

ITEM 311 - PORTLAND CEMENT CONCRETE PAVEMENT

311.1 Description

This Item shall consist of a pavement of Portland Cement Concrete, with or without reinforcement, constructed on the prepared base in accordance with this Specification and in conformity with the lines, grades, thickness and typical cross-sections shown on the Plans.

311.2 Material Requirements

311.2.1 Portland Cement

It shall conform to the applicable requirements of Item 700, Hydraulic Cement. Only Type I Portland Cement shall be used unless otherwise provided for in the Special Provisions. Different brands or the same brands from different mills shall not be mixed nor shall they be used alternately unless the mix is approved by the Engineer.

Cement which for any reason, has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

Samples of cement shall be obtained in accordance with AASHTO T 1217.

311.2.2 Fine Aggregates

It shall consist of natural sand, stone screenings or other inert materials with similar characteristics, or combinations thereof, having hard, strong and durable particles approved by the Engineer. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of concrete without the approval of the Engineer.

It shall not contain more than three (3) mass percent of material passing the 0.075 mm (No. 200 sieve) by washing nor more than one (1) mass percent each of clay lumps or shale. The use of beach sand will not be allowed without the approval of the Engineer.

If the fine aggregate is subjected to five (5) cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 10 mass percent.

The fine aggregate shall be free from injurious amounts of organic impurities. If subjected to the colorimetric test for organic impurities and a color darker than the standard is produced, it shall be rejected. However, when tested for the effect of organic impurities of strength of mortar by AASHTO T 71, the fine aggregate may be used if the relative strength at 7 and 28 days is not less than 95 mass percent.

The fine aggregate shall be well-graded from coarse to fine and shall conform to Table 311.1.

Table 311.1 - Grading Requirements for Fine Aggregates

Sieve Designation	Mass Percent Passing
9.5 mm (3/8 in)	100
4.75 mm (No. 4)	95-100
1.18 mm (No. 16)	45-80
0.300 mm (No. 50)	5-30
0.150 mm (No. 100)	0-10

311.2.3 Coarse Aggregate

It shall consist of crushed stone, gravel, blast furnace slag, or other approved inert materials of similar characteristics, or combinations thereof, having hard, strong, durable pieces and free from any adherent coatings.

It shall contain not more than one (1) mass percent of material passing the 0.075 mm (No. 200) sieve, not more than 0.25 mass percent of clay lump, nor more than 3.5 mass percent of soft fragments.

If the coarse aggregate is subjected to five (5) cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 12 mass percent.

It shall have a mass percent of wear not exceeding 40 when tested by AASHTO T 96.

If slag is used, its density shall not be less than 1120 kg/m³ (70 lb/cu.ft.). The gradation of the coarse aggregate shall conform to Table 316.2.

Only one grading specification shall be used from any one source.

Table 311.2 - Grading Requirements for Coarse Aggregate

Sieve Designation		Mass Percent Passing		
Standard mm	Alternate U.S. Standard	Grading A	Grading B	Grading C
75.0	3 in.	100	-	-
63.0	2 1/2 in.	90-100	100	100
50.0	2 in.	-	90-100	95-100
37.5	1 1/2 in.	25-60	35-70	-
25.0	1 in.	-	0-15	35-70
19.0	3/4 in.	0-10	-	-
12.5	1/2 in.	0-5	0-5	10-30
4.75	No. 4	-	-	0-5

311.2.4 Water

Water used in mixing, curing or other designated applications shall be reasonably clean and free of oil, salt, acid, alkali, grass or other substances injurious to the finished product. Water will be tested in accordance with and shall meet the requirements of Item 714, Water. Water which is drinkable may be used without test. Where the source of water is shallow, the intake shall be so enclosed as to excluded silt, mud, grass or other foreign materials.

311.2.5 Reinforcing Steel

It shall conform to the requirements of Item 404, Reinforcing Steel. Dowel and tie bars shall conform to the requirements of AASHTO M 31 or M 42, except that rail steel shall not be used for tie bars that are to be bent and re-straightened during construction. Tie bars shall be deformed bars. Dowels shall be plain round bars. Before delivery to the Site, one-half of the length of each dowel shall be painted with one coat of approved lead or tar paint.

The sleeves of dowels shall be metal of approved design to cover 50 mm (2 inches), plus or minus 5 mm (1/4 inch) of the dowel, with a closed end, and with a suitable stop to hold the end of the sleeve at least 25 mm (1 inch) from the end of the dowel. Sleeves shall be of such design that they do not collapse during construction.

311.2.6 Joint Fillers

Poured joint fillers shall be mixed asphalt and mineral or rubber filler conforming to the applicable requirements of Item 705, Joint Materials.

Performed joint filler shall conform to the applicable requirements of Item 705. It shall be punched to admit the dowels where called for in the Plans. The filler for each joint shall be furnished in a single place for the full depth and width required for the joint.

311.2.7 Admixtures

Air-entraining admixtures shall conform to the requirements of AASHTO M 154.

Chemical admixtures, if specified or permitted, shall conform to the requirements of AASHTO M 194.

311.2.8 Curing Materials

Cotton mats, burlap cloth, water-proof paper, liquid membranes forming compounds, or sheeting (film) materials shall conform to the applicable requirements of Item 708, Concrete Curing Materials and Admixtures.

311.2.9 Calcium Chloride

It shall conform to AASHTO M 144, if specified or permitted by the Engineer.

311.2.10 Storage of Cement and Aggregate

All cement shall be stored, immediately upon delivery at the Site, in weatherproof building which will protect the cement from dampness. The floor shall be raised from the ground. The buildings shall be placed in locations approved by the Engineer. Provisions for storage shall be ample, and the shipments of cement as received shall be separately stored in such a manner as to allow the earliest deliveries to be used first and to provide easy access for identification and inspection of each shipment. Storage buildings shall have capacity for storage of a sufficient quantity of cement to allow sampling at least twelve (12) days before the cement is to be used. Bulk cement, if used, shall be transferred to elevated air tight and weatherproof bins. Stored cement shall meet the test requirements at any time after shortage when re-test is ordered by the Engineer. At the time of use, all cement shall be free-flowing and free of lumps.

The handling and storing of concrete aggregates shall be such as to prevent segregation or the inclusion of foreign materials. The Engineer may require that aggregates be stored on separate platforms at satisfactory locations.

In order to secure greater uniformity of concrete mix, the Engineer may require that the coarse aggregate be separated into two or more sizes. Different sizes of aggregates shall be stored in separate bins or in separate stock piles sufficiently remote from each other to prevent the material at the edges of the piles from becoming intermixed.

311.2.11 Proportioning, Consistency and Strength of Concrete

The Contractor shall prepare the design mix based on the absolute volume method as outlined in the American Concrete Institute (ACI) Standard 211.1, "Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete".

It is the intent of this Specification to require approximately 9.0 bags of cement per cubic meter of concrete based on a 40 kg per bag of cement. However, leaner or richer mixes may be used in order to meet the minimum strength requirements. The Engineer shall determine from laboratory tests of the materials to be used, the cement content and the proportions of aggregate and water that will produce a workable concrete having a slump of between 40 and 75 mm (1 1/2 k and 3 inches) if not vibrated, or between 10 and 40 mm (1/2 and 1 1/2 inches) if vibrated, and a flexural strength of not less than 3.8 MPa (550 psi) when tested by the third-point method or 4.5 MPa (650 psi) when tested by the mid-point method; or a compressive strength of 24.1 MPa (3,500 psi) when tested at fourteen days in accordance with AASHTO T 97, T 177 or 22, respectively.

Slump shall be determined using AASHTO T 199.

The designer shall consider the use of lean concrete (econocrete) mixture using local materials or specifically modified conventional concrete mixes in base course and in the lower course of composite, monolithic concrete pavements using a minimum of 75 mm (3 inches) of conventional concrete as the surface course.

The mix design shall be submitted to the Engineer for approval and shall be accompanied with certified test data from an approved laboratory demonstrating the adequacy of the mix design. A change in the source of materials during the progress of work may necessitate a new design mix.

311.3 Construction Requirements

311.3.1 Quality Control of Concrete

1. General

The Contractor shall be responsible for the quality control of all materials during the handling, blending, mixing and placement operations.

2. Quality Control Plan

The Contractor shall furnish the Engineer a Quality Control Plan detailing his production control procedures and the type and frequency of sampling and testing to insure that the concrete he produces complies with the Specifications. The Engineer shall be provided free access to recent plant production records, and if requested, informational copies of mix design, materials certifications and sampling and testing reports.

3. Quality of Workmen

Experienced and qualified personnel shall perform all batching or mixing operations for the concrete mix, and shall be present at the plant and job site to control the concrete productions whenever the plant is in operation. They shall be identified and duties defined as follows:

a. Concrete Batcher. The person performing the batching or mixing operation shall be capable of accurately conducting aggregate surface moisture determinations and establishing correct scale weight for concrete materials. He shall be capable of assuring that the proportioned batch weights of materials are in accordance with the mix design.

b. Concrete Technician. The person responsible for concrete production control and sampling and testing for quality control shall be proficient in concrete technology and shall have a sound knowledge of the Specifications as they relate to concrete production. He shall be capable of conducting tests on concrete and concrete materials in accordance with these Specifications. He shall be capable of adjusting concrete mix designs for improving workability and Specification compliance and preparing trial mix design. He shall be qualified to act as the concrete batcher in the batcher's absence.

4. Quality Control Testing

The Contractor shall perform all sampling, testing and inspection necessary to assure quality control of the component materials and the concrete.

The Contractor shall be responsible for determining the gradation of fine and coarse aggregates and for testing the concrete mixture for slump, air content, water-cement ratio and temperature. He shall conduct his operations so as to produce a mix conforming to the approved mix design.

5. Documentation

The Contractor shall maintain adequate records of all inspections and tests. The records shall indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and nature of any corrective action taken.

The Engineer may take independent assurance samples at random location for acceptance purposes as he deems necessary.

311.3.2 Equipment

Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity and mechanical condition. The equipment shall be at the jobsite sufficiently ahead of the start of construction operations to be examined thoroughly and approved.

1. Batching Plant and Equipment

a. General. The batching plant shall include bins, weighing hoppers and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, a hopper, and separate scale for cement shall be included. The weighing hopper shall be properly sealed and vented to preclude dusting operation. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned.

b. Bins and Hoppers. Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.

c. Scales. Scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within one-half percent (0.5%) throughout the range of use. Poises shall be designed to be locked in any position and to prevent unauthorized change.

Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their continued accuracy.

d. Automatic Weighing Devices. Unless otherwise allowed on the Contract, batching plants shall be equipped with automatic weighing devices of an approved type to proportion aggregates and bulk cement.

2. Mixers

a. General. Concrete may be mixed at the Site of construction or at a central plant or wholly or in part in truck mixers. Each mixer shall have a manufacturer's plate attached in a prominent place showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

b. Mixers at site of Construction. Mixing shall be done in an approved mixer capable of combining the aggregates, cement and water into a thoroughly mixed and uniform mass within the specified mixing and discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed 90 counter which shall correctly indicate the number of batches mixed.

c. Truck Mixer and Truck Agitators. Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central-mixed concrete shall conform to the requirements of AASHTO M 157.

d. Non-Agitator Trucks. Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation.

3. Paving and Finishing Equipment

The concrete shall be placed with an approved paver designed to spread, consolidate, screed and float finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specifications.

The finishing machine shall be equipped with at least two (2) oscillating type transverse screed.

Vibrators shall operate at a frequency of 8,300 to 9,600 impulses per minute under load at a maximum spacing of 60 cm.

4. Concrete Saw

The Contractor shall provide sawing equipment in adequate number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required rate. He shall provide at least one (1) stand-by saw in good working condition and with an ample supply of saw blades.

5. Forms

Forms shall be of steel, of an approved section, and of a depth equal to the thickness of the pavement at the edge. The base of the forms shall be of sufficient width to provide necessary stability in all directions. The flange braces must extend outward on the base to not less than $\frac{2}{3}$ the height of the form.

All forms shall be rigidly supported on a bed of thoroughly compacted material during the entire operation of placing and finishing the concrete. Forms shall be provided with adequate devices for secure setting so that when in place, they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing or paving equipment.

311.3.3 Preparation of Grade

After the subgrade or base has been placed and compacted to the required density, the areas which will support the paving machine and the grade on which the pavement is to be constructed shall be trimmed to the proper elevation by means of a properly designed machine extending the work at least 60 cm beyond each edge of the proposed concrete pavement. If loss of density results from the trimming operations, it shall be restored by additional compaction before concrete is placed. If any traffic is allowed to use the prepared subgrade or base, the surface shall be checked and corrected immediately ahead of the placing concrete.

The subgrade or base shall be uniformly moist when the concrete is placed.

311.3.4 Setting Forms

1. Base Support

The foundation under the forms shall be hard and true to grade so that the form when set will be firmly in contact for its whole length and at the specified grade. Any roadbed, which at the form line is found below established grade, shall be filled with approved granular materials to grade in lifts of three (3) cm or less, and thoroughly re-rolled or tamped. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

2. Form Setting

Forms shall be set sufficiently in advance of the point where concrete is being placed. After the forms have been set to correct grade, the base shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. The forms shall not deviate from true line by more than one (1) cm at any point.

3. Grade and Alignment

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. Testing as to crown and elevation, prior to placing of concrete can be made by means of holding an approved Template in a vertical position and moved backward and forward on the forms.

When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

311.3.5 Conditioning of Subgrade or Base Course

When side forms have been securely set to grade, the subgrade or base course shall be brought to proper cross-section. High areas shall be trimmed to proper elevation. Low areas shall be filled and properly compacted. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

Unless waterproof subgrade or base course cover material is specified, the subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

311.3.6 Handling, Measuring and Batching Materials

The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the work. Stockpiles shall be built up in layers of not more than one (1) meter in thickness. Each layer shall be completely in place before beginning the next which shall not be allowed to "cone" down over the next lower layer. Aggregates from different sources and of different gradings shall not be stockpiled together.

All washed aggregates and aggregates produced or handled by hydraulic methods, shall be stockpiled or binned for draining at least twelve (12) hours before being batched.

When mixing is done at the site of the work, aggregates shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers of adequate capacity and construction to properly carry the volume required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or being dumped. When bulk cement is used, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer, with chute, boot or other approved device, to prevent loss of cement, and to provide positive assurance of the actual presence in each batch of the entire cement content specified.

Bulk cement shall be transported to the mixer in tight compartments carrying the full amount of cement required for the batch. However, if allowed in the Special Provisions, it may be transported between the fine and coarse aggregate. When cement is placed in contact with the aggregates, batches may be rejected unless mixed within 1 1/2 hours of such contact. Cement in original shipping packages may be transported on top of the aggregates, each batch containing the number of sacks required by the job mix.

The mixer shall be charged without loss of cement. Batching shall be so as to result in the weight to each material required within a tolerance of one (1) percent for cement and two (2) percent for aggregates.

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over one percent (1%). Unless the water is to be weighed, the water measuring equipment tank shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

311.3.7 Mixing Concrete

The concrete may be mixed at the Site in a central mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time will be measured from the time all materials, except water, are in the drum. Ready-mixed concrete shall be mixed and delivered in accordance with requirements of AASHTO M 157, except that the minimum required revolutions at the mixing speed for transit-mixed concrete may be reduced to not less than that recommended by the mixer manufacturer. The number of revolutions recommended by the mixer manufacturer shall be indicated on the manufacturer's serial plate attached to the mixer. The Contractor shall furnish test data acceptable to the Engineer verifying that the make and model of the mixer will produce uniform concrete conforming to the provisions of AASHTO M 157 at the reduced number of revolutions shown on the serial plate.

When mixed at the Site or in a central mixing plant, the mixing time shall not be less than fifty (50) seconds nor more than ninety (90) seconds, unless mixer performance tests proved adequate mixing of the concrete is a shorter time period.

Four seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The mixer shall be operated at the drum speed as shown on the manufacturer's name plate attached on the mixer. Any concrete mixed less than the specified time shall be discarded and disposed off by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic meter, as shown on the manufacturer's standard rating plate on the mixer, except that an allowed up to ten (10) percent above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batches shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators or non-agitating trucks specified in Sub-section 311.3.2, Equipment. The time elapsed from the time water is added to the mix until the concrete is deposited in place at the Site shall not exceed 45 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when hauled in truck mixers or truck agitators, except that in hot weather or under other conditions contributing to quick hardening of the concrete, the maximum allowable time may be reduced by the Engineer.

Retampering concrete by adding water or by other means shall not be permitted, except that when concrete is delivered in truck mixers, additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, if permitted by the Engineer, provided all these operations are performed within 45 minutes after the initial mixing operation and the water-cement ratio is not exceeded. Concrete that is not within the specified slump limits at the time of placement shall not be used. Admixtures for increasing the workability or for accelerating the setting of the concrete will be permitted only when specifically approved by the Engineer.

311.3.8 Limitation of Mixing

No concrete shall be mixed, placed or finished when natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

During hot weather, the Engineer may require that steps be taken to prevent the temperature of mixed concrete from exceeding a specified maximum.

Concrete not in place within 90 minutes from the time the ingredients were charged into the mixing drum or that has developed initial set shall not be used. Retampering of concrete or mortar which has partially hardened, that is remixing with or without additional cement, aggregate, or water, shall not be permitted.

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete.

311.3.9 Placing Concrete

Concrete shall be deposited in such a manner to require minimal rehandling. Unless truck mixers or non-agitating hauling equipment are equipped with means to discharge concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such a manner as to prevent segregation. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane and mechanical equipment will be operated upon the existing lane, that previously constructed lane shall have attained the strength for 14-day concrete. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three (3) days.

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 15 seconds in any one location.

Concrete shall be deposited as near as possible to the expansion and contraction joints without disturbing them, but shall not be dumped from the discharge bucket or hopper into a joint assembly unless the hopper is well centered on the joint assembly. Should any concrete material fall on or be worked into the surface of a complete slab, they shall be removed immediately.

311.3.10 Test Specimens

As work progresses, at least one (1) set consisting of three (3) concrete beam test specimens, 150 mm x 150 mm x 525 or 900 mm shall be taken from 330 m² of pavement, 230 mm depth, or fraction thereof placed each day. Test specimens shall be made under the supervision of the Engineer, and the Contractor shall provide all concrete and other facilities necessary in making the test specimens and shall protect them from damage by construction operations.

The beams shall be made, cured, and tested in accordance with AASHTO T 23 and T 97.

311.3.11 Strike-off of Concrete and Placement of Reinforcement

Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the Plans. When reinforced concrete pavement is placed in two (2) layers, the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be firmly positioned in advance of concrete placement or it may be placed at the depth shown on the Plans in plastic concrete, after spreading by mechanical or vibratory means.

Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale and loose or thick rust which could impair bond of the steel with the concrete.

311.3.12 Joints

Joints shall be constructed of the type and dimensions, and at the locations require by the Plans or Special Provisions. All joints shall be protected from the intrusion of injurious foreign material until sealed.

1. Longitudinal Joint

Deformed steel tie bars of specified length, size, spacing and materials shall be placed perpendicular to the longitudinal joints; they shall be placed by approved mechanical equipment rigidly secured by chair or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves. When shown on the Plans and when adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint. Tie bars, except those made of rail steel, may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.

Longitudinal formed joints shall consist of a groove or cleft, extending downward from and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the Plans and while the concrete is in a plastic state. The groove or cleft shall be filled with either a premolded strip or poured material as required.

The longitudinal joint shall be continuous, there shall be no gaps in either transverse or longitudinal joints at the intersection of the joints.

Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width and line shown on the Plans. Suitable guide lines or devices shall be used to assure cutting the longitudinal joint on the true line. The longitudinal joint shall be sawed before the end of the curing period or shortly thereafter and before any equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned and, if required, the joint shall immediately be filled with sealer.

Longitudinal pavement insert type joints shall be formed by placing a continuous strip of plastic material which will not react adversely with the chemical constituent of the concrete.

2. Transverse Expansion Joint

The expansion joint filler shall be continuous from form to form shaped to the subgrade and to the keyway along the form. Performed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used.

The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure performed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. finished joint shall not deviate more than 6 mm from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units.

No plugs of concrete shall be permitted anywhere within the expansion space.

3. Transverse Contraction Joint

When shown on the Plans, it shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement and shall include load transfer assemblies.

a. Transverse Strip Contraction Joint. It shall be formed by installing a parting strip to be left in place as shown on the Plans.

b. Formed Groove. It shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place at least until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.

c. Sawed Contraction Joint. It shall be created by sawing grooves in the surface of the pavement of the width, depth, and at the spacing and lines shown on the Plans, with an approved concrete saw. After each joint is sawed, it shall be thoroughly cleaned including the adjacent concrete surface.

Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually within 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on during the day or night, regardless of weather conditions. The sawing of any joint shall be omitted if crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above.

4. Transverse Construction Joint

It shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 1.50 m of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has been mixed at the time of interruption to form a slab of at least 1.50 m long, the excess concrete from the last preceding joint shall be removed and disposed off as directed.

5. Load Transfer Device

Dowels, when used, shall be held in position parallel to the surface and center line of the slab by a metal device that is left in the pavement.

The portion of each dowel painted with one coat of lead or tar, in conformance with the requirements of Item 404, Reinforcing Steel, shall be thoroughly coated with approved bituminous materials, e.g., MC-70, or an approved lubricant, to prevent the concrete from binding to that portion of the

dowel. The sleeves for dowels shall be metal designed to cover 50 mm plus or minus 5 mm (1/4 inch), of the dowel, with a watertight closed end and with a suitable stop to hold the end of the sleeves at least 25 mm (1 inch) from the end of the dowel.

In lieu of using dowel assemblies at contraction joints, dowel may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

311.3.13 Final Strike-off (Consolidation and Finishing)

1. Sequence

The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straight-edging and final surface finish. Work bridges or other devices necessary to provide access to the pavement surface for the purpose of finishing straight-edging, and make corrections as hereinafter specified, shall be provided by the Contractor.

In general, the addition of water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as fog spray by means of an approved spray equipment.

2. Finishing at Joints

The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in Sub-section 311.3.9, Placing Concrete.

After the concrete has been placed and vibrated adjacent to the joints as required in Sub-section 311.3.9, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately 20 cm (8 inches) from the joint. Segregated concrete shall be removed from in front of and off the joint. The front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

3. Machine Finishing

1. Non-vibratory Method. The concrete shall be distributed or spread as soon as placed. As soon as the concrete has been placed, it shall be struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machines on the forms shall be maintained true without wobbling or other variation tending to affect the precision finish.

During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed in its entire length.

b. Vibratory Method. When vibration is specified, vibrators for full width vibration of concrete paving slabs, shall meet the requirements in Sub-section 311.3.2, Equipment. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and method which will produce pavement conforming to the Specifications. All the provisions in item (a) above not in conflict with the provisions for the vibratory method shall govern.

4. Hand Finishing

Hand finishing methods may only be used under the following conditions:

a. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade.

b. In narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical, hand methods may be used.

Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.

The screed for the surface shall be at least 60 cm (2 feet) longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and constructed either of metal or other suitable material shod with metal.

Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

In operation, the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

5. Floating

After the concrete has been struck off and consolidated, it shall be further smoothed, trued and consolidated by means of a longitudinal float, either by hand or mechanical method.

a. Hand Method. The hand-operated longitudinal float shall be not less than 265 cm (12 feet) in length and 15 cm (6 inches) in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion while held in a floating position parallel to the road center line, and moving gradually from one side of the pavement to the other. Movement ahead along the center line of the pavement shall be successive advances of not more than one-half the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.

b. Mechanical Method. The mechanical longitudinal float shall be of a design approved by the Engineer, and shall be in good working condition. The tracks from which the float operates shall be accurately adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustment of the transverse finishing machine so that a small amount of mortar is carried ahead of the float will lap the distance specified by the Engineer on each transverse trip. The float shall pass over each area of pavement at least two times, but excessive operation over a given will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.

c. Alternative Mechanical Method. As an alternative, the Contractor may use a machine composed of a cutting and smoothing flat or floats suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels riding on, and constantly in contact with the side forms. If necessary, following one of the preceding methods of floating, long handled floats having blades not less than 150 cm (5 feet) in length and 15 cm (6 inches) in width may be used to smooth and fill in open-textured areas

in the pavement. Long handles floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a 3-m straight-edge or more in length. Successive drags shall be lapped one-half the length of the blade.

6. Straight-edge Testing and Surface Correction

After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a 300 cm long straight-edge. For this purpose, the Contractor shall furnish and use an accurate 300-cm straight-edge swung from handles 100 cm (3 feet) longer than one-half width of the slab. The straight-edge shall be held in contact with the surface in successive positions parallel to the road center line and the whole area gone over from one side of the slab to the other as necessary. Advances along the road shall be in successive stages of not more than one-half the length of the straight-edge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straight-edge testing and surface corrections shall be continued until the entire surface is found to be free from observable departures from the straight-edge and the slab conforms to the required grade and cross-section.

7. Final Finish

If the surface texture is broom finished, it shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping. The brooming operation should be so executed that the corrugations produced in the surface shall be uniform in appearance and not more than 1.5 mm in depth. Brooming shall be completed before the concrete is in such condition that the surface will be unduly roughened by the operation. The surface thus finished shall be free from rough and porous areas, irregularities, and depressions resulting from improper handling of the broom. Brooms shall be of the quality, size and construction and be operated so as to produce a surface finish meeting the approval of the Engineer. Subject to satisfactory results being obtained, and approval of the Engineer, the Contractor will be permitted to substitute mechanical brooming in lieu of the manual brooming as herein described.

If the surface texture is belt finished, when straight-edging is complete and water sheen has practically disappeared and just before the concrete becomes non-plastic, the surface shall be belted with a 2-ply canvass belt not less than 20 cm wide and at least 100 cm longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the center line and with a rapid advance parallel to the center line.

If the surface texture is drag finished, a drag shall be used which consists of a seamless strip of damp burlap or cotton fabric, which shall produce a uniform of gritty texture after dragging it longitudinally along the full width of pavement. For pavement 5 m or more in width, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap or fabric at least 100 cm wide is in contact with the full width of pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 15 cm wider than the layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1.5 mm in depth. Drag shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags be substituted.

Regardless of the method used for final finish, the hardened surface of pavement shall have a coefficient of friction of 0.25 or more. Completed pavement that is found to have a coefficient of friction less than 0.25 shall be grounded or scored by the Contracted at his expense to provide the required coefficient of friction.

8. Edging at Forms and Joints

After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints, shall be worked with an approved tool and rounded to the radius required by the Plans. A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilling the tool during the use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

All joints shall be tested with a straight-edge before the concrete has set and correction made if one edge of the joint is higher than the other.

311.3.14 Surface Test

As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 3-m straight-edge or other specified device. Area showing high spots of more than 3 mm but not exceeding 12 mm in 3 m shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 3 mm when tested with 3 m straight-edge. Where the departure from correct cross-section exceeds 12 mm, the pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be not less than 1.5 m in length and not less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 1.5 m in length, shall also be removed and replaced.

311.3.15 Curing

Immediately after the finishing operations have been completed and the concrete has sufficiently set, the entire surface of the newly placed concrete shall be cured in accordance with either one of the methods described herein. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both of curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period.

1. Cotton or Burlap Mats

The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and the edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mat shall be so placed and weighed down so as to cause them to remain in intimate contact with the surface covered. The mats shall be maintained fully wetted and in position for 72 hours unless otherwise specified.

2. Waterproof Paper

The top surface and sides of the pavement shall be entirely covered with waterproof paper, the units shall be lapped at least 45 cm. The paper shall be so placed and weighed down so as to cause it to remain in intimate contact with the surface covered. The paper shall have such dimensions but each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement, or at pavement width and 60 cm strips of paper for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together, the joints being securely sealed in such a manner that they do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed. The surface of the pavement shall be thoroughly wetted prior to the placing of the paper.

3. Straw Curing

When this type of curing is used, the pavement shall be cured initially with burlap or cotton mats, until after final set of the concrete or, in any case, for 12 hours after placing the concrete. As soon as the mats are removed, the surface and sides of the pavement shall be thoroughly wetted and covered with at least 20 cm of straw or hay, thickness of which is to be measured after wetting. If the straw or hay covering becomes displaced during the curing period, it shall be replaced to the original depth and saturated. It shall be kept thoroughly saturated with water for 72 hours and thoroughly wetted down during the morning of the fourth day, and the cover shall remain in place until the concrete has attained the required strength.

4. Impervious Membrane Method

The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with jute or cotton mats, it may be applied upon removal of the mats. The curing compound shall not be applied during rain.

Curing compound shall be applied under pressure at the rate 4 L to not more than 14 m² by mechanical sprayers. The spraying equipment shall be equipped with a wind guard. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and concrete surface exposed by the removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints

to be sealed, but approved means shall be used to insure proper curing at least 72 hours and to prevent the intrusion of foreign material into the joint before sealing has been completed. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film be damaged from any cause within the 72-hour curing period, the damaged portions shall be repaired immediately with additional compound.

5. White Polyethylene Sheet

The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 45 cm. The sheeting shall be so placed and weighted down so as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed.

311.3.16 Removal of Forms

After forms for concrete shall remain in place undisturbed for not less than twenty four (24) hours after concrete pouring. In the removal of forms, crowbars should be used in pulling out nails and pins. Care should be taken so as not to break the edges of the pavement. In case portions of the concrete are spalled, they shall be immediately repaired with fresh mortar mixed in the proportion of one part of Portland Cement and two parts fine aggregates. Major honeycombed areas will be considered as defective work and shall be removed and replaced at the expense of the Contractor. Any area or section so removed shall not be less than the distance between weakened plane joint nor less than the full width of the lane involved.

311.3.17 Sealing Joints

Joints shall be sealed soon after completion of the curing period and before the pavement is opened to traffic, including the Contractor's equipment. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign materials including membrane curing compound and the joint faces shall be clean and surface dry when the seal is applied.

The sealing material shall be applied to each joint opening to conform to the details shown on the Plans or as directed by the Engineer. Materials for seal applied hot shall be stirred during heating so that localized overheating does not occur. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. The use of sand or similar material as a cover for the seal will not be permitted.

Performed elastometric gaskets for sealing joints shall be of the cross-sectional dimensions shown on the Plans. Seals shall be installed by suitable tools, without elongation and secured in place with an approved lubricant adhesive which shall cover both sides of the concrete joints. The seals shall be installed in a compressive condition and shall at time of placement be below the level of the pavement surface by approximately 6 mm.

The seals shall be in one piece for the full width of each transverse joint.

311.3.18 Protection of Pavement

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection of and maintenance of warning signs, lights, pavement bridges or cross-overs, etc. The Plans or Special Provisions will indicate the location and type of device or facility required to protect the work and provide adequately for traffic.

Any damage to the pavement occurring prior to final acceptance, shall be repaired or the pavement be replaced.

311.3.19 Concrete Pavement - Slip Form Method

If the Contract calls for the construction of pavement without the use of fixed forms, the following provisions shall apply:

1. Grade

After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of properly designed machine. If the density of the base is disturbed by the grading operation, it shall be corrected by additional compaction before concrete is placed. The grade should be constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placing of concrete.

2. Placing Concrete

The concrete shall be placed with an approved slid-form paver designed to spread, consolidate, screed and float-finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finish

will be necessary to provide a dense and homogenous pavement in conformance with the Plans and Specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accompanied with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur, and that necessary final finishing can be accomplished while the concrete is still within the forms. Any edge slump of the pavement, exclusive of edge rounding, in excess of 6 mm shall be corrected before the concrete has hardened.

The concrete shall be held at a uniform consistency, having a slump of not more than 40 mm (1 1/2 inches). The slip form paver shall be operated with as nearly as possible a continuous forward movement and that all operations of mixing, delivering and spreading concrete shall be coordinated so as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

3. Finishing

The surface smoothness and textures shall meet the requirements of Sub-sections 311.3.13 and 311.3.14.

4. Curing

Unless otherwise specified, curing shall be done in accordance with one of the methods included in Sub-section 311.3.15. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the pavement.

5. Joints

All joints shall be constructed in accordance with Sub-section 311.3.12.

6. Protection Against Rain

In order that the concrete may be properly protected against rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times, materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 50 mm (2 inches) and a nominal width of not less than the thickness of pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper or plastic sheeting material for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

311.3.20 Acceptance of Concrete

The strength level of concrete will be considered satisfactory if the averages of all sets of three (3) consecutive strength test results equal or exceed the specified strength, $f'c$ and no individual strength test result is deficient by more than 15% of the specified strength, $f'c$.

Concrete deemed to be not acceptable using the above criteria may be rejected unless the Contractor can provide evidence, by means of core tests, that the quality of concrete represented by failed test results is acceptable in place. At least three (3) representative cores shall be taken from each member or area of concrete in place that is considered deficient. The location of cores shall be determined by the Engineer so that there will be least impairment of the strength of the structure. The obtaining and testing of drilled cores shall be in accordance with AASHTO T 24.

Concrete in the area represented by the cores will be considered adequate if the average strength of the cores is equal to at least 85% of, and if no single core is less than 75% of, the specified strength, $f'c$.

If the strength of control specimens does not meet the requirements of this Sub-section, and it is not feasible or not advisable to obtain cores from the structure due to structural considerations, payment of the concrete will be made at an adjusted price due to strength deficiency of concrete specimens as specified hereunder:

Deficiency in Strength of Concrete Specimens, Percent (%)	Percent (%) of Contract Price Allowed
Less than 5	100
5 to less than 10	80
10 to less than 15	70
15 to less than 20	60
20 to less than 25	50
25 or more	0

311.3.21 Opening to Traffic

The Engineer will decide when the pavement may be opened to traffic. The road will not be opened to traffic until test specimens molded and cured in accordance with AASHTO T 23 have attained the minimum strength requirements in Sub-section 311.2.11. If such tests are not conducted prior to the specified age the pavement shall not be opened to traffic until 14 days after the concrete was placed. Before opening to traffic, the pavement shall be cleaned and joint sealing completed.

311.3.22 Tolerance and Pavement Thickness

1. General

The thickness of the pavement will be determined by measurement of cores from the completed pavement in accordance with AASHTO T 148.

The completed pavement shall be accepted on a lot basis. A lot shall be considered as 1000 linear meters of pavement when a single traffic lane is poured or 500 linear meters when two lanes are poured concurrently. The last unit in each slab constitutes a lot in itself when its length is at least 1/2 of the normal lot length. If the length of the last unit is shorter than 1/2 of the normal lot length, it shall be included in the previous lot.

Other areas such as intersections, entrances, crossovers, ramps, etc., will be grouped together to form a lot. Small irregular areas may be included with other unit areas to form a lot.

Each lot will be divided into five (5) equal segments and one core will be obtained from each segment in accordance with AASHTO T 24.

2. Pavement Thickness

It is the intent of this Specification that the pavement has a uniform thickness as called for on the Plans for the average of each lot as defined. After the pavement has met all surface smoothness requirements, cores for thickness measurements will be taken.

In calculating the average thickness of the pavement, individual measurements which are in excess of the specified thickness by more than 5 mm will be considered as the specified thickness plus 5 mm and measurement which are less than the specified thickness by more than 25 mm shall not be included in the average. When the average thickness for the lot is deficient, the contract unit price will be adjusted for thickness in accordance with paragraph (3) below.

Individual areas within a segment found deficient in thickness by more than 25 mm shall be evaluated by the Engineer, and if in his judgment, the deficient areas warrant removal, they shall be removed and replaced by the Contractor with pavement of the specified thickness at his entire expense. However, if the evaluation of the Engineer is that the deficient area should not be removed and replaced, such area will not be paid.

When the measurement of any core is less than the specified thickness by more than 25 mm, the actual thickness of the pavement in this area will be determined by taking additional cores at not less than 5 m intervals parallel to the center line in each direction from the affected location until a core is found in each direction which is not deficient in thickness by more than 25 mm. The area of slab for which no payment will be made shall be the product of the paving width multiplied by the distance along the center line of the road between transverse sections found not deficient in thickness by more than 25 mm. The thickness of the remainder of the segment to be used to get the average thickness of each lot shall be determined by taking the average thickness of the additional cores which are not deficient by more than 25 mm.

3. Adjustment for Thickness

When the average thickness of the pavement per lot is deficient, payment for the lot shall be adjusted as follows:

Deficiently in the Average Thickness per lot (mm)	Percent of Contract Price Per Lot
0-5	100% payment
6-10	95% payment
11-15	85% payment
16-20	70% payment
21-25	50% payment
More than 25	Remove and replace, (No payment)

311.4 Method of Measurement

The area to be paid for under this Item shall be the number of square meters (m²) of concrete pavement placed and accepted in the completed pavement. The width from outside edge to outside edge of completed pavement as placed in accordance with the Plans or as otherwise required by the Engineer in writing. The length will be measured horizontally along the center line of each roadway or ramp. Any curb and gutter placed shall not be included in the area of concrete pavement measured.

311.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 311.4, shall be paid for at the contract unit price for Portland Cement Concrete Pavement, which price and payment shall be full compensation for preparation of roadbed and finishing of shoulders, unless otherwise provided by the Special Provisions, furnishing all material, for mixing, placing, finishing and curing all concrete, for furnishing and placing all joint materials, for sawing weekend plane joints, for fitting the prefabricated center metal joint, for facilitating and controlling traffic, and for furnishing all labor, equipment, tools and incidentals necessary to complete the Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
311 (1)	PCC Pavement, Plain	Square meter
311 (2)	PCC Pavement, Reinforced	Square meter

PART E - MATERIALS DETAILS

ITEM 400 - HYDRAULIC CEMENT

400.1 Portland Cement and Masonry Cement

Cement shall conform to the requirements of the following cited Specifications for the type specified or permitted.

TYPE	Specification
Portland Cement	AASHTO M 85 (ASTM C 150)
Blended Hydraulic Cements	AASHTO M 240 (ASTM 595)
Masonry Cement	AASHTO M 150 (ASTM C 91)

When Types IV and V (AASHTO M 85), P and PA (AASHTO M 150) cements are used, proper recognition shall be given to the effects of slower strength gain on concrete proportioning and construction practices. Types S and SA cements will be permitted only when blended with Portland Cement in proportions approved by the Engineer.

Unless otherwise permitted by the Engineer, the product of only one mill of any one brand and type of Portland Cement shall be used on the project.

The Contractor shall provide suitable means of storing and protecting the cement against dampness. Cement which, for any reason, has become partially set or which contains lumps or caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

ITEM 401 - BITUMINOUS MATERIALS

401.1 Asphalt Cements

Asphalt cement shall conform to the requirements of AASHTO M 226.

401.2 Liquid Asphalts

Liquid asphalt shall conform to the requirements of the following specifications :

- Rapid Curing Liquid Asphalts - AASHTO M 81
- Medium Curing Liquid Asphalts - AASHTO M 82

401.3 Emulsified Asphalts

Emulsified asphalts shall conform to the requirements of the following specifications :

- Emulsified Asphalt (Anionic) - AASHTO M 140 (ASTM D 977)
- Emulsified Asphalt (Cationic) - AASHTO M 208

401.4 Acceptance Procedures for Bituminous Materials

401.4.1 General

Bituminous materials will be accepted at the source of shipment subject to the following conditions :

a. The supplier shall conduct laboratory tests of all materials intended for shipment to the Government and certify that the materials meet the Contract Specifications.

b. Before loading, the producer shall examine the shipping container, remove all remnants of previous cargoes which might contaminate the material to be loaded and certify that it was clean and free of contaminating material and loaded.

c. The Contractor shall furnish with each shipment two copies of the delivery ticket. The delivery tickets shall contain the following information :

Consignees _____	Designation _____
Project Number _____	Date _____
Grade _____	Loading Temp. _____
Net Liters _____	Specific Gravity _____
	at 15.5 C (60 F)
Net Weight _____	
Identification No. (Truck, Car, Tank, etc.) _____	

d. The Contractor, or the supplier as his agent, shall deliver to the Engineer, or his representative a certification signed by an authorized representative of the supplier to cover the quality and quantity of material and the condition of container for each shipment. The certification shall be essential in the following form and may stamped, written or printed on the delivery ticket.

"This is to certify that this shipment of _____ (tones/liters) or _____ of asphalt meets all Contract Specification requirements of the DPWH, and the shipping container was clean and free from contaminating material when loaded.

Producer _____
Signed _____

Failure to sign the certification will be a cause to withhold use of the material until it can be sampled, tested and approved.

401.4.2 Quality Control Reviews

Quality control reviews will be conducted by the Government, or an authorized representative at the point of production, at frequencies prescribed by the DPWH, to determine the reliability of the producer's certifications.

If this review indicates that the certifications are not reliable, the acceptance of bituminous materials by shipping container will be sampled at point of delivery, tested and accepted prior to incorporation into the work. This procedure will be followed until an engineering determination is made that the supplier's quality control and testing procedure are such that material meeting Contract Specifications is being consistently produced.

401.4.3 Alternate Acceptance Procedures for Asphalt Materials.

Where required by the Special Provisions, the following alternate acceptance plan for asphalt material will apply in lieu of (a) and (b) above. The Contractor shall provide deliver tickets and certifications as set out in (a), above.

Acceptance samples of bituminous materials shall be obtained in accordance with AASHTO T 40, Sampling Bituminous Materials, at the applicable point of acceptance as defined herein :

a. Bituminous materials used in direct application on the road. Acceptance samples shall be obtained under the provision of the Engineer from the conveyances containing the bituminous material at the point of delivery. Single samples shall be taken of each separate tank load of bituminous material delivered, at the time of discharge, into distributors or other conveyances on the project.

b. Bituminous materials initially discharged into storage tanks on the project. Acceptance samples shall be obtained from the line between the storage tank and distributor or the bituminous mixing plant after each delivery. A single acceptance sample shall be taken after sufficient period of circulation of such bituminous material has taken place to insure samples representative of the total materials then in the storage tank.

As soon after sampling as practicable, the acceptance sample shall be delivered by the Engineer to the nearest authorized laboratory for tests to determine compliance.

401.4-4 Requirements for Bituminous Materials containing Anti-stripping Additives.

a. All the foregoing requirements of item 401 shall apply for the type of bituminous material involved.

b. Additionally, the Contractor or the supplier as his agent, shall furnish the Engineer or his representative along with and the time of delivery of the initial shipment of fortified bituminous material to the project, and thereafter with the subsequent shipments when ordered by the Engineer, 1 liter (1 quart) sealed sample of the bituminous material taken at the time of loading at the refinery and prior to introduction of the additive, along with a separate 0.5 liter (1 pint) sample of the anti-stripping additive involved.

401.5 Application Temperatures

Bituminous materials for the several applications indicated in the Specifications shall be applied within the temperature ranges indicated in Table 401.1

Table 401.1
Application Temperature

Type and Grade of Material	Application Temperature Range (C)	
	Spray (Min./Max.)	Mix (Min./Max.)
MC 30	21 - 62.8	15.5 - 40.5
RC-MC 70	40.5 - 85	32 - 68
RC-MC 250	60 - 107	51.7 - 93
RC-MC 800	79 - 129	71 - 107
RC-MC 3000	106.7 - 143	93 - 126.7
All emulsions	10 - 71	10 - 71
Asphalt Cement		As required to achieve viscosity of 75-150 seconds to achieve a Kinematic Viscosity of 150-300 mm ² (150-300) centi-strokes.

Table 401.1 shall apply unless temperatures ranges applicable to specific lots of material delivered to the job are supplied by the producer.

PART F - DRAINAGE STRUCTURE

Item 504 - Grouted Riprap Side Ditch

504.1 Description

This Item shall consist of the furnishing and placing of riprap with grout furnished and constructed in accordance with this Specification and to the lines and grades and dimensions shown on the Plans.

504.2 Material Requirements

504.2.1 Stones

Stones for riprap shall consist of rock as nearly rectangular in section as is practical, except that round natural stones may be used with the approval of the Engineer. The stones shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended.

Sound pieces of broken concrete obtained from the removal of bridges, culverts and other structures may be substituted for stone with the approval of the Engineer.

504.2.2 Mortar

Mortar for grouted riprap shall consist of sand, cement and water conforming to the requirements given under Item 405, in the DPWH Standard Specification, 1988, mixed in the proportion of one part cement to three parts sand by volume, and sufficient water to produce a thick but fluid mortar.

504.3 Construction Requirements

504.3.1 Excavation

The bed for riprap shall be excavated to the required depths and properly compacted, trimmed and shaped.

The exact elevation of side ditch shall be verified in the field by the Engineer.

504.3.2 Placing

The riprap shall be thoroughly rammed into place as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be filled with small broken fragments firmly rammed into place.

504.3.3 Grouting

The spaces between the stones shall be filled with cement mortar as specified in Subsection 504.2.2, Mortar. Sufficient mortar shall be used to completely fill all voids, except that the face surface of the stones shall be left exposed.

Grout shall be placed from bottom to top of the surface swept with a stiff broom. After grouting is completed, the surface shall be cured as specified in Item 405, in the DPWH Standard Specification, 1988, for a period of at least three days.

504.4 Method of Measurement

The quantities to be measured for payment shall be the number of linear meters of grouted riprap side ditch.

504.5 Basis of Payment

The quantities measured as provided above shall be paid for at the contract unit price, per linear meter for grouted riprap side ditch, which price and payment shall be full compensation for excavation and preparation of the bed, for furnishing and placing all materials and all labor, equipment, tools and incidentals necessary to complete the Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
504	Grouted Riprap Side Ditch	Linear meter

PART G - SPECIAL PROVISIONS FOR SECTION NO. 1, 2, 3 AND 4

SP - 1 Project Manager and Resident Engineers

The Contractor shall at all times during the execution of the work at the site provide the Project Manager and two (2) Resident Engineers, one for Section No. 1 and 2, and another for Section No. 3 and 4.

The Project Manager shall be the authorized representative of the Contractor in execution of the Contract.

SP - 2 Laboratory Improvement and Apparatus

The Contractor shall make the improvement on the space for the testing laboratory which will be provided by the DPWH as shown in Figure G-1.

The Contractor shall furnish the laboratory apparatus as specified in Annex G-1 during the duration of the Contract for the use in the testing laboratory.

SP - 3 Laboratory Staff

The Contractor shall provide competent and experienced laboratory staff as listed below to carry out the material and quality tests under the instruction of the Engineer.

Laboratory Staff:

- 1 - Material Engineer
- 4 - Laboratory Technician
- 10 - Laborer

SP - 4 Preliminary Material Tests

Preliminary material tests shown in Annex G-2 shall be made prior to the commencement of the relevant work.

The acceptance/approval of the preliminary samples shall not be considered as guarantee of acceptance of all materials from the same source, nor the quality or quantity of such materials, and it is understood, any materials which have been sampled and passed satisfactory may be re-sampled and tested anytime before, during and after incorporation into the work.

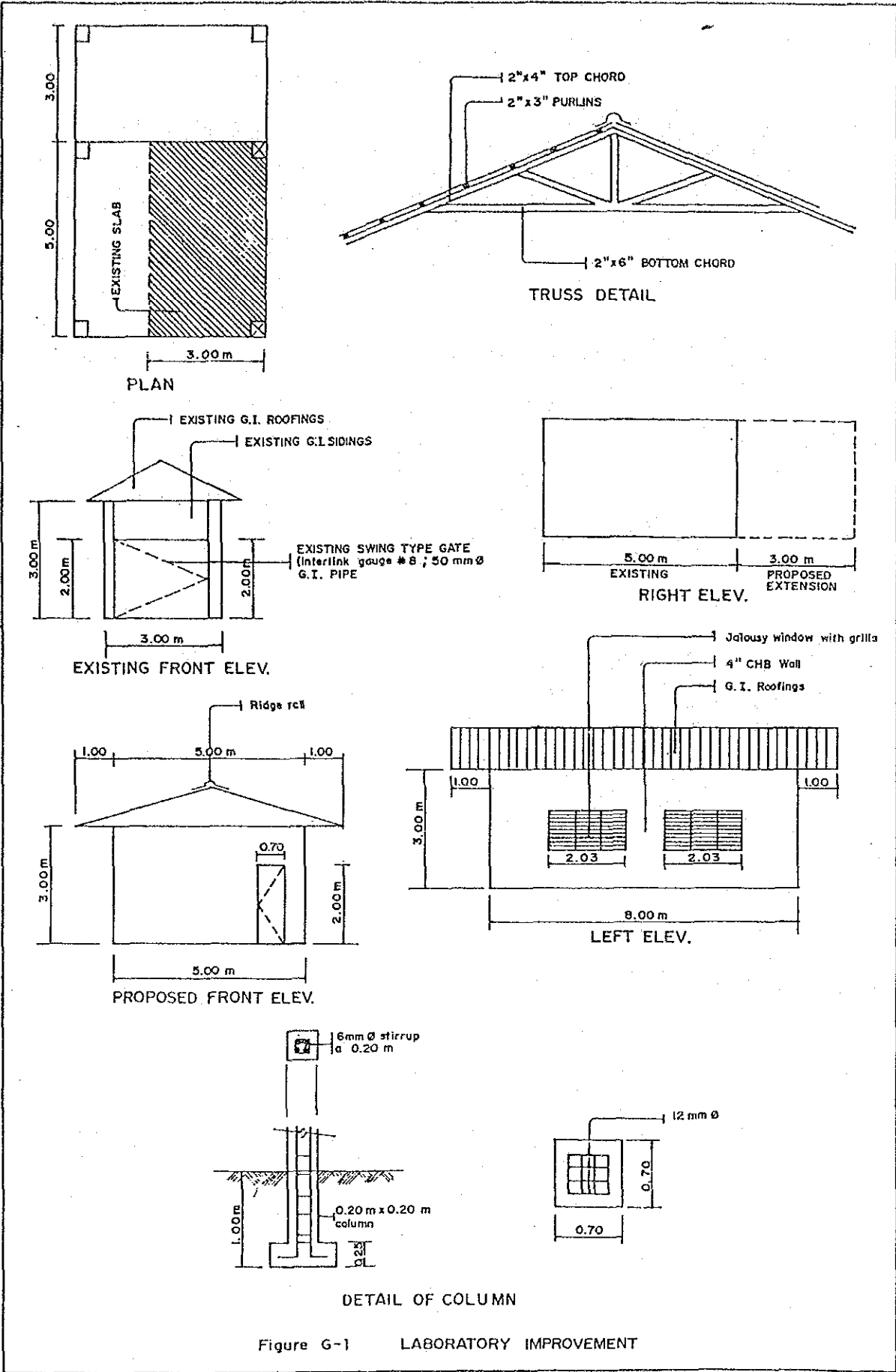


Figure G-1 LABORATORY IMPROVEMENT

SP - 5 Quality Control Tests

Required quality control tests are listed in Annex G-3.

The laboratory staff assigned by the Contractor shall assist the Engineer and his staff in conducting the quality control tests.

The Contractor shall not be allowed any compensation for any delays or damages sustained pending the completion of testing and approval.

SP - 6 Vehicles for the Engineer's Staff

The Contractor shall provide two (2) 4-wheel drive pick-up vehicles with drivers for the exclusive use of the Engineer's Staff. All vehicles to be provided by the Contractor shall be to the satisfaction to the Engineer. All vehicles shall comply in all respects with all relevant Philippines national or local laws, statutes and regulations.

The Contractor shall maintain the vehicles in good condition and shall be supplied with appropriate fuel and lubricants at all times.

He shall provide equivalent substitute vehicles during any period when the specified vehicles are taken out of service for maintenance, repair or any other reason.

SP - 7 Informatory Signs

The Contractor shall furnish and install informatory signs at both ends of each section in accordance with the details shown on the Plans. Exact location of informatory signs will be directed by the Engineer

SP - 8 Photographs

The Contractor shall provide progress photographs taken as, when and where directed by the Engineer. The photographs shall be sufficient in number and location to record the exact progress of the works. The Contractor shall provide one proof print of each photograph taken, and the negative and ten copies, not less than 254 mm x 203 mm and printed on glossy paper, of any of the photographs selected as progress photographs by the Engineer.

SP - 9 Measurement and Payments

Lump-sum items shall be provided for the provision of:

- Laboratory Improvement and Apparatus
- Laboratory Staff
- Vehicles for the Engineer's Staff

The quantities for informatory signs shall be the number of informatory signs installed at site and approved by the Engineer.

The quantities for progress photographs shall be the number of photographs selected and provided as progress photographs.

No measurement for payment will be made for other items, than mentioned above but the costs thereof will be considered incidental to the cost of the other Contract Items.

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
SP - 2	Laboratory Improvement and Apparatus	Lump sum
SP - 3	Laboratory Staff	Lump sum
SP - 6	Vehicles for the Engineer's Staff	Lump sum
SP - 7	Informatory Signs	Each
SP - 8	Photographs	Each

Annex G - 1

List of Laboratory Apparatus

LIST OF LABORATORY APPARATUS

For the Laboratory:

<u>Description</u>	<u>Quantity</u>	<u>Unit</u>
Sieve standard, 200 mm diameter, opening 37.5 mm	2	pcs.
diameter, opening 25.0 mm	2	pcs.
diameter, opening 19.0 mm	2	pcs.
diameter, opening 9.5 mm	2	pcs.
diameter, opening 4.75 mm	2	pcs.
diameter, opening 2.00 mm	2	pcs.
diameter, opening 0.425 mm	2	pcs.
diameter, opening 0.075 mm	2	pcs.
Pan, brass 200 mm diameter x 50 mm deep	2	pcs.
Cover, brass, sieve	2	pcs.
Brush, fine sieve	2	pcs.
Brush, wire sieve	2	pcs.
Moisture content can, 225 ml tin	50	pcs.
Field density consisting of:		
sand density cone	2	pcs.
jug, glass or plastic 4-lit. cap,	2	pcs.
density plate	2	pcs.
straight edge	2	pcs.
spoon	2	pcs.
25 mm chisel, steel	2	pcs.
4-lit. field can	2	pcs.
mallet, sand	2	pcs.
Electronic Precision Balance sensitivity 40 kg or 1 gram	2	pcs.

Description	Quantity	Unit
Electronic Precision Balance sensitivity 310 gram or 0.001 gram	2	pcs.
Balance, solution, 20 kg. capacity x 1 gram (Field Balance)	2	pcs.
Balance, Triple Beam, 311 g. capacity x 0.01 gram	2	pcs.
Oven, field, with temperature control	1	pcs.
Density testing apparatus consisting of:	1	set
Flat, form weighing balance	1	pcs.
wire basket	1	pc.
Water container		
Liquid limit test, consisting of:	1	set
Liquid limit device	1	pc.
spatula, flexible	1	pc.
graduated cylinder	1	pc.
mixing dish	1	pc.
Plastic limit test, consisting of:	1	set
plate glass for rolling	1	pc.
* Compaction testing apparatus	1	set

NOTE: * To be provided by the DPWH

Annex G - 2
Preliminary Material Tests

Preliminary Test for Pavement Materials

1. Aggregate Test for:

- 200 - Aggregate Sub-base Course
- 202 - Crushed Stone Base Course
- 300 - Aggregate Surface Course

Test Item	Test Methods	Note
Grading	AASHTO T 27	
Liquid Limit	AASHTO T 89	
Plasticity Index	AASHTO T 90	
Abrasion Loss	AASHTO T 96	
Compaction Test	AASHTO T 180, Method D	
CBR Test	AASHTO T 193	

2. Aggregate Test for:

- 303 - Bituminous Seal Coat
Grading A (5-3 mm)
- 304 - Single Bituminous Surface Treatment (SBST)
Grading B (10-5 mm)
- 304 - Double Bituminous Surface Treatment (DBST)
Grading A (20-10 mm), Grading B (10-5 mm)
- 305 - Bituminous Penetration Macadam
Coarse, Grading A (50-25)
Key, Grade C (20-10 mm); Key, Grade B (13-5 mm);
Cover, Grade D (10-3 mm)

Test Item	Test Methods	Note
Grading	AASHTO T 27	
Specific Gravity	AASHTO T 84 - T 85	
Water Absorption	AASHTO T 84 - T 85	
Abrasion Loss	AASHTO T 96	

3. Aggregate and Mixture Proportioning Tests for:

310 - Bituminous Concrete, Hot - Laid (AC)

Test Item	Test Method	Note
Coarse and Fine Aggregates		
Grading	AASHTO T 27	
Specific Gravity	AASHTO T 84 - T 84	
Water Absorption	AASHTO T 84 - T 85	
Abrasion Loss	AASHTO T 96	
Soundness	AASHTO T 104	

Marshall Stability Asphalt Institute Manual (MS-2) Test

4. Bituminous Binder Test for:

301 - Bituminous Prime Coat	Cut-Back Asphalt MC-70
303 - Bituminous Seal Coat	Cut-Back Asphalt MC-800
304 - Single Bituminous Surface Treatment	Cut-Back Asphalt MC-800
305 - Bituminous Penetration Macadam	Cut-Back Asphalt MC-800
310 - Bituminous Concrete, Hot Laid	Asphalt Cement 60-70

Binder	Test Item	Note
Cut-Back Asphalt MC-70	AASHTO M-82	
Cut-Back Asphalt MC-800	AASHTO M-82	
Asphalt Cement 60-70	AASHTO M-226	

Annex G - 3
Quality Control Tests

Table 1 Quality Control for Sub-base

Pavement Course	Control Items	Tolerance	Frequency
105 Subgrade Preparation	Proof rolling		Any time required
200 Sub-base	Permitted variation from design THICKNESS OF LAYER	± 20 mm	Every 50 m
	Permitted variation from design LEVEL OF SURFACE	+ 10 mm - 20 mm	Every 50 m
	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	20 mm	Every 50 m
	Permitted variation from design across fall or CAMBER	+ 0.3 %	Every 50 m
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	+ 0.1 %	Every 25 m
	Moisture Content		Any time required
	Grading 25 mm Sieve	55-85 %	Every 50 m
	9.5 mm Sieve	40-75	
	0.075 mm Sieve	0-12	
	LL	35 %	Any time required
PI	12 %		
Compaction	100 %	Every 50 m	
AASHTO T 191			
AASHTO T 180, Method D			

Table 2 Quality Control for Base

Pavement Course	Control Items	Tolerance	Frequency
202 Sub-base	Permitted variation from design THICKNESS OF LAYER	± 10 mm	Every 50 m
	Permitted variation from design LEVEL OF SURFACE	+ 5 mm + 10 mm	Every 50 m
	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	5 mm	Every 50 m
	Permitted variation from design across fall or CAMBER	± 0.2 %	Every 50 m
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	± 0.1 %	Every 25 m
	Moisture Content		Any time required
	Grading 19 mm Sieve	60-85 %	Every 50 m
	4.75 mm Sieve	30-55	
	0.425 mm Sieve	10-30	
	0.075 mm Sieve	2-14	
LL	< 25 %	Any time required	
PI	< 6 %		
Compaction	100 %	Every 50 m	
AASHTO T 191			
AASHTO T 180, Method D			

Table 3 Quality Control for Gravel Surface

Pavement Course	Control Items	Tolerance	Frequency
300 Aggregate Surface	Permitted variation from design THICKNESS OF LAYER	+ 15 mm - 5 mm	Every 50 m
	Permitted variation from design LEVEL OF SURFACE	+ 15 mm - 5 mm	Every 50 m
	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	5 mm	Every 50 m
	Permitted variation from design across fall or CAMBER	+ 0.2 %	Every 50 m
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	+ 0.1 %	Every 25 m
	Moisture Content		Any time required
	Grading	9.5 mm Sieve 4.75 mm Sieve 0.425 mm Sieve 0.075 mm Sieve	50-85 % 35-65 15-30 5-20
LL		35 %	Any time required
PI		4-9 %	
Compaction	AASHO T 191 AASHO T 180, Method D	100 %	Every 50 m

Table 4 Quality Control Item for Bituminous Prime Coat,
Bituminous Seal Coat, Bituminous Surface Treatment

Pavement Course	Control Items	Tolerance	Frequency
301 Bituminous Prime Coat	MC-70 Binder application rate; lit/m ²	%	Every 50 m
302 Bituminous Seal Coat	MC-3000 Binder application rate; lit/m ²	%	Every 50 m
	Aggregate Type 2 spreading rate; kg/m ²	%	Every 50 m
304 Single Bituminous Surface Treatment	MC-3000 Binder application rate; lit/m ²	%	Every 50 m
	Aggregate grading B spreading rate; kg/m ²	%	Every 50 m
304 Double Bituminous Surface Treatment	MC-3000 Binder		
	1st layer application rate lit/m ²	%	Every 50 m
	2nd layer application rate lit/m ²	%	Every 50 m
	Aggregate Grading A		
	1st layer spreading rate kg/m ²	%	Every 50 m
	Aggregate Grading B		
2nd layer spreading rate kg/m ²	%	Every 50 m	
Total Quantities			
	Binder : lit/m ²	%	
	Aggregate : kg/m ²	%	
Permitted surface Irregularity			
Measured by 3-m straight edge		(6 mm	Every 50 mm

Note: Tolerance spreading rate shall be specified during construction as directed by the engineer.

Table 5

Quality Control Item for
Bituminous Penetration Macadam

Pavement Course	Control Items	Tolerance	Frequency
305 Bituminous Penetration Macadam Pavement	Aggregate		
	1st layer, Grading A (Coarse 50-20 mm)		
	spreading rate: kg/m ²	%	Every 50 m
	2nd layer, Grading C (Key 20-10 mm)		
	spreading rate: kg/m ²	%	Every 50 m
	3rd layer, Grading B (Key 13-5 mm)		
	spreading rate: kg/m ²	%	Every 50 m
	4th layer, Grading D (Cover 10-3 mm)		
	spreading rate: kg/m ²	%	Every 50 m
	MC-3000 Binder		
	1st layer application rate lit/m ²	%	Every 50 m
	2nd layer application rate lit/m ²	%	Every 50 m
	3rd layer application rate lit/m ²	%	Every 50 m
Total Quantities			
Aggregate : kg/m ²	%		
Binder : lit/m ²	%		
Permitted surface Irregularity			
Measured by 3-m straight edge	(6 mm)	Every 50 m	

Note: Tolerance spreading rate shall be specified during construction as directed by the engineer.

Table 6

Quality Control for Asphalt Concrete

Pavement Course	Control Items	Tolerance	Frequency
310 Bituminous Concrete Hot Laid	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	<6.0 mm	Every 50 m
	Permitted variation from design across fall or CAMBER	+0.2 %	Every 50 m
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	+0.1 %	Every 50 m
Grading F	Grading		
	4.75 mm Sieve	+7 %	Every 30 ton
	2.36 mm Sieve	+4 %	Mixing Plant
	0.075 mm Sieve	+2 %	
	Asphalt Content	+0.4 %	
	Compaction Degree of Theoretical Max. Density	>90 %	Every 50 ton Core Test
	Marshall Specimen Density		

PART H - SPECIAL PROVISIONS FOR SECTION NO. 5

SP - 1 Project Manager and Resident Engineers

The Contractor shall at all times during the execution of the work at the site provide the Project Manager.

The Project Manager shall be the authorized representative of the Contractor in execution of the Contract.

SP - 2 Laboratory Apparatus

The Contractor shall furnish the laboratory apparatus as specified in Annex H-1 during the duration of the Contract for the use in the testing laboratory, the space for which will be provided by the DPWH.

SP - 3 Laboratory Staff

The Contractor shall provide competent and experienced laboratory staff as listed below to carry out the material and quality tests under the instruction of the Engineer.

Laboratory Staff:

- 1 - Material Engineer
- 2 - Laboratory Technician
- 5 - Laborer

SP - 4 Preliminary Material Tests

Preliminary material tests shown in Annex H-2 shall be made prior to the commencement of the relevant work.

The acceptance/approval of the preliminary samples shall not be considered as guarantee of acceptance of all materials from the same source, nor the quality or quantity of such materials, and it is understood, any materials which have been sampled and passed satisfactory may be resampled and tested anytime before, during and after incorporation into the work.

SP - 5 Quality Control Tests

Required quality control tests are listed in Annex H-3.

The laboratory staff assigned by the Contractor shall assist the Engineer and his staff in conducting the quality control tests.

The Contractor shall not be allowed any compensation for any delays or damages sustained pending the completion of testing and approval.

SP - 6 Vehicles for the Engineer's Staff

The Contractor shall provide one (1) 4-wheel drive pick-up vehicle with driver for the exclusive use of the Engineer's Staff. The vehicle to be provided by the Contractor shall be to the satisfaction to the Engineer. The vehicle shall comply in all respects with all relevant Philippines national or local laws, statutes and regulations.

The Contractor shall maintain the vehicle in good condition and shall be supplied with appropriate fuel and lubricants at all times.

He shall provide equivalent substitute vehicle during any period when the specified vehicle is taken out of service for maintenance, repair or any other reason.

SP - 7 Informatory Signs

The Contractor shall furnish and install informatory signs at both ends of each section in accordance with the details shown on the Plans. Exact location of informatory signs will be directed by the Engineer

SP - 8 Photographs

The Contractor shall provide progress photographs taken as, when and where directed by the Engineer. The photographs shall be sufficient in number and location to record the exact progress of the works. The Contractor shall provide one proof print of each photograph taken, and the negative and ten copies, not less than 254 mm x 203 mm and printed on glossy paper, of any of the photographs selected as progress photographs by the Engineer.

SP - 9 Measurement and Payments

Lump-sum items shall be provided for the provision of:

- Laboratory Apparatus
- Laboratory Staff
- Vehicles for the Engineer's Staff

The quantities for informatory signs shall be the number of informatory signs installed at site and approved by the Engineer.

The quantities for progress photographs shall be the number of photographs selected and provided as progress photographs.

No measurement for payment will be made for other items, than mentioned above but the costs thereof will be considered incidental to the cost of the other Contract Items.

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
SP - 2	Laboratory Apparatus	Lump sum
SP - 3	Laboratory Staff	Lump sum
SP - 6	Vehicles for the Engineer's Staff	Lump sum
SP - 7	Informatory Signs	Each
SP - 8	Photographs	Each

Annex H - 1

List of Laboratory Apparatus

LIST OF LABORATORY APPARATUS

For the Laboratory:

<u>Description</u>	<u>Quantity</u>	<u>Unit</u>
Sieve standard, 200 mm diameter, opening 37.5 mm	1	pc.
diameter, opening 25.0 mm	1	pc.
diameter, opening 19.0 mm	1	pc.
diameter, opening 9.5 mm	1	pc.
diameter, opening 4.75 mm	1	pc.
diameter, opening 2.00 mm	1	pc.
diameter, opening 0.425 mm	1	pc.
diameter, opening 0.075 mm	1	pc.
Pan, brass 200 mm diameter x 50 mm deep	1	pc.
Cover, brass, sieve	1	pc.
Brush, fine sieve	1	pc.
Brush, wire sieve	1	pc.
Moisture content can, 225 ml tin	25	pcs.
Field density consisting of:		
sand density cone	1	pc.
jug, glass or plastic 4-lit. cap,	1	pc.
density plate	1	pc.
straight edge	1	pc.
spoon	1	pc.
25 mm chisel, steel	1	pc.
4-lit. field can	1	pc.
mallet, sand	1	pc.
Electronic Precision Balance sensitivity 40 kg or 1 gram	1	pc.

Description	Quantity	Unit
Electronic Precision Balance sensitivity 310 gram or 0.001 gram	1	pc.
Balance, solution, 20 kg. capacity x 1 gram (Field Balance)	1	pc.
Balance, Triple Beam, 311 g. capacity x 0.01 gram	1	pc.
Oven, field, with temperature control	1	pc.
Density testing apparatus consisting of:	1	set
Flat, form weighing balance	1	pc.
wire basket	1	pc.
Water container		
Liquid limit test, consisting of:	1	set
Liquid limit device	1	pc.
spatula, flexible	1	pc.
graduated cylinder	1	pc.
mixing dish	1	pc.
Plastic limit test, consisting of:	1	set
plate glass for rolling	1	pc.
Slump Test Cone	1	set
Beam Mold	9	pcs.
* CBR compaction testing apparatus	1	set

NOTE: * To be provided by the DPWH

Annex H - 2

Preliminary Material Tests

Preliminary Test for Pavement Materials

1. Aggregate Test for:

- 200 - Aggregate Sub-base Course
- 202 - Crushed Stone Base Course

Test Item	Test Methods	Note
Grading	AASHTO T 27	
Liquid Limit	AASHTO T 89	
Plasticity Index	AASHTO T 90	
Abrasion Loss	AASHTO T 96	
Compaction Test	AASHTO T 180, Method D	
CBR Test	AASHTO T 193	

2. Aggregate and Mixture Proportioning Tests for:

- 310 - Portland Cement Concrete (PCC)

Test Item	Test Method	Note
Coarse and Fine Aggregates		
Grading	AASHTO T 27	
Specific Gravity	AASHTO T 84 - T 84	
Water Absorption	AASHTO T 84 - T 85	
Abrasion Loss	AASHTO T 96	
Soundness	AASHTO T 104	

Marshall Stability Asphalt Institute Manual (MS-2) Test

3. Aggregate and Mixture Proportioning Test for:

- 310 - Portland Cement Concrete (PCC)

Test Item	Test Method	Note
Coarse and Fine Aggregate		
Grading	AASHTO T 27	
Specific Gravity	AASHTO T - 84 - T 85	
Water Absorption	AASHTO T - 84 - T 85	
Abrasion Loss	AASHTO T 96	
Soundness	AASHTO T 104	

Flexural Strength Test

4. Bituminous Binder Test for:

301 - Bituminous Prime Coat	Cut-Back Asphalt MC-70
310 - Bituminous Concrete, Hot Laid	Asphalt Cement 60-70

Binder	Test Item	Note
Cut-Back Asphalt MC-70	AASHTO M-82	
Asphalt Cement 60-70	AASHTO M-226	

5. Portland Cement Test for:

311 - Portland Cement Concrete Pavement

Portland Cement	Test Item	Note
Type I Portland Cement	AASHTO M-85	

Annex H ~ 3
Quality Control Tests

Table 1 Quality Control for Sub-base

Pavement Course	Control Items	Tolerance	Frequency
105 Subgrade Preparation	Proof rolling		Any time required
200 Sub-base	Permitted variation from design THICKNESS OF LAYER	± 20 mm	Every 50 m
	Permitted variation from design LEVEL OF SURFACE	+ 10 mm - 20 mm	Every 50 m
	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	20 mm	Every 50 m
	Permitted variation from design across fall or CAMBER	+ 0.3 %	Every 50 m
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	+ 0.1 %	Every 25 m
	Moisture Content		Any time required
	Grading 25 mm Sieve	55-85 %	Every 50 m
	9.5 mm Sieve	40-75	
	0.075 mm Sieve	0-12	
	LL	35 %	Any time required
PI	12 %		
Compaction	100 %	Every 50 m	
AASHO T 191			
AASH T 180, Method D			

Table 2 Quality Control for Base

Pavement Course	Control Items	Tolerance	Frequency
202 Sub-base	Permitted variation from design THICKNESS OF LAYER	± 10 mm	Every 50 m
	Permitted variation from design LEVEL OF SURFACE	+ 5 mm	
		+ 10 mm	Every 50 m
	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	5 mm	Every 50 m
	Permitted variation from design across fall or CAMBER	± 0.2 %	Every 50 m
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	± 0.1 %	Every 25 m
	Moisture Content		Any time required
	Grading 19 mm Sieve	60-85 %	Every 50 m
	4.75 mm Sieve	30-55	
	0.425 mm Sieve	10-30	
0.075 mm Sieve	2-14		
LL	<25 %	Any time required	
PI	< 6 %		
Compaction	100 %	Every 50 m	
AASHTO T 191			
AASHTO T 180, Method D			

Table 3 Quality Control for Asphalt Concrete

Pavement Course	Control Items	Tolerance	Frequency
310 Bituminous Concrete Hot Laid	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	< 6.0 mm	Every 50 m
	Permitted variation from design across fall or CAMBER	± 0.2%	Every 50 m
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	± 0.1%	Every 25 m
Grading F	Grading		Every 30 ton Mixing Plant
	4.75 mm Sieve	+7 %	
	2.36 mm Sieve	+4 %	
	0.075 mm Sieve	+2 %	
	Asphalt Content	+0.4 %	
	Compaction Degree of Theoretical Max. Density	>94 %	Every 50 m Core Test
	Marshall Specimen Density		

Table 4 Quality Control for Portland Cement Concrete

Pavement Course	Control Items	Tolerance	Frequency	
311 Portland Cement Concrete Hot Laid	Permitted variation from design THICKNESS OF LAYER	- 5 mm	Every 50 m	
	Permitted variation from design LEVEL OF SURFACE	± 5 mm	Every 50 m	
	Permitted SURFACE IRREGULARITY Measured by 3-m straight-edge	> 3.0 mm	Every 50 m	
	Permitted variation from design across fall or CAMBER	± 0.2%	Every 50 m	
	Permitted variation from design LONGITUDINAL GRADE over 25 m length	± 1%	Every 25 m	
Grading C	Grading of Coarse Aggregate	63 mm Sieve 50 mm Sieve 25 mm Sieve	100 95-100 35-70	Every day before start mixing at mixing Plant
	Grading of Fine Aggregate	12.5 mm Sieve 4.75 mm Sieve	10-30 0-50	
	Grading of Coarse Aggregate	9.5 mm Sieve 4.75 mm Sieve 1.18 mm Sieve	100 95-100 45-80	Every day before start mixing at mixing Plant
	Grading of Fine Aggregate	.30 mm Sieve .15 mm Sieve	5-30 0-10	
	Water Cement Ratio			
	Slump Test		40-76 mm	Every track mixer at job site
	Bending Strength		>39 kg/cm ²	Every 50 m sampling Consisting of three (30) Beam specimen

