the State or its nominee. The Contractor agrees in event of said default, that he will make such assignment.

#### 1.4.11. Contractor's Organization.

The working force, equipment and working site, provided by the Contractor for the Project shall at all times be adequate and sufficient to insure the completion of the Project within the time stipulated therefor. When, in the opinion of the Engineer, either the working force, the equipment or the working site, or any or all of them, are inadequate or insufficient to insure completion within said time, the Engineer may order the Contractor to correct the deficiency, and the Contractor shall comply with such order.

### SECTION 5

#### Control of the Work

##### 1.5.1. Duties of Engineer.

The Engineer will furnish Plans and Specifications, set stakes for lines and grades as provided in Art. 1.5.4 (p. 19), and prepare monthly and final certificates as provided in Art. 1.8.5 (p. 33). He will give instructions necessary to attain due and full effect of the provisions of the Specifications. Should any differences of opinion arise as to the meaning or intent of the Plans and Specifications, his decision when approved by the Commissioner shall be final and conclusive. All materials and work shall be subject to his inspection and approval, provided, however, that his approval or acceptance of materials furnished or work performed does not commit the Commissioner to acceptance thereof if said materials or work do not conform to the requirements of the Specifications.

##### 1.5.2. Plans and Specifications.

Plans showing general outlines and details necessary for a comprehensive understanding of the Project form part of the Contract and are on file at the Commissioner's office at Trenton. The Contractor will receive two copies of these Plans and of the Specifications, and one copy of each shall be kept at the site of the Project. The Project

shall be constructed in all respects in compliance with the requirements of the Plans and Specifications.

On the Plans figured dimensions shall govern in case of discrepancy between scaled and figured dimensions. If any discrepancy be found between the Plans and Specifications, the requirements of the Plans shall govern. If there be a discrepancy between the Standard Specifications and the Supplementary Specifications, the requirements of the latter shall govern. The Engineer shall have the right to correct apparent errors or omissions in the Plans and Specifications and to make such interpretations as he may deem necessary for the proper fulfillment of the intent of the Plans and Specifications.

### 1.5.3. Working Drawings.

The Contractor shall submit to the Engineer for his approval such detailed shop or working drawings as may be required for carrying out the Project. These drawings will be checked and approved or returned for correction as promptly as the conditions will permit. The Contractor shall order no materials and do no work relating to said drawings before their approval. The carrying out of the work or the ordering of the materials before the approval of the drawings may constitute a cause for rejection of such work or materials. No deviations from approved working drawings shall be made without the approval of the Engineer.

Working drawings for steel structures shall consist of shop, erection and other drawings, showing details, dimensions, sizes and other information necessary for the complete fabrication and erection of the metal work. Working drawings for concrete structures shall consist of such additional detailed drawings as may be required for the prosecution of the work and may include drawings of false-work, bracing, centering and formwork, and masonry layout diagrams. The Contractor shall check completely the rod lists and details of reinforcement steel shown on the Plans and shall submit complete working drawings for the reinforcement steel to the Engineer for his approval. It is expressly understood that the approval by the Engineer of the Contractor's working drawings relates to the requirements for design and compliance with Plans only and that such approval does not relieve the Contractor from responsibility for errors in dimensions. The Contractor shall furnish the Engineer with such a number of

blueprint copies of the working drawings as may be required for approval and construction purposes, and on completion of the Project the original tracings of the drawings shall be furnished to the Engineer if so required by him. The tracings of working drawings shall be in ink on cloth, and they shall be of such uniform size as may be directed by the Engineer. The cost of preparing and furnishing working drawings as above described shall be included in the prices bid for the various items scheduled in the Proposal.

#### 1.5.4. Construction Stakes.

The Engineer will stake out lines and grades for road work, and for structures he will stake out the centerlines and furnish such benchmarks as may be necessary to lay out the work correctly. The Contractor shall maintain these lines, grades and benchmarks and shall lay out therefrom the work he is to perform under this Contract. He shall be responsible for the finished work conforming to the lines, grades and benchmarks given by the Engineer. The cost to the Contractor of laying out the work as above described shall be included in the prices bid for the various items scheduled in the Proposal. The Contractor shall notify the Engineer in writing not less than 5 days in advance when stakes are required, and no claims shall be made because of delays if the Contractor fail to give such notice. Requests for stakes and other engineering services as above described shall, except in emergency, cover sufficient work for not less than one full day of the force needed for the work. The Contractor shall exercise care in the preservation of stakes and benchmarks set for his or the Engineer's use. If such stakes and benchmarks be damaged, lost, displaced or removed by the Contractor, they shall be reset at his expense.

#### 1.5.5. Inspectors.

The State shall have the right to inspect all work done and all materials furnished, including the preparation, fabrication and manufacture in mill, plant, shop and field of the materials to be used, and may assign an inspector or other authorized representative for this purpose. The Contractor shall provide all facilities necessary for such inspection and shall furnish or cause to be furnished to the said inspector or other authorized representative safe

access at all times to the places where preparation, fabrication or manufacture of materials and construction of the work is in progress, as well as such information and assistance as may be required to make a complete and detailed inspection. When the said inspector or other authorized representative is in or about the premises above referred to in the course of his employment, he shall be deemed conclusively to be an invitee of the Contractor. If the Contractor be not the owner of the place, where fabrication, preparation or manufacture are in progress, the owner thereof shall be deemed to be the agent of the Contractor with respect to the obligation assumed hereunder. The cost of providing the necessary facilities, information, assistance and protection as above described shall be included in the prices bid for the various items scheduled in the Proposal.

Inspectors or other authorized representatives may be stationed on the work to report to the Engineer as to the progress thereof and the manner in which it is being performed; to inform him whenever it appears that the materials furnished and the work performed by the Contractor fail to comply with the requirements of the Plans and Specifications; and to direct the attention of the Contractor to such failure. The inspection, however, shall not relieve the Contractor from his obligations to furnish materials or perform work in conformity with the requirements of the Plans and Specifications.

The Inspector or other authorized representative is not authorized to revoke, alter, enlarge, relax or release any requirements of the Specifications or to issue instructions contrary to the Plans and Specifications. He shall not act as foreman or perform other duties for the Contractor, nor shall he interfere with the management of the Contractor's work. If a difference of opinion arise between him and the Contractor relating to the materials furnished or the performance of the work, he has the authority to reject the materials and suspend the work until the question at issue can be referred to and decided by the Engineer.

#### 1.5.6. Unauthorized or Defective Work.

The Contractor shall use no materials in the work before they have been approved as provided in Art. 1.4.7 (p. 14): he shall perform no work before the lines, grades and benchmarks therefor have been established as provided in

Art. 1.5.4 (p. 19); and he shall perform no work not designated in the Contract unless a written order therefor has been given as provided in Art. 1.8.4 (p. 32). Work performed and materials furnished which do not comply with the requirements therefor will be rejected and shall be removed, replaced or repaired as the Engineer may direct and in a manner satisfactory to him. Materials which have been rejected and the defects of which have been subsequently removed shall not be used unless approved by the Engineer.

#### 1.5.7. Claims for Additional Compensation or Extension of Time.

When the Contractor deems that additional compensation or extension of time is due to him for work required to be performed or materials required to be furnished which in his opinion cannot be classified under the scheduled items of work and which have not been covered by an extra work order or by supplementary agreement as hereinafter specified, he may notify the Engineer in writing of his intention to make claim for such additional compensation or extension of time or both before he begins the work or furnishes the materials in question. If such notification be not given, and if the Engineer be not afforded proper facilities for keeping account of the actual cost to the Contractor of such work and materials, then the Contractor shall agree, and hereby does agree, to waive the claim for such additional compensation or extension of time or both. However, if the Contractor has so notified the Engineer, this circumstance shall in no way be construed as proving the validity of the claim. The claim will be passed on by the Commissioner, and if the Commissioner find it to be just, the work or materials in question will be covered by extra orders or by a supplementary agreement.

#### 1.5.8. Acceptance of Work.

When the Project has been completed, the Contractor shall so notify the Engineer. If it be not acceptable to the Engineer he will advise the Contractor as to the particular defects to be remedied before final acceptance will be made. Payments made to the Contractor before the final acceptance do not commit the Commissioner to acceptance of the Project. The final inspection and accep-

tance will be made by the Commissioner when the Project has been completed.

The State shall not be precluded or estopped by any measurement, estimate or certificate, made either before or after the completion and acceptance of the Project and payment therefor, if such measurement, estimate or certificate be found to be in error or untrue, from showing the true amount and character of the work performed and materials furnished by the Contractor, or from showing that any such measurement, estimate or certificate is incorrectly made or untrue, or that the work or materials do not conform in fact to the requirements of the Contract. The State shall not be precluded or estopped, notwithstanding any such measurement, estimate or certificate, and payment made in accordance therewith, from recovering from the Contractor and his surety, such damages as it may sustain by reason of the Contractor's failure to comply or to have complied with the terms of the Contract.

Neither the acceptance by the Commissioner or by any representative of the Commissioner of nor any payment made for the whole or any part of the Project nor any extension of time granted the Contractor nor any possession taken by the Commissioner shall operate as a waiver of any portion of the Contract or of any power herein reserved, or any right to damage herein provided. A waiver of any breach of the Contract shall not be held to be a waiver of any other or subsequent breach.

## SECTION 6

### Legal and Public Relations

#### 1.6.1. Personal Liability.

In carrying out the provisions of this Contract or in exercising any power or authority granted them by their position there shall be no liability upon the Commissioner, the Engineer and their authorized representatives or assistants, either personally or as officials of the State, it being understood that in such matters they act as agents and representatives of the State.

#### 1.6.2. Damage Claims.

The Contractor shall indemnify and save harmless the Commissioner, his officers, agents and servants and each

and every one of them against and from all suits and costs of every kind and description and from all damages to which the Commissioner or any of his officers, agents or servants may be subjected by reason of injury to the person or property of others resulting from the performance of the Project, or through the negligence of the Contractor, or through any improper or defective machinery, implements or appliances used by the Contractor in the Project, or through any act or omission on the part of the Contractor or his agents, employees or servants; and he shall further indemnify and save harmless the Commissioner, his officers, agents and servants from all suits and actions of any kind or character whatsoever which may be brought or instituted by any subcontractor, materialman or laborer who has performed work or furnished materials in or about the Project or by, or on account of, any claims or amount recovered for any infringement of patent, trade-mark or copyright. The cost thereof shall be included in the prices bid for the various scheduled items in the Proposal. So much money due to the Contractor under and by virtue of the Contract as shall be considered necessary by the Commissioner may be retained by the State and held until such suits, actions, claims or amounts shall have been settled, and suitable evidence to that effect furnished to the Commissioner.

### 1.6.3. Laws.

The Contractor shall observe and comply with all Federal and State laws and local ordinances that affect those engaged or employed on the Project, the materials or equipment used, or the conduct of the work.

Attention is called to the following State Laws:

**Chapter 9, Title 34,** Revised Statutes, providing that citizens of the State of New Jersey who have resided in the State not less than 1 year be given preference in employment on public works. If the provisions of these laws be not complied with, the Contract shall be voidable at the instance of the State.

**Chapter 10, Title 34,** Revised Statutes, providing as a condition of the Contract establishment of an eight-hour working day for laborers, workmen and mechanics and requiring payment of prevailing rates of wages and providing penalties for violations.

**Chapter 2, Title 10, Revised Statutes**, whereby the Contractor as a condition of the Contract shall and hereby does agree:

(a) That in the hiring of laborers, workmen and mechanics for the performance of work under this Contract or any subcontract hereunder, no Contractor, nor any person acting on behalf of such Contractor or subcontractor, shall, by reason of race, creed or color, discriminate against any citizen of the State of New Jersey who is qualified and available to perform the work to which the employment relates;

(b) That no Contractor, subcontractor, nor any person on his behalf shall, in any manner, discriminate against or intimidate any employee hired for the performance of work under this Contract on account of race, creed or color;

(c) That there may be deducted from the amount payable to the Contractor by the State, under this Contract, a penalty of five dollars (\$5.00) for each person for each calendar day during which such person is discriminated against or intimidated in violation of the provisions of the Contract; and

(d) That this Contract may be cancelled or terminated by the Commissioner, and all money due or to become due hereunder may be forfeited, for a second or any subsequent violation of the terms or conditions of this section of the Contract.

**Chapter 15, Title 40, and Chapters 32 and 33, Title 52, Revised Statutes**, whereby the Contractor as a condition of the Contract shall and hereby does agree, that in the performance of the Project, only domestic materials and manufactured and farm products of the United States will be used, whenever available, unless otherwise specifically provided in the Contract with respect to any material, which the Commissioner may deem advisable to except from this requirement in the interest of the State.

#### **1.6.4. Federal Aid.**

When the Project is carried out with Federal Aid, it shall be subject to inspection and approval by the Public Roads Administration and in accordance with the rules and regulations promulgated by it, pursuant to any Act of Congress relating thereto, and in the employment of labor preference shall be given, other conditions being

equal, to honorably discharged soldiers, sailors and marines, in accordance with Section 6 of the certain Act of Congress, relating thereto and approved February 28, 1919.

#### **1.6.5. Permits and Licenses.**

The Contractor shall procure all required permits and licenses, pay all charges and fees therefor, and shall give all notices necessary and incident to the due and lawful prosecution of the Project. The cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

#### **1.6.6. Responsibility for Work.**

The Contractor assumes full responsibility for materials and equipment employed in the construction of the Project and agrees to make no claims against the State for damages to such materials and equipment from any cause whatsoever. Until its final acceptance the Contractor shall be responsible for damage to or destruction of the Project, or any part thereof, due to any cause whatsoever. He shall make good all work damaged or destroyed before the final acceptance, and the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

#### **1.6.7. Explosives.**

Explosives shall be stored safely under lock and key. The storage places shall be marked plainly DANGEROUS EXPLOSIVES and be in care of a competent watchman at all times. The storing and handling of explosives and highly inflammable materials shall conform to the State and local regulations relating thereto. Proper means shall be used to avoid damage by blasting to public and private property, and flagmen shall be provided when necessary to warn passing traffic. The cost of the above shall be included in the prices bid for the appropriate scheduled items.

#### **1.6.8. Public Safety and Convenience.**

The Contractor shall conduct his work with the least possible obstruction to traffic. The convenience of the public and of the residents adjacent to the Project, and the protection of persons and property, are of first importance and shall be provided for by the Contractor in an adequate and satisfactory manner. Commodious tem-

porary crossings shall be constructed and maintained where access to adjacent property is desired, and fire hydrants shall be kept accessible. The cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

#### **1.6.9. Protection of Traffic.**

The Contractor shall erect and maintain barricades, danger signals and warning signs at working sites, closed roads, intersections and other places of danger to traffic or to the completed work. Each barricade shall be provided with red lights not more than 5 feet apart, and not less than 3 lights shall be used. Where traffic lines change, the barricades shall have additional white lights marking their ends. Obstructions, such as stored materials, equipment and excavations, shall be marked with not less than 2 red lights and the lights shall be not more than 4 feet apart. The lights shall be visible not less than 500 feet in all directions of traffic and shall be placed not less than 2 feet above the adjacent roadway carrying traffic. The lights shall be lighted from sunset until sunrise. Watchmen shall patrol hourly and replace missing lights. Standard flares may be used instead of red lights, subject to the approval of the Engineer. The Contractor shall provide sufficient watchmen and directors of traffic and shall take all necessary precautions for the proper protection of the work and the safety of the Public. The Contractor shall not erect direction or detour signs. The cost of protection of traffic as above described shall be included in the prices bid for the various items scheduled in the Proposal.

#### **1.6.10. Property Damage.**

The Contractor shall not enter on or make use of private property unless written permission therefor is secured from the owner. The Contractor shall promptly restore or repair, without cost to the State and in a manner satisfactory to its owner, property damaged or destroyed by the Contractor's operations.

#### **1.6.11. Public Utilities.**

Within the site of the Project there may be public utility structures, and notwithstanding any other clause or clauses of this Contract, the Contractor shall not proceed with his work until he has made diligent inquiry

at the offices of the Engineer, the utility companies and municipal authorities to determine their exact location. The Contractor shall notify in writing the utility companies and the municipal authorities which may be affected, concerning the nature and scope of the Project.

The Contractor shall carry out his work carefully and skilfully and shall support and secure public utility structures, so as to avoid damage to them. Flow in drains and sewers shall be satisfactorily maintained. He shall not move without the owner's consent any public utility structures, and at the completion of the work their condition shall be as safe and permanent as before. When public utility structures are damaged by the Contractor he shall notify their owners who may cause the damage to be repaired at the Contractor's expense. If the cost thereof be not paid by the Contractor within 30 days after repairs have been completed the Commissioner may retain an amount sufficient to cover the cost from any monies due or that may become due the Contractor under this Contract. House connections damaged by the Contractor shall be repaired by licensed plumbers at the Contractor's expense.

The cost of removing and replacing public utility structures which interfere with the Contractor's operations but not with the permanent work under this Contract shall be included in the prices bid for the various scheduled items, except that in case of subsurface structures not shown on the Plans, the removal of which is necessary in carrying out the Project as planned, payment may be made to the Contractor in accordance with Art. 1.8.4 (p. 32).

Due notice will be given to all interested parties in accordance with Revised Statutes 27:7-26 and 27, that all surface openings within the site of the Project shall be made prior to the laying of the finished pavement.

#### 1.6.12. Existing Monuments.

When monuments or title stones are encountered, the Contractor shall not disturb them, except with the approval of the Engineer, and he shall, if required, raise or lower them under the direction of the Engineer. Payment therefor, unless otherwise specified, will be made as provided in Art. 1.8.4 (p. 32). Monuments or title stones moved except as above described shall be replaced at the Contractor's expense.

## SECTION 7

### Procedure and Progress

#### 1.7.1. Commencement and Procedure.

The Contractor shall commence work immediately after execution of the Contract and shall continue without interruption, until the work is completed, except as provided in Art. 1.7.3 (p. 28). The sequence of the work shall conform to the progress schedule specified in Art. 1.3.5 (p. 9), as approved by the Engineer, provided, however, that said schedule may be modified from time to time as directed or approved by the Engineer.

#### 1.7.2. Progress and Time of Completion.

The progress and the time of completion of the Project shall comply with the requirements therefor as stated in the Supplementary Specifications, except as provided in Art. 1.7.8 (p. 31). When the progress and the time of completion are stated in terms of working days, these will be counted as provided in Art. 1.1.3 (p. 3), and when specified in terms of calendar days or months or specific dates, the actual number of working days will not be considered, but the Contractor shall arrange his working force and equipment so as to insure completion within the specified time.

#### 1.7.3. Suspension of Work.

If the Engineer deem it advisable he may notify the Contractor in writing to suspend work on all or any part of the Project, and the Contractor shall do no work where so suspended until he has received written notice from the Engineer to resume work. When work is suspended as above provided, payments for the completed parts of the suspended work will be made as provided in Art. 1.8.5 (p. 34), and a suitable extension of time for completing the suspended work will be granted. No other compensation or allowance will be made on account of such suspension unless it shall be for more than 10 days. Should the suspension be for more than 10 days and should the Contractor be put to additional expense on account thereof, he shall have the right to file with the Commissioner a statement showing the character and amount of such additional expense and, if the Commissioner deem it a proper

charge, he will be reimbursed therefor. However, he shall have no claim for additional expense for said first ten days of suspension, and any claim for allowance as above shall be filed with the Commissioner before the expiration of the first ten days of suspension. No payment will be made for work done by the Contractor on suspended work. If the suspension extend for one year and the value of the suspended work, based on bid prices and estimated quantities, exceed 25 per cent of the Total Price bid, the Commissioner will at the Contractor's request annul the Contract as provided in Art. 1.7.5 (p. 29). When said value be 25 per cent or less and the suspension extend for one year, the Commissioner will at the Contractor's request by Reduction Order as provided in Art. 1.8.4 (p. 32), omit the suspended work from the Contract.

#### 1.7.4. Unavoidable Delays.

If for any reason beyond the control of the Contractor other than as provided for in Art. 1.7.3 (p. 28), the work be delayed, the Contractor shall have no right to nor shall he make any claim whatsoever for damages or additional compensation by reason of the delay, but he may be granted an extension of time, in the discretion of the Engineer, as provided in Art. 1.7.8 (p. 31).

#### 1.7.5. Annulment of Contract.

When the Commissioner deems it advisable in the interest of the State he may annul this Contract on 30 days' written notice to the Contractor and, if not in default, payments will be made as provided in Art. 1.8.5 (p. 33), for all work done under the terms and conditions of this Contract, except that payments will be made in such amounts as the Commissioner may consider just and proper for such parts of the work that are not fully completed and for that reason not susceptible to classification under the bid prices, and for expenditures in connection with the preparing for and moving equipment to and from the work for which the Contractor is not otherwise compensated. It is understood and agreed, however, that no payments shall be made for any claim for loss of anticipated profits.

When the Contract is annulled as above provided the Contractor shall, if so required by the Commissioner, remove promptly any or all of his equipment and supplies

from the site of the Project or other property of the State, failing which the Commissioner may remove such equipment and supplies at the expense of the Contractor.

#### 1.7.6. Default of Contract.

When, in the opinion of the Engineer, the Project or any part thereof has been abandoned, is unnecessarily delayed, or cannot be completed by the Contractor at the rate of progress or within the time specified, or the Contractor is wilfully violating any of the covenants of this Contract, or is carrying it out in bad faith, then the Engineer may so certify in writing to the Commissioner, and the Commissioner may declare the Contractor in default on the Contract and notify him to discontinue the Project. The Commissioner may then call on the Surety to complete the Project or may complete it by other means, as he may elect. He may take over and use materials and equipment at the site of the Project and other equipment used elsewhere for the Project at the time of default, and may procure other materials, equipment and all else necessary for the completion of the Project. The Commissioner shall recover the cost of finishing the Project by deducting the amount thereof from any monies due or which may become due the Contractor under this Contract, and when such monies are insufficient to pay said cost, the amount of said cost in excess of such monies shall be paid by the Contractor or the Surety.

#### 1.7.7. Liquidated Damages.

If the Contractor fail to complete fully, entirely and in conformity with the provisions of this Contract the Project and each and every part and appurtenance thereof within the time stated in the Contract, or within such further time as may have been granted in accordance with the provisions of this Contract, then the Contractor shall and hereby agrees to pay the Commissioner for each and every calendar day that he is in default on time to complete the work the amount of 0.02 per cent of the Total Price bid in the Proposal, provided, however, that if said Total Price is less than \$100,000 the amount shall be \$20; which said amount per day is agreed upon by the parties hereto to be liquidated damages, not a penalty. The Commissioner shall recover said damages by deducting the amount thereof out of any monies due or that may become due the Contractor, and if said monies be insufficient to cover

said damages, then the Contractor or his Surety shall pay the amount due.

#### 1.7.8. Extension of Time.

Extension of the time stipulated in the Contract for completion of the Project will be made if and as the Engineer may deem proper, when work under supplementary agreement or extra work order as hereinafter provided is added to the work under this Contract; when the work is suspended as provided in Art. 1.7.3 (p. 28); and when the work of the Contractor is delayed on account of conditions which in the opinion of the Commissioner warrant such extension; provided, however, that no extension on account of delay will be granted unless notice is given the Engineer in writing of such delay and of the Contractor's intention to claim an extension of time within 5 days after the beginning of such delay, and said notice shall give complete information of the nature, cause and probable extent of the delay.

## SECTION 8

### Payment

#### 1.8.1. Measurement of Quantities.

All work completed under this Contract will be measured for payment by the Engineer according to United States standard measures.

#### 1.8.2. Scope of Payment.

The Contractor hereby agrees to accept the payment as provided in Art. 1.8.5 (p. 33), as full payment for performing and completing the Project, for furnishing all labor, materials, equipment, transportation and all else necessary therefor, for all incidental expenses in connection therewith, for all loss by damage to or destruction of the Project due to any cause whatsoever, for any additional expenses on account of unforeseen difficulties encountered, for settlement of claims and for replacement of defective work and materials for one year after acceptance of the Project by the Commissioner.

#### 1.8.3. Adjustment of Estimated Quantities.

When the Project is completed the authorized quantities of the various items scheduled in the Proposal and

placed in the Project will be measured. When these quantities are greater or less than the corresponding estimated quantities stated in the Proposal, extra or reduction orders, as the case may be, will be issued by the Engineer to cover the differences between estimated and actual quantities, and no payment will be made for work done in excess of the quantities stated in the Proposal until such orders have been issued and approved.

#### 1.8.4. Change of Plans.

It is understood and agreed, that the Commissioner may change the Plans so as to increase or decrease the quantities of work to be performed or materials to be furnished under the various items scheduled in the Proposal, and the Engineer will issue **extra or reduction orders** to cover such changes. These orders will show in detail the kind and quantity of work to be performed or omitted, or of materials to be furnished or omitted, the amount to be added or deducted from the Total Price bid in the Proposal for each scheduled item increased or decreased by the order, and the number of days, if any, that will be added to or deducted from the time for completion stipulated in the Contract on account of the added or decreased work covered by the order. The extra or reduction order will be issued after the issuance of a **Recommended Change of Plan Form**, and the Contractor shall do no work and furnish no materials, except as shown on the Plans, until he has received a copy of said form duly approved by the Engineer. If the Contractor refuse to accept said extra or reduction orders he may be declared in default as provided in Art. 1.7.6 (p. 30).

It is further understood and agreed, that the Commissioner and the Contractor may enter into **supplementary agreements** for the Contractor to furnish materials or perform work of a kind not susceptible to classification under any of the items scheduled in the Proposal. The supplementary agreement shall state the kind and character of such work to be performed or materials to be furnished, the amount to be paid therefor, and the number of days, if any, that will be added to or deducted from the time for completion stipulated in the Contract on account thereof. The work and materials covered by the supplementary agreements shall conform to the requirements therefor of the Specifications. The amount to be paid the Contractor for performing the work or furnishing the ma-

terials covered by the supplementary agreements may be determined at the discretion of the Engineer on a lump sum or unit price basis, or on the basis of actual cost to which a percentage of the actual cost or a fixed sum is added. If the Contractor fail to execute the supplementary agreement the Commissioner may have the materials furnished or the work performed by others, and the Contractor shall not interfere therewith. If any acceptable materials have been furnished, which cannot be used on account of the Change of Plans, such materials may be purchased from the Contractor at the actual cost to the Contractor and shall then become the property of the State, or other allowance may be made therefor as approved by the Engineer.

#### 1.8.5. Payment.

Payment will be made for the actual quantity of authorized work done under each item scheduled in the Proposal at the respective unit prices bid therefor, and under supplemental agreements, if any, at the price or prices stipulated therein.

Monthly certificates will be made of the approximate quantities of work done and of materials furnished but not incorporated in the work during the preceding month, and payments on account will be made not exceeding 90 per cent of the value of such work, based on the prices bid in the Proposal and stipulated in supplementary agreements, if any, and not exceeding 80 per cent of the value of such materials as determined by the Engineer, provided that the materials have been delivered at or near the site of the work, are properly stored and protected and have been inspected and approved, and that the Contractor has furnished the Engineer with satisfactory releases of liens for said materials; and provided further, that if claims have been filed with the Commissioner against the Contractor, sufficient money may be withheld to satisfy such claims until they have been satisfied.

When the Project is completed and accepted by the Commissioner a final certificate of cost of the Project will be made by the Engineer, based on the actual quantities of authorized work done under each item scheduled in the Proposal and under supplementary agreements, if any, at the unit price or prices stipulated therein, and when this final certificate is approved, the money due the Contractor for the performance of the Project as determined by said

final certificate, after deduction of previous monthly payments on account, will be paid the Contractor, provided however, that before such final payment is made the following requirements shall be satisfied: (a) there shall be no outstanding claims against the Contractor filed with the Commissioner, (b) the Contractor shall have paid all due obligations and shall have furnished, when directed by the Engineer, receipted bills or other satisfactory evidence that all obligations incurred by him and by his subcontractors in carrying out the Project have been satisfied, and (c) the Contractor shall have delivered a bond as hereinafter specified in Art. 1.8.7 (p. 35).

When the work is suspended as provided in Art. 1.7.3 (p. 28), a semi-final certificate may be made at the discretion of the Engineer. This certificate will show the cost of the work completed and the estimated cost to complete the work, based on the unit prices bid in the Proposal and on the quantities scheduled in the Proposal as amended by extra or reduction orders, if any, and on additional work and the prices therefor, covered by supplementary agreements, if any, except that for such parts of the work that are not fully completed at the time of suspension of the work and for that reason are not susceptible to estimate as above provided, the estimated cost to complete will be determined by the Engineer. When this semi-final certificate is approved, payment will be made to the Contractor in the sum of the cost of the work completed after deduction of previous monthly payments on account and deduction of 25 per cent of the estimated cost to complete the work determined as described above, provided, however, that before said payment is made the following requirements shall be satisfied: (a) there shall be no outstanding claims against the Contractor filed with the Commissioner, (b) when directed by the Engineer, the Contractor shall have furnished receipted bills or other satisfactory evidence that all obligations incurred by him and his subcontractors in carrying out the work have been satisfied, and (c) the Contractor shall have delivered a bond as hereinafter specified in Art. 1.8.7 (p. 35).

Before semi-final payment will be made, the Contractor shall execute and deliver a release substantially in the following form:

"In consideration of the above payment we hereby release the State of New Jersey, the State Highway Commissioner and his agents from all claims and

liability of whatsoever nature for anything done or furnished or in any manner growing out of the doing of the Project, except that it is understood that credit will be given in the final estimate for the amount, covering 25 per cent of the estimated cost to complete the work which has been deducted in this semi-final estimate."

Before final payment will be made the Contractor shall execute and deliver a release substantially in the following form:

"In consideration of the above payment we hereby release the State of New Jersey, the State Highway Commissioner and his agents from all claims and liability of whatsoever nature for anything done or furnished or in any manner growing out of the doing of the work."

The acceptance by the Contractor of payment of said final or semi-final certificate shall operate as and shall be a release to the State, the Commissioner and his agents from all claims of or liability to the Contractor for anything done or furnished for or relating to the Project, or any act or neglect of the State, the Commissioner or any person, relating thereto, except that in the case of semi-final certificate being paid as above described the Contractor has the right and is obligated to continue and complete the Project when notice to resume has been received by him.

#### **1.8.6. Termination of Responsibility.**

When all the work included in this Contract has been accepted by the Commissioner and the final certificate has been paid, the Project shall be considered as completed, and the Contractor shall be released from all further obligations and requirements, except as set forth and provided in Art. 1.5.8 (p. 21), and 1.8.7 (p. 35).

#### **1.8.7. Guaranty Against Defective Work.**

Before final or semi-final payment is made as provided in Art. 1.8.5 (p. 33), the Contractor shall furnish a surety corporation bond to the Commissioner in a sum equal to 5 per cent of the Contract price. The bond and the surety corporation shall be satisfactory to the Commissioner, and the bond shall remain in full force and effect for a period of 1 year from the date of acceptance of the Project by

the Commissioner and shall provide that the Contractor guarantees to replace for said period of 1 year all work performed and materials furnished that were not performed or furnished according to the terms of the Contract, and make good defects thereof which have become apparent before the expiration of said period of 1 year.

If any part of the Project, in the judgment of the Engineer, for the reasons above stated needs to be replaced, repaired or made good during that time, he will so notify the Contractor in writing. If the Contractor refuse or neglect to do such work within 5 days from the date of service of such notice, the Engineer will have the work done by others and the cost thereof shall be paid by the Contractor or his Surety. Before the surety bond is released, the Engineer will certify in writing that the foregoing obligations have been fully performed.

## SECTION 9

### County and Municipal Projects

#### 1.9.1. Definition.

County and Municipal Projects shall mean Projects carried out under Motor Vehicle, Township or Borough Aid from the State, for which the County or Municipality, and not the State, is the contracting party.

#### 1.9.2. Additions and Modifications.

For County and Municipal Projects the provisions of these Standard Specifications shall apply except as herein provided.

In the text of these Standard Specifications, whenever the words Commissioner or Department, and the word State occur, except in Art. 1.1.3 (p. 1), and hereafter in amendments to Arts. 1.3.1, 1.3.4 and 1.7.1, the meaning of these words shall be Board, and Municipality or County respectively.

Art. 1.1.3 (p. 1), is amended and added to as follows:

**Board** shall mean the county or municipal body, legally constituted to enter into contracts for highway and bridge construction and to make payments therefor.

**County or Municipality** shall mean the political subdivision of the State of New Jersey as represented by the Board.

**Engineer, Solicitor and Clerk** shall mean the engineering representative, the legal representative, and the Clerk of the Board, respectively.

Art. 1.2.2 (p. 4), is amended to read, that the pre-qualification requirements shall be those of the Board, if any are required.

Art. 1.2.6 (p. 5), is amended to read, that the check shall be made payable to the treasurer of the county or municipality.

Art. 1.2.7 (p. 5), is amended to read, that the financial and the plant and equipment statements will not be required, unless forms therefor are included with the Supplementary Specifications.

Art. 1.3.1 (p. 6), is added to as follows: the award of the Contract is subject to the approval of the Commissioner.

Art. 1.3.3 (p. 7), is amended to read, that a personal bond, in the form prescribed by the Board, may be used in place of the surety corporation bond, subject to the discretion and approval of the Board.

Art. 1.3.4 (p. 9), is added to as follows: The 10-days period applies after the approval of the award of Contract by the Commissioner.

Art. 1.4.5 (p. 14), is amended to read, that the field office requirements do not apply, when the cost of the Project is less than 50,000 Dollars.

Art. 1.7.1 (p. 28), is amended to read, that the Contractor shall commence work within 10 days after the approval of the award by the Commissioner.

Art. 1.8.7 (p. 35), is amended to read, that no surety bond is required, unless otherwise stated in the Supplementary Specification.

## **DIVISION 2**

### **Earthwork**

#### **SECTION 1**

##### **Clearing Site**

###### **2.1.1. Description.**

**Clearing Site** shall include the work of clearing the site of the Project, grubbing, removing existing bridges and other structures, and other work as herein described, all in accordance with the Plans and Specifications.

###### **2.1.2. Materials.**

Paint required for cuts on trees, where branches have been removed, shall be an asphalt base paint, prepared for tree surgery and approved by the Engineer.

###### **2.1.3. Methods of Construction.**

Within the limits of the right-of-way and outside thereof within slope areas to be graded, or as otherwise prescribed, the ground surface shall be cleared of trees, brush, weeds, roots, matted leaves, small structures, debris and other unsuitable matter before construction work is commenced, except that trees which do not interfere with the Project, in the opinion of the Engineer, shall not be removed but shall be protected during the progress of the work. Branches of trees overhanging the traveled way shall be cut off to a height of 14 feet above it and cuts made, more than 1 inch in diameter, shall be painted. Tree stumps shall be grubbed out within the areas to be graded where the subgrade will be less than 3½ feet above the ground surface. Elsewhere they may remain extending not more than 1 foot above the ground surface.

The removal and disposal of elm trees in many counties of the State are subject to provisions of State laws and to regulations of the State Department of Agriculture. Before removing any trees within the site of the Project the Contractor shall consult the Supervisor of Pest Control of said department and his instructions relating to the

removal and disposal of elm trees shall be complied with by the Contractor.

Existing bridges and other structures within the Project which are to be removed by the Contractor shall be taken down and disposed of as may be specified. If needed for maintenance of traffic until new structures have been built, they shall not be removed until provisions for traffic, satisfactory to the Engineer, have been made. Cellars of houses, cesspools and similar cavities shall be cleaned out.

Materials accumulated by clearing, grubbing, removal of bridges and other structures and cleaning out as above described shall be burned or otherwise disposed of by the Contractor outside the property of the State and out of sight from any State highway in a manner satisfactory to the Engineer, except that materials suitable for embankment shall be used for that purpose if needed therefor.

#### 2.1.4. Quantity and Payment.

The quantity of Clearing Site, for which payment will be made, will be all the work required as described in Art. 2.1.3.

Payment for Clearing Site will be made at the lump sum price bid for the item CLEARING SITE in the Proposal, which price shall include the cost of clearing, grubbing, removal of bridges and other structures, cleaning out, and disposal of elm trees and other accumulated materials, all as above described, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto; provided, however, that when the item Clearing Site is not scheduled in the Proposal the cost thereof shall be included in the various scheduled items.

## SECTION 2

### Roadway Excavation

#### 2.2.1. Description.

Roadway Excavation shall include the excavation and removal of all earth, rock, boulders, concrete masonry, small structures and other materials encountered of whatsoever nature, required for the construction of roadways and their appurtenances, exclusive of those included under Clearing Site and under Channel, Foundation and Sub-

surface Structure Excavation; the transportation of the excavated materials; the construction of embankments of the materials excavated; the disposal of surplus materials; and other work as herein described, all at the locations prescribed, to the prescribed lines, grades and cross sections, and in accordance with the Plans and Specifications.

Roadway Excavation is classified as **Roadway Excavation, Earth, and Roadway Excavation, Rock**. In this classification, **Rock** shall include such rock only, that cannot be removed by means of a one-yard power shovel in good condition and properly operated, and which in addition requires drilling and blasting for its removal. It shall include also boulders and masses of concrete more than  $\frac{1}{2}$  cubic yard in volume. **Earth** shall include all other materials encountered of whatsoever nature.

### 2.2.2. Materials.

No materials are involved.

### 2.2.3. Methods of Construction.

No excavation shall be made and no embankment shall be formed within slope easement areas at any particular location until specific approval therefor has been given by the Engineer. Before grading work is commenced the vegetation and underlying topsoil of the existing ground surface within excavation and embankment areas, where shown on the Plans, shall be stripped off to a depth of not less than 4 and not more than 6 inches. Stripped off material which is or may be made suitable for topsoiling shall be stored, if needed for that purpose.

Roadway Excavation shall be carried to the lines, grades and slopes shown on the Plans, except that rock and boulders shall be excavated to a depth of not less than 1 foot below roadway subgrade between outside edges of shoulders or curbs, and the space left thereby shall be refilled to subgrade level with material and in a manner satisfactory to the Engineer. Rock slopes shall be finished to a fairly uniform surface, and pieces of rock which have been loosened or may become loose, in the opinion of the Engineer, on account of the Contractor's operations, within or outside the payment lines, shall be removed without cost to the State. Earth slopes, shoulders and other formed surfaces shall have a neat finish. When permission is given to widen an excavation to obtain additional embankment material, the slopes and other surfaces of the widened work shall be smooth and neatly finished

to the lines prescribed by the Engineer. Roadway excavation shall be carried out so that the subgrade throughout the work is kept properly drained. Unless otherwise directed a plough furrow, 6 inches deep, shall be cut in the existing ground surface 4 feet outside the slope line at the top of the excavation and turned toward the excavation.

Excavated material shall be placed in embankment when suitable therefor, or shall be used for backfill or other purposes as may be directed by the Engineer in or adjacent to the Project, except that material in excess of that required therefor shall be disposed of by the Contractor at locations provided by him. Pavements over which excavated materials are being transported shall be maintained clean of such materials.

The Contractor shall make his own arrangements with owners of abutting property regarding permission to store topsoil, to place embankment and other materials, and to excavate beyond the limits of the right-of-way and of slope rights acquired for the Project. Where any such materials remain or excavations have been made beyond the prescribed slope lines and outside of the right-of-way and slope right areas acquired by the State, when the Project is otherwise completed, the Contractor shall obtain written releases from the owners of the abutting properties, on whose land materials remain or excavations have been made. The releases shall be in a form satisfactory to the State, shall protect the State against claims or actions of the owner with respect to the presence of such materials or excavations, and shall be delivered to the Engineer.

When rock is encountered, the Contractor shall remove its earth cover in order that proper measurements may be taken. Rock removed prior to such measurements will be measured as earth.

#### 2.2.4. Quantity and Payment.

Roadway Excavation will be measured in the original position of the excavated materials by the cross section method, and the volumes of earth and rock will be computed by averaging end areas. The quantities for which payment will be made will be the volumes of rock and earth actually removed within the neat lines of excavation shown on the Plans or as directed by the Engineer, except as follows.

Stripping will not be measured as Roadway Excavation, but the area stripped in accordance with the Plans or as directed by the Engineer will be measured and payment made therefor as hereafter provided.

In rock, if removed entirely within the prescribed lines, the volume will extend 1 foot horizontally beyond each of the prescribed slope lines and 6 inches vertically below the grade fixed for bottom of excavation in rock, and the volume of earth overlying the rock cut will be that within 1½:1 slope lines meeting the top edge of the rock cut as made, provided, however, that said slope lines will not be measured more than 1 foot horizontally beyond the prescribed neat rock slope lines at the top of the rock cut. Re-excavation due to slips, slides and other causes will not be measured for payment. Materials removed under the item Clearing Site will not be measured for payment under this item.

When the item Pavement Excavation is scheduled in the Proposal, the excavation of plain and reinforced concrete pavement courses together with any superimposed surface courses will not be measured for payment under Roadway Excavation, but the quantity thereof for which payment will be made will be the area of concrete pavement actually removed in accordance with the Plans or as directed by the Engineer, and payment will be made under the item Pavement Excavation. The removal of existing pipes, culverts and other subsurface structures outside the limits of the excavation for new subsurface structures and the refilling of the spaces left thereby will not be measured for payment, but the cost thereof shall be included in the price bid for Roadway Excavation, Earth. When permission is given to widen the excavation to obtain additional embankment material, the additional excavation will be measured for payment as Roadway Excavation, Earth.

When the item Roadway Excavation, Rock, is not scheduled in the Proposal, the excavation of rock, as defined in Art. 2.2.1, encountered in Roadway Excavation will be measured and paid for at 3 times the price bid for the item Roadway Excavation, Earth, in the Proposal.

Payment for Roadway Excavation, Earth, and Roadway Excavation, Rock, when scheduled in the Proposal, will be made for the quantities of each as above determined, measured in cubic yards, at the prices bid for the items ROADWAY EXCAVATION, EARTH, and ROADWAY

EXCAVATION, ROCK, respectively, in the Proposal, which prices shall include the cost of excavation of the materials encountered; removal of small structures; transportation of the excavated materials; refilling to subgrade in rock excavation except where subbase is required; the forming and compacting of embankments of the materials excavated; the removal of existing pipes, culverts and other structures as specified and the refilling of spaces left thereby; the shaping and dressing of slopes, shoulders, islands and other surfaces; the disposal of all surplus materials; cleaning pavements; all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for Pavement Excavation will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item PAVEMENT EXCAVATION in the Proposal, which price shall include the cost of excavation; transportation; placing in embankment or other disposal of the material excavated; all labor, equipment and all else necessary therefor; and all other work in connection therewith and incidental thereto.

Payment for Stripping will be made for the quantity as above determined, measured in acres, at the price per acre bid for the item STRIPPING in the Proposal, which price shall include the cost of stripping and storing the stripped off material, disposal of unsuitable material, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 3

### Borrow Excavation

#### 2.3.1. Description.

**Borrow Excavation** shall include the furnishing, transporting, placing and consolidating material required for embankment in excess of that obtained from other excavation and other incidental work, all in accordance with the Plans and Specifications, except that widening of roadway excavations, when permitted to obtain additional embankment material, shall be included under the item Roadway Excavation, Earth, as provided in Art. 2.2.4 (p. 41).

#### 2.3.2. Materials.

The borrow excavation material shall be suitable for embankment and approved by the Engineer.

### 2.3.3. Methods of Construction.

The material shall be taken from borrow pits furnished by the Contractor and located not less than 300 feet outside the property of the State, except when otherwise approved. Before opening a borrow pit the Contractor shall notify the Engineer about it, so that elevations and measurements may be taken before excavation is started. All topsoil, sod, brush, weeds and other materials, unsuitable for embankment materials, shall be removed from the surface of the pit before said elevations and measurements will be taken. The Contractor shall keep accurate records of number and sizes of truck loads of embankment material leaving the borrow pit, and of those placed in embankment, in a manner approved by the Engineer and shall furnish these records to the Engineer. Trucks transporting material from borrow pits shall have tight bodies and shall be loaded so that no material is lost while in transport. Pavements over which the material is transported shall be maintained clean of such material.

### 2.3.4. Quantity and Payment.

The quantity of Borrow Excavation for which payment will be made will be the actual volume in place in the borrow pit of material removed, as determined by borrow pit measurements made by the Engineer before and after removal, except that materials removed from the borrow pit before the Engineer has taken cross-sections of the surface and other necessary measurements, or removed and wasted, or used for other purposes than embankment, or used to replace excavated material required for embankment but wasted or used for other purposes, will not be included in the quantity for which payment will be made. Materials obtained from widening of excavations will not be measured under this item.

Payment for Borrow Excavation will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item BORROW EXCAVATION in the Proposal, which price shall include the furnishing of the borrow pit, the excavating, transporting, placing in embankment and compacting the materials, cleaning of pavements, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

**SECTION 4*****Embankment*****2.4.1. Description.**

**Embankment** shall include the placing in embankment of suitable materials obtained from the various scheduled items of excavation, at the prescribed locations, and conforming to the prescribed lines, grades, cross sections and dimensions, and to the Plans and Specifications.

**2.4.2. Materials.**

Materials used for embankment shall be suitable therefor and shall be free from stumps, wood, brush, roots, sod, rubbish, garbage and other matter that may decay. The materials shall be those available from Roadway, Channel, Foundation and Subsurface Structure Excavation. Any such materials wasted, or otherwise disposed of by the Contractor, shall be replaced with other suitable material at the Contractor's expense. When more material is needed it shall be obtained from Borrow Excavation. Embankment material used adjacent to bridge abutments and similar structures shall be porous, permitting free percolation of water, and shall be acceptable to the Engineer. It shall be selected from available excavation material, unless otherwise prescribed.

**2.4.3. Methods of Construction.**

Before placing the embankment material the underlying ground surface shall be stripped as provided in Art. 2.2.3 (p. 40), and the stripped surface shall be compacted by rolling. Except as hereinafter provided, the embankment shall be formed in successive layers, not more than 12 inches deep, and each layer shall be compacted by rolling until it is firm and unyielding, before the next layer is placed. The rolling shall be done by means of 3-wheel power rollers, weighing not less than 10 tons and having a load of not less than 330 pounds per lineal inch width of the rear wheels, as well as by tamping rollers of a design approved by the Engineer and having a load of not less than 200 pounds per square inch of bearing surface when a complete row of tampers is in contact with a level and plane surface. When the required consolidation cannot be obtained by rolling alone, watering, puddling and other methods and equipment may be required by the Engineer.

Embankment adjacent to abutments and other structures shall be formed in the same manner whenever practicable, and if not practicable, other means satisfactory to the Engineer shall be used to secure the required consolidation.

Embankment under water or on wet and unstable ground, shall be constructed by end dumping so that the soft underlying material will be forced to the sides and not to the front of the areas to be filled. End dumping shall be used to such an elevation only that will permit the use of compacting equipment, and the remainder shall be formed in layers as above described. End dumped material shall be properly compacted in a manner satisfactory to the Engineer. End dumping shall not be started until the suitability of the surface on which the embankment is to be placed has been approved by the Engineer, and it shall then proceed immediately and continuously. When interrupted for a period of 24 hours no dumping shall be done until the suitability of the surface has been re-approved by the Engineer. When the embankment material is partly rock and partly earth, the rock shall as far as possible be placed so as to form the lower part of the embankment, and the earth shall be conserved so that not less than 3 feet of the top of the embankment is earth or earth and rock, placed in such a manner that all voids are filled, and the upper part of the rock fill shall be chinked so as to make it earth tight, provided however, that the topmost material in all cases shall be earth to a depth of not less than 1 foot. Adjacent to bridge abutments and other structures and within the limits shown on the Plans, the embankment shall be constructed of porous material as described in Art. 2.4.2 (p. 45).

When the embankment is to be placed against the slope of an existing embankment or hill, the existing slope shall be ploughed or stepped as the Engineer may direct. No material shall be placed above the top of an existing embankment until the new embankment has been formed to that level. When embankment material is to be placed behind walls and other structures, the slope of the adjoining embankment shall be stepped to avoid wedge action. Embankment around culverts and piers and over arch structures shall be formed simultaneously on both sides thereof to approximately the same elevation. The slopes, earth shoulders and other surfaces of embankments, and of widenings of embankments permitted by the Engineer to dispose of surplus material, shall be neatly dressed

and finished to the required lines. Cellars of houses removed, grub holes and other similar depressions shall be filled with suitable material, thoroughly compacted by tamping, puddling and rolling.

#### 2.4.4. Quantity and Payment.

The cost of construction of Embankment as above described, including the placing of porous fill at abutments and elsewhere, will not be paid for under a specific scheduled item but shall be included in the prices bid for the various scheduled excavation items, except that when the item Porous Fill is scheduled in the Proposal such material, if obtained from other sources, will be measured for payment, and the quantity for which payment will be made will be the volume in place in the finished structure, actually placed in accordance with the Plans or as directed by the Engineer.

Payment for Porous Fill will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item POROUS FILL in the Proposal, which price shall include the cost of furnishing, placing and consolidating the fill, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 5

### Channel Excavation

#### 2.5.1. Description.

**Channel Excavation** shall include the excavation required for deepening, widening and relocating water channels, and the construction of ditches other than those within and adjacent to the right-of-way, to the lines and grades, and at the locations shown on the Plans, all in accordance with the Plans and Specifications.

#### 2.5.2. Materials.

No materials are involved.

#### 2.5.3. Methods of Construction.

The excavation shall be neatly finished as directed or approved by the Engineer. Suitable material excavated shall be used for embankment when needed for this pur-

pose. Surplus material shall be disposed of by the Contractor. When he is permitted to dispose of it near the banks of the channel or ditch, provision shall be made to insure proper flow of water from adjacent land to the waterway, and the site shall be restored to a condition satisfactory to the owner of the land and the Engineer.

#### 2.5.4. Quantity and Payment.

The quantity of Channel Excavation for which payment will be made will be the actual volume, measured in place, removed within the neat lines of Channel Excavation shown on the Plans or as directed by the Engineer. No classification will be made of the materials encountered, unless otherwise provided in the Supplementary Specifications.

Payment for Channel Excavation will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item CHANNEL EXCAVATION in the Proposal, which price shall include the cost of excavation of earth, rock, boulders and all other materials encountered, placing excavated material in embankment, shaping and dressing slopes and other surfaces, disposal of excess material, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 6

### Foundation Excavation

#### 2.6.1. Description.

**Foundation Excavation** shall include the excavation required for the construction of piers, walls and other structures and other work as hereafter described at the required locations, to the prescribed lines and elevations, and in accordance with the Plans and Specifications.

#### 2.6.2. Materials.

Timber for cofferdam floor shall be sound and subject to the approval of the Engineer. Broken stone at weep holes shall be of a quality and size approved by the Engineer. Backfill shall be suitable material, free from large and frozen lumps, wood and other foreign materials, and shall be acceptable to the Engineer.

### 2.6.3. Methods of Construction.

Excavations for foundations shall be properly supported and if necessary shoring, sheeting, sheet piling or other means of support shall be used. The Contractor shall at frequent intervals inspect rangers, braces, props, sheeting and other parts of excavation supports and maintain them, so as to guard against cave-ins. Sheeting shall be properly supported by backfill, and wedges holding the supports in place shall be tightly driven. In running sand, sheeting shall be caulked with suitable material. Cofferdams and cribs shall be carried sufficiently below the bottom of the foundation level and shall be properly braced and water tight. Their interior dimensions shall be ample to permit construction and inspection of forms, and for pumping outside of forms. Before the work of construction within the cofferdam is started the cofferdam shall be unwatered and maintained in that condition, and if necessary therefor, the excavation shall be carried below the established elevation of the bottom of the foundation, and a concrete seal shall be constructed below said elevation in accordance with the requirements of Art. 4.1.3 (p. 142). When required by the Engineer, the bottom of the excavation in cofferdams shall be covered with 1-inch planking supported on 2"x4" wales, securely spiked to the cofferdam, all in a manner approved by the Engineer. The planking shall be level and tight and shall be nailed to the wales. Cofferdams shall be constructed and maintained so that masonry placed therein is protected against damage from erosion and rising water. No lumber shall be left extending into the masonry without the approval of the Engineer. Pumping in an excavation shall be done so as to preclude concrete materials being carried away. Pumping shall not be done while concrete is being placed and for a period of not less than 24 hours thereafter, except from a suitable sump, separated from the masonry by a watertight wall or by other approved method. Unwatering of a sealed cofferdam shall not commence until the concrete seal has attained sufficient strength.

When an excavation has been carried to the required depth the material below shall not be disturbed, and in soft soil the last part of the excavation shall not be made until immediately before placing the masonry. If the structure is to be founded on rock or other hard material, loose and soft material shall be removed therefrom, and the hard surface shall be cleaned and cut either level, stepped

or serrated as the Engineer may direct. Seams in the rock shall be cleaned out and filled with concrete, mortar or grout as may be directed. The Contractor shall notify the Engineer when an excavation is completed, and masonry shall not be placed therein until the Engineer has approved the suitability of the underlying material. The Engineer may issue written orders for changes in elevations and dimensions of footings as he may deem necessary to secure satisfactory foundation support, and the Contractor shall comply therewith.

When the masonry has been placed, cofferdams and other temporary supports shall be removed, and excavated spaces not occupied by the permanent structure shall be backfilled to the surface of the surrounding ground with sufficient allowance for settlement of the fill. Backfill shall be placed in successive horizontal layers not more than 12 inches deep, and each layer shall be properly compacted by tamping or other approved method before the succeeding layer is placed or, if required by the Engineer, it shall be compacted by puddling. To prevent wedge action against the masonry slopes bounding the excavation shall be stepped. Backfill around culverts, arches and piers shall be placed simultaneously on both sides thereof to the same elevation. Backfill shall not be placed against concrete masonry, until the latter has been in place not less than 14 days. At weep holes and elsewhere behind the masonry, broken stone shall be placed as shown on the Plans.

Unless otherwise approved by the Engineer, for work in stream channels and other waterways no excavation shall be made and the bed of the water shall not be disturbed outside of the areas occupied by caissons, cofferdams, sheet piling or sheeting. On completion of the work any excess material outside of the limits of the structure resulting from the work shall be removed. When the Project is within or adjacent to navigable waterways the carrying out of the Project and the removal of excess material shall be subject to the approval of the U. S. Secretary of War as well as of the Engineer.

#### 2.6.4. Quantity and Payment.

The quantity of Foundation Excavation for which payment will be made will be the volume in place within vertical planes, 6 inches outside of the neat lines of the footings, from the surface of the ground as it exists at the

time when the foundation excavation is started to the elevations shown on the Plans or to such elevation as the Engineer may direct, provided, however, that where Foundation Excavation underlies excavation for which payment is made under other scheduled items, the quantity for which payment will be made under this item will include only material below the payment lines of such other items and provided further, that additional excavation for concrete seal in cofferdams will not be measured for payment. When it is necessary, in the opinion of the Engineer, to carry the foundations below the elevations shown on the Plans, the volume of excavation for the first 3 feet of additional depth will be included in the quantity for which payment will be made under the item Foundation Excavation. Excavation below this additional depth will be paid for as provided in Art. 1.8.4 (p. 32). Material forced up between piles and reexcavated, or additional material excavated to compensate for swelling due to driving of piles or on account of swelling, slips, slides or cave-ins, will not be measured for payment. Concrete seals in cofferdams will not be measured for payment, as stated in Art. 4.1.4 (p. 156).

The quantity of plank flooring in cofferdams, for which payment will be made, will be the actual volume of lumber placed as directed by the Engineer.

Payment for Foundation Excavation will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item FOUNDATION EXCAVATION in the Proposal, which price shall include the cost of excavation of all materials encountered of whatsoever nature; placing excess material in embankment, or otherwise disposing of it; excavation for concrete seal in cofferdams; backfill; stepping slopes; preparing, cleaning and sealing rock surfaces; shoring; sheeting, sheet piling, cofferdams, cribs and removal thereof; pumping; cleaning up waterways; all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for Plank Flooring in cofferdams will be made for the quantity as above determined, measured in feet board measure, at the price per M. ft. B.M. bid for the item FLOORING IN COFFERDAMS in the Proposal, which price shall include the furnishing and placing the lumber and fastenings, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

**SECTION 7****Subsurface Structure Excavation****2.7.1. Description.**

**Subsurface Structure Excavation** shall include excavation for drains, drain pipes, pipe culverts, sewers, water pipe, gas pipe, conduits, manholes, inlets, catch basins and similar structures, at the required locations, to the prescribed lines and elevations, and in accordance with the Plans and Specifications.

**2.7.2. Materials.**

No materials are involved.

**2.7.3. Methods of Construction.**

The excavation shall be made in open cut and shall be wide and deep enough to permit the installation of the subsurface structure in a workmanlike manner. Trenches for pipes shall be not less than 1 foot wider at the bottom than the outside diameter of the pipe and shall be opened for a distance of not more than 300 feet in advance of the laying of the pipe. The excavation shall be properly shored and braced. If close to existing pavements, sidewalks, curbs, railroads or structures of any kind, the excavation shall be secured by sheet piling or otherwise in a manner satisfactory to the Engineer. Suitable cross-ings shall be provided and maintained where necessary.

When the material at the bottom of an excavation is soft or otherwise unsuitable, additional material shall be removed to such a depth as the Engineer may require. Rock and boulders present in excavations for all pipe, and all materials in excavations for concrete or vitrified clay pipe, shall be removed within 6 inches of the pipe. The space excavated below the center line of pipes shall be refilled with suitable fine material, thoroughly compacted by tamping so that the surface on which the pipes are to be placed is firm and unyielding, at the true grade, and shaped to conform to the shape of the pipe, with recesses for bells, provided, however, that for vitrified clay and concrete pipe the foundation shall be firm but not rigid and shall provide a uniformly compacted bedding, 6 inches thick, around the lower half of the pipe.

When the subsurface structure is in place, the excavation shall be backfilled in layers not more than 6 inches thick. To a height of 1 foot above the top of a pipe, the backfill shall be of suitable fine material. Mechanical rammers, of a type satisfactory to the Engineer, shall be used for compacting the backfill unless the conditions are such that, in the opinion of the Engineer, their use is not warranted. When the backfill has been placed to within 1 foot of the top of the excavation it shall be puddled thoroughly, and the remaining backfill shall be placed and compacted by tamping and rolling. Sufficient backfill shall be placed to avoid the formation of depressions in the finished surface. Shoring, sheet piling and other supports shall be withdrawn as the backfilling proceeds unless otherwise approved by the Engineer.

#### 2.7.4. Quantity and Payment.

No specific payment will be made for subsurface structure excavation, and the cost thereof shall be included in the prices bid for the subsurface structures for which the excavations are made, except that boulders more than  $\frac{1}{2}$  cubic yard in volume and rock encountered, which cannot be removed in a practical manner by means of a trenching machine or ordinary hand methods without blasting, will be measured for payment. The measurement for rock in mass formation will extend 1 foot beyond the external barrel diameter of pipes and the outmost neat lines of other structures at the bottom and sides; for boulders the measurement will be of the actual volume excavated within the limits prescribed for rock in mass formation. The removal of buried crib work, heavy timbers and similar materials, requiring special work for their removal, will not be considered as part of Subsurface Structure Excavation when encountered in the excavation.

Payment for rock and boulder excavation as above described will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item ROCK EXCAVATION, SUBSURFACE STRUCTURES, in the Proposal, which price shall include the cost of excavation and disposal of the rock and boulders, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto. When this item is not scheduled, payment will be made as provided in Art. 1.8.4 (p. 32).

**SECTION 8****Subbase****2.8.1. Description.**

Subbase shall include the furnishing, placing and compacting suitable material in excavations made therefor below pavement subgrade at the locations shown on the Plans, and where the Engineer may find it necessary as the work progresses, all in accordance with the requirements of the Specifications.

**2.8.2. Materials.**

The materials used for subbase shall be as prescribed in the Supplementary Specifications.

**2.8.3. Methods of Construction.**

Within the prescribed lines excavation shall be made for the subbase, including outlet trenches where shown on the Plans. The subgrade for the subbase shall be shaped to the prescribed contour, shall be thoroughly compacted as described in Art. 2.9.3 (p. 55), and shall be free from water pockets. The excavation shall be refilled with the prescribed material, shall be consolidated as specified for Embankment, Art. 2.4.3 (p. 45), except that tamping rollers will not be required, and finished as subgrade as specified in Art. 2.9.3 (p. 55).

**2.8.4. Quantity and Payment.**

The quantity of Subbase for which payment will be made will be the compacted volume, measured in place, of subbase material actually placed in accordance with the Plans or as directed by the Engineer. Excavation for Subbase, including outlet trenches, will be measured as Roadway Excavation.

Payment for Subbase will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item SUBBASE in the Proposal, which price shall include the cost of furnishing, placing and consolidating the specified materials, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

**SECTION 9****Subgrade****2.9.1. Description.**

**Subgrade** shall include the preparing of the surface for pavements and shoulders which are to be placed thereon, at the locations and to the lines and grades shown on the Plans, in accordance with the requirements of the Specifications.

**2.9.2. Materials.**

No materials are involved.

**2.9.3. Methods of Construction.**

Subgrade construction shall be done after the underlying drains and other subsurface structures have been placed and the backfill therefor has been properly consolidated. Unstable places of embankment placed under this Contract within the subgrade area shall be excavated, refilled with suitable material and consolidated without cost to the State. Other unstable places within the subgrade area will be treated as provided under Subbase. Where existing macadam and gravel pavements underlie the subgrade, they shall be thoroughly scarified unless the subgrade level is more than 1 foot above the surface of such pavements.

The subgrade shall be shaped to conform to the required grade and contour and shall be thoroughly consolidated by means of rollers weighing not less than 330 pounds per lineal inch of tread of rear wheels, except when the material is not susceptible to heavy rolling, in which case other means shall be used as may be approved by the Engineer. For concrete pavements the initial preparation shall be not more than 1 inch above or below the true grade and shall extend 1 foot at each side beyond the strip of pavement about to be laid, and after the sideforms are in place the final preparation of the subgrade shall be made for a distance of not less than 400 feet in advance of the pavement to be immediately constructed. Low spots shall be filled in, high spots shall be scraped. The surface shall then be thoroughly rolled, after which it shall be left undisturbed until the concrete is placed. For gravel

roads, no rolling of subgrade is required unless otherwise prescribed.

The finished subgrade shall be at the proper grade and contour, firm, smooth and properly drained, and shall be so maintained until the pavement is placed thereon.

#### 2.9.4. Quantity and Payment.

Except for subgrade for concrete base and surface courses, no payment will be made for Subgrade under a specific scheduled item, but the cost thereof shall be included in the price bid for the pavement or shoulders placed thereon.

For Subgrade for concrete base and surface courses, the quantity of subgrade for which payment will be made will be the area of subgrade actually prepared in accordance with the Plans or as directed by the Engineer, measured within the limits of the concrete base or surface course to be placed thereon.

Payment for Subgrade for concrete base and surface course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item SUBGRADE in the Proposal, which price shall include the cost of preparing the subgrade complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 10

### Shoulders

#### 2.10.1. Description.

**Shoulders** shall include the construction of earth, gravel or stone shoulders as may be prescribed, and the preparing of subgrade for gravel and stone shoulders, at the prescribed locations, to the prescribed lines, grades and dimensions, and in accordance with the Plans and Specifications.

#### 2.10.2. Materials.

Gravel for gravel shoulders shall conform to the requirements of Art. 3.5.2 (p. 75). The material for stone shoulders shall be slag conforming to the requirements therefor specified in Art. 3.13.2 (p. 130), or broken stone of trap rock, dolomite, granite, gneiss, limestone or other

stone, that will not weather or readily shatter or crush under traffic, and that is capable of forming a hard, smooth and dense surface. The material shall be subject to the approval of the Engineer. The grading of the material required for the bottom course shall be such that all will pass a 3½-inch sieve, and not less than 75 per cent will be retained on a ⅝-inch sieve. For the top course, all shall pass a 1-inch sieve and not less than 30 and not more than 70 per cent a ⅝-inch sieve, and so much shall pass a No. 10 sieve as may be necessary to fill the voids and insure thorough binding of the material. This fine material shall be thoroughly distributed throughout the top course material.

### 2.10.3. Methods of Construction.

The construction of earth shoulders shall be part of the work of excavation and embankment construction, and shall include the necessary excavation and filling with suitable embankment material to the required surface, and the shaping, dressing and compacting the shoulder to a dense, hard surface.

Construction of gravel shoulders shall conform to the requirements for construction of gravel surfaces as specified in Art. 3.5.3 (p. 76).

Stone shoulders shall be constructed in 2 courses. Before the bottom course is placed, the subgrade shall have been compacted and finished to the prescribed grade. The bottom course shall be spread and thoroughly compacted, and subsequently the top course shall be spread and compacted so that the finished surface is hard, dense and smooth and conforms to the prescribed lines and grades. The thickness of the compacted top course shall be 2 inches, and the total thickness of the stone shoulders shall be as shown on the Plans. The compacting of the subgrade and the shoulder courses shall be done with rollers, producing a load of not less than 330 pounds per lineal inch of tread of rear wheels except when, in the opinion of the Engineer, the conditions are such that a smaller roller should be used.

### 2.10.4. Quantity and Payment.

The quantity of shoulder of the type indicated for which payment will be made will be the area actually constructed in accordance with the Plans or as directed by the Engineer, except that earth shoulders will not be

measured for payment, but the cost thereof shall be included in the price bid for Roadway Excavation.

Payment for gravel and stone shoulders will be made for the quantity of each type as above determined, measured in square yards, at the prices per square yard bid for the items GRAVEL SHOULDER and STONE SHOULDER, respectively, in the Proposal, which prices shall include the furnishing, placing and compacting of the shoulder material, preparing and compacting the subgrade, all materials, labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

## SECTION 11

### Topsoiling

#### 2.11.1. Description.

**Topsoiling** shall include the work of preparing for use as topsoil the material obtained from stripping, described in Art. 2.2.3 (p. 40), furnishing topsoil as may be required in excess of that obtained from stripping, placing topsoil, furnishing and placing slope boards, seed mixtures and grain seed, fertilizer, lime and other matter as herein specified, to the prescribed lines and grades, at the locations specified, in the quantities required, and in accordance with the Plans and Specifications.

#### 2.11.2. Materials.

**Topsoil.** The material obtained from stripping, which is suitable for topsoil, shall be cleaned by removing lumps, roots, matted leaves, stones more than 1 inch in diameter, branches and other unsuitable matter. Growing weeds shall be removed from stored topsoil immediately before it is used. When the quantity of topsoil obtained in this manner is insufficient for the Project, the Contractor shall furnish from other sources the additional material required and shall clean it as above described, and the cleaned topsoil shall have an organic content of not less than 4 per cent by weight. All topsoil shall have a Hydrogen Ion value of not less than 5.8 and not more than 6.5, and if necessary, lime shall be added to obtain the required value.

**Fertilizer.** Fertilizer shall be a complete commercial fertilizer mixture, analyzing 5 per cent nitrogen, 10 per cent available phosphoric acid and 5 per cent potash, with the following constituents per ton:

16% Nitrate of Soda .....	125 pounds
20.5% Sulphate of Ammonia .....	295 pounds
8% Nitrogen Tankage .....	250 pounds
20% Superphosphate .....	1000 pounds
50% Muriate of Potash .....	200 pounds
Filler .....	130 pounds

**Seed Mixtures.** Seed Mixtures shall be New Jersey Agricultural Experiment Station Mixtures No. 1 and No. 4, and the percentages of the various seeds and of the purity and germination shall be certified to conform to the requirements, specified by said Agricultural Experiment Station.

**Rye and Oats.** Rye and oats shall be rye and oat grain of standard purity and germination.

**Boulders.** Boulders and rock fragments shall be of non-weathering rock and shall be not less than 1 and not more than 3 cubic feet in volume.

**Boards and Stakes.** Boards and stakes shall be of sound, unsplit, full-dimensioned wood with no defects that may impair its usefulness.

### 2.11.3. Methods of Construction.

Immediately before placing the topsoil the slopes on which it is to be placed shall be deeply and thoroughly raked so as to destroy the surface crust and provide means for bonding the topsoil. The surfaces of islands, shoulders and sidewalk areas shall be scarified to a depth of 3 inches, all lumps shall be removed and the surface shall be raked to a uniform grade. On all slope surfaces more than 8 feet high, measured vertically and sloping 2:1 or steeper, continuous rows of 6"x1¼" boards shall be placed, spaced not more than 6 feet apart. The boards shall be set with the 1¼-inch face parallel to the slope surface and shall decline lengthwise at the rate of 3 feet horizontally to 1 foot vertically in the direction of the down grade of the adjacent roadway. The top of the boards shall be ½ inch below the finished topsoil surface, and grooves shall be cut in the slope to make room for the boards. The boards shall be held firmly in place by being nailed to the 2-inch face of 2"x4" stakes, not less

than 24 inches long and spaced not more than 3 feet apart.

The topsoil shall be spread over the surface in a uniform layer having a compacted thickness of 4 inches on slopes and sidewalk spaces, and 6 inches on islands, and fertilizer shall be broadcast over the topsoil at the rate of 1000 pounds per acre. The topsoil shall then be raked to an even surface and compacted with rollers weighing not less than  $4\frac{1}{2}$  and not more than  $5\frac{1}{2}$  pounds per lineal inch of tread to a smooth, even surface, conforming to the prescribed lines and grades. Immediately thereafter the surface shall be seeded.

On islands, Seed Mixture No. 1 shall be used where the underlying soil is fair to good, and No. 4 where the soil is clayey, shaly or sandy, both at the rate of 200 pounds per acre. Elsewhere Mixture No. 4 shall be used at the rate of 175 pounds per acre, together with rye or oat grain at the rate of 25 pounds per acre. Oats shall be used during the spring and rye during the fall. The surface shall then be raked lightly and compacted with rollers weighing not less than  $1\frac{3}{4}$  and not more than  $2\frac{1}{4}$  pounds per lineal inch of tread. The finished surfaces shall be smooth, even and conforming to the designated lines.

Seeding shall be done during the approximate time periods of April 1 to May 15, and August 15 to October 1, when the weather and soil conditions are suitable therefor. The seeding shall be completed during these time periods on all surfaces which are or can be made ready for the seeding. Slopes which are not ready for seeding with the specified seed mixtures during said time periods shall be seeded, as soon as the topsoil is in place, with oats during the summer and rye during the winter, at the rate of 100 pounds per acre. Except as hereafter provided, when the subsequent seeding season is reached, the crop of oats or rye shall be cut down, and the seed mixture shall be spread, raked into the ground and covered with a thin layer of additional topsoil mixed with fertilizer.

Where, in the opinion of the Engineer, the time at which the topsoiling can be completed will not permit the seeding of the specified seed mixture at the prescribed time periods until after the remainder of the Project is completed, the Contractor may omit said seeding and shall then deliver to the Engineer the amount of seed mixture needed for completing the seeding.

Where shown on the Plans, boulders or rock fragments as specified shall be placed at intervals of 3 feet and partly embedded in the earth surface.

#### 2.11.4. Quantity and Payment.

The quantity of Topsoiling for which payment will be made will be the surface areas of topsoil, 4 and 6 inches thick, respectively, actually placed and seeded in accordance with the Plans or as directed by the Engineer.

Payment for Topsoiling will be made for the quantity as above determined, measured in square yards, at the prices per square yard bid for: the items 4-INCH and 6-INCH TOPSOILING, respectively, in the Proposal, which prices shall include the cost of preparing the stripped off material for topsoil and placing it; furnishing, cleaning and placing topsoil in excess of that obtained by stripping; furnishing and placing slopeboards, grain seed, seed mixtures, lime, fertilizer, boulders or rock fragments; rolling; all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 12

### Sodding

#### 2.12.1. Description.

**Sodding** shall include the preparing of stripped off material, as specified in Art. 2.2.3 (p. 40), for topsoil and placing it; furnishing and placing topsoil required in excess of that obtained from stripping; furnishing and placing sod and other matter, as herein specified, on slopes, shoulders, islands and elsewhere, at the locations specified, to the prescribed lines and grades, and in accordance with the Plans and Specifications.

#### 2.12.2. Materials.

Topsoil shall conform to the requirements therefor, specified in Art. 2.11.2 (p. 58). The sod shall be of good quality upland meadow grass, free from noxious weeds and objectionable grasses. It shall contain all the dense root system of the grass and shall be not less than 1½ inches thick. It shall be cut in strips, with suitable tools, of a uniform width of not less than 12 inches. Before

removing the sod the grass shall be cut to a length of 2 inches and its surface shall be raked clean of all debris. Pegs for fastening sod on slopes may be pieces of plasterer's lath not less than 9 inches long, or similar pieces of wood.

### 2.12.3. Methods of Construction.

The sod shall be placed soon after being cut on a bedding of topsoil, 4 inches thick. Immediately before placing the sod the topsoil shall be thoroughly moistened with water. The sod shall be laid with offset joints, and on slopes the placing shall start at the bottom. The sod pieces shall be pressed closely together, and at the top of a slope the upper edge of the sod strips shall be turned into the soil and covered with earth. The sod shall be pressed into the underlying soil by thorough tamping and rolling, after which a thin layer of topsoil shall be spread over the whole sodded area and raked to a smooth, uniform surface. On slopes steeper than 4:1, the sod shall be held in place by pegs driven flush with the surface of the sod. The pegs shall be not more than 1 foot apart and not less than 2 pegs shall be used for each strip of sod.

The finished surface shall be smooth, even and to the prescribed lines. The sod shall be kept moist until the growth is established. Sod showing evidence of dying or other defects before acceptance of the Project shall be replaced.

### 2.12.4. Quantity and Payment.

The quantity of Sodding for which payment will be made will be the actual surface area covered as above described in accordance with the Plans or as directed by the Engineer.

Payment for Sodding will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item SODDING in the Proposal, which price shall include the cost of preparing stripped off material for topsoil and placing it; furnishing and placing topsoil in excess of that obtained from stripping; furnishing, placing and pegging sod; watering; all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 13

## Planting

## 2.13.1. Description.

**Planting** shall include the furnishing and planting of trees, shrubs, vines and plants, of the kinds and sizes specified, at the prescribed locations, and other work as herein specified, all in accordance with the Plans and Specifications.

## 2.13.2. Materials.

**Plant Materials.** In the following, Plant Materials shall mean trees, shrubs, vines and plants of all descriptions, required for the Project. All plant materials shall be of standard quality and first class representatives of their kind. They shall have normal, well developed branch systems and vigorous root systems; they shall be free from disfiguring knots, sun scald injuries, bark abrasions and other objectionable disfigurements, and they shall show appearance of normal health and vigor. Plant materials that are weak or thin, or which have been cut back from larger grades to meet certain specified requirements, will not be accepted. All plant materials shall comply with State and Federal laws relating to inspection for diseases and infestation, and inspection certificates shall be filed with the Engineer.

**Deciduous Trees.** Trees shall have straight bodies according to their habit of growth and shall be well branched and rooted. Top worked trees shall not be furnished. The diameter of trees, measured 6 inches above the collar, and the height of the central leader, measured from the ground line, shall be not less than specified.

**Evergreens.** Cone type evergreens shall have a single leader of the height specified, measured from ground to top, and the spread shall be approximately one-half the height.

**Deciduous Shrubs.** Deciduous shrubs shall be well branched and have a balanced root system capable of sustaining the shrub.

**Vines and Ground Cover.** Vines and ground cover shall be 2 years old field-grown plants unless otherwise prescribed.

**Perennials and Ferns.** Perennials and ferns shall be field-grown clumps.

**Topsoil.** Topsoil shall conform to the requirements therefor, specified in Art. 2.11.2 (p. 58).

**Manure.** Manure shall be horse or cow excrement or a mixture thereof, together with bedding of straw, peanut shells or other approved material, all thoroughly rotted, and shall be not more than 2 years old. The manure shall contain not more than a total of 5 per cent by volume of wood shaving, corn stalks and other foreign materials, and not more than 60 per cent by weight of water. The manure is subject to approval by the Engineer before delivery. Certified weight bills of manure delivered shall be furnished to the Engineer.

**Peat Moss.** Peat moss shall be medium to coarse raw sphagnum moss with an absorbing capacity of not less than 10 times by weight, a moisture content of not more than 15 per cent by weight and an average pH value of 4. It shall be shipped in bales containing 20 to 22 bushels and having an average weight of 170 pounds. Certified weight bills of peat moss delivered shall be furnished to the Engineer.

**Guy Wire.** Guy wire shall be 12-gauge galvanized iron wire.

**Wood Stakes.** Wood stakes shall be new 2"x2"x2 ft. long stakes of southern pine.

**Cedar Posts.** Cedar posts shall be of white cedar, 8 feet long and not less than 2 inches in diameter at the thinnest end.

**Rubber Hose.** Rubber hose shall be  $\frac{3}{4}$  inch corded hose.

**Shipment.** Immediately before shipment plant materials shall be dug with skill and care to avoid injury to or removal of fibrous roots. All precautions shall be taken and methods used, according to good practice, in handling, packing and shipping the plant materials. Plant materials, marked B & B in the itemized list, shall be balled and burlapped. For trees from 6 to 8 and from 8 to 10 feet high, the diameters of the ball shall be from 12 to 15 and 15 to 18 inches, respectively. For trees measured by their diameter, the diameter of the ball shall be as follows:

Diameter of tree, in.	1-1½	1½-2	2-2½	2½-3	3-4	4-5
Diameter of ball, in.	16-20	20-22	26	30	36	42

For bushes, the ball diameter shall be as follows:

Height of bush, ft.	1½-2	2-3	3-4	4-5	5-6	6-8	8-10	10-12
Diameter of ball, in.	12	12	13	15	18	24	30	36

For ferns and perennials, the diameter shall be 6 inches.

All plant materials shall be packed so as to insure against climatic and other injuries in transit. Railroad shipments shall be in adequately ventilated box cars. During transit roots of deciduous trees and shrubs shall be carefully protected with wet straw, moss or other suitable material. In handling of plant materials, care shall be taken to avoid injury to branches and roots. All shipments shall be accompanied by an invoice giving detailed description of the plant materials, the date of shipment and other pertinent information.

**Inspection.** All plant materials will first be inspected where they are growing. Certain items selected shall be marked with a seal furnished by the Department. The plant materials will again be inspected at arrival on the site of the Project, and not less than 24 hours before their arrival notice shall be given the Engineer to that effect. Materials arriving with broken seals or broken or loose balls, or with insufficient protection of roots, or with shriveled, dry or insufficiently developed roots, or which are weak or thin, or damaged or defective, or which do not comply with the Specifications, will not be accepted. The Contractor shall give the Inspector all necessary assistance when inspections are made.

### 2.13.3. Methods of Construction.

Immediately after delivery, exposed roots of all plant materials shall be covered with wet straw, burlap, moss or other suitable material in addition to the wrapping used for shipment, and shall be kept so covered until ready for planting. If not planted on the day of delivery, the roots shall be heeled-in in moist soil, and the tops shall be kept shaded or covered in a manner acceptable to the Engineer. For planting, pits shall be excavated, and minimum diameter and depth of the pits shall be as follows:

Trees 1"-2" diameter,	pit diameter 36",	pit depth 24"
Trees 2"-4" diameter,	" " 48",	" " 24"
Shrubs	" " 24",	" " 18"
Vines	" " 18",	" " 18"

For B & B materials, the pits shall be of such a size that there will be a space, not less than 6 inches, below and at the sides of the ball.

When ready for the planting of trees and shrubs, not less than 6 inches of topsoil, together with 15 pounds of

manure for each tree and 5 pounds for each shrub, shall be placed in the bottom of the pit, and the tree or shrub shall be set vertically thereon with the stand slightly below that in the nursery, except that budded or grafted stock shall be set not less than 3 inches below the previous stand. Care shall be taken that no manure comes in direct contact with the roots. The topsoil in the bottom as well as additional topsoil placed in the pit shall be worked around the roots and thoroughly firmed as the backfilling proceeds. Care shall be taken to avoid bruising or breaking the roots during the backfilling, and any large or fleshy roots bruised or broken shall immediately be pruned with a clean cut. After the pit has been partly backfilled and the soil firmed under and around the ball, the burlap covering shall be cut away from the upper half of the ball, and the remainder shall be adjusted so as to prevent formation of air pockets. The backfill shall then be completed and tamped so as to be firm and free from air pockets. Only topsoil shall be used for backfill, and excess excavated material shall be disposed of by the Contractor outside the limits of the Project. In planting vines, perennials and ferns, a similar procedure shall be followed, except that the depth of topsoil at the bottom of the pit shall be as approved by the Engineer. For each vine 5 pounds of manure shall be used.

Where the ground is level or on a slight slope a shallow basin with a diameter equal to that of the pit shall be left around each planting. On steeper slopes the backfill shall be formed into a dam so as to catch and hold water around the planting. A mulch of peat moss, 2 inches deep, shall be spread around each planting as directed by the Engineer. Where existing grass areas have been injured by the work, they shall be regraded and seeded as described in Art. 2.11.3 (p. 59). As the work of planting progresses all waste material shall be removed and the ground surface within the finished areas shall be raked and smoothed. Deciduous shrubs and trees with heavy tops shall be pruned so as to remove from one-third to one-half of the last season's growth, care being taken to preserve the natural appearance of the shrub or tree. Broken or badly bruised branches shall be removed with a clean cut and treated with paint as specified in Art. 2.1.2 (p. 38). The pruning shall be in accordance with best horticultural practice, appropriate to

the type of shrub or tree and to the special requirements of the individual shrub or tree.

Immediately after planting, deciduous trees of more than 3 inches in diameter, and evergreens more than 6 feet in height, shall be firmly supported by means of 3 guy wires, attached to wood stakes, driven into the ground and notched for the wires. Each guy shall be made up of 2 strands of wire. Pieces of rubber hose shall be used under the wires where they are attached to the tree. Where required by the Engineer, smaller trees shall be supported by cedar posts attached with rubber hose and wire.

Immediately after planting, and later as often as seasonal conditions may require it, the plantings shall be thoroughly watered, and the plantings shall be maintained by the Contractor until the acceptance of the Project. Any plantings which show evidence of dying, before the acceptance of the Project, shall be replaced. Attention is called to the requirements of Art. 1.8.7 (p. 35).

#### 2.13.4. Quantities and Payment.

The quantities of Planting for which payment will be made, will be the number of units of the various plant materials actually planted in accordance with the Plans or as directed by the Engineer.

Payment for Planting will be made for the quantities of each kind of plant material as above determined, at the price for each unit bid for the various items of PLANTING in the Proposal, which prices shall include the cost of furnishing the plant material and protection thereof before planting; excavation, planting, manuring, backfilling with topsoil, mulching, pruning tops and roots, supporting trees, repairing ground surface, disposal of excess excavated and waste materials, watering, maintenance, replacements, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 14

### Rip-Rap Slope Protection

#### 2.14.1. Description.

**Rip-Rap Slope Protection** shall include the furnishing and placing of stones on slopes according to the prescribed

lines and grades, at the required locations and in accordance with the Plans and Specifications.

#### 2.14.2. Materials.

The stones shall be of durable rock approved by the Engineer and shall weigh not less than 50 and not more than 150 pounds each, and not more than 40 per cent shall weigh more than 100 pounds each.

#### 2.14.3. Methods of Construction.

The slope on which the protection is to be placed shall be shaped to an even surface. The stones shall be placed with their longest axis perpendicular to the slope and in close contact and shall be firmly bedded in the slope. Open spaces between stones shall be filled with spalls firmly rammed in place. The larger stones shall be used in the lower courses. The finished surface shall be even and to the required lines.

#### 2.14.4. Quantity and Payment.

The quantity of Rip-Rap Slope Protection for which payment will be made will be the surface area actually covered in accordance with the Plans or as directed by the Engineer.

Payment for Rip-Rap Slope Protection will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item RIP-RAP SLOPE PROTECTION in the Proposal, which price shall include the cost of furnishing and placing the stones as above described, all materials, labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

## SECTION 15

### Concrete Bag Slope Protection

#### 2.15.1. Description.

**Concrete Bag Slope Protection** shall include the furnishing and placing of concrete in bags on slopes, according to the prescribed lines and grades, at the required locations and in accordance with the Plans.

### 2.15.2. Materials.

The concrete shall be Class D, as specified in Art. 4.1.2 (p. 141), with  $\frac{3}{4}$ - or  $\frac{5}{8}$ -inch Size coarse aggregate. The bags shall be approved cloth bags with a capacity of 1 cubic foot.

### 2.15.3. Methods of Construction.

The slope on which the protection is to be placed shall be shaped to an even surface, and the bags, filled two-thirds with dry concrete mixture shall be laid on it as shown on the Plans in close contact and in horizontal courses with staggered joints, and with tied ends turned in and trade marks placed so as not to show. The entire surface shall be pounded flat with planks and mauls so that all spaces between the bags are closed and the surface is even and uniform. After being placed the concrete shall be sprinkled with water so as to moisten the concrete mixture throughout.

### 2.15.4. Quantity and Payment.

The quantity of Concrete Bag Slope Protection for which payment will be made will be the volume of concrete actually placed in accordance with the Plans or as directed by the Engineer.

Payment for Concrete Bag Slope Protection will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item CONCRETE BAG SLOPE PROTECTION in the Proposal, which price shall include the cost of furnishing and placing concrete in bags as above provided, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## **DIVISION 3**

### **Pavements**

#### **SECTION 1**

##### **Gravel Base Course**

###### **3.1.1. Description.**

**Gravel Base Course** shall include the construction of pavement base courses of gravel and the reconstruction of existing gravel roads for base courses at the prescribed locations, to the prescribed lines, grades and dimensions, and in accordance with the Plans and Specifications. For new base courses it shall include also the preparation of subgrade.

###### **3.1.2. Materials.**

The materials shall be as specified in Art. 3.5.2 (p. 75).

###### **3.1.3. Methods of Construction.**

The methods of construction shall be as specified in Art. 3.5.3 (p. 76). The finished base course shall be thoroughly compacted and bound together, hard, smooth and even and at the proper grade and contour.

###### **3.1.4. Quantity and Payment.**

The quantity of new or reconstructed gravel base course for which payment will be made will be the area actually constructed in accordance with the Plans or as directed by the Engineer. In addition, for Reconstructed Gravel Base Course the truck volume of new gravel required and used, or the weight thereof, as may be specified, will be measured for payment.

Payment for New Gravel Base Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item GRAVEL BASE COURSE in the Proposal, which price shall include the cost of preparing subgrade, construction of the course complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for Reconstructed Gravel Base Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item RECONSTRUCTED GRAVEL BASE COURSE in the Proposal, which price shall include the cost of construction complete, all materials except gravel, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for new gravel for Reconstructed Gravel Base Course will be made for the quantity as above determined, measured in cubic yards or tons, at the price per cubic yard or ton bid for the item ROAD GRAVEL in the Proposal, which price shall include the cost of furnishing the gravel, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 2

### Macadam Base Course

#### 3.2.1. Description.

Macadam Base Course shall include the preparation of subgrade for and the construction of pavement base courses of macadam to the prescribed lines, grades and dimensions, at the prescribed locations and in accordance with the Plans and Specifications.

#### 3.2.2. Materials.

The aggregate shall be 2½-inch Size stone or slag, conforming to the requirements therefor, specified in Art. 3.13.2 (p. 129). Binder materials shall be Screenings B, conforming to the requirements therefor, specified in Art. 3.13.2 (p. 131), or Road Gravel, Grade A, or Grade B, conforming to the requirements therefor, specified in Art. 3.5.2 (p. 75).

#### 3.2.3. Methods of Construction.

The subgrade shall be prepared as specified in Art. 2.9.3 (p. 55), and shall be in a properly finished condition and not wet or frozen, when the base course is about to be placed thereon. The aggregate shall be spread on the subgrade in a layer of the proper depth and shall be compacted with 3-wheel power-driven rollers having a

load of not less than 330 pounds per lineal inch of tread of rear wheels, until thoroughly consolidated. The binder shall then be spread over the aggregate in small quantities and shall be swept and rolled into the voids, care being taken to form no surface crust. More binder shall be spread, swept and rolled as many times as may be necessary to fill all voids and until the aggregate ceases to sink or creep under the roller. No rolling shall be done when the binder is wet, and the binder shall not be dumped or stored on the aggregate. If during the construction the subgrade is forced below its proper level or up into the voids of the aggregate, the Contractor shall, without cost to the State, remove and replace loose and unstable subgrade material placed under this Contract, reshape the subgrade and replace and reconsolidate the base course to the satisfaction of the Engineer.

The finished base course shall be at the prescribed grade and contour, shall have the required depth and width, shall be free from excess binder, ruts and loose stones, and shall show no evidence of instability and other defects.

#### 3.2.4. Quantity and Payment.

The quantity of Macadam Base Course, for which payment will be made, will be the area actually constructed in accordance with the Plans or as directed by the Engineer, without deduction of areas occupied by manholes and similar structures within the pavement area.

Payment for Macadam Base Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item MACADAM BASE COURSE in the Proposal, which price shall include the cost of preparing subgrade, construction of base course complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

### SECTION 3

#### Concrete Base Course

##### 3.3.1. Description.

**Concrete Base Course** shall include the construction of pavement bases of concrete, at the prescribed locations, to the required lines, grades and dimensions, and in accordance with the Plans and Specifications.

### 3.3.2. Materials.

The materials shall conform to the requirements therefor, specified in Art. 3.11.2 (p. 104), except that Class D concrete shall be used (p. 141).

### 3.3.3. Methods of Construction.

The concrete base course shall be constructed in all respects in conformity with the requirements of Art. 3.11.3 (p. 107), except as follows: No transverse or longitudinal expansion joints are required. When the placing of the concrete is temporarily discontinued it shall be finished against a vertical bulkhead, and when resumed the bulkhead shall be removed and the concrete shall be placed against the previously finished concrete. Hand finishing may be used. The surface needs not be belted or tooled, but shall be rough broomed. The minimum age required of the concrete for temporary opening for traffic, if so desired by the Contractor, or for placing of pavement surface, shall be 12 days between May 16 and October 15, and 15 days before and after said dates, when standard cement is used. When high early strength cement is used, the time periods shall be 3 and 4 days, respectively.

### 3.3.4. Quantity and Payment.

The quantity of Concrete Base Course, for which payment will be made, will be the area actually constructed in accordance with the Plans or as directed by the Engineer, without deductions of areas occupied by man-holes and similar structures within the pavement area.

Payment for Concrete Base Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item CONCRETE BASE COURSE in the Proposal, which price shall include the cost of constructing, finishing, curing and protecting the pavement, of all materials including reinforcement steel, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 4

### Modified Penetration Macadam, Intermediate Course (P.R.A. Class D)

#### 3.4.1. Description.

**Modified Penetration Macadam, Intermediate Course,** shall include the construction of intermediate courses of hot application modified penetration macadam. The intermediate course will be laid on a base course and subsequently covered with a surface course as may be specified. The course shall be constructed at the prescribed locations, to the prescribed lines, grades and dimensions and in accordance with the Plans.

#### 3.4.2. Materials.

The aggregate shall be stone or slag and shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 129). Bituminous binder shall be asphalt cement Grade NA-4, T-4 or OA-4, or tar Grade RT-11 or RT-12, conforming to the requirements therefor specified in Art. 3.13.2 (p. 120).

#### 3.4.3. Methods of Construction.

The course shall be constructed as specified in Art. 3.8.3 (p. 84), except that the second and third applications of bituminous binder and their cover materials shall be omitted, and that the bituminous binder shall be applied at the rate of from 1.65 to 1.75 gallons per square yard.

The finished surface shall be firmly bound together, without improperly rolled or consolidated spots, porous places and other defects, and shall be true to grade and contour.

#### 3.4.4. Quantity and Payment.

The quantities of Modified Penetration Macadam, Intermediate Course, for which payment will be made, will be the actual area constructed, without deductions of areas occupied by manholes and similar structures within the area paved, and the volume of bituminous material used within the prescribed areas, all in accordance with the Plans or as directed by the Engineer.

Payment for Modified Penetration Macadam, Intermediate Course, will be made for the quantity as above determined, measured in square yards, at the price per

square yard bid for the item MODIFIED PENETRATION MACADAM, INTERMEDIATE COURSE, in the Proposal, which price shall include the cost of construction complete, all materials except bituminous material, labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

Payment for bituminous material will be made for the quantity as above determined, measured in gallons at 60 deg. F., at the price per gallon bid for the item BITUMINOUS BINDER, MODIFIED PENETRATION MACADAM, in the Proposal, which price shall include the cost of furnishing and applying the bituminous material, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 5

### Gravel Surface Course

#### 3.5.1. Description.

**Gravel Surface Course** shall include the construction of pavement surface courses of gravel, and the reconstruction of existing gravel surfaces, at the prescribed locations, to the prescribed lines, grades and dimensions, and in accordance with the Plans and Specifications. For new surface courses, it shall include also preparation of sub-grade.

#### 3.5.2. Materials.

**Road Gravel, Grade A**, shall be from coastal plains deposits and shall be hard, durable pebbles, mixed with sand and clay, so that the material can be compacted into a hard dense mass. It shall be graded so that, after elutriation, all will pass a 1½-inch sieve, not less than 85 per cent a 1¼-inch sieve, from 45 to 85 per cent a ¾-inch sieve, and from 30 to 70 per cent a No. 6 sieve, provided, however, that if more than 70 and not more than 78 per cent will pass a No. 6 sieve, the gravel may be used, if sufficient coarse gravel particles are added of such a size, that the mixture will conform to the requirements specified above. The road gravel shall contain by weight not more than 5 per cent of shale, slate, shist and soft or decomposed pebbles, and from 4.5 to 12 per cent of elutriable clay.

**Road Gravel, Grade B**, shall be from glacial deposits and shall be hard, durable pebbles, mixed with sand and clay, so that the material can be compacted into a hard, dense mass. It shall be graded so that, after elutriation, all will pass a 2-inch sieve, not less than 90 per cent a 1½-inch sieve, not less than 80 per cent a 1¼-inch sieve, from 60 to 90 per cent a ¾-inch sieve, and from 30 to 70 per cent a No. 6 sieve. The gravel shall contain by weight from 5 to 25 per cent of shale, slate, shist and soft or decomposed pebbles, and from 4 to 9 per cent of elutriable clay; provided, however, that gravel with less than 4 per cent of such clay may be approved, when service records indicate its suitability.

### 3.5.3. Methods of Construction.

**New Surface Course.** For new pavements, the subgrade shall be prepared as specified in Art. 2.9.3 (p. 55), shall be in a properly finished condition and not wet or frozen, when the surface course is about to be placed thereon. The construction of the pavement shall start at the point nearest the source of supply, and the construction trucks shall be operated over the newly placed gravel in a manner that will tend to give uniform compaction over the entire width of the pavement.

The gravel shall be spread on the full width of the subgrade in a uniform layer of the proper depth. When the gravel is deficient in coarse particles, as described in Art. 3.5.2 (p. 75), the required coarse gravel particles shall be spread thereon and the two materials shall be thoroughly mixed by harrowing and blading. After being spread, or spread and mixed as above described, the road gravel shall be harrowed and scraped, and places deficient in density or stability or having a tendency to ravel shall be repaired, or the gravel shall be removed and replaced, as the Engineer may direct, and material that does not compact properly shall be replaced with suitable gravel. The harrowing and scraping shall begin as soon as the gravel has been spread and shall continue at intervals, as the gravel is being consolidated by the construction equipment, until it is thoroughly compacted. Highway traffic shall then be carried over the new pavement, which shall be maintained by the Contractor until, in the opinion of the Engineer, the gravel is properly consolidated. During the maintenance period the surface shall be scraped continually in a manner approved by the Engineer.

The finished pavement shall be thoroughly compacted are bound together, hard, smooth and even, free from defects, and at the proper grade and contour.

**Reconstructed Surface Course.** The existing gravel pavement shall be thoroughly scarified to the prescribed bottom of the surface course. Scarified material, containing an excess of clay or other unsuitable materials, shall be removed and replaced with new gravel and, if necessary, new gravel shall be added to obtain the required surface grade. The materials shall be bladed to a uniform mixture and roughly shaped to the contour of the surface course. The surface course shall then be constructed and finished as provided for New Surface Course above.

#### 3.5.4. Quantity and Payment.

The quantity of New or Reconstructed Gravel Surface Course, for which payment will be made, will be the area actually constructed in accordance with the Plans or as directed by the Engineer. In addition, for Reconstructed Gravel Surface Course, the truck volume of new gravel required and used, or the weight thereof, will be measured for payment, as may be specified.

Payment for New Gravel Surface Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item GRAVEL SURFACE COURSE in the Proposal, which price shall include the cost of preparing subgrade, construction of the course complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for Reconstructed Gravel Surface Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item RECONSTRUCTED GRAVEL SURFACE COURSE in the Proposal, which price shall include the cost of construction complete, all materials, except gravel, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for new gravel for Reconstructed Gravel Surface Course will be made for the quantity as above determined, measured in cubic yards, or tons, at the price per cubic yard or ton bid for the item ROAD GRAVEL in the Proposal, which price shall include the cost of furnishing the gravel, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 6

**Bituminous Surface Treatment**

(P.R.A. Class A)

**3.6.1. Description.**

**Bituminous Surface Treatment** shall include the furnishing and placing of bituminous and cover materials on pavement surfaces, and other work as hereafter described, at the prescribed locations, in the prescribed quantities, and in accordance with the Plans and Specifications.

**3.6.2. Materials.**

**Broken stone, slag, gravel and grits** shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 129). **Road Gravel** shall conform to the requirements therefor, specified in Art. 3.5.2 (p. 75). **Sand** for cover material shall be of a quality acceptable to the Engineer. **Asphalt Cement, Emulsified Asphalt, Asphaltic Oils and Tar** shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 120). Materials for specific purposes are shown in Art. 3.13.2, Table 8 (p. 126), and the materials specified in the Supplementary Specifications shall be used.

**3.6.3. Methods of Construction.**

**Distributors.** Bituminous materials shall be applied by means of motor driven pressure distributors of modern design, in good mechanical condition, of not less than 600-gallon capacity, capable of producing sufficient pressure to apply the bituminous material in the proper manner, calibrated as approved by the Laboratory, and equipped with spraying manifolds of various lengths as may be approved by the Engineer. The material shall be applied directly from the manifolds except where the conditions are unsuitable for their use. The distributors are subject to the approval of the Engineer. The distributors shall not be used, unless they are supplied with (a) An approved gauge sheet, available for the convenience of the Inspector, and showing the number and capacity of the truck, and an outage table for not less than each inch out, approved by the Laboratory. The number on gauge sheet shall correspond with the number of the truck. (b)

A metal rod with accurate  $\frac{1}{4}$ -inch divisions, showing inch marks more prominently and starting with the first inch at the bottom. The rod shall be used for gauging the quantity of material in the truck, and shall be not less than 1 foot longer than the diameter of the tank. (c) Duplicate delivery slips which shall accompany each load delivered and shall contain such information as may be required.

**Temperature.** The temperature, at which the various bituminous materials shall be applied, shall be as follows:

Asphaltic							
Oils	MC-O	MC-1, RC-1	RC-2	MC-2, RC-3	MC-3, RC-4&5	SCO	
deg. F.	50-120	80-125	100-175	150-200	175-250	80-150	
Tars	RTCB-5 & 6	RT-1 & 2	RT-3 & 4	RT-7, 8 & 9	RT-10 & 12		
deg. F.	60-120	60-125	80-150	150-225	175-250		

**Preparation of Surface.** On new construction the material shall be applied when the surface is properly shaped and compacted and when notice is received from the Engineer that it is in condition for the application. Immediately before the application the surface shall be thoroughly cleaned and all loose and foreign material that might interfere with proper penetration of the bituminous material shall be swept off.

Previously treated surfaces shall be prepared for the bituminous treatment as specified in the Supplementary Specifications. Where there are indications of unstable bottom or subbase failure, excavation shall be made to the depth required by the Engineer, and the space shall be filled with material, conforming to the existing surface, on an approved subbase. Where directed or approved by the Engineer, the pavement shall be patched with material as hereafter specified by cutting out the present pavement so as to form square openings with straight sides; the openings shall be properly cleaned out and painted with asphaltic oil or tar, shall be filled with patching material and shall be thoroughly compacted. After the surface is properly prepared and notice is received from the Engineer that it is in condition for application, the surface shall be cleaned and swept, as above described.

**Patch Material.** For Gravel Surface the patch material shall be sand and asphaltic oil, Grade SCO or MC-3, thoroughly mixed at the rate of  $3\frac{1}{2}$  tons of sand to 1 barrel of 50 to 55 gallons of asphaltic oil. For other types of

surfaces, the patch material shall be washed gravel, stone or slag, and asphaltic oil, tar or emulsified asphalt, in accordance with the requirements of Table 8 (p. 126), or as may be specified in the Supplementary Specifications, mixed at the rate of 3 tons gravel or stone or 2.1 tons slag,  $\frac{1}{2}$  ton sand or stone sand, and 1 barrel of bituminous material (50-55 gallons).

**Application.** The bituminous materials shall not be applied when the surface is wet. If dust remains that cannot be removed by sweeping the surface shall be sprinkled with water. Application shall not be made, unless the condition of the surface is acceptable to the Engineer.

**Application of Asphaltic Oil, Grade SCO.** On new construction the first application shall be at the rate of from 0.4 to 0.5 gallon per square yard. After the oil has properly penetrated, the specified cover material shall be placed at the rate of not less than 25 pounds per square yard. Four or five weeks later, and only when so directed by the Engineer, the second application of oil shall be made at the rate of about 0.3 gallon per square yard and it shall be covered immediately with the specified cover material at the rate of 25 pounds per square yard. On previously treated surfaces the application shall be as prescribed in the Supplementary Specifications.

After each application and during the curing process the surface shall be dragged with an approved drag two or three times a week, as the Engineer may direct. When the oil comes to the surface before the acceptance of the Project additional cover material shall be spread so as to keep the surface in proper condition.

**Application of other Asphaltic Oils and Tars.** On new construction the first application (prime coat) shall be at the rate of from 0.35 to 0.45 gallon per square yard of bituminous material as specified in the Supplementary Specifications and, if so directed by the Engineer, about 10 pounds of cover material per square yard shall be spread. Traffic shall not be permitted on the surface until the prime coat has thoroughly penetrated the surface and will not pick up under traffic. The second application (seal coat) shall be applied when the prime coat has penetrated properly. The bituminous material used shall be as specified in the Supplementary Specifications, shall be applied at the rate of from 0.3 to 0.4 gallon per square

yard, and shall be covered immediately with grits,  $\frac{3}{8}$ -inch or  $\frac{1}{2}$ -inch Size broken stone, gravel or slag, as may be specified, at the rate of about 35 pounds per square yard of grits, gravel or stone, and about 25 pounds per square yard of slag. The exact quantities shall be as directed by the Engineer.

After this application the surface shall be dragged with a light weight broom drag and shall then be rolled with a 3-wheel power roller, weighing not less than  $3\frac{1}{2}$  tons, unless otherwise specified. When the bituminous material comes to the surface before the acceptance of the Project in such a manner as to be likely to pick up, additional cover material of the proper grade shall be spread where required to keep the surface in proper condition. A sufficient number of barricades or guards shall be placed to keep the traffic off the treated pavement until it is ready to receive traffic. On previously treated surfaces, the application shall be as prescribed in the Supplementary Specifications.

#### 3.6.4. Quantity and Payment.

The quantities of Bituminous Surface Treatment for which payment will be made will be the volume of bituminous material at 60 deg. F., and the weight of cover material actually placed in accordance with the Plans or as directed by the Engineer, except that cover material for SCO treatment will not be measured by weight, but by the surface area covered in accordance with the Plans or as directed by the Engineer.

Payment for bituminous materials and cover materials will be made for the quantities as above determined, measured in gallons, and tons or square yards, respectively, at the unit prices bid for the item SURFACE TREATMENT, BITUMINOUS MATERIALS and the item, SURFACE TREATMENT, COVER MATERIALS, respectively, in the Proposal, which prices shall include the cost of furnishing and placing the bituminous, patch and cover materials complete; sweeping and cleaning; cutting out, cleaning and painting patches; all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto. Subbase reconstruction will be paid for as provided in Art. 1.8.4 (p. 32) or in the Supplementary Specifications.

## SECTION 7

## Lignin Treatment

## 3.7.1. Description.

**Lignin Treatment** shall include the treatment of gravel base and surface courses with lignin binder at the required locations, in the prescribed quantities, and in accordance with the Plans and Specifications.

## 3.7.2. Materials.

Lignin binder shall be liquid extracts from the manufacture of wood pulp, conforming to the following requirements: Solubility in hot or cold water min. 99.5%; Evaporation loss at 100°C. to const. weight max. 55%; Ash content max. 8%; Free acids max. 0.5%; SO<sub>2</sub> content as sulphite max. 1%; Total sulphur content as SO<sub>3</sub> min. 3.5%; CaO max. 6.5%; MgO max. 0.3%; Ferric oxide content max. 0.25%; Spec. grav. at 60° F. min 1.25.

The lignin binder shall be free from animal, vegetable or mineral oils, asphalt, tar and free carbon, and shall be uniform and homogeneous in composition. It shall be free from evidence of fermentation at the time of use. During concentration, the material shall not be heated above 235 deg. F., and shall not at any time be heated above that temperature. Standard evaporation methods shall be used, with the liquid being exposed progressively to lower temperatures.

## 3.7.3. Methods of Construction.

When not more than 0.2 gal. per sq. yd. is specified, only 1 application of the lignin binder is required, unless 2 are found necessary for proper penetration. When 0.2-0.4 gal. is specified it shall be applied in 1 treatment with not less than 2 applications. When more than 0.4 gal. is specified it shall be in 2 treatments, each with the number of applications as outlined above. The amount of lignin binder shall be as elsewhere specified, and the time intervals between applications shall be as approved or directed by the Engineer. Immediately before each treatment the surface shall be lightly scarified, and immediately after the last application of any treatment and after heavy rain the surface shall be scraped.

When applied, the lignin binder shall be diluted with water. The normal mixture shall contain 50 per cent lignin binder by volume, but the binder content may be required to be from 40 to 60 per cent of the mixture. The exact percentage and quantity to be used at each application and the exact number of applications for each treatment will depend on the conditions of the pavement and the weather at the time of application and will be determined by the Engineer. Applications shall not be made during heavy rain or when the surface is muddy or excessively wet. When the conditions of the gravel or the weather may require it, in the opinion of the Engineer, the pavement shall be watered before applying the lignin binder. The lignin binder mixture shall be applied uniformly over the whole surface of the pavement at such a rate that it will be absorbed into the gravel and not run off or form a surface crust.

The lignin binder shall be applied by means of a power driven pressure distributor, designed for the purpose, and equipped with a pump of sufficient pressure to apply the mixture and to keep the mixture uniformly in circulation in the tank. A sufficient number of spray nozzles of different sizes shall be provided to insure proper application of any required amount of lignin binder. The distributor and its equipment shall be subject to the approval of the Engineer. The lignin binder shall not be heated in the distributor or elsewhere.

Unless otherwise specifically provided, the scarifying, scraping and watering the surface is not included in this Project.

#### 3.7.4. Quantity and Payment.

The quantity of Lignin Treatment, for which payment will be made will be the volume of lignin binder at 60 deg. F., as determined by the Laboratory, actually used in accordance with the Plans or as directed by the Engineer.

Payment for Lignin Binder will be made for the quantity as above determined, measured in gallons, at the price per gallon bid for the item LIGNIN TREATMENT in the Proposal, which price shall include the cost of furnishing and applying the lignin binder, diluting water, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto, except that the cost of scarifying, scraping and watering surface shall not be included when this work is not included in the Project.

**SECTION 8****Penetration Macadam Surface Course,  
Hot Application  
(P.R.A. Class D)****Penetration Macadam Surface Course,  
Cold Application  
(P.R.A. Class D)****3.8.1. Description.**

**Penetration Macadam Surface Course** shall include the construction, on a previously prepared base course, of a pavement surface course of bituminous bound macadam, applied either hot or cold as may be specified, at the prescribed locations, to the prescribed lines, grades and dimensions, and in accordance with the Plans and Specifications.

**3.8.2. Materials.**

**Aggregates.** Broken stone shall be used unless otherwise specified and shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 129). For hot application, 1½-inch, ¾-inch or ½-inch and ⅜-inch Sizes shall be used, and for cold application the Sizes shall be 1½-inch, ¾-inch and ⅜-inch.

**Bituminous Binder, Hot Application.** For hot application, the bituminous binder shall be asphalt cement Grade NA-4, T-4 or OA-4, or tar Grade RT-11 or RT-12, conforming to the requirements therefor specified in Art. 3.13.2 (p. 120).

**Bituminous Binder, Cold Application.** For cold application, the bituminous binder shall be emulsified asphalt, Grade AE-3, conforming to the requirements therefor, specified in Art. 3.13.2 (p. 124).

**3.8.3. Methods of Construction.**

**General Requirements.** The surface course shall be constructed on a base course which shall be dry, free from frost, clean, free from loose or adhering foreign materials and properly finished at the time the surface course is placed thereon. All rolling shall be done with 3-wheel power driven rollers having a load of not less than 330

pounds per lineal inch of tread of rear wheels. The rolling shall be first parallel to the axis of the pavement, starting at the edges and working towards the center, and subsequently it shall be diagonal as well as parallel to the axis. All parts of the pavement shall be rolled by the rear wheels.

The 1½-inch Size aggregate shall be spread on the base course to the proper depth. It may be spread directly from a vehicle approved for the purpose, and shall not be dumped in piles within the area on which it is to be spread. After being spread the stones shall be kept clean and protected from coatings of foreign materials until the bituminous binder is applied. Not more than sufficient aggregate for a day's work shall be spread in advance of rolling and application of bituminous binder, unless otherwise approved by the Engineer. The aggregate shall be rolled until thoroughly compacted to the proper grade and contour, and then the surface shall not be used for any purpose until the bituminous binder is being applied. The bituminous binder material shall then be applied as hereafter described from pressure distributors, conforming to the requirements therefor, specified in Art. 3.6.3 (p. 78). Precautions satisfactory to the Engineer shall be taken to prevent spilling of the bituminous material on the pavement surface or adjacent ground when the equipment is being made ready for operation, and to prevent duplication of application when operations have stopped temporarily. Broom drags and other equipment shall be subject to the approval of the Engineer. After the required number of applications of bituminous binder and cover materials have been made as hereinafter specified, any places found deficient in bituminous binder or insufficiently coated or bound or below the required grade shall have additional binder and cover material applied by hand and shall be rerolled; or shall be repaired as the Engineer may direct. If it is desirable to roll the surface after it is opened for traffic, in the opinion of the Engineer, this shall be done when and as directed by him.

The finished surface shall be firmly bound together, free from improperly rolled or consolidated spots, porous places, depressions and projections of more than ¼ inch in 10 feet, and excess of ⅝-inch Size aggregate, and shall be at the proper grade and crown.

**Hot Application.** When the bituminous binder is being applied its temperature in deg. F. shall be as follows:

Air temp.	50-65° F.	Asph. Cem.	325-350	Tar	225-250
"	" over 65° F.	"	" 300-350	"	185-250

The bituminous binder shall be applied only when the atmospheric temperature is above 50 deg. F., and has remained above 40 deg. F. for the preceding 8 hours, when the stone surfaces are dry for the full depth of the course and the conditions are favorable for proper penetration and adhesion, and when the weather conditions are favorable in the opinion of the Engineer. The first application shall be at the rate of 1.75 to 2.25 gallons per square yard of surface. While the bituminous binder is still liquid it shall be covered with a uniform layer of clean, dry  $\frac{3}{8}$ -inch or  $\frac{1}{2}$ -inch Size aggregate just sufficient to fill the surface voids, and the surface shall then be rolled until the material is thoroughly embedded in the bituminous binder and anchored in place and there is no perceptible movement under the roller. When the bituminous binder sticks to the roller wheels, additional aggregate shall be spread.

Immediately after the completion of the rolling, a second application shall be made of the bituminous binder in the manner above described and at the rate of from 0.5 to 0.75 gallon per square yard, and it shall be covered with a layer of  $\frac{3}{8}$ -inch Size aggregate. The surface shall then be rolled, dragged and rerolled until it has the proper density, crown and grade, after which it shall be opened for traffic. If bituminous binder appears on the surface, additional  $\frac{3}{8}$ -inch Size aggregate shall be spread so as to keep the entire surface covered for a period of not less than 30 days after the last binder application.

After 30 to 60 days' use by traffic and at such time as the Engineer may approve, the surface shall be swept thoroughly with a mechanically operated broom, and all dust and dirt shall be removed. A third application of the bituminous binder shall then be made at the rate of not less than 0.33 gallon per square yard, and it shall be covered immediately with  $\frac{3}{8}$ -inch Size aggregate at the rate of not less than 25 pounds per square yard of surface, and immediately thereafter the surface shall be dragged and rolled thoroughly.

**Cold Application.** After spreading the  $1\frac{1}{2}$ -inch Size aggregate as above described under General Requirements and before the bituminous material is applied,  $\frac{5}{8}$ -inch Size aggregate shall be spread uniformly thereon sufficiently to fill the voids in the larger size aggregate. The surface shall then be rolled until it is thoroughly consolidated, uniform and even and at the proper grade and contour.

Emulsified asphalt shall then be applied at the rate of 1 gallon per square yard of surface. When applied the atmospheric temperature shall be above 40 deg. F., and shall have been above 32 deg. F. for the preceding 8 hours, and the aggregate shall be free from water for its full depth but may be damp. Immediately after the application and while the emulsified asphalt is brown and unbroken a course of  $\frac{5}{8}$ -inch Size aggregate shall be spread in sufficient quantity to permit rolling without picking up, and this course shall be immediately rolled, dragged and rerolled. If necessary the wheels of the roller shall be wet to prevent displacement of the surface.

A second application of emulsified asphalt shall then be made at the rate of 1 gallon per square yard of surface as above specified. Immediately after the application and while it is brown and unbroken, a course of  $\frac{3}{8}$ -inch Size aggregate shall be spread in sufficient quantity to permit rolling without picking up, and this course shall be rolled, dragged and rerolled as above specified.

A third application of emulsified asphalt shall then be made at the rate of  $\frac{1}{2}$  gallon per square yard, and immediately thereafter while the asphalt is brown and unbroken a course of  $\frac{3}{8}$ -inch Size aggregate shall be spread uniformly to a one-stone thickness, sufficient to fill all surface voids and cover the emulsified asphalt. The surface shall then be rolled, dragged and rerolled.

A fourth application of emulsified asphalt shall then be made at the rate of 0.35 to 0.45 gallon per square yard, and immediately thereafter while the asphalt is brown and unbroken a course of  $\frac{3}{8}$ -inch Size aggregate shall be spread uniformly to a one-stone thickness, sufficient to fill all surface voids and cover the emulsified asphalt. The surface shall then be rolled, dragged and rerolled. When this application is thoroughly broken and set, the surface may be opened for traffic. The finished pavement shall be thoroughly compacted and bound together, hard, smooth and even, free from defects and at the proper grade and contour.

#### 3.8.4. Quantity and Payment.

The quantities of Penetration Macadam Surface Course, Hot or Cold Application, for which payment will be made, will be (a) the actual area constructed without deductions of areas occupied by manholes and similar structures within the paved area; (b) the volume of bituminous material used, measured at 60 deg. F., for the first and second Hot

Application and for all four Cold Applications; and (c) the actual area covered by the third Hot Application, all in accordance with the Plans or as directed by the Engineer.

Payment for Penetration Macadam Surface Course, Hot Application, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item *PENETRATION MACADAM SURFACE COURSE, HOT APPLICATION*, in the Proposal, which price shall include the cost of the construction of the surface course complete except furnishing and placing 3 applications of bituminous materials and the cover material for the third application, all materials except as above provided, labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

Payment for Penetration Macadam Surface Course, Third Hot Application, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item *PENETRATION MACADAM, THIRD HOT APPLICATION*, in the Proposal, which price shall include the cost of furnishing and placing the bituminous and cover materials for the third application complete, all labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

Payment for bituminous materials for first and second Hot Application will be made for the quantity as above determined, measured in gallons, at the price per gallon bid for the item *BITUMINOUS MATERIAL, FIRST AND SECOND HOT APPLICATION*, which price shall include the cost of furnishing and applying this bituminous material, all labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

**Provided, however,** that when the item Penetration Macadam Surface Course, Hot Application, is scheduled in the Proposal, and no items are scheduled therein for furnishing and applying the bituminous materials, payment for Penetration Macadam Surface Course, Hot Application, will be made for the actual area constructed, measured in square yards, in accordance with the Plans or as directed by the Engineer without deduction of areas occupied by manholes and similar structures within the paved area at the price per square yard bid for the item *PENETRATION MACADAM SURFACE COURSE, HOT*

APPLICATION, in the Proposal, which price shall include the cost of the construction of the surface course complete; all stone, bituminous, cover and other materials; all labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

Payment for Penetration Macadam Surface Course, Cold Application, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item PENETRATION MACADAM SURFACE COURSE, COLD APPLICATION, in the Proposal, which price shall include the cost of the construction of the surface course complete except furnishing and applying the bituminous materials, all materials except bituminous materials, all labor, equipment and all else necessary therefor and all other work in connection therewith and incidental thereto.

Payment for bituminous materials for Penetration Macadam Surface Course, Cold Application, will be made for the quantity as above determined, measured in gallons, at the price per gallon bid for the item BITUMINOUS MATERIALS, COLD APPLICATION, in the Proposal, which price shall include the cost of furnishing and applying the bituminous materials, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 9

### Bituminous Concrete Surface Course, Hot Mixed

(P.R.A. Class I)

### Sheet Asphalt Surface Course

(P.R.A. Class J)

#### 3.9.1. Description.

**Hot Mixed Bituminous Concrete and Sheet Asphalt Courses** shall include the construction of hot mixed bituminous concrete and sheet asphalt surface courses on previously constructed base courses at the prescribed locations, to the prescribed lines, grades and dimensions and of the prescribed types. Types CA-BC-1, FA-BC-1 and S.P.-1 are bituminous concrete, laid in one course. Types CA-BC-2, FA-BC-2 and S.P.-2 are bituminous concrete, and type S.A. is sheet asphalt, all laid in 2 courses.

## 3.9.2. Materials.

**Materials Required.** All types shall be prepared from Asphalt Cement, Grade NA-3, T-3 or OA-3, sand for bituminous work or Stone Sand or both, Mineral Filler, Grade A, and Broken Stone, all as specified in Art. 3.13.2 (p. 120).

**Composition of Mixtures.** The composition of the bituminous concrete and sheet asphalt mixtures required for the various types of surface courses are classified as Grades A, B, C, D and E and shall conform to the requirements shown in Table 1. For Grade A shall be used a combination of 1-inch and ½-inch Sizes broken stone, for Grade B shall be used 1-inch Size, for Grade C shall be used ¾-inch Size and for Grade E shall be used Stone Sand. The amount of the ingredients in the mixtures will be determined by the Engineer within the limits shown in the Table, and the actual amount shall vary therefrom not more than 3 per cent of the total stone content for Grades A, C and E, not more than 5 per cent for Grade B, and not more than 0.5 per cent for filler as well as asphalt content of all Grades. Table 1 shows also the courses, for which the various Grades shall be used.

TABLE 1

Total aggregate passing and retained on sieve size		Percentage by Weight GRADE				
Passing	Retained on	A	B	C	D	E
1¼ in.	¾ in.	0-25	0-35	—	—	—
¾ in.	½ in.	20-45	35-70	0-10	—	—
½ in.	No. 4	10-25	0-20	12-40	—	0-10
No. 4	No. 10	5-15	0-15	8-30	0-2	8-25
No. 10	No. 30	4-16	0-10	3-15	4-25	5-20
No. 30	No. 50	5-16	1.5-9	6-22	10-32	10-35
No. 50	No. 80	4-14	2-8	6-22	10-35	10-30
No. 80	No. 200	4-14	1.5-12	5-18	10-30	8-20
No. 200	—	5-8	0-5	4-8	10-18	6-13
Total retained on No. 10 sieve		50-70	75-90	30-60	0-2	15-30
Asphalt cement content		5.25-7	4-5.5	5.5-9	10-12	8.5-11
To be used for pavement course		CA-BC-1 CA-BC-2, top	All bottom courses	FA-BC-1 FA-BC-2, top	S.A., top	S.P.-1 S.P.-2, top

### 3.9.3. Methods of Construction.

**Plant.** Plants for preparing bituminous pavement mixtures shall be of the batch type, and each mixer shall have a capacity of not less than 10 tons per hour. The plant shall be equipped with twin-pug mixer, screens or sieves, storage bins, hopper, weigh box, weighing scales, driers, proper heating and temperature controls.

The mixer shall be capable of mixing properly 1000-pound batches, and shall have 2 revolving shafts with blades placed so as to insure uniform and complete circulation of the batch. No direct heat except steam shall be applied to the exterior or flame through the mixing chamber. The discharge gate shall be mechanically operated and shall be easily opened and closed without leakage of any ingredients or of the finished mixture. The rate of revolution of the blades and their distance from the walls shall be such as to minimize the chances of sparks. Sufficient space shall be provided between discharge gate and top of trucks being loaded for proper inspection of the material.

The screens and sieves shall be rotary or vibratory and capable of separating the aggregate into not less than 4 sizes (or 3 sizes for sheet asphalt mixtures), exclusive of tailings. The length of the screen and sieve sections shall be less than the width of the corresponding sub-bins into which the main bin is divided, and the openings of the screens and sieves shall be of the required sizes. The screens and sieves shall have a pitch and shall rotate or vibrate at such a rate of speed, that all the aggregate that should pass through any screen or sieve will do so and will not be carried over to an adjacent sub-bin. Each sub-bin shall have an overflow arrangement to prevent any excess accumulation from spilling into adjacent sub-bins, and a tight fitting cut-off gate permitting the withdrawal of a definite quantity of aggregate without leakage into the aggregate weighing hopper. Each sub-bin shall have a suitable located thermometer.

The hopper shall be of approved type, shall have a leak proof and quick operating cut-off gate leading into the mixer, and shall be connected to weighing scales so that a specific amount of aggregates can be weighed out of each sub-bin.

The weigh box for the bituminous material shall be of an approved type; shall be connected to weighing scales

so that a specific amount of bituminous material can be weighed; shall have a quick acting, leak proof cut-off valve; shall be heated by electricity or steam; and shall be arranged so that the bituminous material will flow therefrom into and for the full length of the mixer between the two revolving blades.

The weighing scales shall be either of the multiple beam type with a sufficient number of beams, or of the springless dial type with easily read dials and adjustable pointers. Multiple-beam scales shall have tell-tale springless dial type indicator showing over and under load of 15 pounds or more. Standard weights shall be furnished in sufficient numbers and sizes for the use of the Engineer. The weights shall be easy to handle, shall be protected from damage and shall be within the tolerance limits adopted by the U. S. Bureau of Standards.

Ample storage space shall be provided for the bituminous material, and while in storage it shall be heated by leak proof steam coils, electricity or other approved means. The heat shall have proper control devices so that the material will not be heated above the specified temperatures, and so as to prevent decomposition and reduction of penetration and ductility. The material shall not be agitated by steam or air. Separate tanks and circulating type pipe lines to the weigh box shall be provided for each kind and grade of bituminous material, and the pipe lines shall have recording thermometers, that may be readily read from the mixing platform.

Driers for the aggregate shall be of the revolving type continuously agitating the material during the drying, and shall have effectual moisture and temperature controls. The dried material shall be conveyed to the screens or sieves in covered buckets through an enclosed chute and shall not be discharged in the open.

The various sizes and types of aggregate shall be stored in separate stock piles on 2-inch planks in layers not more than 2 feet deep. Suitable partitions shall be provided to prevent intermixing. The aggregates shall be fed uniformly and constantly to the drier by buckets, so as to maintain uniform temperature and grading of the aggregate.

The mineral filler shall be kept in dust proof containers with bottom outlet arranged so that the required quantity may be taken therefrom. When placed in the mixing chamber the mineral filler shall be uniformly distributed throughout its length without causing unnecessary dust and in a manner acceptable to the Engineer.

A field laboratory, not less than 10 feet by 12 feet by 7 feet high, shall be provided at the plant. It shall have a wood floor, 2 windows, electric lighting and plugs for heating apparatus, work bench, table and chair. It shall be weatherproof, heated in cold weather, furnished with telephone service, and located so that the operation of the plant can be observed therefrom.

**Preparation.** The quantities of the various materials shall be measured by weight. When ready to be coated, the temperature of the materials shall be as follows:

Grades	A, C and E	B	D
Stone	300°-375° F.	275°-350° F.	—
Sand	300°-375° F.	275°-350° F.	325°-425° F.
Asphalt cement	250°-350° F.	250°-350° F.	250°-350° F.
Mineral filler	Unheated but dry	—	Unheated but dry

For Grades A, C and E, the stone and sand shall first be placed in the mixing chamber, then the mineral filler. After the mineral filler has been uniformly distributed the asphalt cement shall be added and the mixing continued until the mixture is uniform and homogeneous, and all particles of the aggregate are uniformly and completely coated with asphalt cement. Grades B and D shall be prepared in the same manner, except that no mineral filler is used for Grade B and no stone for Grade D.

**Condition of Base Course.** The surface of the base course on which the pavement is to be placed shall be clean, dry and free from frost when the paving operations are about to start, and shall be maintained in that condition.

**Transportation.** Trucks used for transportation shall be in proper operating condition, shall have rubber tires, leak proof and heat insulated bodies and ample size canvas covers. The heat insulation shall be provided by means of a complete lining of tongued and grooved 1-inch boards providing a  $\frac{3}{4}$ -inch air space between lining and truck body, or as otherwise approved by the Engineer. The inside surface shall be coated thinly with soapy water, oil or water with 10 per cent of lubricating oil, as may be approved by the Engineer.

The paving mixtures shall be dumped directly from the mixing chamber into trucks and hauled immediately to the site of the Project. They shall be kept clean during the hauling and handling. Mixtures which have segregated

or formed crust or lumps that will not flatten or will remain in part in the truck when the mixture is dumped shall not be used. The mixture may be dumped directly on concrete base courses but outside of the area on which it is to be spread, or shall be dumped on wood or metal platforms, not less than 8'x14' in size. When required the platforms shall be thinly coated with oil. The rate of dumping shall conform to that at which it can be spread. When dumped, Grade B mixture shall have a temperature of from 250 to 325 deg. F., Grades A, C and E from 275 to 375, and Grade D from 300 to 375 deg. F.

**Machine Spreading and Finishing.** When so provided in the Supplementary Specifications, grade control side forms and machine spreading and finishing shall be used, except as hereafter described. The side forms shall be of steel and of an approved design and shall be securely fastened by stakes, provided however, that steel side forms may be omitted, (a) when conditions would be adverse to setting side forms, in which case 8" wide strips of the bituminous concrete specified may first be constructed to the proper grade, in accordance with these Specifications, so as to form part of the finished pavement and may be used as side forms, and if necessary, they shall be armored with suitable bearing plates; (b) when suitable abutting curbs or headers are available for use as side forms, armored with suitable bearing plates, when necessary; (c) when the base course is parallel to the finished surface course and is laid within the tolerance limits of the surface course, provided that the wheel base of the machine is not less than 10 feet or the screed is controlled by a support not less than 10 feet in length, and that the wheel base or support is in complete and continuous contact with the base course or the newly struck-off surface so that the mixture is being struck off at the proper grade without manual adjustment, and that it is found in actual operation that the machine is performing its work accurately and without injury to the pavement. When the machine is designed so that one end rides on side forms and the other end and the entire strike off is controlled and held at grade by an approved leveling device arranged so that the operator can positively and accurately maintain the assembly level, no grade control forms are required for the controlled end. The spreading and finishing equipment shall be of an approved type, shall have adjustable floating screed, riding on or con-

trolled as to elevation by the side forms. Blade graders shall not be used. The screed shall operate without tearing, shoving or gouging the pavement course and shall be able to form a finished surface as hereafter specified. Any equipment which does not produce an acceptable finished pavement, shall be replaced.

The bituminous mixture shall be spread and finished by the mechanical equipment above described to the true grade, contour, thickness and weight.

**Hand Spreading and Raking.** When edges of pavement are not adjacent to curbs or headers, there shall be placed and secured in place 6-inch planks of the thickness of the pavement, along its edges, and they shall remain until the pavement is completed. Immediately after being dumped the bituminous mixture shall be placed in its final position with hot shovels, forks and rakes in such a manner as to correct any segregation or other irregularities in composition, and so that the pavement course will have the proper thickness, grade, contour and weight, when finished. No walking shall be done on the pavement mixture until it is rolled, except when necessary to adjust surface irregularities by raking. All porous spots, depressions and projections shall be carefully removed from the top course by raking, and for this purpose, not less than 3 rakers shall be used for each 100 square yards laid per hour. The rate of spreading shall not exceed that at which the raking can be satisfactorily done.

**Rolling.** For rolling shall be used three-wheel power driven rollers, having a load of not less than 330 pounds per lineal inch of tread of rear wheels, and tandem rollers, weighing not less than 8 tons. When not more than 1200 square yards of wearing surface is laid per day, 1 three-wheel and 1 tandem roller shall be used. When more is laid, more rollers shall be used, as directed or approved by the Engineer.

The rolling shall commence as soon as the material will carry the roller without undue displacement and hair cracking. The rolling shall first be in a longitudinal direction with the three-wheel rollers, starting at each edge and working towards the center. The rolling at each trip shall overlap the previous path about one-half the width of the roller, and each trip shall be of slightly different length. The rolling shall be at the rate of not more than 150 square yards of surface per hour per

roller. Subsequently the longitudinal rolling shall be continued together with diagonal rolling with the tandem roller which shall cross in front of the three-wheel roller when this is in reverse.

The three-wheel roller wheels shall be kept clean and coated with oil, applied from woven mats above the wheels or otherwise and of sufficient length, all in a manner approved by the Engineer. Water may be used for the tandem rollers, but shall not run off onto the pavement and shall not be applied when the roller is in reverse. The rollers shall not pass off the pavement during rolling and shall not stand on cooled pavement. Places inaccessible to rollers shall be compacted with heated tampers.

Bottom courses shall be rolled so as to compact and bind properly the material, and depressions and improperly covered places shall be filled in and rerolled. The surface of bottom courses shall, after the rolling is completed, have no spots with excess asphalt cement or fine aggregate, and if present, spots 1 square foot or more in area shall be cut out and replaced. Smaller spots may be dried with stone dust and smoothing irons. When the rolling is completed the surface of the bottom course shall be kept clean and shall not be traveled upon except for placing the top course. Any part showing lack of bond, or which is loose or broken, or covered with dirt, shall be replaced. If all bottom course is not covered with top course the day it is laid, the top course shall not be placed until the bottom course has been inspected and approved by the Engineer.

Surface courses shall be rolled until thoroughly compacted. Excess material shall be removed from high spots, and low spots shall be roughened with hot rakes, additional material shall be applied and the surface shall be rerolled immediately, all while the asphaltic cement is still soft. No stone dust, filler, cement or other material shall be applied to the surface. Adjacent to masonry, street car tracks, manholes and similar structures, the surface shall be at a level of  $\frac{1}{4}$  inch above the level of such structures.

**Joints and Edges.** The number of joints shall be a minimum. Rope joints may be used, otherwise the edges of previously placed pavement shall be cut to a straight line, and the face of the cut painted with hot asphalt

cement. Hot smoothers and tampers shall be used to insure proper bond. Hot asphalt cement shall be applied to faces of gutters, manholes and other projections. The asphalt cement shall be of the same grade as that used in the mixture.

**Seal Coat.** Pavement course CA-BC-1 and top course of CA-BC-2 shall have an application of asphalt cement of the same grade as that used in the mixture, immediately after completion of rolling and while the material is still hot. The coat shall be sufficient only to coat the surface and fill voids, and shall be applied by means of an approved squeegee distributor at a temperature of from 300-375 deg. F. This coat shall be covered immediately with a uniform dressing of  $\frac{3}{8}$ -inch Size stone or Grits and the cover material shall be rolled into the surface with a tandem roller.

**Thickness and Weight.** The thickness and average weight per square yard of the pavement courses, based on unit areas of not more than 1000 square yards, shall be as shown in Table 2.

TABLE 2

Type	Thickness, Inches			Weight lbs. per sq. yd.
	Ave.	Min.	Max.	
CA-BC-1, FA-BC-1	2	1 $\frac{3}{4}$	2 $\frac{1}{2}$	220
SP-1	2	1 $\frac{3}{4}$	2 $\frac{1}{2}$	210
CA-BC-2, FA-BC-2, top	1 $\frac{1}{2}$	1 $\frac{1}{4}$	2	165
CA-BC-2, FA-BC-2, bottom	1 $\frac{1}{2}$	1 $\frac{1}{4}$	2 $\frac{1}{2}$	155
S.P.-2, top	1 $\frac{1}{2}$	1 $\frac{1}{4}$	2	157
S.P.-2, bottom	1 $\frac{1}{2}$	1 $\frac{1}{4}$	2 $\frac{1}{2}$	155
S.A., top	1 $\frac{1}{2}$	1 $\frac{1}{4}$	2	150
S.A., bottom	1 $\frac{1}{2}$	1 $\frac{1}{4}$	2 $\frac{1}{2}$	155

**Finished Pavement.** The finished pavement shall be free from waves and from depressions and projections measuring more than  $\frac{3}{16}$  inch, when measured with a 10-foot straight edge. The pavement shall be uniform in density and composition, thoroughly bonded, watertight, free from porous and rough spots and at the proper grade and contour. Unsatisfactory portions of the pavement shall be replaced to the satisfaction of the Engineer.

**Construction Season.** The pavements shall be constructed between May 1 and December 1 unless otherwise approved in writing by the Engineer. They shall not be laid when it is raining, when the temperature is below 40 deg. F., or when the conditions otherwise may be unfavorable, in the opinion of the Engineer.

#### 3.9.4. Quantity and Payment.

The quantity of one and two course Hot mixed Bituminous Concrete Surface Course of the various types and of Sheet Asphalt Surface Course, for which payment will be made, will be the areas thereof actually constructed in accordance with the Plans or as directed by the Engineer, without deduction of areas occupied by manholes and similar structures within the pavement areas.

Payment for Hot Mixed Bituminous Concrete Surface Course, Types CA-BC-1, CA-BC-2, FA-BC-1, FA-BC-2, S.P.-1, S.P.-2 and Sheet Asphalt Surface Course Type S.A., will be made for the quantity as above determined, measured in square yards, at the prices per square yard bid for the items PAVEMENT TYPE CA-BC-1, CA-BC-2, FA-BC-1, FA-BC-2, S.P.-1, S.P.-2 and S.A. respectively, in the Proposal, which prices shall include the cost of the bituminous concrete and sheet asphalt pavement complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 10

### Cold Mixed Bituminous Concrete Surface Courses, Type A and Type T (P.R.A. Class H)

#### 3.10.1. Description.

**Cold Mixed Bituminous Concrete Surface Course** shall include the construction of cold mixed bituminous pavements on previously constructed base courses at the prescribed locations and to the prescribed lines, grades and dimensions, and in accordance with the Plans and Specifications. Two types are specified herein, namely Type T, made with tar, and Type A, made with asphalt cement.

### 3.10.2. Materials.

**Stone and Stone Sand** for Types A and T shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 129), and shall be of the Size required to produce finished mixtures complying with the requirement of Table 3. The same kinds of stone and stone sand shall be used throughout the Project, unless otherwise specifically provided.

**Asphalt Cement** for Type A shall be Grade NA-4, T-4 or OA-4, conforming to the requirements therefor, specified in Art. 3.13.2 (p. 120).

**Tar** for Type T shall be Grade RT-9 or RT-10, as may be directed by the Engineer, and conforming to the requirements therefor, specified in Art. 3.13.2 (p. 125).

**Liquefier and Hydrated Lime** for Type A shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 127). The quantity and grade of liquefier shall be as required by the Engineer.

**Bituminous Coatings** for painting curbs, castings and other objects shall be asphaltic oil, Grade RC-2, or asphalt cement of the grade used for the bituminous concrete, for Type A; and tar, Grade RTCB-5 for Type T. Coatings for bottom course, where covered with dust, shall be asphaltic oil, Grade RC-O, or emulsified asphalt, Grade AE-3. Coatings for concrete surfaces to be covered with Repair Course shall be asphaltic oil, Grade C.C. or emulsified asphalt, Grade AE-5, when asphaltic repair course is used; and tar, Grade RTCB-5, when tar repair course is used.

**Composition of Mixture.** The composition of the bituminous concrete mixtures for Types A and T, exclusive of mineral and bituminous surface coatings, liquefier and moisture content, shall conform to the requirements of Table 3. The exact amount of each ingredient will be determined by the Engineer within the specified limits. The percentages shown in the table include the bituminous materials. The table shows 2 bottom course compositions; when the total pavement thickness is 2 inches or less, Bottom Course B shall be used, otherwise Course A shall be used. When laid on an intermediate course of modified penetration macadam, only the top course shall be used.

TABLE 3

Aggregates passing and retained on sieve size		Percentage by Weight				
		Bot. Course (Type A & T)		Top Course		Repair Course
Passing	Retained on	A	B	Type A	Type T	(Type A & T)
1 1/2 in.	3/4 in.	40-70	0-35			
3/4 in.	3/8 in.	25-35	35-70	0-7	0-7	
3/8 in.	No. 4	0-10	0-20	35-60	25-55	0-5
No. 4	No. 10	2-8	0-15	20-45	15-45	50-75
No. 10	No. 30	2-6	0-10	5-15	10-25	5-18
No. 30	No. 80	1-5	1-4	3-8	3-12	2-8
No. 80	No. 200	1-6	1-5	1-6	1-6	2-8
No. 200	—	0-5	0-5	3-7	0-5	3-8
Total retained on No. 10		75-90	70-85	65-80	55-75	55-75
Asphalt cement, Type A		3-5	4-6	5.5-7	—	6.5-8.5
Tar, Type T		3-5	3-5	—	7-9.5	8-10

### 3.10.3. Methods of Construction.

**Plant.** The plant shall conform to the requirements therefor, specified in Art. 3.9.3 (p. 91), except that, when the aggregate is delivered to the plant at the proper temperature, moisture content and grading, the screens and driers may be omitted.

**Preparation.** The quantities of the various materials shall be measured by weight, except that for Type A, the liquefier shall be of a volume determined by the Engineer. When ready to be coated, total aggregates retained on a No. 10 sieve shall have a moisture content of not more than 1 per cent, and aggregates passing a No. 10 sieve shall have a moisture content of not more than 1.5 per cent. Aggregates having a temperature in excess of that specified shall be cooled to the proper temperature. If stored in stock piles to cool, the aggregate shall be protected from the weather. When ready to be coated, the temperature of the aggregate shall be between 35 and 125 deg. F., the tar for Type T shall be between 150 and 250 deg. F., and the asphalt cement for Type A between 250 and 350 deg. F.; and the bituminous materials shall be free from unmelted lumps.

**Mixing, Type A.** The mixing may be done by either of the two methods hereafter described, or by other methods, subject to the approval of the Engineer. (a) Stone and stone sand shall first be placed in the mixer and

sufficient liquefier shall be added to thoroughly wet the aggregates. Asphalt cement shall then be added slowly in a thin sheet for the full width of the mixing chamber and the mixing shall be continued until the aggregates are thoroughly coated. Hydrated lime shall be added in such a manner that it is evenly distributed and not dumped at one end. More liquefier shall be added if necessary to obtain proper distribution of the asphalt cement and proper workability. The mixing shall continue until all particles of the aggregate are completely and uniformly coated with asphalt cement. (b) The mixing shall be done as above described, except that the stone sand is placed in the mixer after the asphalt cement and hydrated lime has been added. The finished product shall be thoroughly mixed and uniform in composition.

**Mixing, Type T.** The mixing may be done by either of the two methods hereafter described, or by other methods, subject to the approval of the Engineer. (a) Stone and stone sand shall first be placed in the mixer and the tar shall then be added slowly in a thin sheet for the full width of the mixer chamber, and the mixing shall be continued until all the particles of the aggregate are completely and uniformly coated with tar. (b) The mixing shall be done as above described, except that the stone sand is placed in the mixer after the tar has been added. The finished product shall be thoroughly mixed and uniform in composition.

**Transportation and Dumping.** The requirements for transportation and dumping shall be as specified in Art. 3.9.3 (p. 93), except that when the atmospheric temperature is above 60 deg. F. truck bodies need not to be insulated but shall be completely covered, that the mixture when dumped shall have a temperature between 35 and 125 deg. F., and that when so specified or authorized by the Engineer, the paving mixture may be placed in stock piles, subject to the following conditions. The mixture shall be prepared with Grade 2 liquefier; the stock piles shall be placed on a flat, clean platform or concrete base course and shall be properly covered to prevent evaporation of the liquefier; the mixture shall be used within 48 hours after being prepared, unless otherwise authorized, and shall be in proper and satisfactory condition when used.

**Machine Spreading and Finishing.** When so specified in the Supplementary Specifications, grade control side forms

and machine spreading and finishing shall be used as described in Art. 3.9.3 (p. 94).

**Spreading and Rolling.** When machine spreading is not required and when the edges of the pavement are not adjacent to curbs or headers, there shall be placed and secured in place along the edges of the pavement 6-inch planks of the thickness of the pavement, and they shall remain until the pavement is completed. The surface of the base course on which the pavement is to be placed shall be clean, dry and free from frost when the paving operations are about to start, and shall be maintained in that condition. Faces of curbs, gutters, iron castings and other objects within the pavement area shall be painted with tar or asphalt cement, as specified in Art. 3.10.2 (p. 99), before the paving mixture is placed. Unless rope joints are used, the edges of previously placed pavement shall be cut straight and painted as above prescribed.

The bituminous mixtures shall have a minimum temperature of 35 deg. F., when being spread. The bottom course shall be spread so that after being rolled it will have the proper grade, contour and thickness. After rolling, as hereafter described, it shall not be traveled upon, except for laying the top course, and shall be kept clean. Any part of the bottom course, which shows lack of bond, or becomes loose or broken, or is covered with dirt, shall be taken up and replaced. Immediately before placing the top course the bottom course shall, if covered with dust, be swept clean, and the parts that were covered with dust shall be given a thin coating of the paint, specified in Art. 3.10.2 (p. 99), or it shall be replaced, as the Engineer may direct. The coating shall be properly cured, and the surface shall be dry when the top course is placed. The top course shall be placed in a uniform layer and shall be rolled until thoroughly compacted.

The rolling of both courses shall be done when the mixture has hardened sufficiently for proper stability. During favorable weather, the bottom course may be rolled when it will not adhere to the roller, but the top course shall not be placed for a period of 12 hours after completing the rolling of the bottom course. The rolling shall conform to the requirements therefor, specified in Art. 3.9.3 (p. 95), except that no water shall be applied to the roller wheels. Immediately after the rolling of the top course is completed and unless otherwise specified, it shall

be covered with stone sand at the rate of 5 pounds per square yard and rerolled. Places inaccessible to rollers shall be compacted with tampers.

**Thickness and Weight.** The average total thickness of the finished pavement, measured in inches, and the average total weight in pounds per square yard, based on unit areas of not more than 1000 square yards, shall be as follows:

	Thickness	Weight
When bottom course A is used	....2½"	250 lbs.
"    "    "    B    "    "	....2"	200 "
When top course only is used	.....1"	100 "

The thickness of the top course shall be not less than 5/8 inch and not more than 1 inch, when both top and bottom courses are constructed.

**Finished Pavement and Construction Season.** The requirements of Art. 3.9.3 (p. 97), for finished pavement and construction season shall apply.

**Repair Course.** The repair course is intended for surfacing worn concrete or other worn pavements. Before applying the course to a concrete surface this shall be coated with asphalt oil, emulsified asphalt or tar as may be specified, at the rate of from 1/10 to 1/8 gallon per square yard of surface or as directed. The repair course shall then be placed and rolled as above described, except that the rolling shall be only sufficient to properly embed and anchor it in place. For repairing other types of pavement surfaces the same requirements shall apply, except that the prime coat is not required.

#### 3.10.4. Quantity and Payment.

The quantity of one and two course Cold Mixed Bituminous Concrete Surface Course, Type A or T, or Repair Course, Type A or T, for which payment will be made, will be the area actually constructed in accordance with the Plans or as directed by the Engineer, without deduction of areas occupied by manholes and similar structures within the pavement areas.

Payment for Cold Mixed Bituminous Concrete Surface Course, Types A and T, and for Repair Course, Types A and T, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the items PAVEMENT TYPE A and T, and REPAIR COURSE TYPE A and T, respectively, in

the Proposal, which prices shall include the cost of the bituminous pavement course complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 11

### Concrete Surface Pavement

#### 3.11.1. Description.

**Concrete Surface Pavement** shall include the construction of concrete surface pavements on the subgrade prepared therefor at the required locations, to the prescribed grades, lines and dimensions, and in accordance with the Plans and Specifications.

#### 3.11.2. Materials.

**Concrete Materials.** Cement and water for concrete shall conform to the requirements therefor, specified in Art. 4.1.2 (p. 137), and sand, gravel and broken stone to those specified in Art. 3.13.2 (p. 129), except that limestone shall not be used. Class B Concrete (p. 141), shall be used.

**Reinforcement Steel.** Reinforcement steel may be either deformed steel bars, plain steel bars or cold drawn steel wire, but only one of these types shall be used in the Project for the mats hereinafter described unless otherwise approved by the Engineer.

Deformed and plain steel bars shall conform to the requirements of either Specification M-31-35, intermediate grade (billet steel), or Specification M-42-35 (rail steel), or Specification M-53-37, intermediate grade (axle steel), all of the American Association of State Highway Officials; or they may be made from rerolled structural shapes and shall then conform to the requirements of said Specification M-53-37, Arts. 4-14, structural grade, except that the yield point shall be not less than 35,000 pounds per square inch. It is provided, however, that cold or hot twisted bars shall not be used, and that all bars used in the Project for the mats hereinafter described shall be made under only one of these Specifications unless otherwise approved by the Engineer. Cold drawn steel wire shall conform to the requirements of Specification M-32-35 for Cold Drawn Steel Wire for Concrete Reinforcement of said Association.

Except for such additional reinforcement as may be prescribed, the reinforcement steel shall be assembled into mats before being placed in the pavement. Deformed bars shall be securely fastened together at all intersections of longitudinal and transverse members of the mat, either at the site of the Project in a manner approved by the Engineer, or in accordance with Specification M-54-37 of said Association. The diameter of all deformed bars in the mat shall be  $\frac{3}{8}$  inch; the number and spacing of bars shall be as shown on the Plans. Plain bars and cold drawn steel wire shall be welded into mats in accordance with the requirements of Specification M-55-37 of said Association. The longitudinal members shall be No. 00 gauge or  $\frac{21}{64}$  inch in diameter and shall be spaced 6 inches centers. The transverse members shall be No. 3 gauge or  $\frac{1}{4}$  inch in diameter and shall be spaced 12 inches centers.

When placed, reinforcement steel shall be clean, free from scale rust, straight and true to form. Material which has become bent or distorted shall be repaired before being used or shall be replaced, as may be required by the Engineer.

**Steel for Transverse Expansion Joints.** Steel for transverse expansion joints shall be either new steel, conforming to the requirements of the Standard Specifications, Serial Designation A1-39, of the American Society for Testing Materials, or steel rolled from Standard Section Tee rails and conforming to the requirements of Specification M-42-35 of the American Association of State Highway Officials.

**Liquid Joint Filler.** Liquid joint filler shall be Grade BM-2, as specified in Art. 3.13.2 (p. 128). Kettles for heating the joint filler shall be of such size that sufficient material at the proper temperature is available when needed. The joint filler shall have a temperature of not less than 350 and not more than 425 deg. F. when used, and the necessary heating shall be done so as not to damage or decompose the material. The temperature of the material shall be ascertainable without removing the thermometer from the kettle.

**Premoulded Joint Filler.** Premoulded joint filler shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 129).

**Bituminous Coating for Curing.** Bituminous material for curing of concrete shall be either emulsified asphalt

Grade AE-5 or asphaltic oil, Grade C.C., as specified in Art. 3.13.2 (p. 120).

**Felt and Fabric Mats.** Felt and fabric mats shall consist of a single layer of filler enclosed in a cover, and shall be of ample width to cover the slab to be cured and lap over its edges. The filler shall be low grade cotton, cotton linters, cotton waste such as comber noils or card flat strips, or any mixture of these, made into an unbroken sheet of cotton felt, weighing not less than 8 ounces per square yard. The cover shall be 6½-oz. burlap or 7-oz. osnaburg. The mats shall have continuous parallel rows of stitching not more than 4 inches apart, or shall be tufted at intervals of not more than 4 inches transversely and longitudinally. The edges of the completed mats, except the flap side, shall be finished with overlapped stitching. The felt mats shall not stain the concrete or tear during use.

**Cellular Compression Material.** Cellular compression material shall be a manufactured product, made principally of wood fiber or other suitable cellular material and waterproofed with a bituminous material. All the materials used, the method of waterproofing and the finished product shall be subject to the approval of the Engineer. The finished product furnished in the prescribed sizes shall be capable of being subjected to all ordinary strains of handling without being damaged or distorted, both when dry and wet. The surfaces of the material shall not stick together during storage.

The finished product shall conform to the following test requirements. The tests shall be made at a temperature of  $75 \pm 2$  deg. F., not less than 48 hours after the bituminous treatment. (a) The load necessary to compress a 2"x2" sample to one-half its original thickness shall be not more than 1050 pounds per square inch when the load is moving at a rate of 0.1 inch per minute. (b) A 4"x4" sample, restrained on 3 sides and compressed to one-half its original thickness, shall extrude not more than ¼ inch on the free side, and the weight of bituminous material pressed out shall be not more than 3 per cent of that of the sample. (c) A ½"x2"x14" sample, supported as a ½-inch deep simple beam on ¼-inch rods spaced 10" centers, shall be able to carry a load of 8 pounds, applied through a ¼-inch rod placed at the center at right angles to the beam, for a period of 5 minutes.

**Transmission Oil.** Transmission oil shall be a straight mineral oil, which shall be used without heat or addition of other materials. The viscosity, Saybolt Furol, 100 deg. F., shall be min. 225 and max. 290 for oil used at or below 70 deg. F., and min. 335, max. 415 for oil used above 70 deg. F. The pour points of the two oils shall be 25 deg. and 35 deg. F., respectively. The oil shall be delivered in sealed containers, plainly marked with the grade and the name of the producer or refiner.

**Sodium Metasilicate.** Sodium metasilicate shall be uniform, white and in granular or crystalline form. Its total alkalinity to methyl orange indicator, calculated as  $\text{Na}_2\text{O}$  shall be min. 28.5 and max. 30.0%. The silica as  $\text{SiO}_2$  shall be min. 27.8%. The molecular ratio  $\text{Na}_2\text{O}:\text{SiO}_2$  shall be min. 0.98:1 and max. 1.02:1. The sodium metasilicate pentahydrate ( $\text{Na}_2\text{SiO}_5\cdot 5\text{H}_2\text{O}$ ) content shall be min. 97%. The clearness of a 2% solution shall be such that a 36 cm. deep layer shall not totally obscure vision. The ignition loss shall be max. 43%. A No. 10 sieve at 50% humidity shall hold max. 10% of the material. Not more than 0.2 per cent shall be insoluble in distilled water.

**White Lead Paint.** The materials for white lead paint shall conform to the requirements therefor of Arts. 4.2.2 (p. 157), and 5.13.2 (p. 222), and the ready mixed paint shall contain the following ingredients, measured in pounds per gallon. Dry pigment, min. 14, max. 14¾; Raw linseed oil, min. 4¾, max. 5½; Turpentine, min. 0.075, max. 0.1; Drier, min. 0.22, max. 0.27. The paint shall weigh not less than 19.5 and not more than 20 pounds per gallon.

### 3.11.3. Methods of Construction.

**Batching Equipment.** Batching equipment shall be of the type specified in detail in Art. 4.1.3 (p. 142).

**Mixing Equipment.** Mixing equipment shall be of the type specified in detail in Art. 4.1.3 (p. 143). The capacity of the mixer shall be not less than ¾ cubic yard. Transit mixers shall not be used.

**Unloading and Hauling Equipment.** Equipment for unloading and hauling shall conform to the requirements specified in Art. 4.1.3 (p. 143).

**Batching and Mixing.** Batching and mixing shall conform to the requirements specified in Art. 4.1.3 (p. 145).

**Consistency.** The required consistency of the concrete mixture will be determined by the Engineer, so that the mixture will be cohesive and plastic, permitting proper handling and finish. When deposited it shall not flow,

but shall remain in a conical pile. There shall be a minimum of segregation and surplus water during the process of handling and finishing. The total water content shall be not more than  $5\frac{1}{4}$  and 5 gallons per bag of cement, when the coarse aggregate is broken stone and gravel, respectively.

**Side Forms.** Side forms shall be of steel not less than  $\frac{3}{16}$  inch thick, not less than 2 inches wide at the top and not less than 8 inches wide at the base when the pavement is not more than 9 inches thick. Otherwise, the width shall be not less than 9 inches. The forms shall be properly stiffened to avoid deformation. The forms shall have anchoring pins of sufficient length and diameter to hold them securely in place. The devices through which the pins extend shall have a height of not less than one-half of that of the forms, and shall be arranged so that the forms can be held firmly in place, but they shall not interfere with the free movement of the finishing apparatus. The ends of the form sections shall be connected in such a manner that the deflection under load at the joints will be no greater than elsewhere and that the alignment can be maintained. The forms shall be straight, free from warp, clean and oiled. Forms for not less than 2 days' work shall be provided. Forms shall be subject to the approval of the Engineer and if unsatisfactory shall be replaced.

The side forms shall be placed to true line and grade and in such a manner that the completed pavement will have the required thickness. The forms shall be held firmly in place and shall have no vertical or horizontal movement when subjected to the load of the finishing machine, or from any other causes. Subsequent to the first passage of the finishing machine over the forms and prior to the last passage the forms shall be checked for line and grade, and such adjustments shall be made as are necessary in order that the forms may conform thereto. The side forms shall not be removed until the concrete within them has been in place for a period of not less than 12 hours.

**Placing Concrete and Reinforcement.** When concreting operations are about to start the subgrade shall be in a finished condition, shall not be muddy or frozen, shall be free from dust and dry earth and, except as hereinafter provided, it shall, if dry, be sprinkled by means of a spray nozzle sufficiently in advance of placing the concrete

so that the subgrade is uniformly dampened to a depth of not less than one-half inch without forming wet spots. Before May 15th and after October 1st, the subgrade shall not be sprinkled unless it is dry for more than one-half inch below the surface and its character is such that it should be dampened, in the opinion of the Engineer, and only sufficient water shall then be applied to dampen the surface.

The placing of the concrete between two transverse joints shall be carried out as a continuous operation. If due to a breakdown in the plant or other emergency it is impossible to carry out this requirement, an intermediate transverse joint shall be constructed and such joint shall be not less than 15 feet from the nearest transverse joint. The mixing and placing of the concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the pavement. A layer of concrete mixture shall first be placed and distributed so that the entire surface between side forms, and for a distance sufficient for placing a reinforcement mat, is covered to such a depth that the surface of the layer after being struck off and consolidated will be at the proper elevation to receive the reinforcement steel. This layer shall be struck off and consolidated by tamping. The reinforcement steel shall then be placed so that it overlaps adjacent reinforcement not less than 40 times the diameter of reinforcement member lapped. Hand tampers shall be used to secure the steel in place at its proper elevation. The next layer of the concrete mixture shall then be placed, spread and consolidated immediately in such a manner that any variations in its composition will be corrected and so that the surface will be at the proper grade when the consolidation and finishing are completed. Concrete of the lower layer which has developed initial set or has been in place more than 15 minutes before being covered with the next layer shall be removed and replaced.

After the concrete is placed the portions thereof within one foot of transverse, longitudinal and other joints and within one foot of all side forms shall be compacted with suitable tools and by vibrating unless otherwise approved by the Engineer. The method of vibrating and number of vibrating units shall be as directed or approved by the Engineer. The vibrating implement shall be subject to the approval of the Engineer and shall have a vibrating frequency of not less than 5000 impulses per minute.

**Machine Finishing.** Machine finishing shall be used unless conditions are such that, in the opinion of the Engineer, machines cannot be practically operated. The finishing machines shall be power driven, substantially constructed and subject to the approval of the Engineer. They shall be equipped with adjustable strike-off screeds and planers, the bottom surface of which shall have the contour of the finished surface. Separate machines shall be provided with transverse and with longitudinal screeds. All machines with transverse screeds shall have a scraping device that will keep the side forms clean.

After being placed and spread as above described, the concrete shall be struck off immediately with a transverse screeding machine above the required grade so that there will be sufficient concrete to fill low and porous places. The operation shall be repeated as may be necessary to produce uniformly consolidated, dense concrete with the surface at the required grade and contour. After slumping and disappearance of excess water from the surface, the concrete shall again be planed so that the surface will be at the required grade over its entire area. The surface shall then be checked by means of an approved straight-edge, furnished by the Contractor and not less than 10 feet long, as the Engineer may direct. Irregularities found, measuring more than  $\frac{1}{8}$  inch vertically, shall be corrected as the Engineer may direct or approve, and the whole surface shall be made smooth and even.

The surface shall then be gone over with a longitudinal screeding machine to remove wavy and other surface irregularities that have not been previously removed. The surface shall then be rechecked and the screeding operation and checking shall be repeated as may be necessary. When all irregularities have been removed the surface shall be swept with a light strip of burlap or other approved material in a manner satisfactory to the Engineer. The pavement surface shall be given a final finish by pulling a light broom gently and squarely across the slab from one edge to the other so as to remove laitance and other surface blemish and so as to produce uniform corrugations, not more than  $\frac{1}{8}$  inch deep. The edges of longitudinal joints shall then be rounded to a radius of  $\frac{3}{4}$  inch, and the edges of transverse joints to a radius of  $\frac{5}{8}$  inch. All other edges shall be tooled for a width of 2 inches. When necessary, this work shall be done from a bridge not in contact with the pavement surface.

The longitudinal screeding and subsequent operations shall be delayed as long as may be possible to permit their completion before initial set of the concrete.

**Hand Finishing.** When hand finishing is used, the major part of the concrete above the required grade shall be removed by a hand operated template, moved forward with a combined longitudinal and transverse motion and so manipulated that it remains on the side forms. A slight excess of material shall be kept in front of the cutting edge. The concrete shall be worked so as to embed coarse aggregate and remove porous spots, but not so as to force excess mortar or water to the surface. Low spots shall be filled and the material worked into place. The finished worked surface shall be only slightly above the required grade and shall be uniform in appearance, density and composition. The concrete shall be brought to the required grade and density and all surplus material removed by a heavy planer. The planer shall be operated with a combined longitudinal and transverse motion advancing each stroke one-half the width of the planer, which shall be held firmly on the forms and operated at a slow, even speed. Not less than one-half inch of concrete shall be kept above the cutting edge of the planer and projections and depressions shall immediately be removed. The planing shall be continued until the required surface is attained. The final operation of the planer shall be made after the concrete has taken its final slump. The surface shall be checked by an approved straight-edge, furnished by the Contractor, and not less than 10 feet long. Irregularities found, measuring more than  $\frac{1}{8}$  inch vertically, shall be corrected as the Engineer may direct or approve, and the whole surface shall be made smooth and even. Excess material in front of planer shall be removed in such a manner that depressions will not be formed thereby. After the final operation of the planer, the surface shall be screeded longitudinally with a wooden handscreed, approved by the Engineer. It shall be worked back and forth across the pavement with an overlap of not less than one-half the length of the screed. This operation shall be continued until all irregularities are removed and a plane surface is obtained. The surface shall be checked, corrected, swept with burlap, broomed and tooled as provided for Machine Finishing.

**Marking.** The pavement slabs shall be numbered consecutively as the work progresses and the last slab placed

each day shall be dated the day laid. The marking shall be made on a corner of the slab at the end last completed. The figures shall be of uniform type, 1½ inches high, and plainly and neatly stamped after the final finish of the surface. When two or more mixers are working, a distinguishing letter for each mixer shall be stamped adjacent to the number.

**Protection.** For both machine and hand finishing, if surface checking or cracking develops the surface shall be covered with wet burlap during the finishing operations and shall be kept so covered and wet until the curing material is to be applied. Any cracking of the pavement or any considerable surface checking shall be cause for the rejection of the work.

The pavement, including its edges, shall be protected from damage due to traffic, to the Contractor's own operations or to any other cause, by barricades and other suitable means until opened for traffic. Pavement damaged shall be replaced or repaired in a manner satisfactory to the Engineer at the Contractor's expense.

**Expansion Joints.** The location and spacing of transverse and longitudinal joints shall be as shown on the Plans. Two types of transverse expansion joints may be shown, namely the Beam and the Tongue-and-Groove types. The beam type shall be used where the joint is square or radial to the sides of the slab and the slab is of a width designated for that type. The tongue-and-groove type shall be used for all other transverse joints. The joints shall be constructed as indicated on the Plans, and cellular compression material shall be used at ends of dowels in the beam type and in joint openings of the tongue-and-groove type. The channel dowels in the beam type, and the steel plates in the tongue-and-groove type shall be painted with white lead paint as specified above, and dowels and plates shall be coated with transmission oil as specified. Longitudinal joints shall be of the type shown on the Plans. Expansion joints with ¼-inch pre-moulded joint filler shall be provided between curbs and pavement, and at manholes and other objects projecting through the pavement. All joints shall be constructed in a workmanlike manner, plumb and true to line, grade and contour. Transverse joints shall be square to the slab and on the same line in adjoining pavement strips, unless otherwise shown on the Plans.

Bituminous joint filler, either liquid or premoulded, shall be used in the joints as indicated. When liquid filler is specified, the openings shall be clean and dry when being filled. The heat shall be applied to the kettles used for heating the bituminous material, so that the joint filler will not be damaged or changed in composition. Each kettle shall have a thermometer arranged so that the temperature of the joint filler can be read without removing the thermometer from the kettle. The material shall be applied at a temperature of from 350 to 450 deg. F. from suitable hand pouring pots, starting at the lower end of the joint. When the material has cooled to normal temperature the operation shall be repeated as often as may be necessary to fill the joints. Material above and outside the joint opening shall be entirely removed.

**Curing.** Unless otherwise specifically provided, the concrete surface shall be cured immediately after the final finish by one of the following methods.

**A. Hay and Straw.** The surface shall be covered with strips of canvas or burlap having a length of not less than 2 feet more than the width of the pavement slab. The strips shall be laid across the slab and shall overlap not less than 1 inch. This covering shall be sprinkled immediately with water and kept saturated until removed. As soon as the concrete is hard enough not to be pitted or easily defaced, this covering shall be removed and replaced with a uniform covering of hay or straw, not less than 6 inches thick. This covering shall be kept saturated with water for a period of not less than 5 days if standard cement is used, and not less than 48 hours if high early strength cement is used, except that in freezing weather water shall not be used. The hay or straw shall be free from decayed matter and organic matter soluble in water. When being placed care shall be taken not to damage the concrete surface.

The water pipe, supplying water for the work shall not be removed before the curing period is over, shall have tees and stop cocks at intervals of not over 200 feet, and shall be of sufficient size to permit proper sprinkling of the straw or hay and the operation of the concrete mixer at the same time.

**B. Bituminous Coating.** Before any marked dehydration of the concrete or checking of the surface occur, the surface shall be coated with emulsified asphalt or asphaltic oil as specified above, at the average rate of  $\frac{1}{8}$  gallon per

square yard of surface, except as hereinafter described. The coating shall be applied so that the concrete is completely and uniformly coated and sealed. After this coating no water or other curing material shall be applied. The application may be delayed for 12 hours, if the surface is immediately covered with canvas or burlap, as provided under Hay and Straw Curing above, and shall then be at the rate of not less than 1/10 gallon per square yard.

Equipment for applying bituminous curing material shall be portable and shall be arranged for travel on side forms, subgrade or shoulders. Spraying shall be done by means of a power driven compressor. The curing material shall be atomized by a jet of air at or near the nozzle, not by pressure in the container. The material shall be mechanically agitated when being applied to prevent segregation. Bituminous coating shall not be used on pavement areas, on which concrete curb is to be placed.

**C. Felt and Fabric Covering.** Before any marked dehydration of the concrete or checking of the surface occurs the surface shall be covered with a layer of felt and fabric mats as described in Art. 3.11.2 (p. 106). The mats shall be kept saturated with water until removed. The covering shall be placed in strips not less than 6 feet wide, laid parallel to the centerline of the pavement and shall be held firmly in place by weights or other approved method that will prevent displacement. The covering shall be left on not less than 72 hours if standard cement is used, and not less than 48 hours if high early strength cement is used, or as much longer as may be required by the Engineer according to the weather conditions.

**Curing in Cold Weather.** In cold weather the temperature of the concrete mixture when discharged from the mixer shall be not less than 40 deg. F., and the concrete when placed shall be protected from freezing by covering it with a layer of hay or straw not less than 8 inches thick, over which canvas shall be spread. The canvas shall be not less than 4 feet longer than the width of the pavement and shall be laid across it with edges overlapping and ends firmly fastened. In severe weather another layer of hay or straw shall be placed above the canvas. Concrete which has frozen before it is 5 days old shall be replaced at the Contractor's expense.

Concrete shall not be mixed and placed when the temperature is at or below 36 deg. F., except with the written

approval of the Engineer. If such approval is given the Engineer may prescribe the manner in which the work is to be done, which may include the heating of the aggregates and the use of accelerators or non-freezing compounds. Such approval, however, shall not relieve the Contractor from his obligation to produce a pavement in strict conformity with the requirements of the Contract, and such additional work shall involve no additional cost to the State.

**Strength and Thickness.** The average thickness of the pavement, and the crushing strength and density of the concrete will be determined by cores cut from the finished pavement at locations as directed by the Engineer. The cores shall be approximately six inches in diameter and of the full depth of the pavement. They shall be tested by crushing when not less than 28 days old and the crushing strength as determined by such tests, made in accordance with Method T-24-31 of the American Association of Highway Officials, shall be considered the crushing strength of the pavement.

**Bridge Approach Slabs.** Bridge Approach Slabs shall be constructed in all respects in conformity with the requirements specified above, except that side forms shall be of a design acceptable to the Engineer, and that the reinforcement steel shall conform to the requirements specified in Art. 4.1.2 (p. 141).

**Defective Work.** The Engineer may from time to time make an examination of the pavement laid by cutting cores or otherwise removing sections therefrom, and if such examination discloses the pavement to be of less than the required thickness, to contain cracks or otherwise failing to meet the requirements of the Specifications, the Engineer may require the Contractor to remove such defective work and replace it with pavement meeting the requirements of the Plans and Specifications without cost to the State.

**Opening for Traffic.** If so desired by the Contractor, and subject to the approval of the Engineer, the pavement may be opened for traffic the number of days after finishing shown below, provided however, that no pavement shall be opened for traffic before joints have been filled, all concrete spilled on the surface has been removed, and all curing and other extraneous materials have been removed.

May 16-Oct. 15	Standard cement	9 days
Oct. 16-May 15	Standard cement	12 "
May 16-Oct. 15	High early strength cement	2 "
Oct. 16-May 15	High early strength cement	4 "

Such approval, however, shall in no manner relieve the Contractor from his responsibility for the work in accordance with Art. 1.6.6 (p. 25).

#### 3.11.4. Quantity and Payment.

The quantity of Concrete Pavement Surface, for which payment will be made, will be the area paved within the limits shown on the Plans or as directed by the Engineer without deduction of the areas occupied by transverse joints, interior longitudinal joints between pavement slabs, manholes, catch basins and similar structures within the pavement area.

The quantity of Bridge Approach Slabs, for which payment will be made, will be the area actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for Concrete Pavement Surface will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item CONCRETE PAVEMENT SURFACE in the Proposal, which price shall include the cost of constructing, finishing, curing and protecting the pavement as above described; the construction of all joints between the outer edges of the pavement placed; all materials, including joint filler and other joint material for all interior joints, reinforcement steel, equipment, labor, and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for Bridge Approach Slabs will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item BRIDGE APPROACH SLABS in the Proposal, which price shall include the cost of constructing, finishing, curing and protecting the slab, of all materials, including joint filler and other joint material, reinforcement steel, equipment, labor, and all else necessary therefor, and all other work in connection therewith or incidental thereto.

Payment for Subgrade will be made as provided in Art. 2.9.4 (p. 56).

## SECTION 12

### Granite Block Pavement

#### 3.12.1. Description.

**Granite Block Pavement** shall cover the construction of pavement surfaces of granite blocks set in a mortar cushion course on a previously prepared concrete base at the prescribed locations and to the prescribed lines, grades and dimensions.

#### 3.12.2. Materials.

**Paving Blocks.** Paving blocks shall be of granite and shall conform to the requirements of Standard Specifications, Serial Designation D59-39 of the American Society for Testing Materials, except that the blocks shall be dressed for  $\frac{3}{8}$  inch wide joints. The blocks for the Project shall be from one quarry only and of the same quality.

**Cement and Sand.** Cement and sand for cushion course and grout joint filler shall conform to the requirements therefor, specified in Art. 4.1.2 (p. 137), except that sand for grout joint filler shall all pass a No. 10 sieve and shall have mortar strength of not less than 75 per cent of similarly prepared mortar, using Ottawa sand.

**Liquid Joint Filler.** The bituminous joint filler shall be Grade BM-3, as specified in Art. 3.13.2 (p. 128).

#### 3.12.3. Methods of Construction.

**Mortar Cushion.** The pavement base course shall be dry, clean and free from adhering matter and frost when the pavement is placed thereon. The mortar for the cushion course shall be 1:3 cement-sand mortar, thoroughly mixed without water in a mechanically operated batch mixer, and the dry mortar shall be placed on the base course in a uniform layer having an average thickness of 1 inch, a minimum thickness of  $\frac{1}{2}$  inch and a maximum thickness of  $1\frac{1}{4}$  inch, or as may be otherwise shown on the Plans. The cushion course shall be placed not more than 15 feet in advance of laying the blocks and shall be covered with the blocks without delay.

**Setting Blocks.** The blocks shall be set in straight rows at right angles to the centerline of the pavement with the longitudinal joints broken not less than 3 inches. The blocks in each row shall have a uniform width, and the joints at the surface shall be not less than  $\frac{1}{4}$  and not more

than  $\frac{1}{2}$  inch in width. The blocks shall be set plumb and fully bedded on the mortar cushion without crowding it into the joints. The best face of the block shall be uppermost. Adjacent to railway tracks the blocks shall be clipped and set as shown on the Plans so as not to be in contact with the rail. When set the blocks shall be rammed with a hand rammer weighing not less than 35 and not more than 50 pounds until each block has a solid, even bearing and the surface is uniform and at the proper grade. Blocks which have not a firm bedding or which have been damaged shall be taken up, reset and rerammed. The surface shall be tested with a straight edge not less than 10 feet long, and blocks found to be above or below the grade shall be taken up by means of suitable tongs, reset and rerammed. No sand, gravel or other material shall be placed in the joints. Blocks shall be laid not more than 15 feet in advance of ramming. Immediately after the blocks have been rammed, tested and approved, they shall be sprinkled with water from a spray nozzle in order to add water to the mortar cushion. Excess water which might damage the mortar cushion shall not be applied. No walking or other traffic shall be permitted on the pavement for a period of not less than 24 hours after sprinkling.

**Grout Joint Filler.** When grout joint filler is specified the joints shall be filled with 1:1 cement-sand grout as hereinafter provided. The grout shall be mixed in a mechanically operated batch mixer with only sufficient water to permit the mixture to enter the joints to the full depth. The amount of water used shall be subject to the approval of the Engineer and shall be kept constant in all batches. The mixing time shall be not less than  $1\frac{1}{2}$  minutes, and the mixture shall be kept stirred until used. The blocks shall be sprinkled with water immediately before the grout is applied, and the joints shall be filled completely with grout so that an excess appears on the surface. This excess shall be swept or scraped into the joints. These operations shall be repeated before initial set until the joints are completely filled. The surface shall then be swept and all excess grout shall be removed before it has developed initial set. After initial set the surface shall be covered with a layer of sand, not less than  $\frac{1}{2}$  inch thick, and the sand shall be kept moist for a period of not less than 7 days, and the surface shall be closed to traffic for a period of not less than 10 days after being

grouted. Grout shall not be applied when the temperature of the atmosphere or the blocks is below 40 degrees F., or during rainy weather.

**Bituminous Joint Filler.** When bituminous joint filler is specified, it shall be applied with hand pouring equipment approved by the Engineer, and the pouring shall be repeated until the joints are completely filled. Surplus material shall be removed from the tops of the paving blocks. Subject to the approval of the Engineer, other methods may be used that will insure proper filling of the joints without leaving any bituminous coating on the surface of the blocks. After the pouring is completed a thin coating of fine sand shall be spread over the surface. When the joint filler is applied it shall have a temperature of not less than 350 and not more than 425 deg. F., the temperature of the atmosphere and the blocks shall be above 40 deg. F., and the blocks and joints shall be dry.

**Reset Blocks.** Reset Stone Block Pavement shall include the removal of existing paving blocks within the area to be repaved, cleaning of blocks so as to remove adhering joint filler, storing of blocks until ready for repaving, furnishing and placing of cushion course as described above, except that its thickness may be increased to conform to the elevation of the pavement as reset, furnishing of additional blocks as may be required to replace lost or damaged blocks, placing and ramming blocks and furnishing and placing joint filler, in conformity with the requirements above.

#### 3.12.4. Quantity and Payment.

The quantity of Granite Block Pavement, for which payment will be made, will be the area actually paved in accordance with the Plans or as directed by the Engineer, without deduction of areas occupied by manholes and similar appurtenances within the pavement area.

Payment for Granite Block Pavement will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item GRANITE BLOCK PAVEMENT in the Proposal, which price shall include the cost of cushion course, paving blocks and joint filler complete in place, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for Reset Stone Block Pavement will be made for the quantity as above determined, measured in square

yards, at the price per square yard bid for the item RE-SET STONE BLOCKS in the Proposal, which price shall include the cost of removing, cleaning, storing and resetting the blocks, furnishing additional blocks as above specified, furnishing and placing joint filler and cushion course, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 13

### Miscellaneous Road Materials

#### 3.13.1. Description.

**Miscellaneous Road Materials** shall include the furnishing of the materials hereinafter specified, conforming to the requirements therefor, and at the time and place required.

#### 3.13.2. Materials.

**General Requirements.** All materials shall be approved before shipment, and the containers in which they are shipped shall bear the name of the product, the producer and the destination, as well as the lot number and the approval date and other pertinent information. When shipped in tank cars, the cars shall be sealed with the Department's seal. Materials furnished shall be uniform in composition and consistency, homogeneous, free from foreign materials and ready for use as furnished, unless otherwise specifically provided. The purposes for which the various bituminous materials may be used in road construction and repairs are shown in Table 8.

**Asphalt Cements and Asphaltic Oils.** Asphalt cements and asphaltic oils may be made either from petroleum or from fluxed or unfluxed native asphalts, and shall be free from tar, tar products and water, and shall show no separation or curdling prior to use. Residual asphalt cements and asphaltic oils shall be made only from petroleum classified as having an asphaltic or semi-asphaltic base. Asphaltic oils shall be a compound of suitable naphtha and petroleum asphalt, except that for NRC grades, native asphalt shall be used and the naphtha, when distilled according to A.S.T.M. Method D86-38, shall yield a maximum residue of 3 per cent by volume. Asphalt cement of

the various grades shall have the properties specified for them in Table 4, and asphaltic oils those specified in Table 5.

TABLE 4. ASPHALT CEMENTS

Prepared from Natural Asphalt	NA-1	NA-2	NA-3	NA-4	NA-5
Specific Gravity, 15.5°C., min.	1.045	1.045	1.035	1.03	1.03
Penetration, 25°C., 100 g., 5 sec.	40-50	50-60	60-70	85-100	100-120
Evap. Loss, 163°C., 20 g., 5 h., %	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.5	1.5-3.5
Pen. Res., 25°C., 100 g., 5 sec., as comp. to pen. bef. heat., %, min.	50	50	50	50	50
Solubility in Benzol, C <sub>6</sub> H <sub>6</sub> , %	95-98	95-98	95-98	95-98	95-98
Bitumen sol. in (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O, %, min.	85	85	85	85	85
Bitumen sol. in CCl <sub>4</sub> , %, min.	99	99	99	99	99
Flash Point, deg. C., min.	175	175	175	175	175
Ductility, 50 pen., cm., min.	40	50	50	50	50
Prepared from Natural Asphalt	T-1	T-2	T-3	T-4	T-5
Specific Gravity, 15.5°C.	1.21 to 1.27	1.20 to 1.25	1.19 to 1.24	1.17 to 1.22	1.15 to 1.20
Penetration, 25°C., 100 g., 5 sec.	40-50	50-60	60-70	85-100	100-120
Ev. L's, 163°C., 20 g., 5 h., %, max.	3.0	3.0	3.0	3.0	3.0
Pen. Res., 25°C., 100 g., 5 sec., as comp. to pen. bef. heat., %, min.	60	50	50	50	50
Solubility in Benzol, C <sub>6</sub> H <sub>6</sub> , %	68-75	70-77	72-79	74-81	76-83
Bitumen sol. in (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O, %, min.	80	81	82	83	83
Bitumen sol. in CCl <sub>4</sub> , %, min.	99	99	99	99	99
Flash Point, deg. C., min.	175	175	175	175	175
Ductility, 50 pen., cm., min.	40	40	40	40	40
Prepared from Petroleum	OA-1	OA-2	OA-3	OA-4	OA-5
Specific Gravity, 15.5°C., min.	1.00	1.00	1.00	1.00	1.00
Penetration, 25°C., 100 g., 5 sec.	40-50	50-60	60-70	85-100	100-120
Ev. L's, 163°C., 20 g., 5 h., %, max.	1.00	1.00	1.25	1.50	1.50
Pen. Res., 25°C., 100 g., 5 sec., as comp. to pen. bef. heat., %, min.	60	60	60	60	60
Solubility in Benzol, C <sub>6</sub> H <sub>6</sub> , %	99.8	99.8	99.8	99.8	99.8
Bitumen sol. in (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O, %, min.	73	75	75	77	78
Bitumen sol. in CCl <sub>4</sub> , %, min.	99	99	99	99	99
Flash Point, deg. C., min.	220	215	210	190	175
Ductility, 50 pen., cm., min.	100	100	90	80	70

TABLE 5. ASPHALTIC OILS

Rapid Curing	GRADE						
	RC-0	RC-1	RC-2	RC-3	RC-4	RC-5	CC
Flash Pt. (Tag open cup), deg. F. min.	—	—	80	80	80	80	
Furol Viscosity at 77 deg. F.	75-150	—	—	—	—	—	75-150
122 deg. F.	—	75-150	—	—	—	—	—
140 deg. F.	—	—	100-200	250-500	—	—	—
180 deg. F.	—	—	—	—	125-250	300-600	—
Duct. at 50 pen. cm., min.	80	80	80	80	80	80	
Dist. (% by vol. of total dist. to 680° F.), to 374° F., min.	15	10	—	—	—	—	15
437° F., min.	55	50	40	25	8	—	55
500° F., min.	75	70	65	55	40	25	75
600° F., min.	90	88	87	83	80	70	90
Res. from dist. to 680° F., vol. % by diff., min.	50	60	67	73	78	82	45
Tests on res. from dist. Pen. 77° F., 100 g., 5 sec.	80-120	80-120	80-120	80-120	80-120	80-120	15-40
% sol. in CCl <sub>4</sub> , min.	99.5	99.5	99.5	99.5	99.5	99.5	92.0

(Table 5 cont'd)

Rapid Curing	GRADE				
	NRC-1	NRC-1a	NRC-2	NRC-3	NRC-4
Spec. Gr. at 60°/60° F.	0.95-0.99	0.95-0.99	0.96-1.00	0.97-1.01	0.98-1.02
Flash Pt. (Tag open cup), deg. F. min.	80	80	80	80	80
Furol Viscosity. 122 deg. F.	170-200	170-220	—	—	—
140 deg. F.	—	—	100-200	250-500	—
180 deg. F.	—	—	—	—	125-250
Ductility at 50 pen., cm., min.	40	40	40	40	40
Distillation (% of total dist. to 680° F.) to 320 deg. F.	min. 5	max. 5	min. 4	—	—
to 374 deg. F.	min. 25	15-45	min. 20	min. 10	—
to 437 deg. F.	min. 50	min. 45	min. 40	min. 25	min. 25
to 500 deg. F.	min. 70	min. 65	min. 65	min. 55	min. 40
to 600 deg. F.	min. 88	min. 85	min. 87	min. 83	min. 80
Res. from dist. to 680° F. vol. % by diff. min.	68	68	70	75	80
Tests on res. from dist. Pen. 77° F., 100 g., 5 sec.	80-120	120-150	80-120	80-120	80-120
% sol. in CS <sub>2</sub>	90-97	90-97	90-97	90-97	90-97
% bitumen sol. in (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O, min.	83	83	83	83	83
Inorganic insoluble in CS <sub>2</sub> , %, min.	2.5	2.5	2.5	2.5	2.5

(Table 5 cont'd)

Medium Curing	GRADE					
	MC-0	MC-1	MC-2	MC-3	MC-4	MC-5
Flash Pt., Tag open cup, min.	100	100	—	—	—	—
Flash Pt., Cle. open cup, min.	—	—	150	150	150	150
Furol Viscosity at 77° F.	75-150	—	—	—	—	—
122° F.	—	75-150	—	—	—	—
140° F.	—	—	100-200	250-500	—	—
180° F.	—	—	—	—	125-250	300-600
Duct. at 50 pen., cm., min.	80	80	80	80	80	80
Dist. (% by vol. of total dist. to 680° F.) to 437° F., max. to 500° F. to 600° F.	25 40-70 75-93	20 25-65 70-90	10 15-55 60-87	5 5-40 55-85	0 max. 30 40-80	0 max. 20 20-75
Res. from dist. to 680° F. vol., % by diff., min.	50	60	67	73	78	82
Tests on res. from dist. Pen., 77° F., 100 g., 5 sec. % soluble in CCl <sub>4</sub> , min.	120-300 99.5	120-300 99.5	120-300 99.5	120-300 99.5	120-300 99.5	120-300 99.5

(Table 5 cont'd)

Slow Curing	GRADE	SCO
Specific Gravity at 60° F./60° F., min.		0.93
Evaporation loss, 325° F., 5 hrs., 20 g., min.		23.0
Float Test, residue, 125° F., from Evap. loss		90-250
Evaporation loss, 212° F., 5 hrs., 20 g., min.		11.0
Viscosity, Engler, 104° F., 1st. 50 c.c.		350-500
Solubility in C <sub>6</sub> H <sub>6</sub> , min.		99.5
Ductility at 50 pen., cm., min.		60
Bitumen content, 100 pen., %		60-75
Flash point (Cleveland open cup), deg. F., min.		158

**Emulsified Asphalt.** Emulsified asphalt shall be made from asphalt cement, suitable emulsifier and water. **Grades AE-1 and AE-2** are high consistency, heavy grades intended for plant mix and patching, and for use with aggregates of such sizes, that substantially all are retained on a No. 8 sieve; Grade AE-1 shall not be kept in storage at a temperature below 35° F., while Grade AE-2 may be stored below 32° F. **Grade AE-3** is quick setting and intended for penetration and surface treatment. **Grade AE-4** is medium setting, intended for being mixed in place with aggregates, substantially all of which will be retained on a No. 8 sieve. **Grade AE-5** may be either quick or slow setting, intended for concrete curing. The emulsified asphalts shall show no separation of asphalt after thorough mixing, unless caused by freezing, for a period of 30 days after delivery, except that Grade AE-2 shall show no separation for 1 year and shall remain homogeneous under the freezing test. The emulsified asphalts shall be capable of coating hard surfaces satisfactorily when applied with a pressure distributor. All grades, except AE-3 and AE-5, shall comply with the stone mixing test. Emulsified asphalt of the various grades shall have the properties specified for them in Table 6.

TABLE 6. EMULSIFIED ASPHALT

GRADE	AE-1	AE-2	AE-3	AE-4	AE-5
Settlement Test, 5 days 77° F., max.	—	—	3	3	5
Sieve Test, No. 20 iron wire sieve, per cent, max.	0.10	0.10	0.10	0.10	0.10
Demulsibility, 35 cc./0.02 NCaCl <sub>2</sub> , %, min. 50 cc./0.10 NCaCl <sub>2</sub> , %, max.	— —	— —	80 —	— 30	— —
Viscosity, Furol, 77° F., sec.	—	—	30-100	30-100	max. 700
Asphalt Content, %	min. 65	min. 65	55-60	min. 55	45-55
Test on residue from evaporation or distillation					
Penetration, 77° F.	100-200	125-225	100-200	100-200	50-90
Ductility, 77° F., cm., min.	40	40	40	40	40
Solubility in CS <sub>2</sub> , %, min.	95	95	95	95	95
Ash, %, max.	2	2	2	2	2
Spec. Gr., 77° F., min.	1.0	1.0	1.0	1.0	1.0

Note. When Grade AE-3 is used for penetration macadam, the viscosity shall be 30-60.

Tar. Tar may be either coal or petroleum water gas tar, and the various grades shall conform to the requirements for them specified in Table 7.

TABLE 7. TARS

GRADE	RT-1	RT-2	RT-3	RT-4	RT-5	RT-6	RT-7
Visc'ty, Engler, 40°C.	5-8	8-13	13-22	22-35	—	—	—
50°C.	—	—	—	—	17-26	26-40	—
Float test, 32°C.							50-80
Sp. Gr., 25/25°C. min.	1.08	1.08	1.09	1.09	1.10	1.10	1.12
Total bitumen, % by wt., min.	88	88	88	88	83	83	78
Water, % by vol., max.	2	2	2	2	1.5	1.5	1
Dist. by w't, to 170°C., max.	7	7	7	5	5	5	3
270°C., max.	35	35	30	30	25	25	20
300°C., max.	45	45	40	40	35	35	30
Soft'ng pt. dist. res., °C.	max. 60	(note) max. 60	38-65	40-65	40-70	40-70	40-70
GRADE	RT-8	RT-9	RT-10	RT-11	RT-12	RTCB -5	RTCB -6
Visc'ty, Engler, 50°C.						17-26	26-40
Float test, 32°C.	80-120	120-200	—	—	—	—	—
Float test, 50°C.	—	—	75-100	100-150	150-220	—	—
Sp. Gr., 25/25°C. min.	1.14	1.14	1.15	1.16	1.16	1.09	1.09
Total bitumen, % by wt., min.	78	78	75	75	75	80	80
Water, % by vol., max.	—	—	—	—	—	1	1
Dist. by w't, to 170°C.	max. 1	max. 1	max. 1	max. 1	max. 1	2-8	2-8
200°C., min.	—	—	—	—	—	5	5
235°C.	—	—	—	—	—	8-18	8-18
270°C., max.	15	15	10	10	10	—	—
300°C., max.	25	25	20	20	20	35	35
Soft'ng pt. dist. res., °C.	40-70	40-70	40-70	40-70	40-70	40-70	40-70

Note. When Grade RT-2 is used for surface treatment (not as primer) the softening point shall be min. 38°C.

TABLE 8. USES OF BITUMINOUS MATERIALS

Material	Asphalt Cement	Asphaltic Oil	Tar	Asph. Emul.
Sheet Asphalt normal traffic heavy traffic	NA-3, T-3, OA-3 NA-2, T-2, OA-2			
Bit. Concrete Hot appl. Type A Type T, bott. Type T, top	NA-3, T-3, OA-3 NA-4, T-4, OA-4		RT-10 RT-9, RT-10	
Bit. Pen. Macadam Hot appl. Cold appl.	NA-4, T-4, OA-4		RT-11, RT-12	AE-3
Bit. Coated Mac'm (New Construction) Prime Coat dense surf. open surf. Seal Coat		MC-0 MC-1 RC-2, NRC-3	RT-2 RT-3 RT-7, RT-8	AE-3
Bit. Coated Gravel (New Construction) SCO treatment Other treat's Prime coat Seal Coat		SCO MC-0 RC-2, NRC-3	RT-1 RT-7, RT-8	
Retreatment Aggregate used Grits 1/4 in. Size 3/8-in. Size 1/2-in. Size 5/8-in. Size 3/4-in. Size Other sizes, use above as guide SCO treat., max. 1/2", sand cover		RC-1, MC-2 RC-2, NRC-2 RC-2, NRC-2 RC-3, NRC-3 RC-4, NRC-4 RC-5  SCO	RT-2 RT-3, RT-4 RT-4 RT-7, RT-8 RT-9, RT-10 RT-10	
Patching Pen. or Hot Mix Cold Mix Max. 1/2" Size 3/8"-1" Size SCO tr't, sand	NA-4, T-4, OA-4	RC-3, NRC-3 RC-4, NRC-4 MC-3	RT-12 RTCB-5 RTCB-6	AE-1 AE-1
Mix-in-Place 1" or 3/4" Size agg.		RC-2, RC-3 NRC-2, NRC-3	RT-5, RT-6	AE-4
Concrete Curing		CC		AE-5

Where two grades of the same bituminous material are specified, use the higher number grade in hot weather.

**Liquefiers.** Liquefiers shall be petroleum distillates, free from insoluble matter, lubricating oil, wax and water, shall have no acid and corrosive action, and shall conform to the following requirements:

	Grade 1	Grade 2
Initial boiling point, deg. F. ....	194-230	175-220
End point, deg. F. ....	max. 400	max. 450
50% distillate over at, deg. F. ....	" 293	—
75% distillate over at, deg. F. ....	" 320	—
95% distillate over at, deg. F. ....	" 374	—
Residue, per cent .....	3-5	—
Distillate over at 325° F., per cent	—	45-85
Gravity (Be) 60° F., deg. ....	50-60	—

**Mineral Filler.** Mineral filler shall be limestone, dolomite, slate or diatomaceous earth free from lumps and foreign materials, and pulverized to the fineness hereafter specified. For Grade A, 95 per cent shall pass a No. 100 sieve, and 85 per cent a No. 200 sieve. For Grade B, all shall pass a No. 200 sieve, and 95 per cent a No. 300 sieve. Grade B shall be capable of being mixed with asphalt cement so that, after being maintained at 163 deg. C. for 2 hours without agitation, the filler content in the lower portion of the mixture shall be not more than 10 per cent greater than the average.

**Diatomaceous Earth.** Diatomaceous earth shall be silica of diatoms free from crystalline silica and clay, and shall weigh not more than 12.5 pounds per cubic foot in dry, loose condition. It shall contain not more than 7 per cent by weight of moisture. A moisture-free sample shall show a loss on ignition at 1800 deg. F. of not more than 7 per cent, and shall contain not less than 90 per cent of silica and not more than 6 per cent of alumina. Not more than 1 per cent shall be retained on a No. 30 sieve, and not more than 8 per cent on a No. 200 sieve.

**Hydrated Lime.** Hydrated lime shall conform to the requirements of Standard Specifications, Serial Designation C6-31, of the American Society for Testing Materials, Masons' Hydrated Lime shall be used.

**Calcium Chloride.** Calcium chloride is classified in Grades A and B, which shall conform to the following requirements:

		Grade A	Grade B
CaCl <sub>2</sub> (Anhydrous)	per cent	min. 77	min. 50
MgCl <sub>2</sub>	" "	max. 1	14-17
NaCl	" "	" 2	max. 1
Other impurities	" "	" 1	" 1

The calcium chloride may be in the form of loose, dry lumps or flakes, all of which shall pass a 5/16" sieve, or may be powdered. It shall be delivered in airtight, moisture-proof bags containing about 100 pounds each, or airtight drums weighing not more than 400 pounds each. The net weight, and the analysis of the content as guaranteed by the manufacturer, shall be marked on each container. When sampled in the field and tested, the materials shall show not less than 74 per cent of CaCl<sub>2</sub> for Grade A, and not less than 47 per cent for Grade B.

**Liquid Joint Filler.** Liquid joint fillers, Grades BM-2 to BM-5, shall be made from asphalt cement and mineral filler, Grade B. For Grades BM-2 and BM-3 shall be used asphalt cement, Grade OA-4, and for Grades BM-4 and BM-5 shall be used Grade OA-3. The asphalt cement and the mineral filler shall conform to the requirements for these materials specified above. When maintained for 2 hours at 325 degrees F. without agitation the bottom filler content of the mixture shall be not more than 10 per cent greater than the average. Joint filler Grade RA, shall be made from suitable asphalt cement and other materials as may be required and shall not shatter or crack when subjected to the Brittleness Test, the specifications for which are on file in the Laboratory.

The joint fillers shall be ready for use when shipped, and shall not be fluxed or blended on the work. They shall be shipped in sealed containers, plainly marked with the grade and net weight, and shall conform to the requirements of Table 9.

TABLE 9. LIQUID JOINT FILLERS

	BM-2	BM-3	BM-4	BM-5	RA
Specific Gravity, 15.5°C., min.					0.985
Penetration, 0°C., 200 g., 60 sec., min.					45
Penetration, 25°C., 100 g., 5 sec.					75-100
Penetration, 46°C., 50 g., 5 sec., max.					200
Melting point, (B&R), deg. C., min.	52	53	56	59	70
Evaporation loss, 163°C., 50 g., 5 hrs. %, max.					1
Penetration on residue, 25°C., 100 g., 5 sec., min.					55
Solubility in (C <sub>6</sub> H <sub>6</sub> ) %	60-75	55-75	45-65	40-60	min. 99
Bitumen soluble in Ether (Sulphuric U.S.P.) %					min. 75
Flash point, deg. C., min.	200	200	200	200	
Ductility, 0°C., 5 cm. per min.					2
Ductility, 25°C., 5 cm. per min.					3
Bend Test, 50 g., 5 sec.	75-150	45-75	30-45	20-30	
Flow Test, 51.7°C., cm., max.					5

**Premoulded Joint Filler.** Premoulded joint filler shall conform to the requirements of Specification M-33-38 of the American Association of State Highway Officials. The finished joint filler shall be of the thickness specified and shall fill the pavement joint completely.

**Broken Stone.** Broken stone shall be either trap rock, dolomite, granite, limestone or gneiss. Only one of these kinds shall be used, unless otherwise approved by the Engineer. **Trap Rock** shall mean a basic igneous rock consisting principally of augite and plagioclase. It shall be of medium or fine grain texture with even distribution of constituent minerals and uniform quality and color, and the percentage of wear (Deval) shall be not more than 3. **Dolomite** shall mean a rock consisting principally of calcium-magnesium carbonate. It shall contain not less than 30 per cent of magnesium carbonate and not less than 80 per cent of combined calcium and magnesium carbonates. It shall be uniform in texture and quality and have a percentage of wear of not more than 3.5. It shall not be affected noticeably by 5 immersions in a saturated solution of sodium

sulphate with proper dehydration after each immersion.

**Granite** shall mean an igneous rock consisting principally of quartz and feldspar. It shall be of medium or fine grain texture, shall have an even distribution of the constituent materials, shall be uniform in quality and structure, and shall have a percentage of wear of not more than 4.5.

**Limestone** shall mean a rock consisting principally of calcium carbonate. It shall contain not less than 55 per cent of calcium carbonates and not less than 80 per cent of combined calcium and magnesium carbonates. It shall be uniform in texture and quality and have a percentage of wear of not more than 5. It shall not be affected noticeably by 5 immersions in a saturated solution of sodium sulphate with proper dehydration after each immersion.

**Gneiss** shall mean a metamorphic rock consisting principally of quartz and feldspar. It shall have a dense structure and shall not break in thin pieces at lines of stratification and shall have a uniform distribution of the minerals. It shall have a percentage of wear of not more than 4.5. The broken stone shall be free from pieces coated with clay, caked stone dust and other foreign materials. It shall contain not more than 5 per cent of weathered or decomposed rock, not more than 3 per cent of flat pieces and pieces with the length less than half the width, not more than 5 per cent of other types of stone, and the total of the above shall be not more than 10 per cent except that stone not required for concrete or which are not to be coated with bitumen need not be free from pieces coated with clay, caked stone dust or other foreign materials unless this is found injurious for the intended purpose of the stone. The percentage of wear shall be determined by Method T-3-35 of the American Association of State Highway Officials.

**Gravel.** Gravel for concrete and other specified purposes shall contain not more than 2 per cent of soft fragments, not more than a total of 0.5 per cent of clay lumps, coal, organic and other foreign matter, not more than 3 per cent of thin, elongated pieces, and shall be practically free from sea salt and other deleterious matter. Before being loaded for shipment, it shall be washed so that the surfaces are clean and free from coatings of foreign matter.

**Slag.** Slag shall be air cooled blast furnace slag, and shall consist of angular fragments reasonably uniform in density and quality, reasonably free from thin, elongated and glassy pieces, dirt and other objectionable matter,

shall weigh not less than 70 pounds per cubic foot, and shall have a percentage of wear, Los Angeles Test, of not more than 40.

**Grading.** Broken Stone, Gravel and Slag shall be graded as shown in Table 10. Both square sieve openings and round screen openings may be used to grade the materials in the Laboratory, but in case of discrepancy the grading by round screen openings shall govern.

Note. For screenings C, the material passing the No. 200 sieve shall contain sufficient clay to bind the screenings. The exact amount required will be determined by tests made by the Engineer.

TABLE 10

Total Per Cent Passing Sieve or Screen Openings											
Round Openings	3½"	3"	2¼"	1¾"	¾"	½"	¼"	10	30	200	
Square Openings	3"	2½"	1⅞"	1"	⅝"	⅜"	No. 4	10	30	200	
2½"—Size	100	85-100	0-45	0-5							
1½" "			100	10-30	0-5		0-2				
1¼" "			100	45-75	20-45	15-30	0-5				
1" "				100	20-50	0-15	0-5				
¾" "				100	45-75	25-45	0-10	0-2			
⅝" "				100	95-100	30-50	0-5				
½" "					100	50-85	15-35	0-5	0-2		
⅜" "						100	95-100	20-50	0-15	0-2	
¼" "							100	85-100	0-25	0-10	
Grits							100	95-100	45-60	0-15	0-2
Stone Sand							100	95-100	70-90		
Screenings A (Stone)					100	50-85	35-70		10-30	0-5	
Screenings B (Stone)					100		40-80		25-65	5-20	
Screenings C (Stone)					100		45-90		30-75	15-35	

**Sand for Concrete and Mortar.** Sand for concrete and mortar shall be particles of quartz or other hard, durable rock, moderately sharp and free from soft particles, clay, loam, cemented particles, mica, salt and organic and other foreign matter. The surfaces of the particles shall be clean, and the sand shall contain not more than 4 per cent of elutriable material. The sand shall be graded as follows:

	Passing 3/8" Sieve	Retained on No. 4 Sieve	Min.	Max.
No.	4	10	0%	5%
"	10	30	0%	20%
"	30	50	20%	60%
"	50	200	20%	50%
"	200	—	12%	25%
			0%	5%

When the sand is mixed with cement and water, the resulting mortar shall have compressive and tensile strengths at the age of 7 and 28 days which are not less than those of mortar similarly prepared with standard Ottawa sand. When for testing purposes Ottawa sand is called for and not available, a similar quartz sand which the Laboratory has compared for strength results with standard Ottawa sand may be used, but all test results shall be reported on the basis of percentage of Ottawa sand strength as computed.

**Sand for Bituminous Work.** Sand for bituminous work shall conform to the requirements specified for Sand for Concrete and Mortar, except that the elutriation requirement does not apply and that the grading shall be as follows:

	Passing No. 4 Sieve	Retained on No. 10 Sieve	Min.	Max.
"	10	30	0%	2%
"	30	50	6%	30%
"	50	80	15%	42%
"	80	200	20%	40%
"	200	—	15%	35%
			0%	5%

**White Traffic Paint.** The ready mixed paint shall consist of from 60 to 62 per cent pigment and from 38 to 40 per cent vehicle by weight. The pigment shall consist of 49 to 51 per cent titanium barium pigment, 19 to 21 per cent zinc oxide and 29 to 31 per cent inerts. The exact composition shall be as directed by the Engineer within the specified

limits. The weight of the paint shall be not less than 12½ pounds per gallon.

The finished product shall be uniform in composition and shall be readily broken up with a paddle to a smooth paint, capable of easy application by means of a mechanical distributor as used by the Department. It shall dry within ½ hour so that there will be no pick up under traffic, and it shall be thoroughly dry within 1 hour after being applied. When dry it shall be flat white and opaque and shall have a roughened surface. A line painted on a concrete surface shall be entirely visible in daylight. The night visibility of the paint shall be not less than 7 foot candles. The paint shall have a viscosity of 85 to 100 at 75° F., as determined by the Stormer-Krebs Viscosimeter 48 hours after manufacture and at time of application.

*Pigment.* The titanium barium pigment shall be from 29 to 31 per cent titanium dioxide and from 69 to 71 per cent barium sulphate, prepared either by precipitating titanium dioxide with barium sulphate or blending them in a wet state. When tested as hereafter described, the amount of titanium dioxide in the total solids shall be not more than 75 per cent. The titanium dioxide shall comply with Specification D-384-36, of the American Society for Testing Materials and shall contain not less than 98 per cent  $TiO_2$ . The barium sulphate shall be a precipitated product containing not less than 98 per cent barium sulphate.

Zinc oxide shall contain not more than 0.2 per cent sulphur and not more than 2 per cent total impurities including moisture. It shall be ground so that all will pass a No. 200 sieve and not more than 2 per cent will be retained on a No. 325 sieve.

The inerts shall be a combination of asbestine, all of which shall pass a No. 200 sieve and not less than 98% a No. 325 sieve, and pumice of such character and ground to such a fineness that the required visibility will be attained.

*Vehicle.* The vehicle shall consist of varnish, volatile material and drier, and shall contain not less than 30% non-volatile material, all derived from the varnish.

The varnish shall consist of oil, resin and basic carbonate of lead as hereafter described in the following proportions: 20 gallons oil, 100 pounds resin (making a varnish of 20 gallons oil length) and 2 pounds basic carbonate of lead, together with the necessary amount of volatile thinner. The varnish shall be cooked to Viscosity M (Gardner-

Holt). The varnish shall contain not less than 60 per cent non-volatile material, and shall be quick drying and pale in color.

The oil for the varnish shall consist of 60 per cent (by weight) Tung oil conforming to Specification D-12-33 of the American Society for Testing Materials, and 40 per cent varnish makers grade Linseed oil heat bodied to viscosity Q (Gardner-Holt) before being used in the varnish.

The resin for the varnish shall be a modified phenolic resin which, when tested as hereafter described shall comply with the following requirements: Color, extra light; Fusion point, 118-125° C.; Melting point, 130-140° C.; Acid number, 12-18; Viscosity (a 56% cut in tolnol), H-N, Gardner-Holt.

The basic carbonate of lead for the varnish shall conform to the requirements therefor specified in Art. 5.13.2 (p. 221).

The volatile material for the varnish and for the vehicle shall consist of naphthanate driers and either a tar or petroleum distillate or a combination thereof.

The drier for the vehicle shall consist of cobalt and lead naphthanates combined so as to provide 1 part cobalt to 10 parts lead (as metals).

*Tests* (TITANIUM DIOXIDE TEST). Prepare a water suspension of the pigment by stirring rapidly with a glass rod in an 800 c.c. beaker for 5 minutes, 50 grams of the pigment, 460 c.c. of water and 40 c.c. of a 10% solution of sodium silicate ("N" Grade, Philadelphia Quartz Company). Pour this and shake well for 1 minute before setting the graduate aside to permit settling. After 18 hours of settling, obtain a sample of the suspension by immersing the end of a 25 c.c. pipette  $3\frac{1}{2}$ " below the level of the liquid and drawing up 25 c.c. of volume carefully without unduly disturbing the suspension. Thoroughly mix this 25 c.c. sample and pipette therefrom two 10 c.c. samples, evaporating each to dryness on a steam bath in a tared 250 c.c. beaker and weigh for total solids. These solids from each 10 c.c. sample shall be analyzed for their titanium dioxide content as follows:

Moisten each of the two samples of solids in the 250 c.c. beakers with a few drops of hydrofluoric acid. Add 25 c.c. of concentrated sulphuric acid and 8 grams of ammonium sulphate. Cover the beakers with watch glasses, heat to  $\text{SO}_3$  fumes and continue digestion until solution is com-

plete. Cool the solution and dilute carefully with 100 c.c. of water. Heat to boiling, settle, filter through filter paper and transfer precipitate completely to the paper. Wash the insoluble residue with cold 5% (by volume) sulphuric acid until titanium is removed. Dilute filtrate to 200 c.c. and add about 30 c.c. of ammonia (sp. gr. 0.90) to lower the acidity to approximately 5% sulphuric acid (by volume). Analyze the solution for titanium dioxide by means of a Jones Reductor.

**RESIN TESTS.** (A) *Fusion Test.* The finely powdered resin is placed in a capillary tube and heated in a sulphuric acid bath. The Fusion Point is the temperature at which the powdered resin first begins to fuse; the Melting Point is the temperature at which it has fused completely to a clear drop.

(B) *Acid Number.* Five grams of the resin are dissolved in 75 c.c. of pure benzol and to this solution neutral alcohol is added drop by drop until the turbidity which first appears clears up. Then add 25 c.c. of saturated sodium chloride solution and five drops of a 1% solution of phenolphthalein in neutral alcohol. Titrate using half normal alcoholic sodium hydroxide solution until after shaking the salt layer acquires a light but permanent pink color.

$$\text{Acid Number} = \frac{\text{c.c. of N/2 NaOH} \times 28}{5}$$

(C) *Viscosity.* Put 11 grams of powdered resin and 10 c.c. of toluol, nitrating grade, in a 125 mm. Erlenmeyer flask fitted with an air condenser. Heat gently until dissolved and read the viscosity at 250° C. against standard Gardner-Holt tubes.

**ULTRA VIOLET RAY TEST.** A thin film of the paint when spread on a glass plate and allowed to thoroughly dry shall not darken or show any discoloration when subjected to Ultra Violet Rays for a period of 5 minutes.

**VISIBILITY TEST.** The light reflected from the paint shall be compared with that of a ground standard milk glass plate having an angle of diffuse reflection of approximately 77 per cent and furnishing an illuminometer reading of 3 foot-candles as determined by a photometric apparatus illuminometer at an angle of incidence of 88° 20' with an angle of reflection of 87° 08'. (This apparatus is described in Proceedings, Part 1, Fifth Annual Meeting, National Research Council, Highway Research Board.)

**NON-VOLATILE TEST.** The non-volatile portion of the vehicle

and varnish shall be determined in accordance with the method given therefor in the Federal Specifications for Mixing Varnish, TT-V-81. The non-volatile portion of the vehicle in the paint ready for use shall be determined in the same manner.

### 3.13.3. Methods of Construction.

No construction is involved.

### 3.13.4. Quantity and Payment.

The quantities of the various materials for which payment will be made, will be those actually received in accordance with the orders for said materials, and conforming to the Specification requirements, provided, however, that no materials will be measured for payment under this Article, when payments for them are provided under other scheduled items in the Proposal. The volume of bituminous materials will be measured at 60 deg. F.

Payment for the various materials will be made for the quantities as above determined, measured in the prescribed unit measures, at the prices bid for the various material items, respectively, in the Proposal, which prices shall include the furnishing of the materials at the prescribed locations and times, and all other work in connection therewith and incidental thereto.

## **DIVISION 4**

### **Structures**

#### **SECTION 1**

##### **Concrete Structures**

###### **4.1.1. Description.**

**Concrete Structures** shall include the construction of concrete piers, walls, bridges, bridge floors, viaducts, culverts 5 feet or more in span, and similar structures, at the locations, to the prescribed lines, grades and dimensions and in accordance with the Plans and Specifications.

###### **4.1.2. Materials.**

**Cement.** Cement shall be either Standard or High Early Strength Portland Cement, conforming to the requirements of Serial Designation C9-38 and C74-39, respectively, of the Standards of the American Society for Testing Materials, and to the following three additional requirements:

1. Standard Portland cement, which is to be used in the Project between the approximate dates of May 1 and October 1, shall have a specific surface of not less than 1600 and not more than 1800 sq. cm. per gram, with upper and lower limit tolerances of 50 sq. cm. per gram. When it is to be used between the approximate dates of October 1 and May 1, the specific surface shall be not less than 1800 sq. cm. per gram, with a lower limit tolerance of 50 sq. cm. per gram. The specific surface shall be determined in accordance with the requirements of Serial Designation C115-38T of the American Society for Testing Materials.

2. The expansion of all cement as determined by the autoclave test, made in accordance with the requirements of Serial Designation C151-40T of the American Society for Testing Materials, shall be not more than 0.5 per cent.

3. The cement shall be mixed with fine and coarse aggregates and water, and the mixture shall be cast in metal cylinders, all as hereinafter described. The resulting concrete cylinders shall be tested for compression strength. When the cement used is standard Portland cement, 3 cylinders shall be tested, when the concrete is 7 days

old, and 3, when 28 days old. When high early strength cement is used, the time periods shall be 3 and 7 days, respectively. The average strength of the three cylinders first tested shall be not less than 4800, and of the three cylinders last tested not less than 6500 pounds per square inch.

The compression test specimens shall be prepared, stored and tested in accordance with the requirements of Serial Designation C39-40 of the Standards of the American Society for Testing Materials, except that the diameter of the cylinders shall be 3 inches. The aggregates for the concrete mixture shall consist of standard Ottawa sand and graded Ottawa sand, complying with the requirements of Serial Designations C77-39 and C109-37T, respectively, of the American Society for Testing Materials, and trap rock free from adherent dust. The trap rock shall be of medium or fine grain texture with even distribution of constituent minerals, and the percentage of wear shall be not more than 3 (A. S. T. M. Serial Des., D2-33).

The aggregates shall be graded so that the weight percentages are as follows:

Standard Ottawa Sand .....	8.3%
Graded Ottawa Sand .....	26.6%
Trap Rock passing No. 8, retained on No. 14 sieve	14.0%
“ “ “ No. 4, “ “ No. 8 “	15.4%
“ “ “ $\frac{3}{8}$ in., “ “ No. 4 “	17.0%
“ “ “ $\frac{3}{4}$ in., “ “ $\frac{3}{8}$ in. “	18.7%

The volume of water in the mixture shall be at the rate of 4.6 gallons per bag of cement, corrected for absorption by aggregates in accordance with the requirements of Serial Designation C127-39 and C128-39 of the Standards of the American Society for Testing Materials. The slump of the fresh concrete mixture, as established in accordance with Serial Designation C143-39 of said Society shall be from 2 to 3 inches with an upper and lower tolerance of  $\frac{1}{4}$  inch.

White Cement shall be standard Portland cement as above specified, containing not more than 0.55 per cent by weight of ferric oxide ( $\text{Fe}_2\text{O}_3$ ).

Complete routine records shall be furnished to the Engineer of the chemical analysis of the cement, the specific surface area, the autoclave expansion percentage, and the compression test results, if made by the cement manufacturer, and such other pertinent data as the Engineer may deem desirable.

Subject to conformity with all other specification requirements, the use of the cement in the Project may begin when the cement has passed satisfactorily the specified 7-days compression test.

Standard Portland cement shall be used, except when the use of high early strength cement is specified or authorized in writing by the Engineer. Only one brand of cement shall be used on the Project, except when more than 10,000 barrels of cement are required or when written permission of the Engineer is obtained for the use of more than one brand. When more than one brand is used, each brand shall be in separate parts of the Project as designated or approved by the Engineer. The cement shall be of a standard brand and shall at the place of manufacture be taken from storage bins containing cement which has been inspected and approved by the Engineer. Orders for cement shall be placed with the manufacturer not less than 10 days before the first shipment is to be made, and duplicates of the orders shall be furnished the Engineer. Except as hereinafter provided, cement shall be shipped in bags containing 94 pounds of cement. The bags may be of cloth or paper of approved type. Cement may be shipped in bulk, subject to the approval of the Engineer and to such strict requirements as he may deem necessary. Railroad cars in which cement is shipped shall be loaded under the supervision of and sealed by the Inspector. Cars with broken seals may be unloaded, but the cement shall not be used until retested and reapproved.

At the site of the Project the cement shall be stored in a suitable weatherproof building, with floor raised above the ground and with ample floor space, unless the quantity required is small. The cement may then be stored on suitable platforms and protected with waterproof covering to the satisfaction of the Engineer. Each shipment of cement shall be stored separately to provide for ready identification and inspection. Cement that has deteriorated during storage at the site of the Project shall not be used. Standard cement stored at the site of the Project for more than 30 days, and high early strength cement stored for more than 10 days, shall not be used until retested and reapproved by the Engineer. The Contractor shall keep suitable daily records of cement received and used. The records shall show, in such details as the Engineer may require, the quantity used for each part of the Project during the day, and copies of the records shall be furnished the Engineer at the close of each day's work.

**Sand.** Sand for concrete and mortar shall conform to the requirements therefor specified in Art. 3.13.2 (p. 132).

**Coarse Aggregate.** Coarse aggregate shall be broken stone or gravel, conforming to the requirements therefor specified in Art. 3.13.2 (p. 129), and shall be graded as therein specified. Except where otherwise specifically provided, the Size of coarse aggregate shall be  $\frac{5}{8}$ -inch or  $\frac{3}{4}$ -inch for Class A concrete, and  $\frac{3}{4}$ -inch or  $1\frac{1}{4}$ -inch for Classes B, C and D.

The  $1\frac{1}{4}$ -inch Size of coarse aggregate shall be prepared at the batcher by mixing  $1\frac{1}{2}$ -inch Size and  $\frac{3}{4}$ -inch or  $\frac{5}{8}$ -inch Size, as may be required by the Engineer. The  $\frac{3}{4}$ -inch Size shall be prepared at the batcher or at the point of production by mixing 1-inch Size and  $\frac{5}{8}$ -inch Size. The proportional parts of each Size will be determined by the Engineer and the mixture shall be uniform throughout.

**Aggregates, General.** Sand, broken stone and gravel shall be kept clean and free from foreign matter until used. Aggregates found segregated when about to be used will be rejected. Gravel shall be washed not less than 24 hours before being used, and no aggregate shall contain surplus water when used. Shipments of aggregates appearing defective will be held until sampled, tested and reapproved. Rejected materials shall be removed.

Stock piles of aggregates shall be placed on platforms of not less than 2-inch planks, laid on firm, well drained ground. The platforms shall be ample in size so that the materials will not be spilled on the ground. The aggregates shall be placed in the stock piles in layers not more than 2 feet deep and so that water will be drained out. Different types and Sizes of aggregates, and similar types and Sizes from different sources, shall not be mixed in the stock piles, and durable partitions of sufficient height shall be provided to prevent mixing.

**Water.** Water shall be clean, fresh and free from oil, acid, injurious alkali and vegetable matter. It may be tested in accordance with *Method T-26-35 of the American Association of State Highway Officials*. If the test indicates that mortar made with the water being tested is unsound or slow setting, or of less strength than mortar made with water of satisfactory quality, the water shall not be used for concrete mixtures.

**Concrete.** Except where otherwise specifically provided, concrete shall be Class A, B, C or D, as may be prescribed, proportioned as follows:

Class	Cement	Sand	Coarse Agg.	Void Content
A	1	1.50	3.0	1.350
B	1	1.75	3.5	1.575
C	1	2.00	4.0	1.800
D	1	2.25	4.5	2.025

provided, however, that when the coarse aggregate has a percentage of voids above or below 45, the volume of coarse aggregate and sand, respectively, shall be decreased so that the volume of said voids will equal 90 per cent of the sand volume. The volumes shall be measured when the materials are dry and loose, not when they are rodded or shaken.

The Class of concrete required for the various items of work shall be as shown on the Plans or in the Specifications.

**Reinforcement Steel.** Reinforcement bars shall be of a deformed type approved by the Engineer and shall have a net section throughout equal to that of plain bars of the same nominal size. Cold or hot twisted bars shall not be used. The bars shall be manufactured from Open Hearth Steel Structural Steel Grade, shall be rolled from new billets of properly identified heats, and shall conform to the requirements of the current Serial Designation A-15 of the American Society for Testing Materials with the following modifications: The actual weight of a lot of bars shall be not more than  $2\frac{1}{2}$  per cent over or under the theoretical weight of that lot. If deemed necessary by the Engineer the bars will be inspected and tested after delivery. Bars showing injurious defects when received will be rejected. Wire, wire mesh, metal caging and other kinds of reinforcement shall be of a type and quality approved by the Engineer. Structural shapes used for reinforcement shall conform to the requirements for structural steel specified in Art. 4.2.2 (p. 157).

**Copper.** Copper for flashing shall be 16-oz. soft annealed copper.

**Cast Iron.** Cast iron for scuppers shall be as specified in Art. 4.2.2 (p. 158).

**Tiles.** Tiles shall be frost proof faience of selected grade with plastic clay body and of the required color and texture equivalent to samples on file in the Department. The tiles

shall be free from warp and other defects and shall be subject to the approval of the Engineer.

**Waterproofing Materials.** Waterproofing materials shall conform to the requirements therefor specified in Art. 4.6.2 (p. 181). Premoulded Joint Filler shall conform to the requirements therefor specified in Art. 3.13.2 (p. 129). Tar Paper shall be of a quality approved by the Engineer.

**Colorless Curing Compound.** Colorless Curing Compound shall be a liquid compound which will dry within 15 minutes to a continuous, impervious film when sprayed on a newly deposited concrete mixture. The compound shall have the following characteristics: Specific Gravity at 64° F., 0.87-0.94; Viscosity (Saybolt Universal) at 64° F., 50-75 secs; total solids when evaporated at 220° F., not less than 40% by weight; freezing point shall be below 0° F.; when cooled to 28° F. and then warmed to 100° F., it shall show no separation; when poured on water it shall form thereon a continuous coherent film; it shall not discolor the concrete surface on which it is applied.

#### 4.1.3. Methods of Construction.

**Batching Equipment.** Except where small quantities of concrete only are to be used and for that reason the Engineer may permit otherwise, the equipment for batching of concrete materials shall conform to the following requirements: The batching equipment shall be substantially constructed on firm foundation, high enough above trucks being loaded to function properly. It shall have 3 bins and a weighing hopper. The bins shall have a total capacity of not less than 100 tons, and the partitions between them shall extend not less than 3 feet above the bins. The bins shall be equipped with baffle boards so as to assist drainage of the aggregates and prevent the drained out water from passing through the outlet gate. A platform shall extend around the weighing hopper for easy means of inspection, adjustment and weighing.

The weighing hopper shall have a single compartment with arrangements for ready removal of excess material, and with discharge gate opening parallel to partitions of receiving trucks. The amount of opening of discharge gate shall be readily controlled. There shall be sufficient clearance at all points for the weighing hopper to function properly. The weighing scales shall be of beam or springless dial type, of standard design and make, and shall be able to record the true weight within 5 pounds at maxi-

mum load. The beam type shall have separate beams for each Size of aggregate, and each beam shall have an easily operated locking device. A dial which will show the weight when the load is within 100 pounds of that required and an approved signal device shall be provided. The weighing scales shall be arranged for ready standardization, and with each scale shall be furnished a set of standard weights including seven 50-pound, two 25-pound, two 10-pound and two 5-pound weights. The tolerances of these weights shall be within those adopted by the U. S. Bureau of Standards, May, 1916. The standard weights shall be protected against defacement and injury, and shall be easy to handle and attach. For batchers of capacity of  $\frac{1}{2}$  cubic yard or less, the standard weights will be furnished by the Inspector. All parts of the weighing devices and appurtenances of the batching equipment shall be substantially made and shall be maintained in proper operating condition. If, in the opinion of the Engineer, any part or all of the weighing devices or other appurtenances are not satisfactory, they shall be replaced in a satisfactory manner at the Contractor's expense.

**Unloading and Hauling Equipment.** Equipment for unloading and handling of materials for batching shall be of standard design and of capacity in excess of that needed to maintain the operation of the mixing plant which it serves. The boom shall be able to reach easily the material in stock pile, shipping vehicle and hopper. Trucks used for hauling batches shall have pneumatic tires and substantial bodies. Partitions shall be not less than 10 inches higher than the sides and shall have locking devices. Compartments shall have a capacity, measured straight across top of side pieces, of not less than 36 cubic feet, except that when cement is hauled with the aggregates the capacity shall be not less than 43 cubic feet and the bags of cement shall be kept separate, unopened and protected, and arrangements shall be made so that the cement will be delivered to the hopper after the aggregates have been dumped, all in a manner satisfactory to the Engineer.

**Mixing Equipment.** The concrete mixer shall be a batch mixer so designed as to insure positive, uniform distribution of materials throughout the mass. The size and type of mixer used on various classes of work shall be as hereinafter specified and shall be approved by the Engineer. For all work where the volume of concrete to be placed justifies it, the mixer shall have a capacity of not less than

$\frac{3}{4}$  cubic yard, shall be of approved make and acceptable to the Engineer, and shall comply with the following requirements:

The mixer shall have locking device preventing the mixture being discharged before the expiration of the specified mixing time, automatic locking device preventing materials being placed in the mixer before discharge gate is closed; regulator that will maintain the rate of speed for which the mixer has been designed; signal device that will function when water is added; vertical water tank with automatic valve shutting when the tank is filled to the required amount; automatic device that will measure and discharge the required volume of water; valves to prevent overflow into mixing chamber or onto ground when the discharge valve is closed, and into the tank when open; and valves and piping in proper order to prevent any leakage. The automatic device for measuring and discharging the required volume of water shall be arranged to discharge a predetermined volume, to be easily adjusted to discharge a larger or smaller volume, and to register the volume discharged accurately on a gauge or dial, which shall be calibrated before the mixer is used and shall be kept properly calibrated. A by-pass valve shall permit the discharge of all the water into a measuring can for calibration purposes. The measuring of the volume of water required shall be done by means of the adjustable discharge device only. The loading skip of the mixer shall be substantially made and shaped so that wet sand and other materials will not remain in it when it is being discharged. The mixer shall not be used when any of the devices above stated are not functioning properly, or when the blades of the mixer have worn down to 90 per cent of their original width. The Contractor shall furnish a certified statement from the manufacturer as to their original width. The mixer shall be kept clean and free from hardened mortar.

On operations involving the placing of small quantities of concrete, the requirements regarding mixing equipment may be modified subject to the approval of the Engineer, and under certain conditions hand mixing may be permitted.

**Transit Mixers.** Transit mixers shall not be used, except when authorized by the Engineer in writing, or by the Specifications for specific items of work. When authorized, their use shall be subject to the provisions of this

article and other articles relating to batching and proportioning of concrete and to the following additional provisions. Only approved transit mixers, mounted on trucks, shall be used. Only sufficient water to permit discharging the concrete mixture from the drum with the specified consistency shall be used. No water shall be admitted to the drum until the mixer is at the working site, and the mixing shall be continuous from the time water is admitted until the mixture is discharged. Not less than 6 and not more than 10 minutes shall elapse between the time water is admitted and the mixture is discharged. The amount of water, the time of mixing and the control of the mixture shall be subject to regulation by the Engineer. The mixer shall be thoroughly cleaned after each batch is discharged. The concrete will be rejected, if there be any evidence of setting up of the mixture in the mixer.

**Batching and Mixing.** The batching of the concrete mixture shall be done by weight. Not less than 3 days before the batching and mixing equipment is installed and ready for use, the materials and equipment necessary for determination of mixture are on hand, and the Contractor is ready to start preparing concrete, he shall notify the Engineer to that effect, and the Engineer will determine at the beginning of the batching operation the quantities of materials, including water, required for a batch, and the controlling devices shall be set accordingly. No subsequent changes shall be made by the Contractor in the devices controlling the quantities delivered unless such changes are directed by the Engineer.

The volume of concrete mixture which may be placed in the mixer shall be determined by the capacity of the mixer, provided however, that part of a bag of cement shall not be used in making up a batch. When the volume is so large that the speed of the mixer is reduced thereby below its rated speed, or the mixture is spilling over during the mixing, or other evidence of overloading is apparent, then the volume of the batch shall be reduced accordingly. The first batch placed in the mixer shall contain excess of cement, sand and water to coat the mixing chamber without reducing the required mortar content of the mixture. The mixer shall be operated at the rate of speed for which it has been designed, as rated by the manufacturer, and said rate of speed shall be not less than 14 and not more than 22 revolutions per minute.

After all materials, including water, have been placed in the mixer and the revolution recording device has started registering, the materials shall be mixed for a period of not less than  $1\frac{3}{4}$  minutes and as much longer as may be necessary to produce a thorough and uniform mixture of the concrete. For dual mixers the mixing time shall be considered to cover the actual total time that the mixture is being mixed in either one or the other of the drums. The mixer shall be emptied completely after the mixing of each batch is finished. The mixer shall be thoroughly cleaned if not used for a period of 30 minutes.

**Consistency.** The concrete mixture shall contain the least amount of water possible for proper workability. In general, its consistency shall be such that the mortar clings to the coarse aggregate; that the mixture will not segregate during transportation and handling; that the mixture, when dropped, will flatten but not spread; that there is no appearance of free water; that the mixture in a chute will slide and not flow into place; that the slump is from 2 to 3 inches; and that the concrete when set will show a cement film, but is free from laitance.

**Forms.** Forms may be of wood or metal and shall be constructed to conform to the lines and grades established by the Engineer and to the exact dimensions of the structure. They shall be substantially constructed, strong, rigid and mortar-tight, and properly braced and tied. The forms shall be designed so that they can be removed without causing damage to the concrete.

Except for curved and other special surfaces, form lumber for exposed concrete surfaces shall be dressed 1 face and 2 edges. Metal forms shall be of substantial thickness and have a smooth, true surface, free from rust, and bolts and rivets shall be countersunk. All forms shall be constructed, braced and lined up so as to produce smooth concrete surfaces without bulges and warps. When the forms appear unsatisfactory, either before or during concreting, the placing of the concrete shall be deferred until the forms have been made good to the satisfaction of the Engineer. Re-used forms shall be in good condition in all respects.

Form ties and anchorages within the forms shall be arranged so that they can be removed to a depth of not less than 2 inches from the surface of the concrete without damage to the surface. Ordinary wire ties shall not be used. The cavities left in the concrete when the ties are

removed shall be filled with mortar similar to that of which the concrete is prepared, and the surface of the concrete shall be left sound, smooth, even and uniform in color and texture. Before concrete is placed in the forms, they shall be thoroughly cleaned so as to remove all loose and foreign material within them, and they shall be coated with oil approved by the Engineer to prevent discoloration or adherence of concrete. For concrete exposed to sea water the forms shall be heavily coated with shellac or approved oil.

**Removal of Forms.** When the placing of the concrete has been completed, under good weather conditions, and subject to the approval of the Engineer, forms and their supports may be removed from under arches, beams and floor slabs after the expiration of 14 days; column forms after 5 days; and wall forms, side forms for beams or carrying no loads after 1 day; provided, however, that for structures exposed to sea water the time for removal shall be as hereafter specified. In counting the number of days, days when the temperature is below 40 degrees F. shall be excluded. In general, forms shall be removed from the lowest level upward. Supports shall be removed so that the concrete will be subjected uniformly and gradually to its dead load stresses.

**Falsework.** Detail drawings of falsework and centering shall be submitted for the Engineer's approval when so required, but his approval of them, or acquiescence in the work constructed according to them shall not relieve the Contractor of full responsibility. If necessary to secure unyielding support the falsework shall be supported on piles. Screw jacks, hard-wood wedges or other suitable means shall be used to correct slight settlements. Falsework shall be set to give the camber indicated and to allow for shrinkage and settlement. Centers for arches shall be gradually and uniformly lowered when struck so as to avoid injurious stresses in any part of the structure. In arch structures of 2 or more spans, the sequence of striking centers shall be as specified or approved by the Engineer.

**Placing of Reinforcement Steel.** When placed in the work reinforcement steel shall be clean and free from mill or rust scale, paint, oil, and other foreign matter. When heated for bending, the temperature of the steel shall be not higher than that producing a dark cherry red color. Proper appliances shall be used for cutting and bending.

The reinforcement steel shall be accurately placed and fastened in a manner approved by the Engineer. Distances from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved supports. Blocks for spacing of reinforcement bars shall be precast mortar blocks of approved design and short enough to permit their ends to be covered with concrete. Layers of bars shall be separated by such blocks, which may be reinforced, and which shall have slots to receive the bars and hold them in place, or by other approved means. When placed, the reinforcement steel shall be inspected and approved before the concrete is placed, otherwise the concrete will be rejected and shall be removed.

Splicing of reinforcement steel, except where shown on the Plans or approved by the Engineer, will not be permitted. Splices shall have a length sufficient to develop the full strength in bond of the bar, and shall be well distributed and located at points of low tensile stress. No splices shall be made at points where the section is insufficient to provide not less than 2 inches between the splices and the nearest adjacent bar or the surface of the concrete. At splices the bars shall be rigidly clamped or wired together in a manner acceptable to the Engineer. Sheets of metal mesh shall overlap so as to maintain uniform strength and shall be securely fastened. Metal caging shall be used for reinforcement of concrete around bottom flanges of beams and girders, and special clips as shown on the Plans shall be used for securing the concrete on webs of beams and girders.

**Placing Concrete.** The placing of the concrete mixture shall be conducted so as to produce a dense, compact, impervious structure of uniform texture and with smooth exposed surfaces. The concrete mixture shall be placed immediately after being mixed in such a manner that segregation does not occur and the reinforcement steel is not displaced. A concrete mixture not placed within 30 minutes of the time that water was first added to the mixture shall not be used. The concrete mixture shall not be dropped for a distance of more than 5 feet and shall not be deposited in quantity at one point and subsequently run or worked along the forms. Long chutes shall not be used except when approved by the Engineer, and if subsequently found unsatisfactory by the Engineer their use shall be discontinued. Long shutes will not be approved for work exposed to the effects of salt or brackish water.

Troughs, pipes or short chutes may be used if of metal or lined with metal. Where the slope of the chute is steep, baffle boards or other approved arrangements shall be used. Troughs, pipes and chutes shall be kept clean and free from coatings of hardened concrete by flushing them with water after each run. The water used therefor shall be discharged at a point clear of the concrete in place. Troughs and chutes shall extend as near as possible to the place of deposit. Pipes shall be kept full of concrete mixture during the placing, and their lower ends shall be kept buried in the newly placed concrete. If the concrete is placed intermittently, a hopper or other device shall be used for regulating the discharge.

The placing shall be so regulated that the pressure of the concrete mixture will not cause damage to the forms. Care shall be taken to fill each part of the forms, to work the coarse aggregate back from the face, and to distribute the concrete under and around the reinforcement steel without displacing it. The concrete shall be compacted by continuous working with suitable tools and by vibrating, unless otherwise approved by the Engineer. The method of vibrating, and the type and number of vibrating units used, shall be as directed or approved by the Engineer. The vibrating implement shall have a vibrating frequency of not less than 5,000 impulses per minute.

Concrete mixtures for slabs, girders, arch ribs and other thin sections shall be placed carefully and thoroughly worked and compacted. The faces shall be well spaded to flush the mortar to the surface of the forms.

The concrete mixture shall be placed in continuous horizontal layers not exceeding 12 inches in thickness. If, on account of an emergency, a layer cannot be completed at one operation, it shall be terminated at a vertical bulkhead. The batches shall follow each other so closely, that a layer is placed and compacted before the preceding one has taken initial set. The surface of each layer shall be sufficiently rough to secure proper bonding with the subsequent layer, and this shall be compacted so as to avoid the formation of a construction joint between the layers. Layers placed at the end of a day's work or when the operations are otherwise temporarily discontinued shall be cleaned as soon as the surface has become firm enough to do so. Visible joints on exposed faces shall be avoided as far as possible by smoothing the top surface of each layer adjacent to the forms with a plaster mason's trowel.

Feather edges shall be avoided by insets in the forms so that any layer will end in a thickness of not less than 6 inches. When the work has progressed to within 18 inches of the top of the finished face the remainder shall be placed monolithically, except that a construction joint may be made at the underside of a coping.

Unless otherwise approved or directed by the Engineer, the concrete shall be placed as follows: In concrete slab and girder bridges the concrete shall be placed by beginning at the center of the span and working towards the ends. Concrete in girders shall be placed uniformly for the full length of the girder and brought up evenly in horizontal layers. In girder haunches less than 3 feet in height the concrete shall be placed simultaneously with that in the girder stem, and the column or abutment tops shall be cut back to form seats for the haunches. If the haunch has a vertical height of 3 feet or more the abutment or columns, the haunch and the girder shall be poured in 3 successive stages, first, to the lower side of the haunch; second, to the lower side of the girder and third, to completion. Concrete in slab spans shall be placed in one continuous operation for each span. The concrete for floors and girders of through girder structures, for T-beam or deck girder spans, and for columns shall in each case be placed in one continuous operation. The concrete in columns shall be not less than 12 hours old before the caps are placed, and no concrete shall be placed above the columns until the column forms have been removed sufficiently to determine the character of the concrete in the columns.

In arch rings the concrete shall be placed so as to load the centering uniformly. If not otherwise approved, arch rings shall be constructed in transverse sections of such size that each section can be cast in a continuous operation. The arrangement of the sections and the sequence of placing shall be approved by the Engineer and shall be such as to avoid creation of initial stress in the reinforcement. The sections shall be bonded by suitable keys or dowels. When permitted by the Engineer arch rings may be cast in a single continuous operation. For arches, the railing and coping, and for filled spandrel arches, such portions of the spandrel walls as may be necessary, shall be left for construction subsequent to the striking of centers to avoid jamming of expansion joints and to attain proper alignment.

On steel spans the concrete shall be placed symmetrically about the center line of the span, beginning either at the center or simultaneously at both ends. If it becomes necessary to introduce a construction joint, it shall be formed by means of a vertical bulkhead constructed so as to form a keyed or dove-tailed joint. In concrete floors not supported by longitudinal joists any necessary construction joint shall be located at the center of the slab. Concrete around steel shapes shall be placed on one side only of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which it shall be placed on both sides to completion. Before concrete floors are placed on steel spans the falsework under the bridge shall be released and the span swung free on its supports. After the concrete of finished surfaces has begun to set it shall not be walked upon or otherwise disturbed for a period of not less than 48 hours.

**Placing Concrete Under Water.** Concrete shall not be deposited in running water and, except with the written approval or direction of the Engineer, it shall not be deposited in or exposed to water before setting. When deposited in water the concrete shall be Class B, and it shall be placed carefully in a compact mass in its final position by means of a tremie, a closed bottom dump bucket or other approved method, in such a manner as not to become segregated, and after being placed it shall not be disturbed.

A tremie shall be a sectional, watertight tube not less than 10 inches in diameter with flanged couplings. The tremie shall be supported so as to permit quick lowering of the pipe and free movement of its discharge end over the entire surface to be concreted. The discharge end shall be plugged at the start of the work, and during the work the tube shall be kept full of concrete mixture. During placing of concrete the tremie shall not be raised above the level of the concrete placed. A bottom dump bucket for placing concrete under water, shall be of not less than  $\frac{1}{2}$  cubic yard capacity. The bucket shall be lowered carefully and slowly, and it shall not be emptied until it rests on the surface on which the concrete is to be placed. It shall then be raised slowly while being emptied, so as to maintain still water at the point of discharge and avoid agitating the concrete mixture.

Concrete seals of cofferdams shall be placed in a continuous operation in horizontal layers, and each succeed-

ing layer shall be placed before the preceding layer has taken its initial set. Laitance or other foreign matter shall be removed before concrete is placed upon it in the dry. Class B concrete shall be used.

**Concrete Exposed to Sea Water.** Concrete for structures exposed to sea water shall be Class B. The clear distance from the face of the concrete to the nearest face of reinforcement steel shall be not less than 4 inches. The concrete shall be mixed for a period of not less than 2 minutes and the water content of the mixture shall be carefully controlled and regulated so as to produce concrete of maximum impermeability. The concrete shall be thoroughly compacted and stone pockets shall be avoided. No construction joints shall be formed between levels of extreme low water and extreme high water, as determined by the Engineer. Between these levels sea water shall not come in direct contact with the concrete for a period of not less than 30 days after being placed. The original surface, as the concrete comes from the forms, shall be left undisturbed.

**Concreting in Cold Weather.** In cold weather the concrete aggregates and water shall be heated, and the structure being concreted shall be enclosed and heated. The aggregates and the water may be heated by dry heat, steam, or if approved by the Engineer by torch, so as to produce uniform temperature throughout the mass without local overheating. When placed in the forms the concrete mass shall have a temperature of not less than 60 deg. F., or more if the Engineer so directs. The enclosure around the structure shall be heated so that the air and the concrete within the enclosure are kept at a temperature of not less than 60 deg. F. for a period of not less than 7 days after placing the concrete, and of not less than 40 deg. F. for a period of 4 days thereafter; then the temperature may be gradually changed to that of the atmosphere. When dry heat is used means of maintaining atmospheric moisture shall be provided. Concrete shall not be placed when the atmospheric temperature is below 36 deg. F., except with the Engineer's approval.

**Construction Joints.** Construction joints shall be placed only where shown on the Plans or as directed or approved by the Engineer. When a concrete mixture is to be placed against set concrete, all loose and foreign material shall be removed from the surface of the latter and the surface shall be cleaned with wire brooms and saturated with

water. Immediately before placing the new concrete the forms shall be drawn tight. Where shown on the Plans construction joints shall be covered with membrane waterproofing as specified in Art. 4.6.3 (p. 181), except that the mortar course shall be reinforced with wire mesh having not more than 4-inch openings and not less than 12-gauge wires. Tar paper and paraffin shall be used in joints where indicated.

**Expansion Joints.** Expansion joints shall be provided where shown on the Plans and shall be of the type specified.

**Type 1 expansion joints** shall be formed by means of premoulded joint filler and, where shown on the Plans they shall be covered with membrane waterproofing as specified for construction joints above.

**Type 2 expansion joints** shall be formed in the following manner. One-ply impregnated cotton fabric shall be cut into pieces of such length that, when thoroughly coated with waterproofing asphalt or tar and tightly rolled, the rolls shall have a diameter equal to the width of the expansion joints. The rolls shall be caulked into the joint openings so as to fill it. Additional waterproofing asphalt or tar shall then be poured into the opening until it is completely filled.

Where shown on the Plans, copper flashing shall be furnished and placed. When the flashing for a joint is in more than one piece, the pieces shall be soldered together.

**Curing.** The curing shall be done by one of the following methods. (a) by a tight covering of felt or fabric mats which will effectively prevent dehydration of the concrete, which will not stain the concrete, which will not tear during use and which are acceptable to the Engineer; the felt mats shall be kept wet during the curing period; (b) by canvas so placed that the covering fits closely to the surface covered; (c) by coating with Colorless Curing Compound applied uniformly by means of an approved spray distributor at the rate of 1 gallon per 30 square yards of surface or as much more as may be required, in the opinion of the Engineer, to obtain a complete sealing coat. The coating shall be applied before any marked dehydration or surface checking has taken place. In addition, horizontal surfaces may be cured by placing thereon a layer of straw, hay, sand or burlap, which shall be kept wet during the curing period. The curing material shall be placed on all surfaces not covered

with forms or from which the forms have been removed and shall remain for not less than 7 days after the placing of the concrete.

**Defective Work.** Defective work shall be replaced or repaired as the Engineer may direct. If the surface of the concrete is bulged or uneven, develops cracks, or shows honeycombing or joint marks which cannot be repaired satisfactorily, in the opinion of the Engineer, the entire section of concrete affected shall be removed and replaced at the Contractor's expense.

**Surface Finish.** As soon as the forms have been removed, the concrete surfaces shall be carefully examined and cavities, irregularities, honeycombing and other defects, which in the opinion of the Engineer may not justify rejection of the work, shall be pointed with mortar as used for the concrete or shall otherwise be repaired as the Engineer may direct. Except as hereinafter provided, exposed surfaces of concrete not specifically exempted on the Plans shall be finished in the following manner. As soon as the pointing above described has set the entire surface shall be thoroughly covered with water by means of a brush and rubbed with blocks of carborundum No. 16, bringing the surface to a paste. The rubbing shall be continued until all form marks and projections are removed and a smooth dense surface without pits and irregularities is obtained. The paste shall be spread or brushed uniformly over the surface and allowed to take a reset. The final finish then shall be obtained by rubbing with blocks of carborundum No. 30 until the entire surface is smooth and of uniform color. When this rubbing is completed the surface shall be cured as specified above.

Tops of balustrades, parapets, copings, bridge seats and other similar horizontal surfaces not subject to wear shall be formed by placing an excess of material in the forms and striking it off with a wood template, forcing the coarse aggregate below the surface; mortar topping shall not be used. The surface shall then be thoroughly worked with a wood, canvas or cork float, and before this finish has set, the surface shall be lightly striped with a fine brush to remove surface film, leaving a smooth, fine-grained texture. The surfaces shall then be cured as specified above. Concrete surfaces intended for roadway surfaces, shall be finished and cured as provided in Art. 3.11.3 (p. 107). Sidewalk surfaces shall be finished as provided in Art. 5.7.3 (p. 212), and cured as above provided.

**Tile Work.** Tile work shall conform to the requirements shown on the Plans and to detail drawings which will be furnished to the Contractor. The Contractor shall submit for approval samples of tiles he proposes to furnish as well as detail layouts as may be prescribed. Inset panels shall be provided in the concrete surface for the tile work. The panel surface shall be roughened and thoroughly wet when the scratch coat is applied. The tiles shall be thoroughly coated with mortar and tamped in place to the true surfaces and with uniform, full and smooth joints. The mortar used shall be of the same mixture and color as used in the concrete structure. The tile work shall be cured in a satisfactory manner, and the tiles shall be cleaned so as to present full, clear cut outlines.

**Name Plates.** No permanent plates or markers shall be placed other than those shown on the Plans or approved by the Engineer.

**Weep Holes and Scuppers.** Weep holes shall be constructed in concrete walls and lined with 4-inch vitrified clay or plain concrete pipe, or as shown on the Plans. Cast iron scuppers as shown on the Plans shall be constructed where indicated.

#### 4.1.4. Quantity and Payment.

Except where otherwise specifically provided, the quantity of concrete for which payment will be made, will be the volumes of each Class of concrete within the neat lines of the construction actually placed as shown on the Plans or as directed by the Engineer. The volumes occupied by structural steel and pile heads will not be measured for payment and timber pile heads will be assumed to have a volume of 0.8 cub. ft. per lin. foot of pile; but the volumes occupied by reinforcement steel and pipes not more than 18 inches in diameter will be measured for payment. Concrete seals in cofferdams will not be measured for payment but the cost thereof shall be included in the prices bid for the various concrete items.

The quantity of Concrete Balustrade for which payment will be made, will be the actual overall length of the balustrade above the top of the sidewalk, structure, bridge deck or wall, that supports the balustrade including posts and panels, constructed as shown on the Plans or directed by the Engineer.

Except where otherwise specifically provided, the quantity of Reinforcement Steel, for which payment will be

made, will be the net theoretical weight of reinforcement steel of the specified nominal cross section, forming part of the permanent work, actually in place in accordance with the Plans or as directed by the Engineer. Fastenings and fastening devices will not be measured for payment. Reinforcement steel for splices, unnecessary in the opinion of the Engineer, will not be measured for payment. If bars larger than those specified have been permitted to be used, the excess material will not be measured for payment. Metal caging will not be measured for payment, but the cost thereof shall be included in the price bid for Class B concrete.

Payments for Class B, C and D Concrete will be made for the quantities of each Class, respectively, as above determined, measured in cubic yards, at the prices per cubic yard bid for the items CLASS B, C and D CONCRETE IN STRUCTURES, respectively, in the Proposal.

Payment for Concrete Balustrade will be made for the quantity as above determined, measured in lineal feet, at the price per lineal foot bid for the item CONCRETE BALUSTRADE in the Proposal.

These prices shall include the cost of the concrete construction complete in place, including falsework; forms; bracing; curing; curing materials; heating in cold weather; surface finish; tiles; scuppers; metal caging; drain pipe for weep holes; waterproofing of expansion and construction joints; joint fillers of any kind specified; tar paper joints; paraffined joints; copper flashing; concrete seal in cofferdams; all materials, labor, equipment and all else necessary therefor; and all other work in connection therewith and incidental thereto.

Payment for Reinforcement Steel will be made for the quantity as above determined, measured in pounds, at the price per pound bid for the item REINFORCEMENT STEEL IN STRUCTURES in the Proposal, which price shall include the cost of furnishing, bending, placing and securing in place the reinforcement steel, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 2

### Steel Structures

#### 4.2.1. Description.

**Steel Structures** shall include the furnishing, fabrication, erection and painting of all metal work required for the construction of steel bridges and other structures in accordance with the Plans and Specifications. Curb angles, steel nosings, steel expansion joint construction and other metal work required for the Project, for which provision has not otherwise been made, is included in the work. Steel Structures shall be constructed to the lines, grades and dimensions specified and at the prescribed locations.

#### 4.2.2. Materials.

**Transportation and Storing.** Plain and fabricated materials shall be stored on platforms, skids or other supports above the surface of the ground, shall be protected from surface deterioration and damage, and shall be kept clean. The loading, transportation and unloading of the materials shall be conducted so as to avoid injury and deformation of the metal.

**Structural Steel.** Structural steel and structural rivet steel shall conform to the requirements of the current Specifications A7 of the American Society for Testing Materials, supplemented as follows: Test specimens shall show a fracture of silky or fine granular structure throughout with a bluish gray or dove color, and shall be free from granular, black and brilliant specks. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged or imperfect edges and other defects; it shall have a smooth, uniform finish, shall be straightened before shipment and shall be free from loose mill scale, rust pits or other defects affecting its strength and durability.

**Steel Forgings.** Steel forgings shall conform to the requirements of the current Specifications A20 of the American Society for Testing Materials. The forgings shall be thoroughly annealed before being machined.

**Wrought Iron.** Wrought iron shall conform to the requirements of the current Specifications A41 of the American Society for Testing Materials.

**Steel Castings.** Steel castings shall conform to the requirements of the current Specifications A27 of the Ameri-

can Society for Testing Materials, supplemented by the following: Unless otherwise specified, castings shall be Class B, Medium Grade, and shall be thoroughly annealed; they shall be true to pattern in form and dimensions, with filleted angles and corners, free from pouring faults, sponginess, cracks, blowholes and other defects affecting their strength and value for the service intended. For acceptance blowholes on finished castings must be located so that a straight line laid in any direction will intersect a total length of cavity not greater than one inch per foot, and no blowholes shall exceed one inch in any dimension or have an area greater than one-half square inch. Blowholes shall not have a depth affecting injuriously the strength of the casting. Minor defects, not impairing the strength, may be welded, subject to the approval of the Engineer, by an approved process, and the defects shall be removed to solid metal by chipping, drilling or other satisfactory means. If required by the Engineer, the castings shall be annealed after such welding. Castings welded without the approval of the Engineer will be rejected. Large castings, if required by the Engineer, shall be suspended and hammered all over, and no cracks, flaws or other defects shall appear after such treatment.

**Iron and Malleable Iron Castings.** Iron castings and malleable iron castings shall conform to the requirements of current Specifications A48 and A47, respectively, of the American Society for Testing Materials, supplemented with the following: Castings shall be boldly filleted and the arises shall be sharp and perfect. The castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and other defects affecting their strength and value for the service intended.

**Bronze.** Bronze for bridge seats and bearings shall be cast or rolled, conforming to the requirements of the current Specifications B22 and B100, respectively, of the American Society for Testing Materials. Grade B shall be used for cast and Type A for rolled bronze. Castings shall be free from inclusions of foreign materials, injurious blowholes and other defects affecting their value for the purpose intended.

**Paint.** Except as hereinafter provided, paint shall consist of pigments of the required fineness and composition, ground to the desired consistency in raw or boiled linseed

oil with added oil and turpentine or drier or both. All materials shall be unadulterated and comply with the requirements hereinafter specified. The paint shall be shipped in substantial containers, plainly marked with the name, net weight and volume of the contents, and with the name and address of the manufacturer. When required, samples and analyses of pigments, vehicles, oils, turpentines, driers and paints shall be furnished within ten days after the request is made. Weights hereinafter specified are net weights.

**Paint Paste.** Paint paste shall be the required pigments, thoroughly ground in raw linseed oil. The paste shall be uniform in composition and consistency, shall not cake or segregate in containers and shall break up easily in oil to form a smooth, uniform paint of brushing consistency, which will not run or sag. The color, hiding power and weight shall be similar to those of the approved sample.

**Ready Mixed Paint.** The paste shall be mixed with the specified quantities of linseed oil, turpentine and drier so as to obtain a paint of the required consistency and covering properties. Changes in the specified quantities shall be made only on the written directions of the Engineer.

**Linseed Oil.** Raw and boiled linseed oil shall conform to the requirements of the current Specifications D234 and D260, respectively, of the American Society for Testing Materials. Boiled linseed oil shall be of the high viscosity type.

**Turpentine.** Turpentine shall be Gum Spirits of Turpentine or Wood Turpentine, steam or destructively distilled, as may be required, and conforming to the requirements of the current Specification D13 of the American Society for Testing Materials.

**Drier.** Drier shall consist of lead and manganese oxides, linseed oil and solvent, and shall be free from adulterants, sediment and suspended matter. The flash point shall be not less than 95 and 72 deg. F., in an open and in a closed Abel tester, respectively.

**Red Lead Shop Coat Paint.** The dry pigment for red lead shop coat paint shall be oxides of lead with not less than 95 per cent of  $Pb_3O_4$ , and not more than 1 per cent of total impurities. Not more than 0.3 per cent shall be retained on a No. 200 sieve. The paste and ready mixed paint shall conform to the following requirements:

	Paste	Paint
Red Lead ( $Pb_3O_4$ ), % .....	92-94	76.5-78.5
Raw Linseed Oil, % .....	6- 8	17.5-19.5
Moisture and other volatile matter, % .....	0-0.5	—
Coarse particles and skins left on No. 200 Sieve, % of pigment ....	0-0.5	—
Turpentine, % .....		1.5- 2.0
Drier, % .....		1.5- 2.0
Weight per gallon, pounds .....		24.5-25.5

**Red Lead Field Coat Paint.** The dry pigment for red lead field coat paint shall be as specified above for Red Lead Shop Coat Paint, except that it shall contain not less than 97 per cent  $Pb_3O_4$ . The ready mixed paint shall conform to the following requirements:

Red Lead .....	22.5-22.85	pounds	per	gallon
Linseed Oil .....	4.9- 5.18	"	"	"
Drier .....	0.2- 0.42	"	"	"
Weight .....	28.0-29.00	"	"	"

**Graphite Paint.** The dry pigment for graphite paint shall be pure natural flake graphite and silicate rock. When a color is required other than that of the graphite pigment alone, other approved pigments shall be added. The pigments shall all pass a No. 200 sieve, and not more than 5 per cent shall be retained on a No. 325 sieve, and shall contain not less than 45 and not more than 55 per cent flake graphite, having a specific gravity greater than 2.15 at 15.5°C. Flake graphite shall be natural crystalline graphite, not an artificial product. The ready mixed paint, when brushed on a smooth, vertical iron surface, shall dry hard and elastic, and shall not run, streak or sag. The paste and the ready mixed paint shall conform to the following requirements:

	Paste	Paint
Pigment, % .....	62-66	32-35
Linseed Oil, % .....	34-38	55-65
Moisture and other volatile matter	0- 0.8	—
Coarse particles and skins left on No. 325 sieve, per cent of pigment	0- 1	—
Drier, % .....		3-5
Turpentine, % .....		3-5

**Red Lead-Graphite Primer.** The pigment for red lead-graphite primer shall be prepared from red lead, graphite and silica rock as specified above under Red Lead Shop Coat Paint and Graphite Paint, and iron oxide, which shall be a calcined product and not a ground ore, contain-

ing not less than 60 per cent  $\text{Fe}_2\text{O}_3$ . The total of ferric oxide, insoluble silicious matter and the loss on ignition shall be not less than 90 per cent. The prepared pigment shall contain not less than 22.5 per cent flake graphite. The paste and ready mixed paint shall conform to the following requirements:

	Paste	Paint
Graphite, % .....	16-19	10.0 -12.0
Silicates, % .....	14-16	9.5 -11.5
Ferric Oxide, % .....	15-16	9.75-10.5
Red Lead, % .....	26-27	17.0 -17.5
Linseed Oil, % .....	26-27	46.0 -50.0
Drier, % .....		3.5 - 4.5
Weight per gallon, pounds .....		min. 12.

**Leaded Zinc Oxide Paint.** Leaded zinc oxide paint shall conform to the requirements of Specification M-70-38 of the American Association of State Highway Officials.

**White Lead and Tallow Mixture.** White lead and tallow mixture shall be a mixture made in the proportions of 4 pounds of tallow, 2 pounds of white lead and 1 quart of linseed oil.

#### 4.2.3. Methods of Construction.

**Design.** In preparing working drawings the design requirements shall conform to those of the current Standard Specifications for Highway Bridges of the American Association of State Highway Officials. H20-S16 loading, or as modified on the Plans, shall be used.

**Workmanship and Finish.** Workmanship and finish shall be equal to the best general practice in modern bridge shops. Shearing and chipping shall be accurately done, and work exposed to view shall be neatly finished. Rolled material shall be straight before being laid off or worked. Straightening, if necessary, shall be done so as not to injure the material. Kinks and bends may be cause for rejection.

**Substitutions.** Substitutions of sections having dimensions different from those shown on the Plans shall be made only when approved in writing by the Engineer.

**Punched and Reamed Work.** General reaming will not be required except when so specified. When general reaming is not required, all main material forming parts of a member of not more than 5 thicknesses may be punched 1/16 inch larger than the nominal size of the rivets, when the thickness of the metal is not more than 3/4 inch. When there are more than 5 thicknesses or when any of the

main material is more than  $\frac{3}{4}$  inch thick, all of the holes shall be punched  $\frac{3}{16}$  inch smaller and after assembling reamed  $\frac{1}{16}$  inch larger than the rivet size, except that, when the metal is thicker than the rivet size, the holes shall be drilled.

If general reaming is required, holes shall be subpunched and reamed in material forming a part of the section of main members, if the thickness of the materials is not greater than the nominal diameter of the rivet. Holes may be punched full size in materials used for lateral, longitudinal and sway bracing, lacing bars, stay plates and diaphragms not forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes shall be drilled in material the thickness of which is greater than the nominal diameter of the rivet.

**Punched Holes.** Full-sized punched holes shall be  $\frac{1}{16}$  inch larger than the nominal diameter of the rivet. The diameter of the die shall be not more than  $\frac{3}{32}$  inch greater than that of the punch. Holes shall be clean cut, without torn or ragged edges. Punching of holes shall be done so accurately that, after assembling the component parts of a member, a cylindrical pin,  $\frac{1}{8}$  inch smaller than the nominal diameter of the punched hole, may be passed through at the rate of not less than 75 of any group of 100 contiguous holes. If this requirement is not fulfilled the badly punched pieces shall be rejected. If 10 per cent of any group of 100 or fewer holes will not pass a pin,  $\frac{3}{16}$  inch smaller than the nominal diameter of the punched hole, the mispunched pieces shall be rejected. If any holes must be enlarged to admit the rivet, they shall be reamed.

**Subpunched and Reamed Holes.** Subpunched and reamed holes for rivets more than  $\frac{3}{4}$  inch in diameter shall be punched  $\frac{3}{16}$  inch smaller than the nominal diameter of the rivet, and for rivets having a diameter of  $\frac{3}{4}$  inch or less the holes shall be punched  $\frac{1}{16}$  inch smaller than the nominal diameter of the rivet. The punch and die shall have the same relative sizes as specified for full-size punched holes. After assembling, the holes shall be reamed to a diameter  $\frac{1}{16}$  inch larger than the nominal diameter of the rivet. Burrs resulting from reaming shall be removed with a tool producing a  $\frac{1}{16}$  inch fillet around the edge of the hole. Reaming shall be done with twist drills or short taper reamers, and preferably not by hand. No oil or grease shall be used as a lubricant. Reaming

shall be done after the component parts of a member have been assembled and firmly bolted together. Reamed parts shall not be interchanged.

**Drilled Holes.** Drilled holes shall be  $1/16$  inch larger than the nominal diameter of the rivet. Burrs shall be removed with a tool producing a  $1/16$  inch fillet around the edge. If members are drilled while assembled, the parts shall be held securely together while being drilled.

**Accuracy of Holes.** Reamed and drilled holes shall be cylindrical and perpendicular to the member, and their accuracy shall be so that, after reaming or drilling, 85 per cent of any group of contiguous holes in the same surface shall not show an offset greater than  $1/32$  inch between adjacent thicknesses of metal. If this requirement is not fulfilled the faulty pieces shall be rejected.

**Reaming of Field Connections.** Holes for field connections of floor beams and stringers and at such other places as may be specified shall be reamed or drilled in the shop with the connecting parts assembled, or shall be reamed or drilled to a metal template not less than 1 inch thick. Riveted trusses shall be assembled in the shop, the parts adjusted to line and fit, and the holes for field connections reamed or drilled while so assembled. If general reaming is specified, holes for other field connections, except as provided above under Punched and Reamed Work, shall be reamed or drilled in the shop with the connecting parts assembled, or shall be reamed or drilled to a metal template not less than 1 inch thick.

**Shop Assembling.** Drifting during assembling shall be only such as to bring the parts into position and not sufficient to cause enlargement of holes or distortion of metal. If any holes must be enlarged to admit rivets, they shall be reamed. Surfaces to be in contact when assembled shall be carefully cleaned. The component parts of a built member shall be assembled, drift pinned to prevent lateral movement, and firmly bolted to draw the parts into close contact before reaming, drilling or riveting is begun. Assembled parts shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The members shall be free from twists, bends or other deformations.

If necessary, the rivet holes of full size punched material shall be cleared for the admission of the rivets by spear-reaming. The reamed holes shall be not more than  $3/32$  inch larger than the nominal diameter of the rivets. End

connection angles, stiffener angles and other parts shall be carefully adjusted to correct location and rigidly bolted, clamped or otherwise firmly held in place until riveted. Parts not completely riveted in the shop shall be secured by bolts as far as practicable to prevent damage to them in shipment and handling. Connecting parts assembled in the shop for reaming or drilling holes in field connections shall be match marked and a diagram showing such marks shall be furnished to the Engineer.

**Rivets.** Rivets shall be of the specified diameter before driving and shall be free from furnace scales. Rivet heads shall be of approved shape, concentric with shank, true to size, full, neatly formed and free from fins.

**Bolts.** Bolts shall not be used in the finished structure unless authorized on account of riveting being impracticable. When authorized, the bolts shall be unfinished or turned as may be specified and shall have hexagonal head and nut and standard thread. The threads of the bolts shall be entirely outside the grip of the metal of the members, and the bolts shall extend entirely through the nut, but not more than  $\frac{1}{4}$  inch beyond. The diameter of the unfinished bolt shall be not more than  $\frac{1}{16}$  inch smaller than that of the hole. Approved lock nuts shall be used on all bolts. Holes for turned bolts shall be carefully reamed or drilled and the bolts turned to a driving fit by being given a finishing cut.

**Riveting.** Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. Points of rivets shall not be heated more than the remainder. When ready for driving, rivets shall be free from scale, slag or other adhering matter and when driven they shall fill the holes completely. The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins and in full contact with the surface of the member. Heads of driven rivets shall not be caulked or re-cupped. Loose, burned, badly formed or otherwise defective rivets shall be replaced. In removing defective rivets, care shall be taken not to injure the adjacent metal and, if necessary, the shank shall be drilled out. Countersinking shall be neatly done and countersunk rivets shall completely fill the holes. Shop rivets shall be driven by direct acting riveters where practicable and the riveting machine shall retain the pressure for a short time after the upsetting is complete.

**Planing.** Sheared edges of material more than  $\frac{5}{8}$  inch thick and carrying calculated stress shall be planed to a

depth of  $\frac{1}{4}$  inch. Re-entrant cuts shall be filleted before cutting. The top and bottom surfaces of steel slabs and base plates, and cap plates of columns and pedestals, shall be planed or hot straightened. Parts of members in contact with them shall be faced. Sole plates of beams and girders shall have full contact with the flanges. Sole plates and masonry plates shall be planed or hot straightened. Cast pedestals shall be planed on surfaces to be in contact with steel and shall have the surface to be in contact with masonry rough-finished. Surfaces of bearing plates intended for sliding contact shall be finished, except that rolled bronze surfaces shall not be finished when the surfaces are true. In planing the cut shall be in the direction of expansion.

**End Connections and Abutting Joints.** Floorbeams, stringers and girders having end connection angles shall be built to exact length back to back of connection angles. End connection angles shall be finished when so specified, or when necessary on account of faulty work, but the thickness shall not be reduced by more than  $\frac{1}{16}$  inch and the rivet bearing value shall not be reduced below design requirements. Abutting joints in compression members and girder flanges, and in tension members when so specified on the Plans, shall be faced and brought to an even bearing. When joints are not faced, the opening shall not exceed  $\frac{1}{4}$  inch.

**Built Members.** The several pieces forming a built member shall be straight and close fitting. The members shall be true to dimensions, free from twists, bends, open joints and other defects. Ends of lacing bars shall be neatly rounded.

**Welding.** Welding shall be done according to best modern practice and shall conform to the requirement of the current Specifications for Arc Welding Metal Bridge Structures of the American Association of State Highway Officials.

**Plate Girders.** Web plates of girders without cover plates or with cover plates not extending for the full length, and not encased in concrete, shall have the top edge flush with back of flange angles. Web plates of girders encased in concrete or with cover plates extending for the full length may be  $\frac{1}{2}$  inch less in width than the distance back to back of flange angles. At web splices the clearance between the ends of the web plates shall not exceed  $\frac{3}{8}$  inch. Web stiffeners supporting loads shall be milled or ground to true length and full bearing. Other stiffeners shall fit

tight and web splice plates and fillers shall fit within  $\frac{1}{8}$  inch.

**Pins and Rockers.** Pins, rollers and rockers shall be accurately turned to the dimensions shown on the Plans and shall be straight, smooth and free from flaws. The final surface shall be produced by a finishing cut. Pins more than 7 inches in diameter shall be forged and annealed. In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored the full length along the axis. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other, unless otherwise required. The final surface shall be produced by a finishing cut. The distance outside to outside of pin holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than  $\frac{1}{32}$  inch. Boring of holes in built-up members shall be done after the riveting is completed. The diameter of the pin holes shall not exceed that of the pin by more than  $\frac{1}{50}$  inch for pins 5 inches or less in diameter, or  $\frac{1}{32}$  inch for larger pins.

**Weight of Members.** Unless otherwise provided, the finished members shall be weighed at the shop on satisfactory scales in the presence of the Inspector. If the scale weight of any member is less than 97.5 per cent of the computed weight as hereinafter specified, it will be rejected.

**Mill Orders and Shipping Statements.** The Contractor shall furnish as many copies of mill orders and shipping statements as the Engineer may direct. The weights of the individual members shall be shown on these statements. Members weighing more than 3 tons shall be marked with their weight.

**Rejections.** The acceptance of any material or finished member by the Inspector shall not be a bar to its subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

**Testing.** Prepared test specimens, testing machine and necessary facilities for testing shall be furnished by the Contractor.

**Erection Method.** A description of the method of erection and character of equipment therefor shall be submitted to the Engineer and if not satisfactory to him shall be revised. If required drawings of falsework shall be submitted to the Engineer for his approval. Approval of

the method of erection or drawings of falsework shall not be considered as relieving the Contractor of any responsibility.

**Setting Bearing Plates.** Column bases, truss and girder pedestals and shoes shall have a full and uniform bearing on the substructure masonry. Masonry bearing plates shall not be placed on surfaces which are improperly finished, deformed or irregular. Shoes and pedestals of truss and girder spans, bases of columns, and center and end bearings of swing spans shall be rigidly and permanently located to correct alignments and elevations and, unless otherwise provided, they shall be placed on layers of canvas and red lead applied as follows: Thoroughly swab the bearing area with red lead paint and place upon it 3 layers of 14-ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure in position while the paint is plastic.

**Setting Anchor Bolts and Expansion Bearings.** If the anchor bolts have not been set in the masonry during its construction, the holes for the anchor bolts shall be drilled in correct locations, and the anchor bolts shall be set in 1:2 cement-sand mortar. The anchor bolts shall first be dropped into the dry holes to insure their proper fit after setting. They shall then be set as follows: Fill the hole about two-thirds full of mortar and by a uniform, even pressure or by light blows with a hammer force the bolt down until the mortar rises to the top of the hole and the anchor bolt nut firmly rests against the metal shoe or pedestal. Remove all excess mortar which may have flushed out of the hole. The location of the anchor bolts in relation to the slotted holes in expansion shoes shall conform to the temperature at the time of erection. Similar adjustment shall be made in setting rockers and other movable bearings. The nuts of anchor bolts at the expansion ends shall permit the free movements of the span. Anchor bolts which are to be set in the masonry prior to the erection of the superstructure shall be carefully set to proper location and elevation with templates or by other suitable means.

**Handling Members.** The field assembling of the component parts of a structure shall be done by methods and appliances not likely to produce injury by twisting, bending, or otherwise deforming the metal. No member slightly bent or twisted shall be put in place until its defects are corrected, and members badly damaged will be rejected.

**Alignment.** Before beginning the field riveting the structure shall be adjusted to correct grade and alignment and the elevations of panel points and ends of floor beams properly regulated. For truss spans a slight excess camber will be permitted while the bottom chords are being riveted, but the correct camber and relative elevations of panel points shall be secured before riveting the top chord joints, the top lateral system and sway bracing.

**Straightening Bent Material.** The straightening of bent edges of plates, angles and 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, and then the heating shall be to a temperature not higher than that producing a dark cherry-red color. After heating the metal shall be cooled as slowly as possible. Following the completion of the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of incipient or other fractures.

**Assembling Steel in Field.** The parts shall be accurately assembled as shown on the drawings and any match-marking 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 by blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and 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, except that splices and connections carrying traffic during erection shall have not less than 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  $1/32$  inch larger.

**Field Riveting.** Pneumatic hammers shall be used for field riveting and pneumatic buckers shall be used when practicable. Cup-faced dollies, fitting the head closely to insure good bearing shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes and

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. The rivet head 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.

**Bolted Connections.** In bolted connections the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool.

**Defective Work.** Twisted or bent members shall not be erected until the defects are corrected in a manner satisfactory to the Engineer. Only minor defects, which can be remedied without injury to the metal, shall be corrected in the field. Members with major defects, in the opinion of the Engineer, shall be returned to the shop for repairs or replacement.

**Painting.** Painting shall include preparation of surfaces to be painted; application, protection and drying of paint coatings; protection of traffic on and under the structure; protection of structure against disfigurement by paint, paint materials or rust; and supplying all tools, tackle, scaffolding, labor, materials and all else necessary for performing and completing the work. Painting shall be done with round or oval brushes, unless otherwise permitted, in a neat and workmanlike manner. The paint for shop coat and field coats shall be of the kind specified. The color of each subsequent coat shall be sufficiently different from that previously applied to distinguish it therefrom and shall be approved by the Engineer.

Paint shall be applied only in dry air on dry, frost-free surfaces and at an atmospheric temperature of over 40 deg. F. Painting shall not be done on hot metal causing paint to blister. Material painted under cover in damp or cold weather shall remain under cover until dry or until the weather conditions permit its exposure in the open. Paint shall be applied so as to produce a uniform, even coat, filling all surface irregularities. Rivet heads and edges of metal shall be striped in advance of the general painting. Surfaces inaccessible to paint brushes shall be coated by means of sheepskin daubers. Impure, unauthor-

ized or improperly applied paint shall be removed and the surfaces cleaned and repainted at the Contractor's expense. Paint shall be thoroughly stirred before being removed from containers, and shall be kept stirred until applied. Mechanical mixers shall be used for stirring paint in original containers and necessary thinning in cold weather shall be done by heating only unless otherwise approved by the Engineer. Steel to be encased in concrete shall not be painted.

**Shop Painting.** Surfaces to be painted shall be thoroughly cleaned, and all rust, loose scale, dirt, grease and other foreign matter shall be removed. Except as herein-after specified, the surfaces shall be painted with one coat of red lead paint after the steel work has been accepted by the Inspector and before it is shipped. Surfaces not in contact but inaccessible after erection shall be painted 2 coats. Shop contact surfaces shall not be painted. Where a shop coat would make difficult erection of main splices for chords of trusses and of large girder splices involving multiple thicknesses of material, the field contact surfaces shall not be painted with the shop coat, but they shall be given a coat of approved lacquer or other protective coating if the steelwork is not expected to be erected within one month. Erection marks shall be painted on the shop coat. The paint shall be dry before the steelwork is loaded for shipment. Machined surfaces, except at splices and surfaces to be set on masonry, shall not be painted, but shall be covered with a hot coat of white lead and tallow mixture or other approved preparation.

**Field Painting.** When the erection and riveting is completed all adhering rust, scale, dirt, grease and other foreign matter shall be removed. When this has been done, heads of rivets, surfaces with defective shop coat and shop or erection marks shall be painted with shop coat paint. All small cracks, cavities or openings shall be filled with red lead and linseed oil. The first and subsequently the second field coat shall then be applied. No paint shall be applied over a previous coat until the latter is dry throughout the full thickness of the paint film.

#### 4.2.4. Quantity and Payment.

Except as hereafter provided, the quantity of steel work for which payment will be made will be the shop scale weight of structural steel and other metals for which payment is not elsewhere provided, forming part of the per-

manent structure. Excess field rivets shipped and not incorporated in the structure, members or parts used for erection purposes but not forming part of the permanent structure, excess weight of substituted members, excess weight of members increased in size for erection purposes, and excess weight above that computed of more than 1.5 per cent will not be measured for payment. Unless otherwise specifically provided, all castings and other metal work, except reinforcement steel, included in the Contract will be measured for payment as structural steel.

If authorized by the Engineer, the payment quantity for all or part of the work may be the computed weight instead of the scale weight. In computing the weight, the weight of structural steel and steel castings shall be taken to be 0.2833 pound per cubic inch; of cast iron 0.26 pound per cubic inch and of bronze 0.315 pound per cubic inch. The weights of plates 36 inches or less in width and of rolled shapes shall be computed on the basis of their nominal weight deducting for cuts and open holes. Plates of greater width shall be computed on the basis of their dimensions, deducting for cuts and open holes, and adding one-half of the allowed percentages of over-run in weight given in the current Specifications A7 of the American Society for Testing Materials. The weight of rivet heads shall be included as follows: For  $\frac{3}{4}$  inch rivets 12.5 pounds, for  $\frac{7}{8}$  inch rivets 18.5 pounds, and for 1 inch rivets 27 pounds per 100. The weight of castings shall be computed from the net dimensions shown on the approved shop drawings with 10 per cent added for fillets and over-run. For painted metal, 0.4 per cent shall be added to the computed weight when the shop coat is Red Lead paint, and 0.2 per cent when the shop coat is Red Lead-Graphite Primer. The Contractor shall compute the weight of all members and furnish complete and detailed records of the computed weight of all metal work when so requested by the Engineer.

Payment for Structural Steel and other metal work as above described will be made for the quantity as above determined, measured in pounds, at the price per pound bid for the item STRUCTURAL STEEL in the Proposal, which price shall include the cost of all equipment, tools, handling, falsework, scaffolding, transportation, labor, materials and all else necessary for the complete fabrication, erection, shop and field painting and proper completion of the work and all other work in connection therewith and incidental thereto.

## SECTION 3

## Timber Structures

## 4.3.1. Description.

**Timber Structures** shall include the furnishing of all materials for and the erection of framed timber structures, to the prescribed lines, grades and dimensions, at the prescribed locations, and in accordance with the Plans and Specifications.

## 4.3.2. Materials.

Timber shall be of the kind specified and shall be Dense Select Structural Grade, well seasoned, straight grained, sound, free from loose knots, worm holes, shattered or cracked ends, barked edges and other defects that may impair its strength and durability. It shall be cut or sawed to the specified dimensions, and when it is required to be painted, it shall be surfaced on the faces to be painted. It shall be long enough to give square ends for the full cross section of the timber. The timber will be inspected in conformity with the rules of the current Standard Specifications for Highway Bridges of the American Association of State Highway Officials. For timber to be treated, heart requirements will be waived.

Timber preservatives and preservative treatments shall conform to the requirements therefor specified in the Standard Specifications mentioned above. Creosote oil shall be used.

## 4.3.3. Methods of Construction.

The methods of construction shall conform to the requirements therefor specified in the current Standard Specifications for Highway Bridges of the American Association of State Highway Officials.

## 4.3.4. Quantity and Payment.

The quantity of Timber Structures, for which payment will be made, will be the actual volume of timber of each of the various classifications if any, in the finished structure, based on nominal cross section dimensions and actual lengths. No allowance will be made for waste.

Payment for Timber Structures will be made for the quantity or quantities as above determined, measured in

1000 feet board measure, at the price or prices per M. feet B. M. bid for the item **TIMBER STRUCTURES** or for the various classified items of timber work, if any, in the Proposal, which price or prices shall include the cost of timber, hardware, preservatives and preservative treatment, painting, equipment, tools, labor and all else necessary for furnishing and placing the timber work as specified, and all other work in connection therewith and incidental thereto.

## SECTION 4

### Bearing Piles

#### 4.4.1. Description.

**Bearing Piles** shall include the furnishing and placing of piles of the materials and dimensions prescribed and at the prescribed locations in accordance with the Plans and Specifications and other specified work.

#### 4.4.2. Materials.

The materials including reinforcement steel for concrete piles shall conform with the requirements therefor of Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120), except that the coarse aggregate shall be  $\frac{5}{8}$ -inch Size broken stone of trap rock or dolomite. Class A concrete (p. 141), shall be used. Metal shells for cast-in-place piles shall be of such thickness and so reinforced that they will show no sign of distortion when driven, and their design shall be submitted to and approved by the Engineer, before the shells are used in the work.

Timber bearing piles, timber preservatives and method of treatment shall conform to the requirements therefor, specified in the current Standard Specifications for Highway Bridges, of the American Association of State Highway Officials. Unless otherwise specified, piles to be treated shall be of southern yellow pine, and they shall be pressure treated with creosote oil. Piles for land and fresh water use shall be treated by empty cell process and shall retain not less than 12 pounds of oil per cubic foot of timber; piles for salt water use shall be treated by full cell process and shall retain not less than 20 pounds of oil per cubic foot of timber.

#### 4.4.3. Methods of Construction.

**Equipment.** All equipment for pile driving shall be subject to the approval of the Engineer. Timber piles shall be driven with a gravity or a steam hammer or, if permitted by the Engineer; with a combination of hammer and water jet. Concrete piles shall be driven with a steam hammer if possible, or by steam hammer and water jet if so approved by the Engineer. Gravity hammers for timber bearing piles shall weigh not less than 3000 pounds, and the drop of the hammer shall be regulated so as not to damage the piles while being driven and shall not exceed 20 feet. Steam hammers for timber bearing piles shall develop an energy of not less than 6000 foot-pounds per blow for each full stroke of the piston. Steam hammers for concrete bearing piles shall develop an energy of not less than 4500 foot-pounds per cubic yard of concrete in the pile, for each full stroke of the piston, and the total energy shall be not less than 10000 foot-pounds per blow.

The leads of the pile drivers shall afford freedom of movement to the hammer, shall be braced to insure support to the pile during driving and shall be of full driving length. Followers shall not be used except with the written permission of the Engineer, and when permitted, one pile from each group of ten shall be of sufficient length to be driven without follower and shall be used to determine the average bearing power of the group. Proper temporary bracing shall be provided to hold the piles in alignment during driving. Water jets shall have a water volume and pressure at the nozzle, and shall be sufficient in number, to erode freely the subsurface material adjacent to the pile while it is being driven. The plant shall be able to deliver water for not less than two  $\frac{3}{4}$ -inch jets at a nozzle pressure of not less than 100 pounds per square inch. The jets shall be withdrawn before the desired penetration is reached, and the piles shall be driven to final penetration for a distance to be determined by the Engineer.

**Length.** Foundation piles have been designed to carry a certain load, and a certain pile length, based on available information of the subsurface conditions, has been assumed in preparing the estimate of quantity. All piles, however, unless otherwise directed, shall be driven to practical refusal as determined by the Engineer, and the

Contractor shall determine the actual length of untreated timber piles required by driving test piles of greater length than that assumed in the estimate. These test piles shall be driven at locations determined or approved by the Engineer so as to form part of the permanent structure. The number of test piles shall be not less than that stated in the Proposal. The length of precast concrete and treated timber piles shall be determined by driving of long and stout timber or concrete test piles as may be required by the Engineer. If timber piles are used, they shall be subsequently removed. Concrete test piles shall be driven at locations where they will form part of the permanent structure.

**Bearing Value.** The safe bearing value of timber piles and cast-in-place concrete piles, and a rough approximation thereof for precast concrete piles, may be determined by the following equations:

For gravity hammer..... $P=2WH/(S+1)$

For single acting steam hammer.. $P=2WH/(S+0.1)$

For double acting steam hammer.. $P=2H(W+Ap)/(S+0.1)$

where

$P$ =safe bearing value, in pounds.

$W$ =weight of striking parts of hammer, in pounds.

$H$ =height of fall, in feet.

$A$ =area of piston, in square inches.

$p$ =gauge pressure at the hammer, in pounds per square inch.

$S$ =average penetration per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam hammers, in inches.

The equations are applicable only when the hammer has a free fall, the pile head is free from brooming, the penetration is at a uniform rate and there is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from the value of  $H$  in the equations. When water jets are used, the formulas are not applicable until the jets have been withdrawn.

**Driving.** Piles shall not be driven until the excavation, in which they are to be placed is complete. Piles shall be driven with a variation of not more than  $\frac{1}{4}$  inch per foot from the vertical or from the batter line indicated. Improperly driven piles shall be withdrawn and replaced.

**Loading Tests.** When required, loading tests shall be made, consisting of application of a test load on a suitable platform, supported by the pile to be tested, together with

suitable apparatus for determining the load and the amount of settlement under each increment of load. The safe load shall be considered as one-half of that load, which after 48 hours' application causes a permanent settlement, measured at the top of the pile, of not more than  $\frac{1}{4}$  inch.

**Order Lists.** The Contractor shall furnish piles in accordance with an itemized list furnished by the Engineer and showing the number and lengths of all piles. The lengths stated will be those assumed to remain in the completed structure. The Contractor shall, at his own expense, increase these ordered lengths to provide for fresh headings and for such additional length as may be needed to suit the Contractor's method of operation.

**Timber Piles.** If so specified timber piles shall be treated with a preservative as specified above. Timber piles shall be stored and handled so as to avoid damage to them. The surfaces of treated piles shall not be broken and cant hooks, dogs and pike poles shall not be used. Cuts and breaks in the surface of treated piles shall be given 3 brush coats of hot creosote oil of approved quality, and similar oil shall be poured into all bolt holes in the piles.

When necessary to protect them from splitting or brooming, piles shall be provided with collars and driving caps with suitable cushions fitting into a casting supporting a timber shock block. When the pile area is greater than the hammer area, suitable caps shall be provided to distribute the hammer blow over the full area of the pile head. When driven the tops of piles shall be sawed to a true plane at the required elevation. Piles for support of timber caps or grillage shall be sawed to the exact plane of the bottom of the superimposed structure. Broken, split or misplaced piles shall be withdrawn and properly replaced. Piles driven below the required elevation shall be withdrawn and replaced with longer piles. The sequence of driving shall be such as to avoid raising piles previously driven, and if raised, they shall be redriven to firm bearing.

**Precast Concrete Piles.** Forms for precast concrete piles shall conform with the requirements for forms, specified in Art. 4.1.3 (p. 142), and the piles shall be cast on unyielding beds, satisfactory to the Engineer. The reinforcement steel shall be held rigidly to true position in the forms by devices approved by the Engineer. The concrete mixture in each pile shall be placed in one operation and shall be

compacted by vibration as described in Art. 4.1.3 (p. 149), and more concrete mixture shall be added and vibrated into place until there is a surplus at all points. The surplus shall then be screeded off and the upper face finished to a uniform, even texture. When the side forms are removed, the piles shall be carefully examined, and cavities and other irregularities, which do not justify rejection as hereinafter provided shall be pointed with mortar, consisting of 1 part of cement and  $1\frac{1}{2}$  parts of sand. No other finishing shall be done. Piles showing stone pockets, honeycomb, porous spots, shrinkage cracks or other defects, or which are bent, cracked, broken or otherwise damaged, will be rejected.

As soon as the concrete has set sufficiently to permit it, the forms shall be removed from the piles, and for a period of not less than 7 days after the concrete is placed, the piles shall be kept separated, properly supported, moistened with water and sheltered from the sun. Piles shall not be shipped or driven until the concrete has set for a period of not less than 21 days, or, in cold weather for a longer period, as may be determined by the Engineer, except that piles for use in sea water shall be cured for a period of not less than 30 days before being used.

The work on and handling of concrete piles, shall be done so as to avoid excessive bending stresses, cracking or other damage. The method of handling shall not induce computed stresses in the reinforcement steel of the piles in excess of 12,000 pounds per square inch, after adding 100 per cent of the calculated load for impact and shock. For piles to be used in sea water, care shall be taken to avoid abrasion and other surface damage.

Precast concrete piles shall be of such a length that they will extend to the required elevation when driven to practical refusal. However, if in the opinion of the Engineer, the piles are of such length as to make it necessary to drive below the required elevations to obtain practical refusal, extensions shall be made in the following manner. After the driving is completed, the concrete at the upper end of the pile shall be cut away, leaving the steel reinforcement exposed for a length of 50 diameters. The final cut shall be at right angles to the axis of the pile. Reinforcement steel, similar to that used in the pile, shall be securely fastened to the exposed pile reinforcement steel, and the necessary form work shall be placed, care being taken to make it mortar-tight. Just prior to placing

the concrete mixture, which shall be similar to that used in the pile, the top of the pile shall be coated with neat cement. The forms shall remain in place not less than 7 days, and when removed, the surfaces of the extension shall be finished as above described for the pile. Precast concrete piles, which, when driven, extend above the permissible elevation, shall be cut off square at the required elevation.

**Cast-in-Place Concrete Piles.** Reinforcement steel for cast-in-place concrete piles, if required, shall be held rigidly fastened together so as to form a single unit. When in position, the reinforcement steel shall be secured so as to insure its proper location in the finished pile. The concrete for cast-in-place concrete piles shall be cast in previously driven strong metal shells which shall remain permanently in place. The shells shall be inspected and approved by the Engineer immediately before being filled with concrete. Improperly driven, broken, distorted, or otherwise defective shells shall be removed and replaced. Pendent lights and other facilities for proper inspection shall be provided by the Contractor. Unless otherwise permitted by the Engineer, concrete shall not be placed in the shell until all driving within a radius of 15 feet has been completed, or until all shells for a structure bent have been completely driven. If this cannot be done, driving shall be discontinued within the above stated limits, until the concrete in the last pile poured has been in place not less than 7 days. The concrete shall be placed in the pile in one operation, care being taken to fill the shell completely and thoroughly embed the reinforcement steel, if any, without displacing it.

#### 4.4.4. Quantity and Payment.

The quantity of timber test piles, for which payment will be made will be the number of test piles actually driven as prescribed and forming part of the permanent structure, or driven and subsequently removed when used for determination of length of precast concrete or treated timber piles. Precast concrete test piles will be measured for payment as precast concrete piles as hereafter described.

In the following Cutoff shall mean the difference between the pile length ordered by the Engineer and that remaining in the finished structure. The quantity of cutoff for which payment will be made will be the actual

total length of cutoffs, except that individual cutoffs measuring less than 1 foot will not be measured for payment.

The quantity of piles for which payment will be made will be the actual total length of piles of the type specified in place in the finished work in accordance with the Plans or as directed by the Engineer.

Payment for timber test piles will be made for the number as above determined, at the price for each bid for the item TEST PILES in the Proposal.

Payment for piles of the type or types specified will be made for the quantity as above determined, measured in lineal feet, at the price or prices bid for the items TIMBER PILES, TREATED TIMBER PILES, PRECAST CONCRETE PILES, and CAST-IN-PLACE CONCRETE PILES, respectively, in the Proposal.

Payment for Cutoffs will be made according to the prices therefor stated in the Supplementary Specifications.

These prices shall include the cost of furnishing, driving and cutting off the piles, treating timber piles, extensions of concrete piles, all materials, equipment, labor and all else necessary therefor and all other work in connection therewith and incidental thereto.

Payment for loading tests will be made for each pile loaded and tested at the price bid for the item LOADING TESTS in the Proposal, which price shall include the cost of all materials, equipment, labor and all else necessary for furnishing and constructing loading platforms, procuring and placing the load, making and recording the test, removing and disposing of loads and platforms, and all other work in connection therewith and incidental thereto.

## SECTION 5

### Sheet Piling

#### 4.5.1. Description.

**Sheet Piling** shall include the furnishing and placing of sheet piling forming part of the Project in accordance with the Plans and Specifications and other work as herein specified. The piling shall be of the materials and dimensions specified and shall be driven true to lines and grades at the prescribed locations.

#### 4.5.2. Materials.

Timber for sheet piling shall be as may be specified. It shall be sawed with square corners and shall be free from

worm holes, loose knots, windshakes, decayed or unsound wood and other defects that may impair its strength and the tightness of the piling. The sheet piles shall be tongued and grooved, the lower end of each pile shall be drift sharpened to wedge adjacent piles together, and the piles shall be treated in the manner and with the materials prescribed.

The materials for concrete sheet piling shall conform to the requirements of Art. 4.1.2, except that the coarse aggregate shall be  $\frac{3}{8}$ -inch Size broken stone of trap rock or dolomite. Class A concrete (p. 141), shall be used.

Steel for sheet piling shall conform to the requirements for Structural Steel, Art. 4.2.2 (p. 157), except as follows: The tensile strength shall be min. 70,000 pounds per square inch; the percentage of elongation shall be min. 1,400,000 divided by the tensile strength. The bend test shall be 180 degrees around a pin of a diameter twice the thickness of the specimen. The piling shall be of a type and weight and shall have a section modulus as specified or approved.

#### 4.5.3. Methods of Construction.

The methods of manufacture of concrete sheet piling and the construction of all sheet piling shall conform in general to those specified in Art. 4.4.3 (p. 176), except that lighter driving equipment may be used when suitable, subject to the approval of the Engineer. Walings shall be provided and painting shall be done as shown on the Plans. The finished piling shall be vertical, true to line, driven to the prescribed depth, cut off to a straight line at the prescribed elevation, and practically watertight at the joints.

#### 4.5.4. Quantity and Payment.

The quantity of Sheet Piling for which payment will be made will be measured by the outer vertical surface area of piling actually placed exclusive of indentation of pile sections, in accordance with the Plans or as directed by the Engineer. Sheet piling used by the Contractor for carrying out his work, and not forming part of the Project as shown on the Plans or as directed by the Engineer, will not be measured for payment.

Payment for Timber, Concrete and Steel Sheet Piling will be made for the quantity or quantities as above determined, measured in square feet, at the prices per square foot bid for the items TIMBER SHEET PILING, CON-

CRETE SHEET PILING and STEEL SHEET PILING, respectively, in the Proposal, which prices shall include the cost of furnishing, driving and cutting off of piling; furnishing, placing and fastening walings; painting; all materials, equipment, labor and all else necessary therefor, and of all other work in connection therewith or incidental thereto.

## SECTION 6

### Waterproofing

#### 4.6.1. Description.

**Waterproofing** shall include the covering of the surfaces to be waterproofed with a membrane of cotton fabric and asphalt or pitch, protected by a cement-mortar course in accordance with the Plans and Specifications in the amounts of materials specified and at the prescribed locations, and other work as specified.

#### 4.6.2. Materials.

Waterproofing Asphalt, Waterproofing Pitch and Fabric shall conform to the requirements therefor, specified under the heading Waterproofing Materials in the current Standard Specifications for Highway Bridges of the American Association of State Highway Officials. Either the asphalt or the pitch may be used, but the same material shall be used for saturating the fabric and for the mopping courses. The fabric shall be stored in a dry, protected place, and the rolls shall not be stored on end.

Cement and sand for the protection course shall conform to the requirements therefor, specified in Arts. 4.1.2 (p. 137), and 3.13.2 (p. 132), respectively.

#### 4.6.3. Methods of Construction.

The surfaces to be waterproofed shall be smooth, free from projections, clean and dry, when the waterproofing is being placed thereon. No waterproofing shall be done in wet weather or when the atmospheric temperature is below 35 deg. F., or when the surface is wet or frozen. Damp surfaces may be dried by means of hot sand, subject to the approval of the Engineer.

Waterproofing asphalt shall be heated to a temperature of not less than 300 and not more than 350 deg. F., and

waterproofing pitch to not less than 200 and not more than 250 deg. F., with frequent stirring to avoid local overheating. The heating kettles shall be equipped with thermometers.

The waterproofing membrane shall extend vertically at edges to the heights shown on the Plans. The laying shall start at the lowest part of the floor. When the surface is crowned, one-half of its width shall be done first then the second half, finishing at the high part at the middle of the floor. The surface shall be coated with waterproofing asphalt or pitch for a width equal to one-half the width of the fabric, and for a length equal to its length. The asphalt or pitch shall be distributed immediately with a squeegee or mop to a uniform thickness and, while soft, this coating shall be covered with a one-half width of fabric in complete contact with the surface and free from wrinkles, creases and air pockets. The upper surface of the fabric and the adjacent concrete floor shall then be coated sufficiently for placing a full width of fabric as above described. The third and each succeeding strip shall be of full width and lapped so that there will be 2 layers of fabric at all points, with laps not less than 2 inches wide. This procedure shall be continued until one-half of the floor has been waterproofed, and this half shall then be coated with asphalt or pitch. The other half of the floor shall then be waterproofed in the same manner, and an additional lap of the fabric shall be used at the junction of the two parts. For other surfaces, the waterproofing shall be done in a similar manner. The fabric shall be laid with as few transverse joints as possible and shall be lapped not less than 12 inches at such joints.

The total quantity of waterproofing asphalt or pitch for the 3 applications shall be not less than 12 gallons per 100 square feet of surface covered for horizontal and slightly inclined surfaces, and not less than 15 gallons per 100 square feet for more inclined or vertical surfaces. The concrete surface shall be covered so as to show no grey spots, and the fabric shall be covered so as to conceal the weave. At the close of a day's work, all fabric laid shall have been coated with the final coat. The completed waterproofing shall be a firmly bonded membrane, consisting of 2 layers of fabric and 3 coatings of waterproofing asphalt or pitch.

**Patching.** Care shall be taken to avoid damage to the membrane. No walking on it shall be permitted. Damage

to it shall be repaired by patching. Patching shall be done so that the first layer of fabric extends not less than 12 inches beyond the damaged portion, and the second layer extends not less than 3 inches beyond the first.

**Mortar Protection Course.** The waterproofing membrane shall be covered with a protection course of 1:2 cement-sand mortar, not less than  $\frac{1}{2}$  inch thick or as specified, troweled into place so that it has a uniform, dense and smooth surface, free from porous spots. The mortar course shall be cured as specified in Art. 4.1.3 (p. 153), and during the curing it shall not be walked upon. When specified wire mesh shall be embedded in the mortar course.

#### 4.6.4. Quantity and Payment.

Except where otherwise specifically provided, the quantity of Waterproofing for which payment will be made will be the area actually covered with waterproofing in accordance with the Plans or as directed by the Engineer, including vertical surfaces covered.

Payment for Waterproofing will be made for the quantity as above determined, measured in square feet, at the price per square foot bid for the item WATERPROOFING in the Proposal, which price shall include the cost of furnishing and placing complete the waterproofing membrane; mortar protection course and wire mesh; all materials, labor, equipment and all else necessary therefor; and all other work in connection therewith and incidental thereto.

## SECTION 7

### Pneumatically Applied Mortar

#### 4.7.1. Description.

**Pneumatically Applied Mortar** shall include the furnishing and placing on steel structure surfaces and elsewhere a course of mortar placed pneumatically by means of a machine that discharges water and a mortar mixture under regulated pressure through pipes or hose and a discharge nozzle, the water being combined with the mortar mixture at the nozzle. The course shall be reinforced with rods and wire mesh and shall be constructed at the locations and to the dimensions prescribed and in accordance with the Plans and Specifications.

#### 4.7.2. Materials.

Cement, sand, water and steel shall conform to the requirements therefor, specified in Arts. 4.1.2 (p. 137) and 3.13.2 (p. 132). The mortar shall be mixed in the proportions of 1 part of cement to 3 parts of sand. When ready to be used the sand shall have a normal content of from 4 to 8 per cent of moisture, and the mixture shall be screened so as to remove lumps and pieces more than  $\frac{1}{4}$  inch in size.

#### 4.7.3. Methods of Construction.

**Cleaning Steel.** The steel to be covered shall be thoroughly cleaned by sand blasting and all rust, grease and other foreign materials shall be removed before applying the mortar course.

**Reinforcement.** Steel rods,  $\frac{3}{8}$  inch in diameter, shall be securely attached to the steel structure by spot welding or by wiring through holes provided for the purpose. Wire fabric of 2"x2" mesh, No. 12 gauge galvanized wire shall then be securely fastened to and outside of the rods with wires, spaced not more than 2 feet apart. Adjacent sheets of wire fabric shall lap not less than 4 inches and shall be securely fastened together. When in place, the wire fabric shall be approximately  $\frac{3}{4}$  inch from the surface of the steel.

**Mortar Course.** Mortar course shall be applied by means of a suitable pneumatic machine under air pressure of not less than 35 pounds per square inch. When more than 100 feet of hose or a lift of more than 25 feet is required, the air pressure shall be increased proportionately to maintain the same pressure at the nozzle. The water used for hydrating the mortar mixture at the nozzle shall be maintained at a uniform pressure of 60 pounds per square inch, or at a pressure of more than 25 pounds in excess of that of the air. Only men with extensive experience in similar work shall be used for placing the pneumatically applied mortar. Their qualifications shall be proved to the satisfaction of the Engineer, but his approval of men or their qualifications shall in no way relieve the Contractor of his responsibility to produce satisfactory results.

In shooting all surfaces, the nozzle shall be held at such distances and in such position, that the stream of material will impinge as nearly as possible at right angles to the surface being covered. Any previously placed mortar coating shall be thoroughly washed with water and com-

pressed air before new material is applied on top or adjacent thereto. Any deposit of loose sand shall be removed before placing the mortar coating, and if loose sand is covered the mortar shall be cut out, the sand removed and the mortar coating replaced. No mortar shall be placed in freezing weather except when authorized by the Engineer and under such precautions as he may direct or approve. No mortar shall be placed against surfaces in which frost is present.

The pneumatically applied mortar shall follow accurately the outline of the steel members and shall have a thickness of not less than 2 inches. Shooting strips shall be used for the purpose of securing true and uniform lines for all members. The surface finish shall be made by first truing the surface to a plane by cutting off all high spots with a sharp-edged tool and then dragging the surface with a wide long-haired whitewash brush, thoroughly wetted with clean water. The mortar coating shall be kept moistened with water for not less than 7 days after it is placed. The finished surfaces shall be workmanlike in appearance, of uniform color, straight and true, and satisfactory to the Engineer.

#### 4.7.4. Quantity and Payment.

The quantity of Pneumatically Applied Mortar, for which payment will be made, will be the superficial area thereof, as limited by the prescribed dimensions, placed in accordance with the Plans or as directed by the Engineer.

Payment for Pneumatically Applied Mortar will be made for the quantity as above determined, measured in square feet, at the price per square foot bid for the item PNEUMATICALLY APPLIED MORTAR in the Proposal, which price shall include furnishing and placing reinforcement steel and mortar course complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## **DIVISION 5**

### **Miscellaneous Structures**

#### **SECTION 1**

##### **Underdrains**

##### **5.1.1. Description.**

**Underdrains** shall include the excavation for and the construction of drains for subsoil drainage in accordance with the Plans and Specifications. The underdrains shall be of the type and size specified and shall be constructed to the prescribed lines and grades and at the prescribed locations.

##### **5.1.2. Materials.**

**Pipe** shall conform to the requirements therefor specified in Art. 5.2.2 (p. 187). **Boards** shall be of sound wood and acceptable to the Engineer. **Burlap, Salt Hay, Straw and Tar Paper** shall be of good quality, satisfactory to the Engineer. **Stone, Gravel and Slag** shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 129).

##### **5.1.3. Methods of Construction.**

**Excavation, Laying of Pipe and Backfill.** Excavation and backfilling of trenches and laying of pipe shall conform to the requirements therefor specified in Arts. 2.7.3 (p. 52) and 5.2.3 (p. 191), respectively, except as herein provided.

**Underdrain Type T.** Underdrain Type T shall be pipe of the type and size prescribed laid with open joints in a trench. When so specified, the pipe shall be laid on 6"x1" boards. The joints of the pipe shall be wrapped with 2-ply tar paper or caulked with burlap or salt hay so as to prevent passage of earth, and the trench shall be backfilled as above provided.

**Underdrain Type F.** Underdrain Type F shall be constructed as specified for Type T, except that the trench shall be backfilled with stone, gravel or slag and covered with a layer of salt hay or straw as shown on the Plans.

**Underdrain Type S.** Underdrain Type S shall be stone, gravel or slag of the Sizes shown on the Plans, placed in a trench as prescribed. The large Size aggregate shall be

placed first in 2 layers, each compacted with pneumatic tampers. The next smaller Size aggregate shall then be placed and covered with  $\frac{1}{4}$ -inch Size aggregate and compacted with a roller weighing not less than 220 pounds per lineal inch of wheel tread.

**Combination Drain.** Combination drain shall be constructed in general conformity with the requirements for Underdrain, Type F, and to the requirements shown on the Plans.

#### 5.1.4. Quantity and Payment.

The quantity of Underdrain and Combination Drain, for which payment will be made will be the length of each type actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for Underdrains, Types T, F and S, and for Combination Drain will be made for the quantities of each as above determined, measured in lineal feet, at the prices per lineal foot bid for the items UNDERDRAIN TYPE T, F, and S, and COMBINATION DRAIN, respectively, in the Proposal, which prices shall include the cost of excavation (except rock), furnishing and placing pipe, stone, gravel, slag and other materials specified, caulking, back-filling, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 2 Storm Drains

### 5.2.1. Description.

**Storm Drains** shall include the excavation for and construction of pipe drains for surface drainage in accordance with the Plans and Specifications. The drains shall be of the type and size specified, and shall be constructed to the prescribed lines and grades at the locations shown on the Plans.

### 5.2.2. Materials.

**Pipe.** The various types of pipe shall conform to the requirements stated herein. The specified diameter is the internal diameter of the pipe. The pipe shall be inspected and approved before being shipped. Culls, used, damaged or defective pipe shall not be placed in the Project.

**Vitrified Clay Pipe.** Vitrified clay pipe shall conform to the requirements of Specification M-65-38 of the American Association of State Highway Officials.

**Reinforced Concrete Pipe.** Except as herein provided, reinforced concrete pipe shall conform to Standard Specification M-41-38 of the American Association of Highway Officials, Standard Strength, Concrete 4500 pounds per square inch. Class A concrete (p. 141), made of materials as specified in Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120), shall be used, except that the coarse aggregate shall be broken stone of trap rock, or gravel, ½-inch or ⅝-inch Size.

**Plain Concrete Pipe.** Plain concrete pipe shall conform to the requirements of the current Specifications C 14 of the American Society for Testing Materials, except that the concrete shall conform to the requirements therefor, specified under Reinforced Concrete Pipe above.

**Cast Iron Culvert Pipe.** Cast iron culvert pipe shall conform to the requirements of Specification M-64-38, Extra Heavy Pipe, of the American Association of Highway Officials, except that pipe more than 48 inches in diameter shall conform to current Specifications A44 of the American Society for Testing Materials, Class A Pipe.

**Cast Iron Water Pipe.** Cast iron water pipe shall conform to the requirements of current Specifications A44 of the American Society for Testing Materials, Class C Pipe

**Corrugated Metal Pipe.** Corrugated metal pipe and perforated corrugated metal pipe shall conform to the requirements of Specification M-36-38 of the American Association of State Highway Officials, except that, when the Project is not a federal aid project either pure iron, copper bearing pure iron, copper iron, or copper molybdenum iron shall be used. For 6-inch perforated pipe there shall be 5 rows of holes. When bituminous coating is specified the pipe shall be coated uniformly and completely inside and outside with asphalt cement, not less than 0.03 inch thick, and when bituminous invert is specified the pipe shall have an additional thickness of coating for not less than one-quarter of its circumference. The asphaltic cement shall conform to the following requirements:

Specific Gravity at 60 deg. F. . . . .	min.	1	max.	—
Penetration, 32 deg. F., 200 gr., 60 sec.	"	25	"	—
Penetration, 77 deg. F., 100 gr., 5 sec.	"	25	"	50
Penetration, 115 deg. F., 50 gr., 5 sec.	"	65	"	80
Softening point (R. and B.), deg. F.	"	190	"	230
Evaporation loss, 325 deg. F., 50 gr., 5 hrs. % . . . . .	"	—	"	1
Bitumen soluble in CS <sub>2</sub> . . . . .	"	99.5	"	—

The bituminous coating shall adhere firmly to the metal, shall be moisture proof, shall not chip, shall be erosion resistant, and shall conform to the following test requirements. (a) Parallel lines shall be drawn on the crests of the corrugations and the specimen shall be placed on end in an oven with the lines horizontal. After being maintained at a temperature of  $150 \pm 2$  deg. F. for 4 hours no part of any line shall have dropped more than  $\frac{1}{4}$  inch. (b) A 25 per cent solution of sulphuric acid or sodium hydroxide, or a saturated solution of sodium chloride, shall be maintained in the valleys of the corrugations for 48 hours, without causing loosening of coating from the galvanized surface.

The bituminous invert may be provided in one of the following manners. (a) The bituminous material shall be placed so that, when completed the coating extends not less than  $\frac{1}{8}$  inch above the crest of the corrugations and that there are no appreciable depressions in its surface. (b) The bituminous material shall be placed in approximately uniform thickness of  $\frac{3}{8}$  inch, conforming to the shape of the corrugations. (c) The invert shall be formed prior to the coating of the pipe by means of a pad and a smooth, galvanized, perforated and bituminous coated metal shield of same metal as used for the pipe and not less than 24-gauge thick. The pad shall be asphalt cement saturated and coated rag felt, not less than 0.04 inch thick and weighing not less than  $\frac{1}{4}$  pound per square foot. The perforations of the shield shall be not less than  $\frac{3}{8}$  inch diameter and shall be spaced 2  $\frac{2}{3}$ -inch centers longitudinally and not more than 2  $\frac{1}{2}$  inches circumferentially to the pipe. The pad and shield shall be attached in proper alignment to the pipe with rivets spaced not more than 25 inches centers longitudinally and not more than 6 inches circumferentially. The pad shall be butt jointed and held firmly in place by the shield at the crest of the corrugations. The shield shall be lap jointed 1  $\frac{1}{2}$  inches and pointing in the same direction as the lap joints of the pipe. When the pad and shield are in place, the spaces in the valleys of the corrugations under the shield shall be filled with asphalt cement, and the surface of the shield shall be covered therewith to a thickness of not less than  $\frac{1}{8}$  inch.

**Helical Corrugated Pipe.** Helical corrugated pipe shall conform to the requirements for corrugated metal pipe specified above, except as follows. The pipe shall have a diameter of 6 or 8 inches as may be specified, and not less

than 18-gauge metal shall be used. The corrugations of the sheets shall be from  $1\frac{1}{4}$  to  $1\frac{1}{8}$  inches centers and not less than  $\frac{1}{4}$  inch deep, and shall run helical to the pipe. The pipe shall be formed by joining the edges of the sheet either by a welded or a lock seam, continuous in each section, and so as not to decrease the strength of the pipe. The galvanizing shall be done after fabrication of the pipe. Connecting bands shall be not less than 7 inches wide with corrugations enmeshing those of the pipe. Connections between each pipe and band shall be made with 2 and 4 galvanized  $\frac{3}{4}$ -inch bolts, when the band is in 1 and 2 pieces, respectively. Perforated helical corrugated pipe shall have holes from  $\frac{1}{4}$  to  $\frac{3}{8}$  inch in diameter in the inside corrugation crests except at ends and through seams. There shall be 6 longitudinal rows of perforations, spaced either 1 inch centers throughout, or so as to leave an unperforated space at the bottom of the pipe, half the width of the diameter of the pipe. The holes shall be punched before galvanizing the pipe. Bituminous coated helical corrugated pipe, perforated or unperforated, shall be coated as previously specified without closing any perforations.

**Corrugated Plate Pipe and Arches.** Corrugated Plate Pipe and Arches shall conform to the requirements for corrugated metal pipe except as follows. The zinc coating shall be not less than  $1\frac{1}{2}$  ounces per square foot of surface coated. The corrugations shall be not less than  $5\frac{3}{4}$  and not more than  $6\frac{1}{4}$  inches centers and not less than  $1\frac{3}{8}$  inches deep. The plates shall be shaped to true curvature and punched so that when erected the joints are tight and the shape is circular. Longitudinal joints shall have 2 rows of bolts 2 inches apart. One row shall have a bolt in each ridge and the other in each valley. Bolts in circumferential joints shall be not more than 12 inches apart. The minimum edge distance of bolt holes shall be 1 inch. All bolts shall be galvanized and shall have a diameter of  $11/16$  inch. They shall be long enough to extend not less than  $\frac{1}{8}$  inch through the nut when the pipe is assembled.

The thickness of the sheets and the number of longitudinal joints shall be as follows:

Diameter of pipe, inches	60	75	90	105	120	135	150
Gauge .....	7	7	5	5	3	3	1
Gauge, bottom plates ...	5	5	3	3	1	1	1
Longitudinal joints, No.	4	5	6	7	8	9	10

**Wrought Iron Pipe.** Wrought iron pipe and couplings shall conform to the requirements of current Specifica-

tions A72 of the American Society for Testing Materials. Fittings not manufactured of wrought iron shall be of malleable iron or if so specified, of bronze approved by the Engineer. The pipe shall be Standard Weight, threaded and furnished with couplings and shall be galvanized by the hot dip process. The zinc coating shall weigh not less than 2 ounces per square foot of surface coated, shall be free from imperfections of any kind, and shall show no signs of cracking or blistering. Each length of pipe shall be marked with the manufacturer's name, identifying mark and year of manufacture.

**Mortar.** Mortar shall be 1:2 cement-sand mortar, the materials conforming to the requirements therefor specified in Arts. 4.1.2 (p. 137) and 3.13.2 (p. 120).

**Jute and Oakum.** Jute and oakum shall be of good quality and shall be approved by the Engineer.

### 5.2.3. Methods of Construction.

Excavation and backfill shall conform to the requirements of Art. 2.7.3 (p. 52). Starting at the low end the pipe shall be laid with the spigot entering the full depth of the socket and with the bell end up grade, and shall be bedded in the underlying soil for its full length. A gasket of a single piece of jute or oakum shall be caulked firmly into each joint so as to close it entirely, and the remainder of the joint shall be filled with mortar.

Corrugated metal pipe shall have the connecting bands neatly fitting the corrugations, and the connections shall be made in a neat and workmanlike manner. Corrugated plate pipe shall have longitudinal joints offset not less than 2 feet, and circumferential joints shall lap one-half a corrugation. All bolts shall be drawn tight and burred.

Broken or otherwise damaged pipe shall be replaced, and the pipe shall be kept clean of any deposit and debris. The drains shall not be laid until the exact locations of utility structures in the vicinity have been determined in the field. The drains as laid shall be approved by the Engineer before the trench is backfilled. Except when necessary to maintain flow, drains shall not be placed in embankment until this has been constructed and consolidated not less than 3 feet above the top level of the drain or to the finished level of the embankment, and a trench shall then be excavated for the placing of the drain.

Where shown on the Plans, existing drains shall be taken up without causing damage to the pipe, shall be

cleaned, and shall be relaid as required in accordance with these Specifications.

#### 5.2.4. Quantity and Payment.

The quantities of Storm Drains and Relaid Drains for which payment will be made will be the actual lengths constructed in accordance with the Plans or as directed by the Engineer, measured in place where laid or relaid, except that the length between inner faces of catch basin, inlet and manhole walls will not be measured for payment.

Payment for Storm Drains and Relaid Drains, of the types and sizes specified, will be made for the length of each type and size as above determined, measured in lineal feet, at the prices per lineal foot bid for the various STORM DRAIN and RELAID DRAIN items, respectively, in the Proposal, which prices shall include the cost of excavation (except rock), furnishing, laying, assembling, and caulking the pipe complete, shoring, pumping, backfilling, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto. For relaid drains, the prices shall include also the cost of excavation necessary for removal of the pipe for which payment has not elsewhere been provided, and cleaning of pipe.

### SECTION 3

#### Manholes, Inlets and Catch Basins

##### 5.3.1. Description.

**Manholes, Inlets and Catch Basins** shall include the excavation for and the construction of these structures in accordance with the Plans and Specifications at the required location and to the prescribed lines, grades and dimensions.

##### 5.3.2. Materials.

**Concrete.** Materials for concrete and mortar shall conform to the requirements therefor, specified in Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120), and their preparation to those of Art. 4.1.3 (p. 142), except that the batching and mixing equipment may be of a size and type suitable for the work to be done and subject to the approval of the Engineer. Transit mixers may be used, subject to the provisions of Art. 4.1.3 (p. 144).

**Concrete Blocks.** Concrete blocks shall be of Class A concrete as specified in Art. 4.1.2 (p. 141), except that the coarse aggregate shall be broken stone or trap rock or dolomite, or gravel,  $\frac{3}{8}$ -inch or  $\frac{1}{2}$ -inch Size. Not more than 5 gallons of water shall be used per bag of cement. In the fabrication of the concrete blocks the concrete shall be machine mixed for a period of not less than  $1\frac{3}{4}$  minutes per batch, or as much longer as may be necessary to insure a uniform, homogeneous mixture of the proper consistency. The mixture shall be placed in a manner that will insure that the forms are completely filled, and shall be spaded, tamped or vibrated so as to obtain proper density.

The concrete blocks may be either steam or air cured. Steam curing shall be done by saturated steam at a temperature of not less than 75 and not more than 115 deg. F. for not less than 24 hours, and thereafter they shall be kept wet for a period of not less than 10 days. When air cured the blocks shall be kept wet and properly covered for a period of not less than 14 days. While being cured, the blocks shall not be exposed to a temperature of less than 50 deg. F. The average absorption of the concrete blocks shall not exceed 7 per cent by weight as determined by testing 3 whole undamaged blocks in accordance with Standard P1-C-29 of the American Concrete Institute for a period of 24 hours. The compressive strength of the concrete blocks when 28 days old shall be not less than 5,500 pounds per square inch. The strength test will be made on concrete blocks selected at random.

The blocks shall be either rectangular or segments of a circular cylinder of the required radius with a tolerance of not more than 2 inches above or below the required radius. The overall length shall be not less than 12 and not more than 18 inches and shall be such that the blocks can be laid with joint widths as hereinafter specified without being cut. The height of the blocks shall be not less than 6 and not more than 8 inches. The width shall be not less than 6 inches. All faces of a block shall be true to shape and in true relation to each other, and shall have a dense, uniform surface. The blocks shall have such dimensions that they can be placed in position in the structure with joints not less than  $\frac{1}{4}$  and not more than  $\frac{1}{2}$  inch in width. If necessary, blocks of special heights shall be provided so that the head casting of the structure may

be set at the required elevation on a mortar bed not more than  $\frac{1}{2}$  inch thick without cutting the blocks.

**Brick.** Clay or shale brick shall conform to the requirements of current Specifications C32, Grade MA, of the American Society for Testing Materials, and shall be new, whole, of best quality and of a standard brand and manufacture. Concrete brick shall conform to the requirements for concrete block specified above, except that the size shall be as specified for clay or shale brick.

**Cast and Wrought Iron.** Cast and wrought iron shall conform to the requirements therefor, specified in Art. 4.2.2 (p. 157).

### 5.3.3. Methods of Construction.

**Excavation.** Excavation and backfill shall conform to the requirements of Art. 2.7.3 (p. 52).

**Concrete Structures.** The foundation for concrete, concrete block and brick manholes, inlets and catch basins shall be Class D concrete (p. 141). Concrete manholes, inlets and catch basins shall be of Class C concrete. The construction shall conform in general to the requirements of Art. 4.1.3 (p. 142), where applicable.

**Brick and Concrete Block Structures.** The concrete blocks and brick shall be laid with broken joints, and all vertical and horizontal joints shall be filled with 1:2 cement-sand mortar. Straight joints shall be not more than  $\frac{3}{8}$  inch wide and radial joints not more than  $\frac{1}{2}$  inch in average width. The masonry shall be carried to such a height that a mortar joint not more than  $\frac{1}{2}$  inch thick is needed for setting the head casting without using split blocks or bricks. The outside wall shall be plastered with a  $\frac{1}{2}$  inch thick coat of 1:2 cement-sand mortar, troweled to a smooth finish.

**Head Castings and Steps.** Cast iron frames and covers shall be fitted together and match marked before being delivered to prevent rocking of covers. Wrought iron steps shall be provided in manholes as shown on the Plans.

**Reset and New Heads.** When so prescribed head castings of present structures shall be removed and reset to new elevation, new head castings shall be furnished and set on present structures, and masonry of present structures shall be added to or removed as may be necessary to conform to new surface grades and elevations. The work shall be done in conformity with the requirements above.

### 5.3.4. Quantity and Payment.

The quantity of manholes, inlets and catch basins for which payment will be made will be the number of each type of structure constructed or reconstructed in accordance with the Plans or as directed by the Engineer.

Payment for manholes, inlets and catch basins constructed or reconstructed will be made for the quantity of each type and classification as above determined at the unit prices bid for the items MANHOLES, INLETS, CATCH BASINS, RESET HEADS and NEW HEADS, respectively, in the Proposal, which prices shall include the cost of excavation (except rock), shoring, pumping, construction or reconstruction complete, backfill, all materials, including head castings and steps, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 4

### Gutters

#### 5.4.1. Gutters.

**Gutters** shall include the excavation for and construction of gutters together with their foundations in accordance with the Plans and Specifications at the required locations and to the prescribed lines, grades and dimensions.

#### 5.4.2. Materials.

**Concrete.** Materials for concrete, grout, and reinforcement steel shall conform to the requirements therefor, specified in Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120), and the preparation of concrete to those of Art. 4.1.3 (p. 142), except that the batching and mixing equipment may be of a size and type suitable for the work to be done and subject to the approval of the Engineer. Transit mixers may be used, subject to the provisions of Art. 4.1.3 (p. 144).

**Rubble Stones.** Rubble stones shall be of hard, durable, tough trap rock, granite, gneiss or other approved rock with fairly uniform fine grain, and shall be sound, free from weathered or decomposed pieces, shattered ends, structural defects, marked lamination, seams or cracks, and acceptable to the Engineer. The stones shall be not less than 6 and not more than 8 inches in depth, not less than 2 and not more than 5 inches in width, and not less

than 6 and not more than 10 inches in length. The upper surface shall be practically flat.

**Joint Filler.** Joint filler for concrete gutters shall be premoulded, as specified in Art. 3.13.2 (p. 129).

**Sand.** Sand for rubble stone gutters shall be a coarse sand, approved by the Engineer.

#### 5.4.3. Methods of Construction.

**Excavation.** Excavation and backfill shall conform to the requirements of Art. 2.7.3 (p. 52).

**Concrete Gutters.** Class B concrete (p. 141), shall be used for concrete gutters. The construction and curing shall conform in general to the requirements of Art. 4.1.3 (p. 142), where applicable. Before initial set of the concrete it shall be finished with a wood float to an even, smooth surface at the proper grade. Forms shall be left in place not less than 24 hours after finishing. Expansion joints with  $\frac{1}{4}$  inch premoulded joint filler shall be provided at intervals of 25 feet, unless otherwise prescribed.

**Rubble Stone Gutter.** Rubble stone gutters shall be laid on earth or other foundation as may be prescribed. The stones shall be laid on edge with the greatest length at right angles to the centerline of the gutter. Spaces between stones shall be filled with spalls hammered into place, and the surface shall be covered with dry sand which shall be swept into the joints until they are filled. The stones shall then be rammed to firm bearing and true surface. Additional sand shall then be swept into the joints until they are filled.

**Grouted Rubble Stone Gutter.** Grouted rubble stone gutter shall be constructed on a sand cushion not less than 2 inches deep. The stones shall be laid on the cushion on edge with the greatest length at right angles to the centerline of the gutter, and spaces between stones shall be filled with spalls. The stones shall then be rammed to firm bearing and true surface. The stones shall be sprinkled with water, and 1:1 cement-sand grout with sufficient water to produce a thick grout shall be poured into the joints until they are completely filled and the surface is covered with a thin layer of grout. The surface shall be cured as specified in Art. 4.1.3 (p. 153).

#### 5.4.4. Quantity and Payment.

The quantity of gutter of the type prescribed for which payment will be made will be the area, measured by the

length and horizontal width, actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for gutters will be made for the areas as above determined, measured in square yards, at the prices per square yard bid for the items CONCRETE, RUBBLE STONE and GROUTED RUBBLE STONE GUTTER, respectively, in the Proposal, which prices shall include the cost of excavation, construction of foundation and gutter complete, backfill, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 5

### Curbs and Headers

#### 5.5.1. Description.

**Curbs and Headers** shall include the excavation for and construction of curbs and headers, except White Concrete Curb, in accordance with the Plans and Specifications, at the required locations and to the prescribed lines, grades and dimensions.

#### 5.5.2. Materials.

**Concrete.** Materials for concrete shall conform to the requirements therefor specified in Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120), and the preparation of concrete to those of Art. 4.1.3 (p. 142), except that the batching and mixing equipment may be of a size and type suitable for the work to be done and subject to the approval of the Engineer. Transit mixers may be used, subject to the provisions of Art. 4.1.3 (p. 144).

**Granite.** Granite shall be medium grained with uniform texture and distribution of minerals, unstratified, unlaminated and free from seams and evidence of weathering. The percentage of wear shall be not more than 4.5. The curb or header stones furnished for the Project shall be all from one quarry and of the same color and texture. Quarry split stone for curbs and headers shall have the top face machine finished or dressed to an even surface without depressions or projections of more than  $\frac{3}{8}$  inch below or above the plane of the face. Edges shall be straight and even, and the ends shall be cut square for the entire depth of exposed curb face as shown on the Plans for curb stones, and for a depth of 4 inches for header stones, and curb stones shall be so dressed that

joints can be made not more than  $\frac{3}{8}$  inch wide from top to gutter line and not more than 1 inch wide below the gutter line.

Dressed stone for curbs shall be dressed on top face, front face for the entire depth of the exposed curb face as shown on the Plans, back face to a depth of 2 inches and ends to a depth of 1 inch, to an even, smooth finish and the projections and depressions on the various faces shall be no greater than as follows:

Top and dressed part of fronts and ends . . . . .	Depression	$\frac{1}{4}$ "	Projection	$\frac{1}{4}$ "
Front, undressed part ..	"	$1\frac{1}{2}$ "	"	$\frac{1}{2}$ "
Back, dressed part . . . . .	"	$\frac{1}{2}$ "	"	$\frac{1}{2}$ "
Back, undressed part ...	"	$1\frac{1}{2}$ "	"	$1\frac{1}{2}$ "
Ends, rough dressed part	"	$\frac{1}{2}$ "	"	$\frac{1}{4}$ "
Ends, undressed part ...	"	$1\frac{1}{2}$ "	"	$\frac{1}{4}$ "

The rough dressed part of end faces shall extend 1 inch below the gutter line. The back edge of the top shall be parallel to the front face. When so indicated, the top and front faces shall be sloped, and the front edge shall be rounded as shown on the Plans. The stones shall have the width specified at the top, and the bottom width shall be not less than 1 and not more than 3 inches greater than the top width. The stones shall be furnished in lengths of not less than 4 and not more than 8 feet. Straight cut stone may be used for curved curb having a radius of not less than 50 feet, but shall be dressed to true radius after being set in place. For smaller radii the stone shall be cut to the required radius, and the ends shall be cut so that the joints can be made not more than  $\frac{1}{4}$  inch wide for the full depth.

Granite headers shall comply in general with the requirements specified for curb.

**Joint Filler.** Joint fillers and cellular compression material shall conform to the requirements therefor, specified in Arts. 3.13.2 (p. 128), and 3.11.2 (p. 106), respectively.

### 5.5.3. Methods of Construction.

**Excavation.** Excavation and backfill shall conform to the requirements of Art. 2.7.3 (p. 52).

**Concrete Curb and Headers.** Class B concrete shall be used (p. 141). The construction, including curing, shall conform in general to the requirements of Art. 4.1.3 (p. 142). Metal form shall be used, unless otherwise approved by the Engineer, and shall be lubricated with an approved ma-

terial that will not cause stains. The concrete shall be tamped and spaded or vibrated so that the forms are completely filled, the concrete thoroughly compacted and mortar is flushed to the face and top. Before initial set the top, and as soon as the forms can be removed, the face shall be finished with a wood float to an even, smooth and dense surface. For curbs, expansion joints shall be provided at intervals of 20 feet and shall be filled with  $\frac{1}{2}$  inch cellular compression material to within  $\frac{1}{4}$  inch of top and face. For headers joints shall be provided as shown on the Plans. Where the curb is adjacent to concrete surface or base course,  $\frac{1}{4}$  inch premoulded pavement expansion joints shall be provided.

**Granite Curbs and Headers.** Granite curbs and headers shall be dressed or quarry split as may be specified. When a concrete foundation is required, Class D concrete shall be used therefor (p. 141), and its construction shall conform in general to the requirements of Art. 4.1.3 (p. 142). The curb and headers shall be set with the top surface at the required grade, and the joints shall be not more than  $\frac{1}{4}$  inch wide for dressed, and  $\frac{3}{8}$  inch wide for split curb and headers. The joints shall be pointed with 1:1 cement-sand mortar. Adjacent to the curb concrete surface and base course expansion joints shall be provided and filled with liquid joint filler.

**Finished Curb and Headers.** The finished curb and headers shall be true to the required grades, lines and curvatures, and shall be neat and workmanlike in appearance.

#### 5.5.4. Quantity and Payment.

The quantities of curb and headers for which payment will be made will be the lengths, measured on face of curbs and centerline of headers, actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for concrete and granite curbs and headers (other than white concrete curb) will be made for the quantity of each as above determined, measured in lineal feet, at the price per lineal foot bid for the items CONCRETE CURB, CONCRETE HEADERS, GRANITE CURB and GRANITE HEADERS, respectively, in the Proposal, which prices shall include the cost of excavation, concrete foundation, construction of curbs and headers, expansion joints, backfill, pavement expansion joints, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 6

## White Concrete Curb

## 5.6.1. Description.

**White Concrete Curb** shall include the excavation for and the construction of white concrete curb in accordance with the Plans and Specifications at the required locations and to the prescribed lines, grades and dimensions.

## 5.6.2. Materials.

**Definitions.** In the following, White Mortar shall mean mortar made with white cement and white sand; White Concrete shall mean concrete made with white cement, white sand and light colored coarse aggregate; and Grey Concrete shall mean concrete made with standard cement.

**Cement.** Cement for white mortar and white concrete shall be white cement, and cement for grey concrete shall be standard cement, both as specified in Art. 4.1.2 (p. 137).

**Sand.** Sand for grey concrete shall be as specified in Art. 3.13.2 (p. 132). White Sand shall conform to the requirements for sand as specified in Art. 3.13.2 (p. 132), except that it shall be white quartz sand or crushed limestone, marble or granite and shall contain no iron and other discoloring matter. White quartz sand shall contain not more than 0.5 per cent, and crushed limestone, marble or granite not more than 1 per cent of elutriable matter. The sand shall be graded as follows:

Passing $\frac{3}{8}$ in.,	retained on No.	4 sieve,	% min.	0 max.	5
" No. 4,	" " No. 10	" " "	" " "	0	" 20
" No. 10,	" " No. 30	" " "	" " "	5	" 60
" No. 30,	" " No. 50	" " "	" " "	20	" 60
" No. 50,	" " No. 200	" " "	" " "	10	" 45
" No. 200,				0	" 5

The sand shall have a light reflection value not less than that of the standard sample on file with the Department, as determined by the photo-electric equipment and methods used by the Laboratory. When tested for soundness by the use of sodium sulphate or magnesium sulphate in accordance with Tentative Specification C88-39T of the American Society for Testing Materials, the loss shall be not more than 4 per cent. When mixed with cement and water, the resulting mortar shall have tensile and compressive strengths at the end of 7 days which are not less than 90 per cent of those produced by mortar similarly prepared with standard Ottawa sand.

**Coarse Aggregate.** The coarse aggregate for grey concrete shall be broken stone or gravel as specified in Art. 3.13.2 (p. 129). For white concrete it shall be light colored quartz gravel, limestone or granite, containing not more than a trace of iron. The Sizes required shall be as hereinafter described. The aggregates for white concrete and mortar shall be free from dirt and discoloring matter and shall be washed before being used if necessary.

**Reinforcement Steel.** Reinforcement steel shall conform to the requirements therefor specified in Art. 3.11.2 (p. 104).

**Joint Filler, Cellular Compression Material, Calcium Chloride and Diatomaceous Earth** shall conform to the requirements therefor, specified in Art. 3.13.2 (p. 120).

**Sodium Metasilicate** shall conform to the requirements therefor, specified in Art. 3.11.2 (p. 107).

**Colorless Curing Compound** shall conform to the requirements therefor specified in Art. 4.1.2 (p. 142).

### 5.6.3. Methods of Construction.

**General.** The quantities of aggregates for a batch shall be determined by weight or volume. Transit mixers may be used for grey concrete, subject to the provisions of Art. 4.1.3 (p. 142). Calcium chloride may be added as an accelerator to concrete mixtures in the amount of not more than 2 pounds per bag of cement. The equipment and methods used for weighing or measuring shall produce accurate results and shall be arranged conveniently for checking. The aggregates shall be kept separated until batched. Frozen aggregates shall not be used. Forms for cast-in place curb shall be of metal, unless otherwise approved by the Engineer. The materials and methods used for lubricating the forms shall not cause discoloration of the curb at any time.

When the curb is placed on a concrete pavement, the area to be covered shall be washed clean and all loose and adhering material shall be removed. Where spots of oil, tar, grease and other foreign substances occur, the surface shall be flushed with water and sprinkled with sodium metasilicate at the rate of 1 to 2 pounds per 100 square feet of surface. The metasilicate shall remain not less than 15 minutes, during which time the spots shall be scrubbed until removed, and the surface shall then be thoroughly rinsed. The entire area of pavement within the limits of the new curb shall be covered with a layer of 1:1 $\frac{3}{4}$  mortar, not less than  $\frac{1}{4}$  inch thick, and before this

has taken initial set the curb shall be constructed or laid thereon.

**Cast-in-Place Plain Curb.** For cast-in-place plain curb the concrete shall be Class B (p. 141), and the coarse aggregate may be either  $\frac{3}{4}$ ,  $\frac{5}{8}$  or  $\frac{1}{2}$ -inch Size for grey concrete and either  $\frac{1}{2}$  or  $\frac{3}{8}$ -inch Size for white concrete. The curb shall have an inner course of grey and an outer course of white concrete as shown on the Plans. In the white concrete mixture shall be incorporated diatomaceous earth at the rate of 3 pounds per bag of cement. The grey concrete shall be placed so as not to touch the part of the form to be occupied by the white concrete, and any grey concrete particles or film adhering to that part shall be removed. The surface of the grey concrete shall be roughened if necessary to obtain proper bond. The outer course shall be placed immediately after the grey concrete has slumped and before its initial set. Suitable devices and methods shall be used to prevent grey concrete from being brought into the outer course and to insure obtaining the required thickness of the outer course. The concrete mixtures shall be tamped, spaded or vibrated into place so that the forms are completely filled, the materials thoroughly compacted and mortar is flushed to the face and top. The edges of the curb shall be rounded to the prescribed radius with suitable edging tools and the curb shall be given a finish with a wood float. Expansion joints,  $\frac{1}{2}$  inch wide, shall be provided at intervals of not more than 20 feet except where otherwise prescribed, and the joint openings shall be filled to within  $\frac{1}{4}$  inch of the face and top with cellular compression material. Joints shall be constructed with  $\frac{1}{4}$  inch thick premoulded joint filler between the curb and concrete surface or base courses. Where shown on the Plans, the curb shall be constructed monolithic with the adjoining pavement.

Curing shall be done by one of the following methods.

(a). Immediately after placing the outer course the curb shall be protected by canvas covers, suspended on frames so as to avoid contact with the curb. Except for such periods when finishing operations or removal of forms are in progress this covering shall remain in place for a period of not less than 48 hours after the finishing is completed; provided, however, that the canvas may be replaced with a substantial waterproof non-staining paper, approved by the Engineer, as soon as the surface is hard enough to support the paper without being marred. Adjoining

lengths of the paper shall lap not less than 3 feet and the paper shall be secured in place by weights placed clear of the curb. Care shall be taken to avoid discoloration of exposed surfaces during and after construction. If required the surfaces shall be cleaned with carborundum or by other means satisfactory to the Engineer. (b). By coating with Colorless Curing Compound as described in Art. 4.1.3 (p. 153). Application of grout or paint coat of cement or other material during or after the finishing of the curb will not be permitted.

**Cast-in-Place Scored Curb.** Cast-in-place scored curb shall conform to the requirements for plain curb above with the following modifications. The curb shall be of Class B concrete with a top facing of 1:1 $\frac{3}{4}$  white mortar not less than 1 inch thick. The top surface shall be scored and tooled according to design shown on the Plans. The scoring shall be done twice, first immediately after the white mortar has been screeded and finished to proper grade, and again after excess water has disappeared and the mortar is stiff enough to stand without slumping. All surfaces of the scored band shall be smooth with true inclination and draft. Top corners of the reflecting faces shall be sharp. Top and bottom tooled surfaces shall be smooth, true to grade and alignment, and shall be free from excess material along the edges of the scored band. The top edge of the curb shall be tooled before the first and after the second scoring operation when the mortar is stiff enough to stand without slumping. The scoring tool and equipment and the edging tools shall conform to the design shown on the Plans and the workmanship shall be subject to the approval of the Engineer.

**Reflecting Vertical Curb.** Reflecting vertical curb may be cast-in-place or precast and shall be Left Hand (L.V.) or Right Hand (R.V.) as may be shown on the Plans. It shall conform to the requirements for plain curb above with the following modifications. Diatomaceous Earth may be omitted for precast curb. Approved forms shall be used for reflecting face. The concrete shall be so placed and vibrated that all posts and recessed surfaces of the reflecting panels have smooth surfaces requiring no finish. Other exposed faces shall be finished with a wood float. All outside edges of reflecting faces shall be sharp. Defects in contour and finish shall be made good as directed

or approved by the Engineer. For precast curb the pavement joints adjacent to the curb shall be filled with liquid joint filler. Precast curb shall be laid with close joints, except that  $\frac{1}{2}$  inch wide expansion joints with cellular compression material shall be provided 40 feet apart or as otherwise prescribed. Curved precast curb having a radius of 40 feet or over shall be in curved or straight pieces of the designated lengths as shown on the Plans. The precast curb shall be laid on a foundation and with a backing of Class C concrete (p. 141), as shown on the Plans.

**Precast Reflecting Sloping Curb.** Precast reflecting sloping curb shall conform to the design or designs shown on the Plans. The Contractor shall take all measurements, prepare all schedules required for the manufacture and lay the curb in accordance with Plans, Specifications and instructions of the Engineer. The Engineer will furnish information as to the location of joints affected by slabs shown on the Plans to be irregular in shape and length. Where island openings shown on the Plans appear to require special lengths of curb, the Engineer may revise the location and length of opening so that no piece of straight curb will be less than 4 feet in length.

The curb shall have a core of grey concrete and a facing of white concrete not less than  $\frac{1}{2}$  inch thick on the exposed faces. For grey concrete the coarse aggregate shall be  $\frac{5}{8}$ ,  $\frac{1}{2}$  or  $\frac{3}{8}$ -inch Size, and for the white concrete it shall be  $\frac{1}{2}$  or  $\frac{3}{8}$ -inch Size. Provisions shall be made for keeping fine and coarse aggregate separated until they are batched.

**Proportioning and Batching.** The mixture for both the grey and white concrete shall consist of not less than 1 part of cement to 5 parts total of fine and coarse aggregates, proportioned by volume, with a ratio of fine to coarse aggregate of not less than 50 per cent nor more than 67 per cent. This ratio shall be the same for the grey and white concrete in any piece of curb manufactured. Repairs shall be made with cement-sand mortar of the same materials and mixed in the same ratio as the mortar content of the white concrete.

The quantities of the separate aggregates for each batch of concrete shall be determined by weight or by volume. The equipment and methods used for proportioning and weighing or measuring the aggregates shall be of a type which will give uniformly accurate results and shall be designed and arranged for convenient access and checking

by the Inspector or other representative of the Department. Frozen aggregates shall not be used.

*Mixing.* After all materials, including water, have been placed in the mixer, the materials shall be mixed for a period of not less than  $1\frac{3}{4}$  minutes, or as much longer as may be necessary to produce a thorough and uniform mixture of the concrete. No water shall be added to any batch after the completion of the initial mixing period. Each batch of concrete shall be completely emptied from the mixer before placing more materials in it. A batch which has not been placed within 30 minutes from the time water was first added shall not be used. The mixers shall be kept in good repair and be equipped with an automatic timing device and a positive device for regulating the quantity of water added to each batch, said devices must be approved by the Engineer before use. The amount of water in both the grey and the white concrete shall be kept at a minimum, consistent with the manufacture of dense curb free from air bubbles and surface defects in excess of the tolerance limits herein specified.

*Forms.* The use of forms or molds made of plaster of Paris or other porous material will not be permitted. Bulkheads shall be tight-fitting so that there is no leakage of mortar between the bulkhead and form. The materials and methods used for lubricating the forms shall be such as will not result in discoloration of the curb at any time. A minimum quantity of lubricant shall be used and all excess lubricant in the corners forming the top edges of the reflecting surfaces shall be removed.

*Placing Concrete and Reinforcement Steel.* The grey concrete shall be placed not later than 30 minutes after the white concrete is in place in the form and before the white concrete has taken initial set. The grey and white concrete shall be thoroughly bonded but the methods of placing and manipulating shall be such that the grey concrete is not forced or worked through the white concrete facing. The method of consolidation shall be such as to produce a dense concrete throughout, having a minimum of air bubbles and honey-combing. Use of the Vacuum Process for dehydration of the concrete will not be permitted. The reinforcement shall not vary from the position shown on the Plans by more than  $\frac{1}{2}$ " and the means employed for placing the reinforcement shall be subject to the approval of the Engineer. Curb shall not be manufactured in an atmospheric temperature of less than  $40^{\circ}$  Fahrenheit.

**Removal of Forms.** The curb shall be removed from the molds or forms in accordance with the instructions issued pertaining thereto by the Engineer, or by some other method acceptable to the Engineer. Failure to remove the curb from the molds in accordance with the instructions pertaining thereto issued by the Engineer, or removal by any method which, in the opinion of the Engineer, is detrimental to the curb will be cause for rejection of the curb. The loosening of the curb from the molds shall be carefully performed to avoid excessive shock and straining of the curb. When, in the opinion of the Engineer, undue shock is required to remove the curb from the molds the stripping operation shall be deferred until such time as the curb may be removed without breakage.

**Dimensions and Shape.** The curb shall be manufactured according to the dimensions and shape shown on Plans within the following tolerance limits:

<b>Dimension</b>	<b>Tolerance</b>
Curb Ends .....	1/8" out of square
Top Surface Alignment and Contour .....	1/64" per foot of length
Height of Reflecting Faces	1/32"
Draft of Reflecting Faces	One degree
Alignment of Bottom Sur- face at Front Edge ....	1/8"
Anchor Groove .....	Width and depth not less than, nor more than 1/8" greater than shown on Plans. Angle of sides shall not vary by more than 5° from that shown on Plans.

All other dimensions .... 1/8" in not more than 10 per cent of the pieces, and 1/16" in at least 90 per cent of the pieces produced.

**Curb Lengths.** The curb shall be made and laid in pieces not less than 6 feet nor greater than 9 feet in length, except in special instances where shorter lengths are required. However, no curb piece less than 4 feet in length shall be laid without the approval of the Engineer. Circular curbing shall be made only for such radii as called for

on detail Plans. For radii from 100 feet to 450 feet the curb shall be in straight pieces with beveled ends as shown on Plans the length of which shall vary between 4 and 8 feet, as required. For any radius larger than 450 feet the curb pieces shall be straight and the ends shall be square.

*Curb Finish.* The curb shall be white and shall have a smooth, glassy finish on all exposed surfaces. The top corners of all reflecting faces shall be sharp within a tolerance limit of  $1/32$  inch radius. Excess honey-combing in the back of the curb may be cause for rejection of the curb. Honey-combed areas in the back of the curb which, in the opinion of the Engineer, are not detrimental to the curb need not be patched. The workmanship of the bottom finish shall be such that no mechanical interlocking of the mortar bed and the curb bottom or anchor groove will occur, and the finish shall be at least equivalent to the approved sample. The bottom surface shall not vary in straightness by more than  $1/4$ ".

*Defective Curb.* Not more than 2 per cent of the top area in any one piece of curb shall be defective and not more than 5 per cent of the total length of the top corners of reflecting faces in any one piece of curb shall be broken or rounded. There shall be not more than 30 air holes in any lineal foot of curb nor more than 50 in any 3 lineal feet of curb. All curb having defects in excess of any of the above will be rejected immediately upon inspection after removal from the forms. However, failure to reject the curb at this time will not assure it final acceptance. 90% of the curb laid shall not have more than 10% of the maximum allowable number of defects specified above. An air hole shall be defined as any hole  $1/8$  inch or larger in diameter or depth. All defects within the limits herein permitted, apparent upon removal of forms, shall be repaired immediately thereafter. The sum of the lengths of the lines of discoloration caused by a cracked mold in any one piece of curb shall not exceed 50 per cent of the length of the curb, and the maximum length of any single line of discoloration shall not exceed 18 inches. 75 per cent of the curb laid shall be entirely free from lines of discoloration. The employment of means involving the use of heat to obliterate lines of discoloration will not be permitted. Any means utilized to obliterate lines of discoloration shall be subject to the approval of the Engineer. The repairing of molds which are chipped or broken shall be done in such a manner that the broken or chipped areas will not be

apparent on the curb made in these molds. Molds in which more than 2 per cent of the surfaces which form the reflecting surfaces of the curb are broken or defective in any way shall be discarded. All curb in which surface checking is apparent prior to 5 days from date of manufacture shall be rejected. Hidden air holes at or immediately below the exposed surface of the curb, in excess of the limits specified herein, which are disclosed by testing the surface by means of a rubber hammer will be cause for rejection of the curb. All curb in which cracking is in evidence immediately after removal from the molds will be rejected. A crack is defined as any separation of the concrete of a continuous length greater than 3 inches. All curb which varies in dimensions, alignment or surface contour in excess of the tolerance specified herein will be rejected. Not more than 1 square inch of grey concrete shall be apparent in any one location in the exposed surface of the curb and the total area of the grey concrete showing through shall not exceed 4 square inches for any piece of curb. Not more than 16 square inches of the exposed surface of any piece of curb shall be discolored by reason of the grey concrete mixing with the white concrete. At least 75 per cent of the curb pieces laid shall be entirely free from discoloration. Failure to comply with the Plans, Specifications or instructions of the authorized representatives of the Department in the manufacture and laying of any curb will be cause for rejection of such curb.

*Repairing Curb.* Curb having defects which are not sufficient cause for its rejection shall be neatly repaired immediately after removal from the molds, in a manner subject to the approval of the Engineer. However, no patching or other repairs shall be made without the permission of the inspector. Patches shall be undercut if, in the opinion of the inspector, this operation is necessary to cause the patch to remain. All holes larger than 1/16 inch diameter in the exposed surfaces of acceptable curb shall be filled with white cement-sand mortar.

*Curing Concrete.* The curb shall be kept covered and wet continuously in an atmospheric temperature of not less than 40 degrees Fahrenheit for a period of not less than 48 hours, in a manner to be approved by the Engineer, and the curb shall not be subjected to an atmospheric temperature of less than 40 degrees prior to five days from the date of manufacture. Methods of curing shall be used which will not stain nor discolor the curb.

*Identification Marks.* The date of manufacture shall be stencilled in black paint on the back of each piece of curb. Rejected curb shall be marked at a specific point on the back or end surfaces by a chisel cut and by numerals painted in red lead paint corresponding to the cause of the rejection.

*Samples.* A standard specimen of curb is on file with the Department in Trenton. The Contractor shall submit, for the approval of the Engineer, an advance sample of curb which shall be at least equivalent in whiteness, surface texture, and bottom finish to the standard specimen. No repairing of any kind shall be done to the advance sample. Upon approval, the advance sample shall be stored at the plant or site of manufacture in a location readily accessible to the inspector where there is adequate daylight for examination. The advance sample shall be protected from damage and discoloration, and shall be used as a standard of comparison for whiteness, surface texture, and bottom finish for all curb manufactured. All curb furnished for this contract shall be at least equivalent thereto in the foregoing respects.

*Inspection.* The Department's Inspector or Representatives shall be free at any time to make any inspection necessary for the complete fulfillment of the requirements herein set forth. The manufacturer shall provide telephone facilities in the plant for the use of the Department's Inspector, but the manufacturer shall not be required to pay for toll calls made by employees of the Department.

*Shipment.* No curb shall be shipped prior to seven days after manufacture without written consent of the Engineer.

*Installation.* The curb shall be firmly bedded for its entire length and breadth on a mortar bed composed of 1 part standard portland cement and 2 parts of concrete sand. The anchor grooves in the bottom of the curb shall be entirely filled with the mortar. If wedges are used to temporarily support the curb pieces on the mortar bed while adjusting the curb to line and grade the wedges must be removed as soon as the mortar bed will support the curb without settlement. The alignment and the top surface of adjoining sections of curb shall be true and even within a maximum tolerance of 1/16 inch. The curb shall be laid with open joints varying in width from a minimum of 1/2 inch to a maximum of 1 inch which shall be free and clear of all mortar and other materials at the

time of acceptance of the contract. In no instance shall any curb piece be laid across a joint in the pavement slab unless approval to lay it in that manner is received from the Engineer. Before the cement mortar bed is laid all dirt shall be cleaned from the pavement surface by washing. All old pavements, and any portion of new pavements constructed under this contract, which are covered with oil or grease within the curb limits shall be further cleaned as follows: (1) The concrete shall be flushed with water. (2) While the concrete is still wet, sodium metasilicate, complying with the requirements as specified elsewhere herein, shall be evenly distributed over the pavement surface at the rate of 1 to 2 pounds per 100 square feet of pavement surface. (3) The metasilicate shall remain on the pavement for at least 15 minutes. Where patches of oil, tar or grease occur, these areas shall be scrubbed with a brush or broom until clean. (4) The pavement surface shall then be thoroughly rinsed.

*Final Inspection.* At the completion of the contract the curb shall be inspected for line and grade and for any defects which may have developed since being manufactured. Curb which is broken in excess of the maximum limits specified herein shall be removed and replaced. Defects within these limits shall be repaired in a manner to be approved by the Engineer. Any curb piece in which a crack extends entirely through the Section shall be replaced. 95% of the curb pieces shall be entirely free from cracks. The remaining 5% of the curb may have one or more transverse hair cracks provided the total length of the crack or cracks per piece of curb does not exceed 20". All curb shall be entirely free from diagonal corner cracks of any description. At the completion of the work the curb shall be clean and white. If in the opinion of the Engineer the curb required cleaning before acceptance this shall be done in a manner to be approved by him.

#### 5.6.4. Quantity and Payment.

The quantity of White Concrete Curb, for which payment will be made, will be the length of curb actually constructed in accordance with the Plans or as directed by the Engineer, measured on the front face of single curb and on the center line of double curb, except that for precast reflecting curb nosings, the quantity will be the number of nosings actually constructed as above provided.

Payment for White Concrete Curb, except curb nosings, will be made for the quantity as above determined of each type of curb, measured in lineal feet, at the prices per lineal foot bid for the various items of WHITE CONCRETE CURB, respectively, in the Proposal, which prices shall include the cost of excavation and backfill, construction of cast-in-place curb complete, furnishing and placing precast curb complete, reinforcement steel, mortar bed, concrete foundation and backing for precast vertical curb, cleaning of pavement, curb expansion joints, expansion joints adjacent to curb, joint filler, sample pieces, telephone service, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for precast Reflecting Curb Nosings will be made for the quantity above determined at the price for each bid for the item CURB NOSINGS in the Proposal, which price shall include the cost of all the items of material and work applicable stated above under White Concrete Curb.

When curbs are constructed monolithic with the pavement, payment for curb as above provided shall include only the part of the structure within the limits of the curb proper. Payment for the monolithic pavement strip will be made as elsewhere provided.

When curbs are constructed or placed on new pavement built under this Contract, the underlying pavement will be paid for at the unit price bid for the pavement.

## SECTION 7

### Sidewalks

#### 5.7.1. Description.

**Sidewalks** shall include the preparing of subgrade for and the construction of sidewalks of the type specified in accordance with the Plans and Specifications, at the prescribed locations and to the prescribed lines, grades and dimensions.

#### 5.7.2. Materials.

**Concrete Materials.** Materials for concrete shall conform to the requirements therefor, specified in Arts. 4.1.2 (p. 137) and 3.13.2 (p. 120), and its preparation to those of Art. 4.1.3 (p. 142), except that the batching and mixing equipment may be of a size and type suitable for the work and subject to the approval of the Engineer. Transit

mixers may be used, subject to the provisions of Art. 4.1.3 (p. 144). Class C Concrete shall be used (p. 141).

**Gravel Base Material** shall be Road Gravel, Grade A, as specified in Art. 3.5.2 (p. 75).

**Bituminous Concrete Materials** shall be as specified for Repair Course, Art. 3.10.2 (p. 99).

**Penetration Macadam Materials** shall be as follows: Bituminous binder shall be Asphalt Cement, Grades NA-4, T-4, or OA-4, or Tar, Grades RT-11 or RT-12, conforming to the requirements therefor, specified in Art. 3.13.2 (p. 120). Aggregates shall be  $\frac{3}{4}$  and  $\frac{3}{8}$ -inch Size broken stone and Screenings B, conforming to the requirements therefor, specified in Art. 3.13.2 (p. 129).

### 5.7.3. Methods of Construction.

**Rollers.** Rollers shall be tandem rollers, weighing not less than  $3\frac{1}{2}$  and not more than 5 tons.

**Subgrade.** The subgrade shall be constructed smooth and even at the prescribed grade and shall be compacted by rolling.

**Gravel Base.** Gravel base shall be constructed as provided in Art. 3.5.3 (p. 76), except that compacting shall be done by tamping or with a roller, or in both manners, subject to the direction of the Engineer.

**Bituminous Concrete Surface.** Bituminous Concrete Surface shall be constructed as specified in Art. 3.10.3, except that the rolling shall be longitudinally only, that the average weight shall be not less than 100 pounds per square yard per inch of depth, and that the thickness shall be as shown on the Plans.

**Penetration Macadam Sidewalk.** Penetration Macadam Sidewalk shall conform to the requirements for Penetration Macadam Surface Course, Hot Application, specified in Art. 3.8.3 (p. 84), except as follows: The  $\frac{3}{4}$ -inch Size stone shall be spread on the previously prepared subgrade. The first application of bituminous binder shall be at the rate of 0.75 gallon per square yard of surface and the surface shall be covered with  $\frac{3}{8}$ -inch Size stone. The second application of bituminous binder shall be at the rate of from 0.25 to 0.35 gallon per square yard of surface, and the surface shall be covered with a  $\frac{1}{2}$ -inch thick layer of Screenings B. No third application is required. Roller shall be as specified above. Hand distributors approved by the Engineer may be used.

**Concrete Sidewalk.** After being placed, the concrete shall be tamped, screeded and finished to true grade and surface. The finish shall be with a wood float, followed by brushing with a wet soft-haired brush to a neat and workmanlike surface. Expansion joints,  $\frac{1}{2}$  inch wide, shall be provided at intervals of 20 feet and filled with sand. Surface grooves shall be cut at right angles to the line of the sidewalk at intervals equal to its width. Exposed edges shall be neatly rounded to a radius of  $\frac{1}{2}$  inch. The concrete shall be cured as provided in Art. 4.1.3 (p. 153).

**General.** The sidewalks shall be constructed after the construction of adjacent curb, if any. Bituminous sidewalks shall be constructed before adjacent sidewalk areas have been seeded.

#### 5.7.4. Quantity and Payment.

The quantity of sidewalk for which payment will be made will be the area actually covered with sidewalk (including base course, if any) in accordance with the Plans or as directed by the Engineer.

Payment for Bituminous Concrete Surface on the prescribed Base, Penetration Macadam Sidewalk and Concrete Sidewalk will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the items BITUMINOUS CONCRETE SIDEWALK, PENETRATION MACADAM SIDEWALK, and CONCRETE SIDEWALK, respectively, in the Proposal, which prices shall include the cost of the sidewalk complete (including base course, if any), subgrade, backfill, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto, except excavation for which payment will be made under the item Roadway Excavation or elsewhere.

## SECTION 8

### Corrugated Island Pavement

#### 5.8.1. Description.

**Corrugated Island Pavement** shall include the construction of dark colored surface corrugated concrete pavements for center islands, placed on existing concrete pavements in accordance with the Plans and Specifications at the prescribed locations and to the prescribed lines, grades and dimensions.

### 5.8.2. Materials.

**Concrete and Mortar** materials, and the preparation of concrete, shall conform to the requirements therefor of Arts. 4.1.2 (p. 137) and 3.13.2 (p. 120); and 4.1.3 (p. 142), respectively, except that the batching and mixing equipment may be of a size and type, suitable for the work to be done and subject to the approval of the Engineer. **Class C** concrete (p. 141), with  $\frac{3}{4}$ -inch Size coarse aggregate shall be used. Transit mixers may be used, subject to the provisions of Art. 4.1.3 (p. 144).

**Carbon Black** shall be made by burning natural gas so as to form a deposit of carbon, shall contain not more than 1 per cent of ash, shall be free from lamp, mineral and bone black, silica, asbestine, talc and other fillers.

**Black Mortar** shall be 1:2 cement-sand mortar containing  $\frac{1}{2}$  pound of carbon black per bag of cement. The carbon black shall be added directly to the cement during the grinding of the cement. Briquets made of the black mortar shall have a 7-days tensile strength of not less than 95 per cent of that of similar briquets made without the carbon black.

**Cellular Compression Material** shall conform to the requirements therefor, specified in Art. 3.11.2 (p. 106).

### 5.8.3. Methods of Construction.

Before placing the concrete, the pavement on which the island pavement is to be placed shall be cleaned by sweeping off all loose material and dirt, and shall be coated with lubricating oil to prevent bond. The concrete course shall then be placed and struck off at the proper level, and immediately thereafter and before initial set the black mortar course shall be placed. The surface of the mortar shall be shaped as shown on the Plans, and the methods, equipment and tools used therefor shall be subject to the approval of the Engineer before being used. The crests of the corrugations shall be sharp, not rounded.

Transverse joints,  $\frac{1}{2}$  inch wide, shall be provided at the joints, center and quarter points of underlying concrete pavement slabs and 20 feet apart where the island pavement is on earth, and they shall be filled with cellular compression material. Open joints,  $\frac{1}{2}$  inch wide, shall be provided adjacent to the island curb and butt joints may be provided longitudinally at the center of the island. The pavement shall be cured with felt and fabric covering as specified in Art. 3.11.3 (p. 114). Any defects in the pavement constructed shall be repaired as may be approved

by the Engineer and positive means, satisfactory to the Engineer, shall be used to prevent damage to and discoloration of the adjacent curb while placing and curing the island pavement.

#### 5.8.4. Quantity and Payment.

The quantity of Corrugated Island Pavement for which payment will be made, will be the area actually constructed in accordance with the Plans or as directed by the Engineer, measured between the back faces of the island curbs.

Payment for Corrugated Island Pavement will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item CORRUGATED ISLAND PAVEMENT in the Proposal, which price shall include the construction of the pavement complete, joints, cleaning and lubricating the underlying pavement, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 9

### Rubble Walls

#### 5.9.1. Description.

**Rubble Walls** shall include the excavation for and the construction of rubble walls in accordance with the Plans and Specifications at the specified locations and to the prescribed lines, grades and dimensions, and other incidental work.

#### 5.9.2. Materials.

**Rubble Stones.** Rubble stones shall be hard, durable and tough trap rock, granite, gneiss or other approved stone with fairly uniform fine grain, sound, free from weathered or decomposed pieces, shattered ends, structural defects, marked lamination, seams or cracks and shall be acceptable to the Engineer. The face stones shall be not less than 8 inches thick. The width shall be not less than 1.5 times the thickness, and the length not more than 3 times the thickness and not less than 1.5 times the width.

**Mortar.** Mortar materials shall conform to the requirements of Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120).

#### 5.9.3. Methods of Construction.

Excavation and backfill shall conform to the requirements of Art. 2.6.3 (p. 49). Rock encountered in excava-

tion shall be leveled to provide a horizontal bearing. Excavations shall be approved before the construction of the wall is started. Selected stones, rough squared and cut to the required pitch, shall be used at angles and ends of walls. The largest stones shall be used for the bottom courses of the wall and the size shall gradually decrease toward the top. The stones shall be laid so as to break joints and bond together, with their bedding planes and lines of stratification horizontal. Not less than 25 per cent of the face area shall be headers uniformly distributed. The face stones shall have exposed faces parallel with face of wall. The finished wall shall be substantially built and have a neat and workmanlike appearance. Drainage openings shall be provided where required.

**Dry Rubble Walls** shall have face joints of not more than 2 inches in width and other joints shall be not more than 4 inches in width. Spaces between stones shall be filled with spalls, neatly fitted into place, except that no spalls shall be used in the face. The two top courses shall be laid in 1:2 cement-sand mortar. Sufficient mortar shall be used to fill all voids and firmly embed the stones.

**For Mortar Rubble Walls** all the stones shall be laid in a bed of mortar. The face joints shall be not more than 1 inch wide. The backing stones shall be of same depth as face stone and firmly embedded in mortar. Spaces between stones shall be filled with mortar and packed with spalls. All voids shall be filled with mortar. The face joints shall be raked and pointed.

#### 5.9.4. Quantity and Payment.

The quantity of Rubble Walls for which payment will be made will be the volume of wall constructed as above described in accordance with Plans or as directed by the Engineer.

Payment for rubble walls will be made for the quantity of each type, as above determined, measured in cubic yards, at the prices per cubic yard bid for the items DRY RUBBLE WALLS and MORTAR RUBBLE WALLS, respectively, in the Proposal, which prices shall include the cost of excavation, trimming of rock surface, backfill, furnishing and placing stone and mortar, drainage openings, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 10

## Concrete Crib Walls

## 5.10.1. Description.

**Concrete Crib Walls** shall include the excavation for and construction of walls of precast reinforced concrete crib members, placed as headers and stretches to form a cribbing of the required dimensions, and of stone fill placed within and behind the cribbing, in accordance with the Plans and Specifications, at the required locations and to the prescribed lines, grades and dimensions, and other incidental work. The design of crib wall and crib members shown on the Plans, or other designs complying with the requirements herein specified and acceptable to the Engineer, may be used, and the Contractor shall submit detail drawings of the crib members as well as assembly drawings for the Engineer's approval.

## 5.10.2. Materials.

Concrete materials and reinforcement steel shall conform to the requirements therefor, specified in Art. 4.1.2. Class A concrete shall be used, and the coarse aggregate may be 50 per cent  $\frac{3}{4}$ -inch and 50 per cent  $\frac{3}{8}$ -inch Size gravel.

Stones shall be one-man stones of good, non-weathering quality and subject to the approval of the Engineer.

## 5.10.3. Methods of Construction.

**Crib Members.** The reinforcement steel shall be of not less than  $\frac{3}{8}$ -inch diameter and shall be arranged symmetrically about the principal axis of the member. The cross section area of the reinforcement steel shall be not less than 1 per cent of that of crib members for headers and not less than 0.9 per cent for stretchers. The volume of concrete header and stretcher members shall be not less than 16 per cent of the gross volume of the finished wall.

**Wall.** Sill pieces not less than 20 inches in total width shall be laid at the front and back at starting course. Cap stretchers weighing not less than 50 pounds per lineal foot shall be used at the top of the front of the wall. The front face of the finished wall shall have not more than 50 per cent openings. The total height of a course of headers and stretchers shall be not more than 12 inches.

Stretchers shall be formed and arranged so as to retain backfill adequately. Exposed edges of crib members shall be beveled. The Contractor shall excavate as much as may be necessary to prepare a proper foundation for the wall and shall set it on a bed of bank-run gravel or other approved material to provide an even bearing. Crib members shall be free from cracks, spalls and depressions. Damaged members shall not be used and shall be replaced at the Contractor's expense. The finished face shall be neat and workmanlike. The maker of the cribbing shall furnish a superintendent to supervise and instruct the Contractor in the placing of the cribbing.

**Stone-fill.** Stone-fill shall be placed by hand inside and for a width of 2 feet behind the cribbing to within 2 feet of the top of the walls. The stones shall be laid in courses, and the spaces between the stones shall be chinked, and each course shall be covered with a thin layer of cinders, bank-run gravel or other approved material. The stone fill shall be placed to the full height of cribbing placed as the construction of the wall proceeds. The embankment fill behind the stone fill shall be placed as the wall is being built up.

#### 5.10.4. Quantity and Payment.

Except as hereinafter provided, the quantity of Concrete Cribbing for which payment will be made will be the volume of the concrete crib members in the finished wall placed in accordance with Plans or as directed by the Engineer.

The quantity of Stone Fill for which payment will be made will be of the volume of stone fill placed in accordance with the Plans or as directed by the Engineer.

Payment for Concrete Cribbing will be made for the quantity as above determined, measured in cubic feet, at the price per cubic foot bid for the item CONCRETE CRIBBING in the Proposal, which price shall include the cost of excavation, bedding, furnishing and placing crib members, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto; provided, however, that if a design other than that shown on the Plans is approved and used, and said design involves the use of a greater volume of concrete than that for the design shown, payment will be made only for the volume of concrete re-

quired for the construction of the cribbing of the design shown on the Plans.

Payment for Stone Fill as above described will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item **STONE FILL FOR CRIB WALL** in the Proposal, which price shall include the furnishing and placing stone fill as above described, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 11

### Headwalls and Culverts

#### 5.11.1. Description.

**Headwalls and Culverts** include excavation for and the construction of concrete headwalls, concrete culverts less than 5 feet in span, and other incidental work, all in accordance with the Plans and Specifications at the required locations and to the prescribed lines, grades and dimensions.

#### 5.11.2. Materials.

Concrete materials and reinforcement steel shall conform to the requirements of Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120), and the preparation of concrete to those of Art. 4.1.3 (p. 142), except that the batching and mixing equipment may be of a size and type suitable for the work to be done and subject to the approval of the Engineer. Transit mixers may be used subject to the provisions of Art. 4.1.3 (p. 144).

#### 5.11.3. Methods of Construction.

Excavation shall conform to the requirements of Art. 2.7.3 (p. 52), and the methods of construction, finish and curing to those of Art. 4.1.3 (p. 142).

#### 5.11.4. Quantity and Payment.

The quantity of Headwalls and Culverts less than 5 feet in span for which payment will be made will be the volume of concrete actually placed in accordance with the Plans or as directed by the Engineer.

Payment for headwalls and culverts less than 5 feet in span will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid

for the item HEADWALLS and CULVERTS in the Proposal, which price shall include the cost of excavation, shoring, pumping, backfill, construction complete, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 12

### New Monuments

#### 5.12.1. Description.

**New Monuments** shall include the placing complete of new concrete monuments with metal markers in accordance with the Plans and Specifications at the locations specified. The monuments will be furnished to the Contractor at the site of the Project, unless otherwise specified.

#### 5.12.2. Materials.

When furnished by the Contractor, the concrete shall be Class A (p. 141), and the materials therefor shall be as specified in Arts. 4.1.2 (p. 137), and 3.13.2 (p. 120). Bronze and copper markers shall be of materials approved by the Engineer.

#### 5.12.3. Methods of Construction.

Monuments furnished by the Contractor shall be pre-cast or cast in place as may be specified, and the concrete shall be placed, finished and cured as specified in Art. 4.1.3 (p. 142). Excavation and backfill shall conform to the requirements of Art. 2.7.3 (p. 52). When in place, the top surface of the monument shall be horizontal, and the metal marker shall be exactly in the true position.

#### 5.12.4. Quantity and Payment.

The quantity of monuments for which payment will be made will be the actual number of monuments set in accordance with the Plans or as directed by the Engineer.

Payment for monuments will be made for the quantity as above determined at the unit price bid for the item MONUMENTS in the Proposal, which price shall include the furnishing when specified, excavation, backfill, placing of monuments, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

**SECTION 13****Guard Fence****5.13.1. Description.**

**Guard Fence** shall include the construction of wire rope guard fence consisting of wood posts and 3 wire ropes supported on flexible offset brackets and other incidental work, all in accordance with the Plans and Specifications, at the required locations, and to the prescribed lines and grades.

**5.13.2. Materials.**

**Timber.** Timber for posts and struts shall be 1200#C dense longleaf or dense shortleaf southern pine, square edge, no heartwood requirements, saw finished. The timber will be inspected for grading at the treating plant prior to treatment in accordance with the requirements of Section 25 of the Standard Specifications for Highway Bridges of the American Association of State Highway Officials.

**Timber Preservatives.** The preservative shall be Zinc Chloride, Sodium Fluoride-Arsenate Dinitrophenol solution (Wolman Salts), Chromated Zinc Chloride, Zinc Meta Arsenite or Acid Cupric Chromate Mixture. The first four shall conform to the requirements specified in Arts. 4.26.4, 4.26.5, 4.26.6 and 4.26.7, respectively, of the Standard Specifications for Highway Bridges, 1941, of the American Association of State Highway Officials. Acid Cupric Chromate Mixture shall contain by weight from 45 to 47 per cent Sodium Dichromate ( $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$ ), 45 to 47 per cent Copper Sulphate ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ), and from 7 to 8 per cent 80% Acetic Acid dissolved in water in sufficient quantity to produce a liquid of the required density.

**Timber Treatment.** The net retention in any charge shall be not less than 90 per cent of the quantity hereafter specified but the average retention by the material treated for this Project and for any five consecutive charges shall be not less than 100 per cent of the quantity specified. The minimum amount of preservative (dry salt) retained per cubic foot of timber shall be 1 pound for Zinc Chloride; 0.75 pound for Chromated Zinc Chloride and Acid Cupric Chromate Mixture; and 0.35 pound for Wolman Salts and Zinc Meta-Arsenite.

The timber shall be treated according to current Standard Specifications for Preservative Treatment by Pressure Process of the American Wood Preservers Association.

Method of treatment with Acid Cupric Chromate Mixture shall be the same as that required for treatment with Zinc Chloride.

**Wire Rope.** Wire rope shall conform to the requirements of Specification M-30-38,  $\frac{3}{4}$ -inch, Class A Rope, of the American Association of State Highway Officials.

**Fittings.** Fitting shall conform to the requirements of Specification M-30-38 of the American Association of State Highway Officials. Offset brackets shall be of spring steel, tempered and drawn, and shall conform to the design shown on the Plans. When subjected to a load of 15000 pounds as hereafter described, the deflection of the bracket shall be not less than  $\frac{3}{4}$ -inch and not more than  $1\frac{1}{2}$  inches. This loading held for 1 minute shall produce a permanent set of not more than  $\frac{3}{8}$  inch, measured from front to back. The load shall be applied in accordance with the standard method of the Laboratory.

Splices and turnbuckle connectors, when in assembly, shall have a minimum tensile breaking strength of 25000 pounds, when tested by the standard method of the Laboratory, and the types used shall be subject to the approval of the Engineer. All parts that need to be turned for assembly shall be provided with parallel flats to standard wrench dimensions. Not more than 1 splice will be permitted in a length of 300 feet of guard fence.

**Concrete.** Concrete materials shall conform to the requirements of Art. 4.1.2 (p. 137), and 3.13.2 (p. 120), and the preparation of concrete to those of Art. 4.1.3 (p. 142), except that the batching and mixing equipment may be of a size and type suitable for the work to be done and subject to the approval of the Engineer. Transit mixers may be used, subject to the provisions of Art. 4.1.3 (p. 144), Class D concrete (p. 141), shall be used.

**Paint.** Paint materials shall conform to the requirements therefor, specified in Art. 4.2.2 (p. 158).

**Pure White Lead Paint.** The dry pigment for pure white lead paint shall be pure basic carbonate of lead of the formula  $2\text{PbCO}_3\cdot\text{Pb}(\text{OH})_2$ , containing not less than 65 and not more than 75 per cent of lead carbonate and not more than 2 per cent of total impurities including moisture. Not more than 2 per cent shall be retained on a No. 325 sieve, and all shall pass a No. 200 sieve.

The paste shall be dry pigment ground in oil and shall consist of Pigment, min. 90%, max. 92%; Linseed Oil, min. 8%, max. 10%; Moisture and other volatile matter,

max. 0.7%; Coarse particles and skins (total residue retained on a No. 325 sieve, based on pigment); max. 0.2%.

The weight in pounds per gallon of the ready mixed paint shall be: Pigment, min. 11.25 max. 12; Raw linseed oil, min. 5.5, max. 6.0; Turpentine, min. 0.10, max. 0.15; Drier, min. 0.22, max. 0.27. The ready mixed paint shall weigh not less than 17.5 and not more than 18 pounds per gallon.

**Titanium-Magnesium and Leaded Zinc Paint, White.** The dry pigment shall be a combination of titanium-magnesium, leaded zinc and magnesium silicate. The titanium-magnesium shall comply with the requirements therefor of Serial Designation D442-37T and subsequent revisions of the American Society for Testing Materials. The leaded zinc pigment shall contain from 33 to 37 per cent lead as  $PbSO_4$ , the remainder being zinc oxide, and shall be manufactured by the co-fume process. The magnesium silicate pigment shall be of the fibrous type and shall contain not more than 5 per cent of carbonates. All of the above pigments shall be ground so that they will all pass a No. 200 sieve, and not more than 2 per cent will be retained on a No. 325 sieve. The proportions by weight shall be as follows:

Titanium-magnesium pigment, % ..	min. 36	max. 40
Leaded zinc pigment, % .....	" 43	" 47
Magnesium silicate pigment, % ...	" —	" 18

The vehicle shall be free from resin and shall consist of the following by weight:

Linseed oil, raw, % .....	min. 80	max. 62
Linseed oil, heat bodied Q to S, %	" 6	" 9
Turpentine and drier, % .....	" —	" 10
Iodine number of fatty acids (Wijs or Hanus) .....	" 175	" —

The ready mixed paint shall be prepared by properly grinding the pigments with the linseed oil and mixing with the turpentine and drier, and shall comply with the following requirements by weight:

Pigment, % .....	min. 58.0	max. 62.0
Vehicle (containing not less than 90% linseed oil), % ..	" 37.0	" 42.0
Water, % .....	" —	" 0.5
Coarse particles and skins retained on No. 325 sieve, based on pigment, % .....	" —	" 1.5
Weight, pounds per gallon ..	" 13.7	" —

**Tar Paint.** Tar paint shall be made from refined coal tar or water gas tar and a tar distillate, shall be free from water and petroleum distillates, and shall conform to the following requirements:

Viscosity, 25°C., first 50 cc. (Engler), sec. ....	min. 100	max. 400
Solubility in CS <sub>2</sub> , % .....	" 82	" 96
Distillation, oil up to 170°C., %	" 5	" 20
" " " " 235°C., %	" 15	" 35
" " " " 270°C., %	" 25	" 41
" " " " 300°C., %	" 30	" 46
Melting point of distillation residue (B&R), % .....	" 55	" 75

### 5.13.3. Methods of Construction.

The posts shall be set vertical and parallel to the adjacent pavement. On curves having a radius of less than 1200 feet, the posts shall be set in concrete as shown on the Plans. The backfill shall be thoroughly tamped, so that the posts are held in the required position. The top of the posts shall then be cut off to the required grade and bevel, and the holes shall be bored for the bolts. Struts shall be attached securely with 60d galvanized spikes and the holes for the spikes shall be drilled to a slightly smaller size. Ends of struts and notches in posts shall be painted as hereinafter specified before assembly. The lower end of struts shall be securely supported before concrete is placed. The offset brackets shall be set at right angles to the grade of the fence. The wire rope shall be cut and assembled to end fittings to such a length as to provide a length at each end of not less than 6 inches for future take-up. The tension in each wire rope shall be such that the weight of a man, weighing approximately 160 pounds, applied midway between two posts, will cause a deflection of the wire rope of approximately 3½ inches. Intermediate anchorages as shown on the drawings shall be provided at intervals of not more than 500 feet, when the distance between end posts is more than 800 feet.

The portion of the posts from the ground line to 1 foot thereabove shall be painted with 2 coats of tar paint. The remainder of the railing timber above the ground surface shall be painted 3 coats of white paint. To facilitate penetration, the paint for the first white paint coat may be thinned with not more than ½ pint of turpentine per gallon of ready mixed paint. Each coat shall be thoroughly dry

before the next is applied. Two coats shall be applied and shall be dry under each bracket before the cable brackets are attached.

#### 5.13.4. Quantity and Payment.

The quantity of Wire Rope Fence (exclusive of anchor posts), for which payment will be made, will be the length or lengths of fence, measured from back to back of end posts of each continuous length of fence, actually constructed in accordance with the Plans or as directed by the Engineer. In addition payment will be made for the number of end and intermediate anchor posts actually placed in accordance with the Plans or as directed by the Engineer.

Payment for Wire Rope Fence (exclusive of anchor posts) will be made for the quantity as above determined, measured in lineal feet, at the price per lineal foot bid for the item WIRE ROPE FENCE in the Proposal, and payment for Anchor Posts will be made for the number as above determined at the price for each bid for the item ANCHOR POSTS in the Proposal which prices shall include the cost of the fence and its appurtenances complete in place, preservative treatment, painting, excavation in earth and rock, concrete, backfill, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## SECTION 14

### Pipe Railing

#### 5.14.1. Description.

Pipe railing shall include the construction of wrought iron pipe railing and other incidental work, all in accordance with the Plans and Specifications at the required locations and to the prescribed lines, grades and dimensions.

#### 5.14.2. Materials.

Wrought iron pipe and fittings shall conform to the requirements therefor, specified in Art. 5.2.2 (p. 190). Steel anchor bolts shall be subject to the approval of the Engineer. Cement and Sand shall conform to the requirements therefor, specified in Arts. 4.1.2 (p. 137) and 3.13.2 (p. 132), respectively.

### 5.14.3. Methods of Construction.

The posts shall be anchored into supporting masonry and grouted in place. The grout shall consist of 1 part of cement and 2 parts of sand. The posts shall be screwed into the fittings, and the rails shall be screwed into the end fittings and slide through intermediate fittings. Threads shall be coated with white lead before assembly. The finished railing shall be straight and true to line. Exposed threads and places, where the galvanizing has been damaged, shall be painted with aluminum paint, as specified in Art. 5.15.2 (p. 226).

### 5.14.4. Quantity and Payment.

The quantity of pipe railing for which payment will be made will be the actual length constructed in accordance with the Plans or as directed by the Engineer. The length measured for payment will be the overall length of railing or, if the railing is constructed in more than one section, the sum of the overall lengths of all the sections of railing.

Payment for Pipe Railing will be made for the quantity as above determined, measured in lineal feet, at the price per lineal foot bid for the item PIPE RAILING in the Proposal, which price shall include the cost of furnishing and placing the railing and anchorage, drilling holes in the masonry for the anchorage, all labor, equipment, materials and all else necessary therefor, and all other work in connection therewith or incidental thereto.

## SECTION 15

### Pipe Conduits

#### 5.15.1. Description.

**Pipe conduits** shall include the excavation for and construction of pipe conduits in accordance with the Plans and Specifications at the required locations and to the prescribed grades, lines and dimensions, and other incidental work.

#### 5.15.2. Materials.

**Aluminum Paint** shall conform to the requirements of Specification M-69-38 of the American Association of State Highway Officials.

**Electric conduit pipe and couplings** shall be wrought iron pipe, conforming to the requirements of Art. 5.2.2 (p. 190), except as hereinafter provided or, when so speci-

fied, Standard Weight galvanized steel pipe may be used, conforming to the requirements of the National Electric Code and of the local electric lighting company. For steel pipe, fittings not made of steel, shall be of malleable iron, as specified in Art. 4.2.2 (p. 158), or other approved or specified metal. Unless otherwise specified, steel pipe shall be threaded and furnished with couplings, and shall be galvanized either by the hot dip method or by other methods approved by the Engineer. The thread shall be tapered so that the pipe lengths will practically butt in the couplings, and the ends of the pipe shall be rounded smoothly on the inside so as to remove all burrs. The inside of the pipe shall be smooth, and bends shall be made in such a manner that the true cross section of the pipe is maintained. The radius of the bend shall be not less than 9 times the diameter of the pipe.

Water pipe shall be wrought iron pipe, conforming to the requirements therefor specified in Art. 5.2.2 (p. 190).

#### 5.15.3. Methods of Construction.

Excavation and backfill shall conform to the requirements of Art. 2.7.3 (p. 52). Where constructed under roadways water pipe shall be not less than 3, and electric conduit pipe not less than 1 foot below subgrade unless otherwise indicated. Joints shall be made watertight in a workmanlike and approved manner. Ends of pipes shall be threaded and capped and if below the surface, their location shall be permanently marked as directed by the Engineer. Fish wires shall be placed in all electric conduits. All electric conduit work shall conform to the requirements of the National Electric Code.

#### 5.15.4. Quantity and Payment.

The quantity of each type and size of Pipe Conduits for which payment will be made, will be the actual length placed in accordance with the Plans or as directed by the Engineer.

Payment for Pipe Conduits, of the types and sizes designated, will be made for the quantity of each type and size as above determined, measured in lineal feet, at the prices per lineal foot bid for the items PIPE CONDUIT, of the type or size indicated in the Proposal, which prices shall include the cost of excavation (except rock), laying of pipe, backfill, marking location of pipe, all materials, labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

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**SPECIFICATIONS  
FOR  
BITUMINOUS CONCRETE AND SHEET  
ASPHALT PAVEMENTS  
GENERAL REQUIREMENTS**

**1. Description**

**1.0—Scope.**

These specifications shall cover the general requirements that are applicable to all types of bituminous concrete pavements irrespective of gradation of mineral aggregate, kind and amount of bituminous material or pavement use. Deviations from these general requirements will be indicated in the specific requirements for each type.

**1.1—Description.**

All pavement surfaces covered in these specifications shall be designated as "bituminous concrete" irrespective of type.

The bituminous concrete pavement shall consist of one or more courses of bituminous concrete, constructed on the prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in conformity with the lines, grades, thickness, and typical cross-section shown on the plans.

The bituminous concrete shall be composed basically of a mixture of "coarse mineral aggregate" and/or "fine mineral aggregate", "mineral filler", and "bituminous material".

**1.2—General Composition of Mixtures.**

The several mineral constituents for the bituminous concrete shall be so sized and graded and shall be combined in such proportions that the resulting composite blend when combined with the bitumen or tar will meet the requirements of the specific type under contract for grading and percent of bitumen or tar as required.

**1.3—Formula for Job Mix.**

The general composition limits prescribed in the specifications for each specific type are extreme ranges of tolerance that must not be exceeded regardless of any formula that may be set up.

The laboratory shall establish a job-mix formula for each mixture to be supplied for the project, to which the contractor shall conform within the tolerances specified in Article 1.4. The job-mix formula shall be in effect until modified by the laboratory. The job-mix formula for each mixture shall establish a single definite percentage of mineral aggregate to be weighed from each bin, a single definite percentage of asphalt or tar to be added to the aggregate and percentage or amount of any other ingredient that may be required, and a single definite temperature at which the mixture is to be laid on the project (all within the ranges of the specifications of the specific type under contract).

**1.4—Application of Job-Mix Formula and Allowable Tolerances.**

After the job-mix formula is established as prescribed above, all mixtures furnished for the project shall conform thereto within the following ranges of tolerances:

Coarse Aggregate—Bottom Course (total ret. on No. 10 Sieve).....	plus or minus 5.0%
Coarse Aggregate—Top Course (total ret. on No. 10 Sieve).....	plus or minus 4.0%
Passing No. 200 Sieve for Type S.A. Top Course .....	plus or minus 2.0%
Passing No. 200 Sieve for all other types .....	plus or minus 1.5%
Bitumen Content for Type S.A. Top Course .....	plus or minus 0.5%
Bitumen Content for all other types except Type T.....	plus or minus 0.3%
Tar Content of Types T-1 & 2, and T S.W.-1 & 2 .....	plus or minus 0.3%
Temperature of the bituminous material .....	plus or minus 15°F.
Temperature of the mineral aggregate.....	plus or minus 20°F.
Temperature of bituminous concrete when leaving plant .....	plus or minus 15°F.

Each day the engineer shall take as many samples as he considers necessary, for checking the uniformity of the mixture.

Should a change in sources of materials be made, a new job-mix formula shall be established before the mixture containing the new materials is produced.

### 1.5—Basis of Acceptance.

The acceptability of the bituminous concrete pavement shall be determined by the quality of the materials, mixing, spreading, and compacting meeting the limits prescribed in these specifications and by inspection and tests of the finished pavement to determine whether it conforms to these specifications as to design and freedom from defects.

## 2. Materials

### 2.0—Approved Materials.

Approval of the coarse and fine mineral aggregate, mineral filler, hydrated lime, bituminous materials, liquefiers and any other materials that are used in the mix shall be obtained before production of bituminous concrete at any bituminous mixing plant.

### 2.1—Mineral Filler.

Mineral filler shall be limestone dolomite fly ash or other inert mineral matter from sources approved by the engineer, free from lumps and foreign materials, and be of a quality and fineness hereinafter specified.

Limestone and dolomite shall conform to the quality requirements as prescribed in the Standard Specifications for Road and Bridge Construction for 1941, Article 3.13.2. Ninety-five (95) percent shall pass a No. 100 Sieve and eighty-five (85) percent through a No. 200 Sieve.

Fly ash shall be the residue from the combustion of pulverized coal that is removed from the flue gas by electrical or mechanical means. It shall contain not more than 15% of carbon and not more than 2.5% of sulphuric anhydride ( $\text{SO}_3$ ). It shall all pass a No. 100 Sieve and 85% a No. 200 Sieve.

### 2.2—Hydrated Lime.

Hydrated lime shall conform to the requirements prescribed in the Standard Specifications for Normal Finishing Hydrated Lime A.S.T.M. Designation C 6-46T. The amount of hydrated lime for each batch may be measured by volume on the basis of a volume-weight relation.

### 2.3—Coarse Mineral Aggregate.

Coarse mineral aggregate (total ret. on the No. 10 Sieve) shall be broken stone prepared from trap rock, gneiss, limestone or dolomite, conforming to the quality requirements as prescribed in the Standard Specifications for Road and Bridge Construction for 1941, Article 3.13.2. It shall be so graded to meet the gradation requirements under composition of mixture for the specific type under contract.

Only one kind of broken stone shall be used in any one contract, unless approved by the engineer.

For all practical purposes, the following sizes of coarse aggregate complying with the requirements given therefor in Table 10 of Article 3.13.2, Materials, of the Standard Specifications for Road and Bridge Construction for 1941, are used in these types of surfaces.

Bottom Course	Mix No. 1	Use 1" size
CA-BC-1, Top	Mix No. 2	Use combination of 1" & ½" sizes
MA-BC-1, Top	Mix No. 3	Use ½" size
FA-BC-1, Top	Mix No. 4	Use ¾" size
SP-1, Top	Mix No. 5	Use ¼" size

### 2.4—Fine Mineral Aggregate.

Fine mineral aggregate may be either a natural bank sand or a crushed broken stone complying with the requirements given in Article 2.3 as to quality or may be a combination thereof, each of which must be free from lumps of clay, loam, organic matter or other foreign matter and shall conform to the following grading when tested by means of laboratory sieves:

Passing	Retained on	Percent	
		Min.	Max.
No. 4 Sieve	No. 10 Sieve	—	5.0
" 10 "	" 30 "	6.0	30.0
" 30 "	" 50 "	15.0	42.0
" 50 "	" 80 "	20.0	40.0
" 80 "	" 200 "	12.0	35.0
" 200 "		—	5.0

**2.5—Liquefier**

The liquefier shall be a petroleum distillate, free from insoluble matter, lubricating oil, wax and water, shall have no acid or corrosive action, and shall conform to the following requirements:

Initial boiling point, deg. F.....	194-255
End point, deg. F.....	max. 400
50% distillate over at, deg. F.....	" 293
75% distillate over at, deg. F.....	" 320
95% distillate over at, deg. F.....	" 374
Residue, per cent.....	3-5
Gravity, (Be), 60° F., deg.....	50-62

**2.6—Bituminous Material.**

All bituminous materials shall comply with the specifications for the material designated for use in the specifications for the specific type of pavement under contract.

Only those materials which have been demonstrated by service tests as satisfactory for the specific type of mixture specified will be acceptable under this specification. Unless otherwise required by the special provisions, the contractor may elect to furnish any kind of bituminous material covered by the specifications, but the penetration grade shall be designated by the engineer, or shown on the Plans or specified in the Supplementary Specifications.

Only one kind and grade of bituminous material shall be used in any one contract unless the contract indicates the use of more than one penetration grade or kind for a specific type of mixture.

**(a)—Asphalt Cement.**

Asphalt Cements may be prepared by the distillation of asphaltic petroleum or by the fluxing of hard native Trinidad asphalt with a suitable petroleum flux, shall be homogeneous, free from water, tar and tar products, and shall not foam when heated to a temperature of 347° F. No mineral matter other than that naturally contained in the asphalt shall be present. Either petroleum or fluxed native asphalt may be used, unless otherwise specified. It shall comply with the penetration grade and type selected by the engineer or as specified in the Supplementary Specifications or on the Plans for each individual contract. The various penetration grades and types shall conform to the following requirements:

Penetration Grade Type (1)	40-50		50-60		60-70	
	OA-1	T-1	OA-2	T-2	OA-3	T-3
Specific Gravity, 77°F./77°F. (2)	1.00+	1.21-1.26		1.195-1.245		1.185-1.235
Flash Point, deg. F., not less than	428	347	419	347	410	347
Softening Point, °F. (2)		122-140		118-136		114-133
Loss on Heating, not more than, %	1.0	1.0	1.0	1.0	1.0	1.0
Penetration on Residue from Loss on Heating, Compared to Penetration before Heating, not less than, %	80	75	80	75	80	75
Ductility, 5 cm. per min., cm. (3)	100	100	100	100	100	100
Total Bitumen, Soluble in 100% Benzol, %	99.5+	68-74	99.5+	69-76	99.5+	71-78
Proportion of Bitumen Soluble in Carbon Tetrachloride, min., %	99	99	99	99	99	99
Inorganic Matter or Ash, %	—1.0	21-28	—1.0	20-27	—1.0	18-25

Penetration Grade Type (1)	70-85		85-100		100-120	
	OA-3a	T-3a	OA-4	T-4	OA-5	T-5
Specific Gravity, 77°F./77°F. (2)		1.17-1.22		1.16-1.21		1.145-1.195
Flash Point, deg. F., not less than	392	347	374	347	347	347
Softening Point, °F. (2)		111-129		108-126		104-122
Loss on Heating, not more than, %	1.0	1.0	1.0	1.0	1.0	1.0
Penetration on Residue from Loss on Heating, Compared to Penetration before Heating, not less than, %	75	75	75	75	75	75
Ductility, 5 cm. per min., cm. (3)	100	100	100	100	100	100
Total Bitumen, Soluble in 100% Benzol, %	99.5+	72-79	99.5+	73-80	99.5+	75-82
Proportion of Bitumen Soluble in Carbon Tetrachloride, min., %	99	99	99	99	99	99
Inorganic Matter or Ash, %	—1.0	17-24	—1.0	16-23	—1.0	15-22

- (1) The types designated as "OA" are prepared by the distillation of asphaltic petroleum and those designated as "T" are prepared by the fluxing of hard, native Trinidad asphalt with a suitable petroleum flux.
- (2) The material furnished under this specification for a given contract, type and grade shall be uniform in character and samples from deliveries shall not vary more than  $\pm 5^{\circ}\text{C}$ . in softening point within the limits specified in Table 2 nor more than  $\pm 0.010$  in specific gravity from the results of tests on a representative sample taken by the Department's representative prior to being used.
- (3) When the asphalt cement furnished under the "T" Types fails to comply with the ductility requirement, the test shall be made on the extracted bitumen containing not more than 5% of ash. The ductility on all "OA" Types shall be determined at 50 penetration. For Penetration Grades 40-50, 50-60 and 60-70, there shall be added to or subtracted from the actual ductility secured 1 cm. for each point in penetration above or below 50. All other grades under Type "OA" shall be reduced to 50 penetration in accordance with A.S.T.M. Serial Designation D 243-36, "Tests for Residue of Specified Penetration", and the ductility made on this residue. The penetration on this residue shall be not more than 60 nor less than 40 and the same correction made when the penetration is not exactly 50 as described above.

## (b)—Tars

Tars furnished under these specifications shall be produced from suitable gas-house, cokeoven and/or water gas tars. They shall comply with the type selected by the engineer or as specified on the Plans or in the Supplementary Specifications for each individual contract.

The grade or grades of tar specified shall comply with the requirements given therefor in the table below:

Grades	RT-9	RT-10	RT-11	RT-12
Float Test at 32° C. (89.6° F.) seconds	120-200			
Float Test at 50° C. (122° F.) seconds		75-100	100-150	150-220
Specific Gravity, 25° C./25° C. (77° F./77° F.), min.	1.14	1.15	1.16	1.16
Total Bitumen, % by weight, min.	78	75	75	75
Water, % by volume	0.0	0.0	0.0	0.0
Distillation, % by weight				
To 170° C. max.	1.0	1.0	1.0	1.0
To 270° C. max.	15.0	10.0	10.0	10.0
To 300° C. max.	25.0	20.0	20.0	20.0
Softening Point of Distillation Residue, °C.	40-70	40-70	40-70	40-70

## 2.7—Tack Coat Materials.

Where a tack coat is specified either an asphaltic oil or emulsified asphalt may be used, unless otherwise specified or directed by the engineer, and shall conform with the following requirements:

1. **Asphaltic Oil** — The asphaltic oil shall be a liquid petroleum product produced by fluxing an asphaltic base with a suitable light volatile solvent, free from water and tar or tar products, and shall show no separation or curdling prior to use and shall conform to the following requirements:

Grade	RC-O
Viscosity, Saybolt Furol, seconds	75-150
Ductility at 50 penetration, 77° F., 100 gms., 5 secs., 5 cm. per minute — cm.	80+
Distillation	
Distillate, % by volume of total distillate to 680° F.	
To 320° F.	20+
To 374° F.	55+
To 437° F.	75+
To 500° F.	85+
To 600° F.	90+
Residue from distillation to 680° F., % volume by difference	45+
Tests on residue from distillation	
Penetration, 77° F., 100 gms., 5 secs.	80-120
Percent soluble in CCl <sub>4</sub>	99.5+

2. **Emulsified Asphalt** — The emulsified asphalt shall be made from petroleum asphalt cement, suitable emulsifier and water. It shall be homogeneous and show no separation of asphalt after thorough mixing, be of proper consistency for application, and shall conform to the following requirements:

Residue by distillation, %	45-55
Settlement, 5 days	3
Demulsibility, 50 ml. of 0.10N CaCl <sub>2</sub>	5-30
Screen test, %	0.1—
Tests on residue from distillation	
Penetration, 77° F., 100 gms., 5 secs.	75-150
Solubility in CS <sub>2</sub> , %	95.0+
Ductility, 77° F., 5 cm. per min., cm.	40.0+
Ash, %	2.0—

### 2.8—Pavement Samples.

When and as directed by the engineer the contractor shall cut samples from the completed work. The areas of pavement so removed shall be replaced with new mixtures and refinished. No additional compensation will be allowed for furnishing test samples and replacing the areas with new pavement.

## 3. Equipment

### 3.0—General Requirements.

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 subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools, machinery and plant used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units including at least:

- Bituminous paving plant.
- Bituminous concrete paver.
- Rollers.

Also sufficient vehicles for transporting bituminous mixtures, small tools and all other equipment, etc., essential or required to complete the construction as indicated or directed; also necessary equipment for conditioning the previous layer or base.

### 3.1—Bituminous Plant and Equipment.

Paving plants used in the preparation of bituminous paving mixtures shall be of sufficient capacity, so designed and coordinated to adequately handle the proposed bituminous concrete mixtures within the specified job mix tolerances as fixed by the contract. The plant shall be maintained in good mechanical condition, and any defect which affects the proper functioning of the plant or plant units, or which adversely affects the quality of the mixture in any manner, shall be corrected immediately upon instruction from the engineer.

The plant site shall have adequate storage facilities. Sufficient storage space shall be provided for separate stock piles, bins or stalls for each size of aggregate, and the different aggregate sizes shall be kept separated until they have been delivered, without segregation, by the feeder or feeders to the boot of the cold elevator or elevators in the proper proportions. The storage yard shall be maintained neat and orderly and the separate stock piles shall be readily accessible for sampling.

All plants used by the contractor for the preparation of bituminous concrete mixtures shall conform to the following requirements:

1. Scales. All mixing plant scales shall be certified to and sealed by a duly constituted Weights & Measures Officer prior to the delivery of the material. These scales shall be accurate to within the tolerances permitted by the State Weights & Measures Department.

2. Equipment for Preparation of Bitumen. Tanks for storage of bitumen shall be equipped for heating the material, under effective and positive control at all times, to the temperature requirements set forth in the specifications for the paving mixture. Heating shall be accomplished by steam coils, electrically, or other means so that no flame shall come in contact with the heating tank. A circulating system for the bitumen shall be provided, of adequate size to ensure the proper and continuous circulation between storage tank and bitumen bucket during the entire operating period. Other systems of conveying the bitumen to the bitumen bucket may be used when approved by the engineer.

All pipe lines and fittings shall be steam-jacketed or otherwise properly insulated to prevent heat loss. Storage tank capacity shall be sufficient for at least one day's run. When fluxed native bitumens are used, means shall be provided for adequate agitation to maintain a uniform product.

3. Feeder for Drier. The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregates into the drier so that a uniform production and a uniform temperature may be secured, unless otherwise specified.

4. Drier. A drier of any satisfactory design for drying and heating the mineral aggregate shall be provided. The drier shall be capable of drying and heating the mineral aggregate to the temperature requirements set forth in the specifications for the paving mixture.

If the drier is not equipped to heat, dry and cool the aggregate in one operation for "cold" mixes, the plant shall have sufficient storage bins equipped with cooling devices to accomplish the specific result.

5. Screens. Plant screens, capable of screening all aggregate to the sizes required for proportioning, and having normal capacities slightly in excess of the production capacity of the mixer, shall be provided, unless otherwise specified.

6. Bins. The plant shall include storage bins having sufficient capacity to ensure uniform and continuous operation. Bins shall be divided into at least three compartments arranged to ensure separate and adequate storage of appropriate fractions of the aggregate. Each compartment shall be so equipped as to prevent the overflow of its material into any other compartment. Adequate additional dry storage shall be provided for mineral filler, or hydrated lime when required, and provision made for proportioning them for each batch of mixture. Gates on the bins shall be so constructed as to prevent leakage when they are closed.

7. Mineral Aggregate Weigh Box or Hopper. The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper, suspended on scales, ample in size to hold a full batch without hand raking or running over. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be easily thrown out of alignment or adjustment. Gates on the weigh box shall be so constructed as to prevent leakage when they are closed.

8. Mineral Aggregate Scales. Scales for the mineral aggregate weigh box or hopper may be either of the beam or springless dial-type and shall be of a standard make and design. When a beam-type scale is used, provision shall be made for indicating to the operator that the required load in the weighing hopper is being approached; the device shall indicate at least the last 200 lb. of load. The scale shall also

be equipped with a tare beam or adjustable counter-balance for balancing the hopper. A minimum of ten 50-lb. standard test weights shall be available for checking accuracy.

9. Mixer Unit. The plant shall include a batch mixer of an approved twin pug-mill type and shall be capable of producing a uniform mixture within the permissible job-mix tolerances. It shall have a batch capacity of not less than one thousand (1,000) pounds. The mixing blades shall be so placed as to rotate the mixture around the mixer unit. The mixer shall be so constructed as to prevent leakage of contents.

When ordered by the engineer, the mixer shall have an accurate time lock to control the operation of a complete mixing cycle by locking the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle; it shall lock the bitumen bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the application of bitumen; the wet mixing period is the interval of time between the application of bitumen and the opening of the mixer gate. The control of the timing shall be flexible and capable of being set at intervals of not more than 5 sec. throughout cycles up to 3 min. A mechanical batch counter shall be installed as a part of the timing device and shall be so designed as to register only completely mixed batches.

10. Bitumen Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Suitable means shall be provided either by steam-jacketing or other insulation for maintaining the specified temperature of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

Where the quantity of bitumen is controlled by metering, provisions shall be made whereby the delivery of the meter may be readily checked by actual weight.

If a bucket is used for weighing the bitumen, it shall have sufficient capacity to hold the amount of bitumen required for one batch. It shall be steam-jacketed or equipped with properly insulated electric heating units. The scales may be either of the horizontal-beam or springless-dial type. They shall be accurate within 1 percent under operating conditions. When beam-type scales are used, provision shall be made for indicating to the operator that the required load in the bitumen bucket is being approached; the device shall

indicate at least the last 20 lb. of load. The beam-type scale shall be equipped with a tare beam or adequate counterbalance for balancing the bucket and compensating periodically for the accumulation of bitumen on the bucket. The bucket shall be so arranged that it will deliver the bitumen in a thin uniform sheet or in multiple streams at least three-quarters the length of the mixer, except in the case of a mixer where the bitumen is sprayed.

For mixtures requiring a liquefier to be added separately, adequate means for proportioning shall be provided.

11. Thermometric Equipment A thermometer of suitable range shall be fixed in the bitumen feed line at a suitable location near the discharge valve at the mixer unit.

The plant shall be further equipped with an approved dial-scale, mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregate.

The dial of the instrument shall be in full view of the drier fireman or aggregate feed operator. The engineer reserves the right to pass upon the efficiency of the thermometric instruments and for better regulation of temperature of aggregates may direct replacement of any instrument by some approved temperature recording apparatus and may further require that daily temperature charts be filed with him.

12. Dust Collectors. When plants are located in any vicinity where dust may be objectionable, or when dust interferes with the efficient operation of the plant, proper housings, mixer covers, or dust-collecting system shall be installed. Provision shall be made to waste the material so collected, unless it can be demonstrated that the collected material can be returned to the plant in a uniform and satisfactory manner.

13. Safety Requirements. Adequate and safe stairways to the mixer platform and guarded ladders to other plant units shall be placed at all points required for accessibility to all plant operations. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space, free of drippings from the mixing platform, to permit easy and safe inspection of the mixture as it is delivered into the trucks. A platform shall also be provided away from the plant to permit of further inspec-

tion and taking temperatures of the mixture before delivery. Easy and safe access shall be provided to the location above the mixer where samples of the aggregate in the bins can be procured. Adequate overhead protection shall be provided where necessary. In addition to the above, all other State or local safety requirements shall be adhered to.

14. Inspection of Asphalt Plant Operation. For checking the adequacy of the equipment in use, inspecting the conditions and operation of the plant for verification of weights, proportions and character of materials, and for the determination and checking of temperatures being maintained in the preparation or mixtures, the engineer or his authorized representative shall have access at all times to any part of the paving plant.

At each plant, as defined in these requirements, there shall be provided a field laboratory for use as an office and for testing purposes to be used by the engineer or his inspectors during construction. This laboratory may be a separate building or part thereof, not less than 10 ft. x 12 ft. x 7 ft. high, with a wooden floor, two windows, electric lighting and plugs for heating apparatus, workbench, table and chair. It shall also be waterproofed, heated in cold weather, furnished with telephone service, and so located that details of main plant operations are plainly visible from one window of the field laboratory.

### 3.2—Bituminous Concrete Pavers.

Bituminous concrete pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous concrete 8 feet to 12 feet wide and from  $\frac{3}{4}$  inch to 6 inches in depth true to the line, grade, and crown with or without the use of forms or side supports. The screed or screeds shall be adjustable to lay courses in widths of more than 8 feet in 6-inch increments or less.

The receiving hopper shall be of such size and capacity as to prevent any delay in emptying the trucks during spreading operations. The hoppers shall be equipped with distribution screws or paddles to evenly place the mixtures in front of the screed or screeds.

The paver shall have sufficient power and traction to operate efficiently on grades up to 8 per cent.

Pavers shall employ mechanical devices such as equalizing runners, straight-edge runners, evener arms or other com-

pensating devices to adjust the grade line so that minor changes in grade elevations will not be reflected immediately in the finished surface, and shall also confine the edges of the mixture to true lines.

The screed or strike-off assembly shall operate by cutting, crowding or other practical action which is effective on mixtures without tearing, shoving or gouging at the workable temperature specified, and which produces a finished surface without segregation and of the evenness and texture specified. The screed or screeds shall be adjustable as to level and shall have an indicating level attached thereto in full view of the operator.

The pavers shall be further equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips of bituminous concrete.

The pavers shall be capable of being operated, when laying mixtures, at forward speeds varying from 5 to 50 feet per minute consistent with the satisfactory laying of the mixtures, and shall be equipped with a quick and efficient steering device.

### 3.3—Vehicles for Bituminous Mixtures.

The mixture shall be transported from the mixing plant to the project in motor trucks equipped with tight, clean bodies which shall be lightly lubricated with a thin oil, soap or lime solution or dusted with hydrated lime, as directed by the engineer, to prevent the mixture from sticking to the bodies. Each truckload of mixture delivered shall be covered with a canvas tarpaulin or other approved material of such size and so fastened as to protect the mixture from the weather. When directed by the engineer, the trucks shall be suitably insulated to insure delivery of the mixture to the project within the temperature requirements, and be of a suitable condition for proper laying. Any truck causing excessive segregation of the mixture by its spring suspension or other contributing factors or that shows oil leaks of any magnitude or causes undue delays shall, upon direction of the engineer, be discharged from the work until such conditions are corrected.

### 3.4—Rollers.

Rollers shall be in good condition, capable of reversing without back lash and shall weigh not less than 200 pounds to the inch width of tread. The speed of the roller shall not exceed 3 miles per hour and shall at all times be slow enough

to avoid displacement of the bituminous concrete mixture. All roller wheels shall be mechanically and uniformly moistened with water by means of saturated mats or other methods approved by the engineer.

## 4. Construction Methods

### 4.0—Weather Limitations.

Bituminous concrete mixtures shall not be placed when the atmospheric temperature is below 40° F., when the weather is foggy or rainy, or when the conditions otherwise may be unfavorable in the opinion of the engineer. The temperature requirements may be waived, but only when approved by the engineer.

### 4.1—Conditioning of Existing Surface.

The surface of the base course upon which the bituminous concrete pavement is to be placed shall be clean, dry and free from frost when the paving operations are about to start and shall be maintained in that condition.

Newly constructed base courses shall be prepared as set forth in the specification item covering base course for the particular project under construction.

When the bituminous concrete is to be placed on an existing pavement which is to be used as a base it shall be conditioned prior to the placement of the surfacing material in accordance with the requirements set forth in the specification item for each particular project. When specified on the Plans or in the Supplementary Specifications the existing paved surface is to be used as a base upon which the bituminous concrete is to be placed, said base shall be given an application of tack coat material prior to placing the new surface, at the rate specified, unless otherwise directed by the engineer.

Contact surfaces of curbing, gutters, manholes and other structures shall be painted with a thin uniform coating of Asphaltic Oil Grade RC-2 or 3 for asphalt mixtures, and Tar Grade RTCB-5 or 6 for tar mixtures, just prior to the placing of the bituminous concrete mixture against them.

### 4.2—Retaining Forms.

When required, retaining forms of material and design satisfactory to the engineer shall be provided so far as considered necessary to prevent lateral displacement or squeezing out or side shoving under the roller.

#### 4.3—Preparation of Bituminous Material.

The bituminous material shall be heated in tanks conforming to the requirements of Article 3.1 (a) and so designed as to heat the entire contents uniformly to the temperature specified for the particular type under contract.

#### 4.4—Preparation of Mineral Aggregate.

The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid injury to the aggregate. The aggregates shall be heated to the temperature specified for the particular type under contract.

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.

#### 4.5—Preparation of Bituminous Concrete Mixture.

The size of the batch shall be determined by the engineer based on the manufacturer's capacity rating.

The dried mineral aggregate, prepared as prescribed above, shall be combined in the proportionate amounts of each fraction of aggregate required to meet the job-mix formula.

The engineer shall determine the proportions and sequence of introducing the materials into the mixer. The bituminous material shall be measured by weight or metered and introduced into the mixer in the proportionate amount determined by the engineer for the particular material being used. Prior to adding the 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 45 seconds, but longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are coated uniformly. The mineral filler, when used, shall be introduced in such a manner that it will be uniformly incorporated in the mass.

When the engineer finds that there is difficulty in obtaining the specified mixing time, he may require that the plant be equipped with positive means to govern the time of mixing and to maintain it constant.

The ingredients shall be heated and combined in such a manner as to produce a mixture which, when discharged,

shall be at the temperature specified by the engineer within the range for the type of mixture under contract.

The introduction of the materials into the mixer, and the mixing operation, shall be carried out as outlined above unless the mixing operation for the particular type of paving mixture that is being manufactured calls for some other method of procedure, in which case the mixing operation and that particular specification shall be followed.

#### 4.6—Transportation and Delivery of Mixtures.

The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Article 3.3. No loads shall be sent out so late in the day as to prevent completion of the spreading and compaction of the mixture during daylight, unless artificial light satisfactory to the engineer is provided.

#### 4.7—Spreading and Finishing.

The mixture shall be laid only upon a base or existing surface which is dry and when the weather conditions are otherwise suitable, as provided in Art. 4.0 of Construction Methods, General Requirements for Bituminous Concrete Pavement.

Upon arrival at the point of use, the mixture shall be spread and struck off to the profile grade, elevation and cross section intended. For this purpose bituminous concrete pavers conforming to the requirements of Article 3.2 shall be used to distribute the mixture either over the entire width or over such partial width lanes as may be practicable.

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

On areas where irregularities or unavoidable obstacles make the use of self-powered spreading and finishing equipment impracticable, in the judgment of the engineer, the mixture shall be spread and raked by hand. On such areas the mixture shall be dumped on steel dump boards and spread and raked to give the amount of material required.

The contractor shall provide suitable means for keeping all small tools clean and free from accumulation of bituminous material. He shall provide and have ready for use at all

times enough tarpaulins or covers, as may be directed by the engineer, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may be dumped and not spread.

No bituminous concrete material shall be placed against the transverse edge of a course or layer that has been rolled and/or 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 Cement for hot bituminous concrete mixtures and Tar for tar mixtures.

#### 4.8—Compaction.

After the spreading and strike off and while still hot, the course shall be compacted thoroughly and uniformly by rolling. However, unless otherwise ordered by the engineer, following the spreading of the top course of Type CA-BC-1, CA-BC-2, MA-BC-1 and MA-BC-2 by the finishing machine or paver, and before the initial rolling, there shall be uniformly applied to the surface course a fine aggregate seal coat complying with the requirements given therefor in Article 2.0, Bituminous Concrete Surface Course, Hot Mix, at the rate of approximately five (5) pounds per square yard of surface by means of an approved mechanical spreader or other means approved by the engineer. Only sufficient quantity shall be used to seal any voids or honeycombed areas in this surface, but not enough to build up any part of the surface which does not require additional material. The fine aggregate seal coat shall have a temperature of not less than 200° F. at the time of application and shall be free from lumps or balls.

At least two rollers shall be used for obtaining compaction. One shall be an 8 to 12 ton tandem roller and the other a 10 to 12 ton three-wheel roller. Initial rolling shall be done with a three-wheel roller. When the number of sq. yds. laid each day exceeds 2,000, the engineer reserves the right to order additional three-wheel rollers and/or tandem rollers for proper finishing and compaction.

Each roller shall be operated by 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 shall progress from the lower to the upper edge parallel with the center line of the road and uniformly lapping each preceding track, as directed by the engineer, until the entire surface has been

rolled by the rear wheels. If the width of the surface course permits, it shall be subjected to a diagonal rolling in two directions, the second diagonal rolling crossing the lines of the first. Rolling shall be continued until all roller marks are eliminated and the finished surface meets the requirements given in Article 4.10. 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 will not be permitted. Care shall be exercised in rolling not to disturb the line and grade elevation of edges of bituminous concrete.

Along forms, curbs, headers, and walls and at other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers. 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.

The surface of the pavement after compaction shall be smooth and true to the established crown and grade. Any pavement that becomes loose and broken or mixed with dirt, or is in any way defective, shall be removed and replaced with fresh hot mixture, which shall be immediately compacted to conform with the surrounding area. Any area showing an excess of bituminous material shall be removed and replaced.

#### 4.9—Joints.

Placing of a course shall be as nearly continuous as possible and the roller shall pass over an unprotected end or side of freshly laid mixture only when the laying of the course is to be discontinued long enough to permit the mixture to be chilled. In all such cases, including the formation of joints as hereinafter specified, provision shall be made for proper bond with the new surface for the full specified depth of the course. Joints shall be formed by cutting back on the previous run so as to expose a vertical face the full depth of the course. When the laying of the course is resumed, the exposed edge of the joint shall be painted with a thin coat of asphalt cement for asphalt mixtures and tar for tar mixtures. The fresh mixture shall be raked against the joint, thoroughly tamped with hot tampers, and rolled.

#### 4.10—Surface Requirements.

Before final acceptance, the finished course shall be tested by a crown template and a 10-foot straight edge 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  $3/16$  inch. The variation in the surface of bituminous concrete pavements when laid on existing bases shall at no point exceed  $3/16$  inch and when laid on newly constructed bases shall not exceed  $1/8$  inch between any two contact points with the surface for the 10-foot straight edge in both cases.

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. After final rolling but before acceptance of the work, the smoothness of the course shall be checked again and all humps or depressions exceeding the specified tolerances shall be corrected by removing defective work and replacing it with new material as specified. Portions of the surface otherwise unsatisfactory shall be replaced to the satisfaction of the engineer.

#### 4.11—Protection of Pavement.

Traffic will be permitted on newly finished surfaces only upon order of the engineer.

## 5. Compensation

#### 5.0—Method of Measurement.

Bituminous concrete pavement will be measured in tons of 2,000 pounds.

In computing the tonnage, proven truck weight shall govern. The tonnage shall be the actual weight and no deductions shall be made for the weight of liquefier or any other ingredients in the mixture.

The net weight of mixture delivered in each truckload shall be determined in the following manner:

Each truckload of bottom and/or top course delivered shall be weighed by a certified weighmaster on certified scales approved by the State Department of Weights and Measures. The weighmaster shall furnish to the truck driver duplicate weigh slips showing the gross, tare and net weight. To each weigh slip shall be affixed his signature and official seal or

approved commissioned stamp attesting that he is a duly constituted weighmaster. One of these delivery slips will be furnished to the Department's representative on the project. No material will be accepted unless accompanied by such a delivery slip.

The engineer shall deduct the weight of all material lost, wasted, damaged or rejected, or applied in excess of the engineers direction or contrary to these specifications.

#### **5.1—Basis of Payment.**

The quantity determined as provided above shall be paid for at the contract unit price per ton for bituminous concrete pavement of the types specified in the proposal, which price and payment will be full compensation for furnishing, hauling, and placing all materials, for the preparation of all materials, and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment for furnishing and applying tack coat will be made separately at the unit price per gallon at 60° F. bid therefore in the proposal.

## **BITUMINOUS CONCRETE SURFACE COURSE, HOT MIXED**

**(P.R.A. Class I)**

## **SHEET ASPHALT SURFACE COURSE**

**(P.R.A. Class J)**

### **1. Description**

#### **1.0—Description.**

Hot bituminous concrete and sheet asphalt courses shall include the construction of hot mixed bituminous concrete and sheet asphalt surface courses on previously constructed base courses at the prescribed locations, to the prescribed lines and grades and of the prescribed types.

Types CA-BC-1, MA-BC-1, FA-BC-1 and SP-1 are bituminous concrete laid in one course. Types CA-BC2, MA-BC-2, FA-BC-2 and SP-2 are bituminous concrete and Type S.A. is sheet asphalt, laid in two courses.

All provisions of "General Requirements for Bituminous Concrete Pavement," unless otherwise stipulated, shall form a part of these specifications.

The thickness indicated on the Plans or in the Supplementary Specifications shall be the final compacted thickness. In order to maintain the indicated thickness, the weight of mixture in place per square yard shall be adjusted to provide the thickness indicated. Unless otherwise specified on the Plans or in the Supplementary Specifications, the minimum weight per square yard for the thickness indicated shall be as given in the table below based on the number of square yards laid each day.

	Thickness	Minimum Weight
	(inches) Ave.	
CA-BC-1, FA-BC-1, MA-BC-1.....	2	220
CA-BC-2, FA-BC-2, MA-BC-2, Top.....	1½	165
CA-BC-2, FA-BC-2, MA-BC-2, Bottom.....	1½	155
S.A., Top .....	1½	150
S.A., Bottom .....	1½	155
SP-1, Top .....	2	210
SP-2, Top .....	1½	157
SP-2, Bottom .....	1½	155

The minimum weight for other thicknesses than those indicated above may be interpolated based on the weights and thicknesses given above.

The bituminous concrete for bottom course shall be composed of "coarse aggregate," "fine aggregate" and "bituminous material." The bituminous concrete for Types CA-BC-1, MA-BC-1, FA-BC-1 and SP-1 shall be composed of "coarse aggregate," "fine aggregate," "mineral filler" and "bituminous material." For Type S.A. Top Course it shall be composed of "fine aggregate," "mineral filler" and "bituminous material."

### 1.1—General Composition of Mixtures.

The several mineral constituents for each of the mixtures shall be combined in such proportions that the resulting composite blend will meet the grading requirements given in the table hereinbelow. In calculating the percentages of the various aggregate sizes the bituminous material is included.

At least two-thirds of the amount of mineral aggregate passing the No. 200 Sieve shall be mineral filler.

Total Aggregate Passing & Retained on Screen & Sieve Size		Percentage by Weight Mix No.					
Passing	Retained on	I	II	III	IV	V	VI
1½" Screen	1" Screen	0-35	0-25				
1" "	½" "	35-70	20-45	0-25	0-10		
½" "	¼" "	0-20	10-25	20-45	12-40	0-10	
¼" "	No. 10 Sieve	0-15	5-15	5-25	8-30	8-25	0-4
No. 10 Sieve	No. 30 "	0-10	2-14	2-14	2-17	3-20	4-25
No. 30 "	No. 50 "	2-8	5-18	5-18	4-24	8-30	10-35
No. 50 "	No. 80 "	2-8	4-18	4-18	6-22	10-28	12-33
No. 80 "	No. 200 "	2-12	3-16	3-16	3-20	6-25	8-28
No. 200 "		0-5	4-8	4-8	4-8	4-10	10-15
Total Retained on No. 10 Sieve		65-85	45-65	45-65	30-60	15-30	0-5
Bitumen Content (Solubility in Benzol)		4-5.5	5-7	5-8	5.5-9	8-11	9.5-12
To be used for pavement course		All Bottom Courses	CA-BC-1 CA-BC-2, Top	MA-BC-1 MA-BC-2, Top	FA-BC-1 FA-BC-2, Top	S.P.-1 S.P.-2, Top	S.A., Top

Note: All screens ¼" and above are round openings.

The job mix formula, its application, and allowable tolerances, shall conform to the requirements of Articles 1.3 and 1.4 of "General Requirements of Bituminous Concrete Pavement."

Unless otherwise indicated on the Plans or in the Supplementary Specifications, Types CA-BC-1, MA-BC-1 and FA-BC-1 shall be laid to a depth of 2 inches in thickness; CA-BC-2, MA-BC-2, FA-BC-2 and S.A. to a depth of 3 inches in thickness, consisting of 1½ inches of bottom course and 1½ inches of top course. Types S.P.-1 and S.P.-2 shall be laid to the depth indicated on the Plans or in the Supplementary Specifications.

## 2. Materials

### 2.0—Material Requirements.

All materials used in this construction, in addition to the requirements specified in Articles 2.0 to 2.8 inclusive of "General Requirements for Bituminous Concrete Pavement," shall conform to the following:

(a) Bituminous Material. The bituminous material shall consist of asphalt cement penetration grades 60-70, 70-85, 85-100, or 100-120 as specified on the Plans or in the Supplementary Specifications. If no grade is thus specified, the penetration grade to be used will be that directed by the engineer.

(b) **Fine Aggregate Seal Coat.** The fine aggregate seal coat shall be a combination of fine aggregate and asphalt cement of the grade and type used in the preparation of the surface course upon which it is to be used. It shall be prepared in the same plant and at the same temperature as required for the preparation of the surface course upon which it will be used. The proportioning of fine aggregate and asphalt cement shall be as designated by the engineer. However, the quantity of asphalt cement shall be between 1.5 and 3.0 per cent.

### 3. Equipment

#### 3.0—Equipment Requirements.

The equipment outfit used by the contractor shall be made up of suitable units conforming to the requirements specified in Articles 3.0 to 3.4 inclusive of "General Requirements for Bituminous Concrete Pavement."

### 4. Construction Methods

#### 4.0—Construction Details.

The scope of work and methods of construction shall be as prescribed in Articles 4.0 to 4.11 inclusive of "General Requirements for Bituminous Concrete Pavement," with the following modifications applicable to these types:

A fine aggregate seal coat complying with the requirements therefor and the method of application as defined in Article 4.8, Compaction, of the General Requirements for Bituminous Concrete Pavement, shall be applied to Types CA-BC-1, CA-BC-2, MA-BC-1 and MA-BC-2, unless otherwise specified.

The asphalt cement shall be brought to a temperature between 250° F. and 325° F while in tanks or kettles.

Mineral aggregates shall be heated to a temperature between 225° F. and 350° F. as determined on the mixing platform.

The mixture shall leave the plant at a temperature sufficient for workability under prevailing conditions. In no case, however, shall the temperature of the mixture exceed 325° F.

## 5. Compensation

### 5.0—Quantity and Payment.

The quantity of one and two-course hot mixed bituminous concrete surface course of the various types and of sheet asphalt surface course for which payment will be made will be the quantity actually constructed at the unit prices per ton bid respectively therefor in the proposal.

Payment for Hot Mixed Bituminous Concrete Surface Courses Types CA-BC-1, CA-BC-2, MA-BC-1 MA-BC-2, FA-BC-1, FA-BC-2, S.P.-1, S.P.-2 and S.A. will be made for the quantity as above determined, measured in tons at the prices per ton bid for items Pavement Type CA-BC-1, CA-BC-2, MA-BC-1, MA-BC-2, FA-BC-1, FA-BC-2, S.P.-1, S.P.-2 and S.A. respectively in the proposal, which prices shall include the cost of the bituminous concrete and sheet asphalt pavement complete, all materials, except Fine Aggregate Seal Coat, labor, equipment, and all else necessary therefore, and all other work in connection therewith and incidental thereto.

Payment for Fine Aggregate Seal Coat for application to Pavement types CA-BC-1, or CA-BC-2 and MA-BC-1 and MA-BC-2 will be made for the quantity measured in tons at the price per ton bid for item Fine Aggregate Seal Coat in the proposal, which price shall include the cost of furnishing and applying the Fine Aggregate Seal Coat complete, all labor, equipment, and all else necessary therefor, and all other work in connection therewith and incidental thereto.

## BITUMINOUS CONCRETE SURFACE COURSE, COLD MIXED

### TYPE A

### (P.R.A. Class H)

## 1. Description

### 1.0—Description.

Cold mixed bituminous concrete surface course shall include the construction of "cold" mixed bituminous concrete surface courses on previously constructed base courses at the prescribed locations, to the prescribed line, grades and dimensions, and of the prescribed types. Types A-1 and ASW-1

are bituminous concrete laid in one course. Types A-2 and ASW-2 are bituminous concrete laid in two courses.

All of the provisions of "General Requirements for Bituminous Concrete Pavement," unless otherwise stipulated herein, shall form a part of these specifications.

The thickness indicated on the Plans or in the Supplementary Specifications shall be the final compacted thickness. In order to maintain the indicated thickness, the weight of mixture in place per sq. yd. shall be adjusted to provide the thickness indicated. Unless otherwise specified on the Plans or in the Supplementary Specifications, the minimum weight per sq. yd. for the thickness indicated shall be as given in the table below based on the number of sq. yds. laid each day.

Type	Thickness (inches)	
	Ave.	Minimum Weight lbs. per sq. yd.
A-1, ASW-1 .....	1	100
A-1, ASW-1 .....	1½	150
A-2, ASW-2, Top .....	¾	75
A-2, ASW-2, Top .....	1	100
A-2, ASW-2, Bottom .....	1	103
A-2, ASW-2, Bottom .....	1½	155
A-2, ASW-2, Bottom .....	2	206

The minimum weight for other thicknesses than those indicated above may be interpolated based on the weights and thicknesses given above.

When Types A-2 or ASW-2 are specified, they shall be laid in the approximate proportions of two-thirds bottom course and one-third top course by weight required for the thickness indicated on the Plans or in the Supplementary Specifications based on the thicknesses and weights given above.

The bituminous concrete for both the bottom and the top courses shall be composed of "coarse aggregate," "fine aggregate," "bituminous material," "liquefier" and "hydrated lime."

### 1.1—General Composition of Mixtures.

The several mineral constituents for each of the mixtures shall be combined in such proportions that the resulting composite blend will meet the grading requirements given in the table hereinbelow. In calculating the percentages of the various aggregate sizes, the bituminous material is included and any liquefier or moisture content excluded.

Aggregates		Percentage by Weight		
Passing & Retained on Screen & Sieve Size		Mix No.		
Passing	Retained on	I	II	III
1 1/4" Screen	1" Screen	0.35		
1" "	1/2" "	35-70	0-7	
1/2" "	1/4" "	0-20	30-50	0-10
1/4" "	No. 10 Sieve	0-15	20-45	50-75
No. 10 Sieve	No. 30 "	0-10	5-20	5-18
No. 30 "	No. 80 "	1-4	2-8	2-8
No. 80 "	No. 200 "	1-5	1-6	2-8
No. 200 "		0-5	2-6	2-7
Total Retained on No. 10 Sieve		70-85	65-80	55-70
Liquefier		0.5-1.0	0.5-1.0	0.5-1.0
Hydrated Lime		0.5-1.5	0.5-1.5	0.5-1.0
Bitumen Content		4-6	3.3-7	6.5-8.5
To be used		Bottom Course	A-1	ASW-1
for		for all	A-2, Top	ASW-2, Top
pavement course		types		

Note: All screens 1/4" and above are round openings.

The job mix formula, its application, and allowable tolerances shall conform to the requirements of Articles 1.3 and 1.4 of "General Requirements for Bituminous Concrete Pavement."

## 2. Materials

### 2.0—Material Requirements.

All materials used in this construction, in addition to the requirements specified in Articles 2.0 to 2.8 inclusive of "General Requirements for Bituminous Concrete Pavement," shall conform to the following:

(a) Bituminous Material. The asphalt cement used shall consist of Asphalt Cement Penetration Grades 85-100, 100-120 and 120-150 as specified on the Plans or in the Supplementary specifications. If no grade is thus specified, the penetration grade to be used will be that directed by the engineer.

(b) Fine Aggregate. The fine aggregate used shall consist of dry stone sand of such grading that it will produce a mixture complying with the requirements given in Article 1.1, "General Composition of Mixtures," but shall contain no more than 20.0% of elutriable material passing the No. 200 Sieve.

(c) Aggregate for Top Dressing. The material for the top dressing shall consist of dry stone sand or screenings so graded that at least 95% will pass the No. 4 Sieve and not more than 40% shall pass the No. 50 Sieve.

### 3. Equipment

#### 3.0—Equipment Requirements.

The equipment outfit used by the contractor shall be made up of suitable units conforming to the requirements specified in Articles 3.0 to 3.4 inclusive of "General Requirements for Bituminous Concrete Pavement," with the following additions or exceptions:

No mechanical "Feeder for Drier" nor "Plant Screens" will be required if the plant is equipped with a satisfactory method of feeding and delivering the various aggregate to the drier and plant bins in the sizes required for proper proportioning to the satisfaction of the engineer.

### 4. Construction Methods

#### 4.0—Construction Details.

The scope of work and methods of construction shall be as prescribed in Articles 4.0 to 4.11 inclusive of "General Requirements for Bituminous Concrete Pavement," with the following modifications applicable to this type:

The asphalt cement shall be brought to a temperature between 250° F. and 325° F. while in the tanks or kettles. The liquefier and hydrated lime shall be at atmospheric temperatures when incorporated into the mixture.

Mineral aggregate shall be dried until it has no surface moisture and not more than 0.5% of contained moisture. Mixing temperatures of the aggregate shall at no time be less than 75° F. nor more than 140° F.

The mixture may be prepared by either of the two methods hereinafter described or by other methods subject to the approval of the engineer.

(a) The coarse and fine aggregates shall first be placed in the mixer and sufficient liquefier added thereto to thoroughly wet the aggregates. Asphalt cement shall then be added slowly to the aggregate and mixing continued until the aggregates are thoroughly coated. Hydrated lime shall then be added in such a manner that it is evenly distributed and not dumped at one end. More liquefier may then be added, if necessary, to obtain proper distribution of the asphalt cement and to produce proper workability of the mixture for laying. The mixing for each step in this preparation will vary in relation to the nature of the aggregates, the job mix and the size of the batch, but in no case shall the mixing time after the introduction of the asphalt cement be less than two minutes.

(b) The mixing shall be done as described above except that the fine aggregate is placed in the mixer after the asphalt cement and hydrated lime have been added. In this procedure, the mixing time after the introduction of the fine aggregate shall not be less than two minutes.

Rolling of both bottom and top courses shall be done only when the mixture has hardened sufficiently for proper stability. During favorable weather, the bottom course may be rolled when it will not adhere to the roller but the top course shall not be placed on a bottom course for a period of 12 hours after completing the rolling of the bottom course. The top course shall not be rolled for a period of at least 4 hours after it has been laid or otherwise directed by the engineer. Immediately after the rolling of the top course is completed, an application of top dressing aggregate complying with the requirements given in Article 2.0, "Material Requirements", shall be uniformly applied thereto at the rate of 5 to 8 lbs. per sq. yd., and then rolled without the use of any water. All places inaccessible to rollers shall be compacted with tampers.

## 5. Compensation

### 5.0—Quantity and Payment.

The quantity of one and two-course cold mixed bituminous concrete surface course of the various types for which payment will be made will be the quantity actually constructed at the unit prices per ton bid respectively therefor in the proposal.

Payment for Cold Mixed Bituminous Concrete Surface Course Types A-1, A-2, ASW-1 and ASW-2 will be made for the quantity as above determined measured in tons at the prices per ton bid for items Pavement Type A-1, A-2, ASW-1 and ASW-2 respectively in the proposal, which prices shall include the cost of bituminous concrete complete, all materials, labor, equipment, and all else necessary therefor and all other work in connection therewith and incidental thereto.

## BITUMINOUS CONCRETE SURFACE COURSE, COLD MIXED

### TYPE T

#### (P.R.A. Class H)

#### 1. Description

##### 1.0—Description.

Cold mixed bituminous concrete surface course shall include the construction of "cold" mixed bituminous concrete surface courses on previously constructed base courses at the prescribed locations, to the prescribed lines, grades and dimensions, and of the prescribed types. Types T-1 and TSW-1 are bituminous concrete laid in one course. Types T-2 and TSW-2 are bituminous concrete laid in two courses.

All of the provisions of "General Requirements for Bituminous Concrete Pavement", unless otherwise stipulated herein, shall form a part of these specifications.

The thickness indicated on the Plans or in the Supplementary Specifications shall be the final compacted thickness. In order to maintain the indicated thickness, the weight of mixture in place per sq. yd. shall be adjusted to provide the thickness indicated. Unless otherwise specified on the Plans or in the Supplementary Specifications, the minimum weight per sq. yd. for the thickness indicated shall be as given in the table below based on the number of sq. yds. laid each day.

	Thickness (inches) Ave.	Minimum Weight lbs. per sq. yd.
T-1, TSW-1 .....	1	100
T-1, TSW-1 .....	1½	150
T-2, TSW-2, Top .....	¾	75
T-2, TSW-2, Top .....	1	100
T-2, TSW-2, Bottom .....	1	103
T-2, TSW-2, Bottom .....	1½	155
T-2, TSW-2, Bottom .....	2	206

The minimum weight for other thicknesses than those indicated above may be interpolated based on the weights and thicknesses given above.

When Types T-2 or TSW-2 are specified, they shall be laid in the approximate proportions of two-thirds bottom course and one-third top course by weight required for the thickness indicated on the Plans or in the Supplementary Specifications based on the thicknesses and weights given above.

The bituminous concrete for both bottom and top course shall be composed of "coarse aggregate", "fine aggregate" and "bituminous material."

### 1.1—General Composition of Mixtures.

The several mineral constituents for each of the mixtures shall be combined in such proportions that the resulting composite blend will meet the grading requirements given in the table hereinbelow. In calculating the percentages of the various aggregate sizes, the bituminous material is included and any moisture content excluded.

Aggregates		Percentage by Weight		
Passing & Retained on Screen & Sieve Size		Mix No.		
Passing	Retained on	I	II	III
1 1/4" Screen	1" Screen	0-35		
1" "	1/2" "	35-70	0-7	
1/2" "	1/4" "	0-20	25-50	0-10
1/4" "	No. 10 Sieve	0-15	15-45	50-75
No. 10 Sieve	No. 30 "	0-10	10-25	5-18
No. 30 "	No. 80 "	1-4	3-12	2-8
No. 80 "	No. 200 "	1-5	1-6	2-8
No. 200 "		0-5	0-5	2-8
Total Retained on No. 10 Sieve		70-85	55-70	55-70
Tar Content		3.5-5	6.5-9.5	8-10
	To be used for Pavement Course	Bottom Course for all types	T-1, T-2, Top	TSW-1, TSW-2, Top

Note: All screens 1/4" and above are round openings.

The job mix formula, its application, and allowable tolerances shall conform to the requirements of Articles 1.3 and 1.4 of "General Requirements for Bituminous Concrete Pavement."

## 2. Materials

### 2.0—Material Requirements.

All materials used in this construction, in addition to the requirements specified in Articles 2.0 to 2.8 inclusive of "General Requirements for Bituminous Concrete Pavement," shall conform to the following:

(a) Bituminous Material. The bituminous material shall be Tar Grade RT-9, RT-10, RT-11, or RT-12, as specified on the Plans or in the Supplementary Specifications. If no grade is thus specified, the grade to be used will be that directed by the engineer.

(b) Fine Aggregate. The fine aggregate used shall con-

sist of dry stone sand of such grading that it will produce a mixture complying with the requirements given in Article 1.1, "General Composition of Mixtures," but shall contain no more than 20.0% of elutriable material passing the No. 200 Sieve.

(c) Aggregate for Top Dressing. The material for the top dressing shall consist of dry stone sand or screenings so graded that at least 95% will pass the No. 4 Sieve and not more than 40% shall pass the No. 50 Sieve.

### 3. Equipment

#### 3.0—Equipment Requirements.

The equipment outfit used by the contractor shall be made up of suitable units conforming to the requirements specified in Articles 3.0 to 3.4 inclusive of "General Requirements for Bituminous Concrete Pavement," with the following additions or exceptions:

No mechanical "Feeder for Drier" nor "Plant Screens" will be required if the plant is equipped with a satisfactory method of feeding and delivering the various aggregates to the drier and plant bins in the sizes required for proper proportioning to the satisfaction of the engineer.

### 4. Construction Methods

#### 4.0—Construction Details.

The scope of work and methods of construction shall be as prescribed in Articles 4.0 to 4.11 inclusive of "General Requirements for Bituminous Concrete Pavement," with the following modifications applicable to this type:

The tar shall be brought to a temperature between 150° F. and 250° F. while in the tanks or kettles.

The mineral aggregate shall be dried until it has no surface moisture and not more than 0.5% of contained moisture. Mixing temperatures of the aggregate shall at no time be less than 75° F. nor more than 150° F.

The mixture may be prepared by either of the two methods hereinafter described or by other methods subject to the approval of the engineer.

(a) The coarse and fine aggregates shall first be placed in the mixer and the tar shall then be added slowly to the aggregate and the mixing continued until all the particles of the aggregates are completely and uniformly coated with tar. In no case shall the mixing time, after the introduction of the tar, be less than one (1) minute.

(b) Mixing shall be done as above described except that the fine aggregate is placed in the mixer after the tar has been added to the coarse aggregate. In this procedure, the mixing time, after the introduction of the fine aggregate, shall not be less than one (1) minute.

Rolling of both the bottom and top courses shall be done in accordance with Article 4.8, "Compaction." Immediately after the rolling of the top course is completed, an application of top dressing aggregate complying with the requirements of Article 2.0, "Material Requirements," shall be uniformly applied thereto at the rate of 5 to 8 lbs. per sq. yd. and then rolled. All places inaccessible to rollers shall be compacted with tampers.

## 5. Compensation

### 5.0—Quantity and Payment.

The quantity of one and two-course cold mixed bituminous concrete surface course of the various types for which payment will be made will be the quantity actually constructed at the unit prices per ton bid respectively therefor in the proposal. Payment for Cold Mixed Bituminous Concrete Surface Course Types T-1, T-2, TSW-1 and TSW-2 will be made for the quantity as above determined measured in tons at the prices per ton bid for items Pavement Type T-1, T-2, TSW-1 and TSW-2 respectively in the proposal, which prices shall include the cost of bituminous concrete complete, all materials, labor, equipment, and all else necessary therefor and all other work in connection therewith and incidental thereto.

## BITUMINOUS CONCRETE SURFACE COURSE, PROPRIETARY AND PATENTED

### 1. Description

#### 1.0—Description.

The construction of Special, Proprietary and Patented Bituminous Concrete Pavements, other than those specified hereinbefore, may be permitted but only under the following conditions:

(a) The pavement shall be prepared and constructed in conformity with Articles 1.0 to 5.1, inclusive, of "General Requirements of Bituminous Concrete and Sheet Asphalt Pavements" as given hereinbefore, unless otherwise speci-

fied, and the specifications covering the pavement approved by the engineer.

(b) The pavement, if used, shall have been bid upon in competition with one of the types of pavement specified hereinbefore as designated in the Proposal.

(c) Specifications covering the pavement, its method of preparation and laying and all materials required shall be submitted to the Department and approved by the engineer before a Proposal is submitted.

(d) The weight per square yard of pavement for the thickness indicated shall be not less than that of the competing type.

(e) The contractor shall furnish a surety bond, in the full amount of his contract, for laying of the pavement, which bond shall run for a period of 5 years from date of completion and shall guarantee that at the end of the 5-year period the pavement shall be in good, serviceable condition. If, in the opinion of the engineer, after the 5-year period, the pavement is not in good, serviceable condition, it shall be replaced or repaired to the satisfaction of the engineer and all charges therefor paid for under the surety bond. However, if a pavement prepared and constructed under identical specifications approved by the engineer shall have given satisfactory service for a period of 5 years under traffic conditions similar to those to be reasonably expected on the pavement being bid upon, no bond other than that required for pavement laid in accordance with the Department's Standard Specifications shall be required.

## 2. Compensation

### 2.0—Quantity and Payment.

The quantity of one and two-course Special, Proprietary and Patented Bituminous Concrete Surface Course as above described, for which payment will be made will be the quantity actually constructed at the unit prices per ton bid respectively therefore in the Proposal.

Payment for Special, Proprietary and Patented Bituminous Concrete Surface Course of the type designated in the Proposal will be made for the quantity as above determined, measured in tons at the prices per ton bid for items Pavement Type Special, Proprietary and Patented Type designated in the Proposal, which prices shall include the cost of the bituminous concrete pavement complete, all materials, labor, equipment, and all else necessary therefor and all other work in connection therewith and incidental thereto.

**STATE OF NEW JERSEY**  
**HIGHWAY DEPARTMENT**  
**STANDARD SPECIFICATIONS**  
**FOR**  
**ROAD AND BRIDGE CONSTRUCTION**  
**1941**

**ADDENDA A**

**REVISION OF**  
**SECTION 9**  
**BITUMINOUS CONCRETE SURFACE COURSE,**  
**HOT MIXED**  
**(P.R.A. CLASS I)**  
**SHEET ASPHALT SURFACE COURSE**  
**(P.R.A. CLASS J)**  
**AND**  
**SECTION 10**  
**COLD MIXED BITUMINOUS CONCRETE**  
**SURFACE COURSE,**  
**TYPE A AND TYPE T**

**(APPROVED MAY 16, 1949)**

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