SERIES 7000: RIGID PAVEMENTS

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DIVISION 7100: RIGID (CONCRETE) PAVEMENT

7101 SCOPE

This Division covers the construction of a surface course of Portland cement concrete, with or without reinforcement, and includes, inter alia, the specifications for materials, the placing and compacting of concrete, applying the surface texture, and constructing the joints.

7102 MATERIAL FOR CONCRETE

(a) Cement

Cement used for concrete shall be Portland cement, Type I or Type II conforming to AASHTO M 85 or equivalent ISO standard class.

Portland cement, Type II, which has been pre-blended with a maximum of 15 percent fly ash, by weight, and conforming to AASHTO M 240, may be used. When blended Portland cement is used, no additional fly ash shall be added.

Different brands of cement, or the same brand of cement from different mills, shall not be mixed.

The use of other cementitious binders may be allowed by the Engineer, provided that it can be proved by the Contractor that they perform similarly to the cements specified above.

Suitable means shall be provided for storing and protecting the cement against dampness. Cement which for any reason has become partially set or which contains lumps of caked cement will be rejected. The temperature of the cement at the time of delivery to the mixer shall not exceed 71°C.

(b) Water

Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

Water will be tested in accordance with and shall meet the requirements of AASHTO T 26. Water known to be of potable quality may be used without test.

Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

(c) Admixtures to concrete

No admixtures shall be used without the written permission of the Engineer.

Accelerating, Retarding and Water-Reducing Chemical admixtures shall comply with AASHTO M 194.

When a retarding admixture is required it shall be Type D, a water -reducing -retarding admixture as designated in the above specification.

Care should be taken not to combine chemical admixtures together in to a mixture unless they are compatible.

Chloride accelerators shall not be used. Admixtures shall not contain calcium chloride, calcium formate, or triethanolamine. An air-entraining agent shall be included in the mix.

The Contractor shall submit details of the nominated mix and the Contractor shall nominate the proprietary source, type and name for each admixture to be used. Documentary evidence of the quality and chemicals compatibility shall be furnished by the Contractor to the Engineer upon request at any stage of the work.

(d) Air-entraining admixtures

Air -entraining admixtures shall comply with AASHTO M154.

A certified affidavit and test result evidence based on tests made in a recognised laboratory shall be submitted to the Engineer by the Contractor.

(e) Aggregates

Aggregates from a single source shall be used in any one-construction work unless specifically authorized by the Engineer. The maximum soluble sulphate salt content of aggregates, expressed as percentage SO_3 by mass, shall not exceed 0.1 %.

Aggregates containing more than the maximum permissible amount of sulphates or with visible encrustation of salts shall be washed and drained before being used in concrete. The Engineer may direct washing or re washing of the aggregates until he is satisfied that harmful quantities of salts are not present.

(i) Fine Aggregate

Fine aggregate can be natural sand, manufactured sand, or a combination of natural and manufactured sand, meeting the following requirement

a) Natural Sand - shall be composed of clean, hard, durable, uncoated grains, free from lumps or flaky particles, organic matter, loam, or other deleterious substances.

b) Manufactured sand - shall be made from stone meeting all the quality requirements for coarse aggregates.

c) Mixtures of Natural Sand and Manufactured sand - when the blend is approved the two materials shall be stored and batched separately.

2) Organic Impurities - all fine aggregate shall be free from injurious amounts of organic impurities. Fine aggregates subjected to the colorimetric test of AASHTO T 21 for organic impurities and producing a colour darker than 3 shall not be used unless the following criteria is met: A fine aggregate with the colour darker than 3 may be used provided that the relative strength at 7 and 28 days is not less than 95% when tested in accordance with AASHTO T 71.

3) Soundness - When the fine aggregate is subjected to five alternations of the sodium sulphate soundness test AASHTO T 104 the weighted loss shall not exceed 10% by weight.

4) Gradation of Fine Aggregate- for all classes of Portland cement concrete and concrete pavement shall confirm to the following gradation:

Table 7100-1 Gradation of Fine Aggregate

AASHTO Standard Sieve Designation	Per Centage by weight passing
9.5 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	50-85
0.600 mm	25-60
0.300 mm	10-30
0.150 mm	1-10
0.075 mm	0-3

(ii) Coarse Aggregate

Coarse aggregate for Portland cement concrete shall conform to the following requirements:

1) General- Coarse aggregate shall be clean, tough, durable gravel, crushed gravel, hard durable rock, metallurgical furnace slag or gravel. It shall be free from soft, thin, elongated or laminated pieces. If required, coarse aggregate shall be washed to produce a clean aggregate.

2) Los Angeles abrasion AASHTO T96 shall not exceed 40%.

3) Sodium sulphate soundness test AASHTO T 104, the weighted loss shall not exceed 15%.

4) Adherent coating in accordance with FLH T 512 shall not exceed 1.0%.

5) The nominal size of coarse aggregate shall not exceed 37.5 mm. When the spacing between longitudinal reinforcement is less than 90 mm, the nominal size of coarse aggregate shall not exceed 19 mm.

In addition, when the slab thickness is 150 mm and over but less than 175 mm, the nominal size of coarse aggregate shall not exceed 25 mm, and when the slab thickness is 100 mm and over but less than 150 mm, the nominal size of coarse aggregate shall not exceed 19 mm.

6) Gradation of Coarse Aggregate are as follows:

Table 7100-2 Gradation for Coarse Aggregate

AASHTO Standard Sieve(mm)	Percentage by Mass Passing								
	50	**37.5**	**25**	**19**	**12.5**	**9.5**	**4.75**	**2.36**	**1.18**
37.5 to 19.0	100	90-100	20-55	0-15		0-5			
37.5 to 4.75	100	95-100		35-70		10-30	0-5		
25.0 to 12.5		100	90-100	20-55	0-10	0-5			
25.0 to 9.5		100	90-100	40-75	15-35	0-15	0-5		
25.0 to 4.75		100	95-100		25-60		0-10	0-5	
19.0 to 9.5			100	90-100	20-55	0-15	0-5		
19.0 to 4.75			100	90-100		20-55	0-10	0-5	
19.0 to 2.36			100	90-100		30-65	5-25	0-10	0-5
12.5 to 4.75				100	90-100	40-70	0.15	0-5	
12.5 to 2.36				100	90-100	40-70	5-25	0-10	0-5

(f) Materials for joints

(i) Preformed Expansion Joint Filler

Preformed fillers for joints shall conform to AASHTO M 33, AASHTO M 153 Type II, and AASHTO M 213 and shall be punched to admit the dowels. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape by stapling or other positive fastening.

The use of preformed, closed-cell, polyethylene foam backer joint filler shall conform to ASTM D 3204, Type I and shall be limited to vertical applications only.

(ii) Preformed Elastomeric Compression Seals

Preformed elastomeric compression seals used shall comply with the requirements of AASHTO M 220. The seals shall be manufactured in accordance with an extrusion process, from an elastomeric material consisting entirely of polychloroprene, which is subsequently vulcanized.

(iii) Preformed Self-Expanding Cork Joint Sealer

This shall comply with the requirements of AASHTO M 153.

(iv) Joint Sealers

Hot-poured joint sealer shall conform to AASHTO M 301. Cold-poured joint sealant shall be silicone type conforming to US Federal Specification TT-S-1543A, Class A. The sealant shall be a one-part, low-modulus silicone rubber type with an ultimate elongation of 1200 percent.

Silicone Sealant -when specified, shall meet the detailed requirements as stated in the special provisions or as provided by the manufacturer. The test methods shall conform to ASTM-D-792, ASTM D 2240, ASTM C 794 & ASTM C793-7. The silicone joint sealant shall be grey in colour and shall be stored and installed in accordance with the manufacturer's written instructions.

(g) Materials for reinforcing steel, tie-bars and dowels

Reinforcing steel for concrete pavements shall be of the type, length, size, spacing, and quantity shown on the plans and shall meet the requirements specified herein after.

All steel shall be clean and free from mill scale, loose rust or oil.

Reinforcement steel may be either deformed steel bars or cold-drawn steel wire conforming to the following:

(i) Bar Mats

Bar mats shall be cold-drawn steel wire or deformed steel bars from new billet steel conforming to AASHTO M 31 M. The bars shall be size No. 10. All bars shall have the tensile requirement of Grade 300 or 400.

Fabrication of bar mats using deformed steel bars shall be in accordance with ASTM A 184/A 184 M. Bar mats fabricated using rolled cold-drawn steel wire shall be in accordance with ASTM A 82.

(ii) Welded Steel Wire Fabric

Welded steel wire fabric shall conform to AASHTO M 55M/M 55.

Wire fabric shall not be less than 1.5 meters in width and shall be shipped in sheets and not in rolls.

(iii) Tie Bars & Dowels

Tie bars shall be deformed bars conforming to AASHTO M 31 M. All bars shall have the tensile requirements of Grade 400.

Tie bars for use across joints shall have an epoxy coating conforming to AASHTO M 284/M 284 M except that the thickness of the cured coating shall be 250 +/- 50 microns.

Dowel bars shall be plain, round bars conforming to AASHTO M 254 type A or B. They shall be free from burring or other deformation restricting slippage in concrete.

Dowel bars shall be coated with an approved material to break the bond between the steel and concrete.

Place dowels and tie bars across joints where indicated, correctly aligned, and securely held parallel to the surface of the finished pavement, such that after placement they remain in their specified location. The spacing and vertical location of dowels and tie bars shall be as detailed except where the planned spacing cannot be maintained because of form length or interference with form braces. In such cases, closer spacing with additional dowels or tie bars shall be used.

All reinforcement, dowels and tie bars shall be clean and free of oil, grease, loose rust and other foreign material when the concrete is placed. Paint free portions of dowel S, including ends, with two coats of bituminous emulsion. The unpainted portions of dowels shall be installed in the initially placed concrete slab.

Dowels installed in contraction joints during paving operations shall be held securely in position by means of rigid metal frame cradles to prevent them from rising, sliding out or becoming distorted under paving operations.

Dowels and tie bars in fixed form paving shall be placed by the bonded-in-place method. Installation by removing and replacing dowels and tie bars in preformed holes, including their withdrawal to assist in form stripping, will not be permitted.

(h) Curing materials

Curing materials for Portland cement concrete shall conform to the following:

Liquid membrane-forming compounds shall conform to AASHTO M 148, Type 1-D, clear or translucent with fugitive dye, or Type 2, white pigmented.

Burlap cloth made from jute or kenaf shall conform to AASHTO M 182, Class 4.

White polyethylene sheeting shall conform to AASHTO M 171 for white opaque polyethylene film.

White burlap-polyethylene sheeting shall conform to AASHTO M 171.

Waterproof paper shall conform to AASHTO M 171.

Hay or straw when used for insulation in cold weather shall be dry and shall not be reused unless otherwise approved.

Liquid membrane -Forming compounds, shall conform to AASHTO M 148

(i) Separation membrane

Separation membranes, to be used between jointed reinforced concrete surface slabs or unreinforced concrete surface slabs and the sub-base, shall be impermeable plastic sheeting 125 microns thick.

(j) Concrete requirements

(i) Proportions

Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, fly ash, water-granulated blast- furnace slag, water, and chemical admixtures as proposed by the Contractor and approved by the Engineer to produce concrete of the specified strength and workability.

Mix design, manufacture, placing, compaction and finishing of concrete shall be the responsibility of the Contractor.

Concrete Strength- the mix will be designed to produce concrete with a minimum job average flexural strength of 35 MPa at 28 days.

The concrete shall contain the amount of cement as directed by the Engineer but in no case shall the concrete contain less than 320 kg/m^3 .

Water cement ratio, including moisture on the aggregates, shall not be more than 0.53. This shall be maintained by use of chemical admixtures and or additional if necessary.

Workability of Concrete -concrete shall be uniformly plastic and workable. The consistency of the concrete shall be determined by the slump test in accordance with Method SC-T-42. The slump shall be in the range of 25 mm to 60mm or 37.5mm +or- 25mm for slip - form paving and 4 inches maximum for hand or other means of paving.

Air Content -Where the Contractor wishes to use an air-entraining agent, the total air content in the freshly mixed concrete shall be M ± 1%, where M is the target value within the limits of 2% to 4%. Tests shall be conducted in accordance with ASTM C 231.

The percentage of entrained air voids in the mix shall be from 3 to6 percent.

Where concrete is to be cast between fixed forms the nominal maximum size of the mix shall be 40mm.

Where the Engineer has approved of the placement of concrete by means of a self-propelled slip-form paving machine, the mix design, slump and workability shall suit the machine proposed for use.

(ii) Determining the Mix Proportions

1. General

The preliminary proportions of cement and aggregate required for producing concrete which complies with the requirements of these Specifications shall be determined by way of laboratory tests on concrete manufactured from the cement, coarse and fine aggregates, admixtures (if any) and water proposed for use in the works.

2. Preliminary Tests

At least sixty days prior to the construction of the trial pavement as specified in Clause 7117, the Contractor shall submit to the Engineer samples of all the components of the concrete he proposes to use, and a report by an approved testing laboratory showing the mix proportions proposed for each combination of material sources for the concrete. The report shall also show the following:

- The results of tests on the specified properties of all components.
- The relationship between the 28-day compressive strength and flexural strength of the concrete at each of at least three water : cement ratios namely 0.48, 0.53 and 0.58.
- The effect of the particular admixture (if any) proposed by the Contractor in regard to variations in admixtures, air content (if air entraining) and concrete setting and sawing times.
- The effect of at least three water contents on concrete consistence.

In determining the relationship between compressive and flexural strength, the tests shall be based on not less than six compressive-strength specimens and six flexural-strength specimens for each water : cement ratio. All strength tests shall be conducted in accordance with ASTM C 39 and ASTM C 78.

3. Changes in the Mix Proportions or the Materials

If during the progress of the work the requirements set out in Sub-clause 7102(j) are not being met by concrete manufactured from the materials or material mix proportions being used, the Contractor shall immediately cease producing such concrete and shall effect such changes to the mix proportions and/or materials as may be necessary in order to meet those requirements.

If during the progress of the work the Contractor wishes to use materials or mix proportions other than those originally approved, or if the materials from the sources originally approved change in regard to properties, he shall before proceeding with further work submit adequate evidence to the Engineer that the new materials or combination of materials will produce concrete which complies with the requirements of Sub-clause 7102(j) and will not bring about detrimental changes in the properties of the concrete.

Any such changes made shall be at the Contractor's expense, and no extra payment will be allowed by reason of such changes.

Where concrete is placed by hand and vibrated or finished with hand equipment, the requirements of Sub-clause 7102(j) shall remain applicable irrespective of the size of the concrete panel or concrete patch placed. The mix proportions, however, shall be adjusted to promote hand placing, vibrating and finishing, and only if the Contractor has produced written proof to the Engineer that the requirements of Sub-clause 7102(j) cannot be complied with under the circumstances, will the Engineer change the requirements in accordance with Sub-clause 7102(j)(ii)4 at his own discretion.

(iii) Changes in Requirements

The Engineer shall have the power, at any time during the progress of the work, to order changes in the requirements set out in Sub-clause 7102 J.In such cases, the Contractor shall be compensated in accordance with the terms of the General Conditions for the additional cost of materials or additional handling, placing and/or other costs, if any, entailed by such changes. If such changes result in savings, the Engineer shall recover such savings from the Contractor.

(k) Handling, measuring and batching materials for concrete

(i) Storing the Materials

Stockpiling of aggregates, the location and preparation of the sites, the minimum size of pile and the method adopted to prevent coning or other segregation of component sizes shall be subject to the approval of the Engineer.

Stockpiles shall be built up in layers of not more than 3 feet 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. Under no circumstances will coning of stockpiles be permitted.

Aggregates from different sources shall not be stockpiled together unless approved by the Engineer.

The fine aggregate and coarse aggregate shall be separately weighed into the hopper in the respective amounts set by the Engineer in the job mix approval.

Cement shall be stored in a silo or in a dry weatherproof shed with a raised wooden floor, and each consignment shall be stacked separately. Cement shall be used in the order in which it has been delivered at the site.

The various types of admixtures shall be properly marked and stored separately.

(ii) Transporting

When mixing of the concrete is to be done at the job site, materials shall be transported from the batching plant to the mixer in vehicles appropriate for this job.

In the dry batch process, bulk cement shall be transported to the roadside paver in watertight compartments carrying the full amount of cement required for the batch, or, if permitted, between the fine and coarse aggregate.

Concrete shall be so transported to its final position that segregation or loss of any of the ingredients, or contamination will be prevented and that the mix is of the required workability at the point and time of placing.

Concrete shall be protected against rain, heat, direct sunlight and/or evaporation by means of covers on all open vehicles. No additional water may be added in transit or where delivered.

The time lapse from the moment when the cement and aggregate are intermingled up to the time of placing and compacting the concrete shall not exceed 60 minutes when concrete is

transported In truck agitators, and shall not exceed 45 minutes in mild weather or 30 minutes when the concrete temperature is 30°C or higher when transported in ordinary trucks.

(iii) Proportioning the Components

All components shall be accurately proportioned in approved automatic proportioning devices to within the following tolerances, and supplied separately at the mixing drums.

a) Cement : ± 2% of the prescribed mass of cement.
b) Aggregate: Each fraction within ± 3% of the prescribed mass of the fraction in question.
c) Water: ± 2% of the prescribed volume or mass.

Admixtures: Admixtures shall be admixed in part of the mixing water after having been carefully measured in an automatic proportioning device capable of proportioning the admixture in quantities which will not deviate by more than 2% from the required quantities, and shall be done so as to spread the agent uniformly throughout the entire concrete mix during the mixing process.

Water for the mix may be measured by volume or by weight. The accuracy of the water - measuring equipment shall be within a range of error of not over 1%, and shall be so arranged that the measurement will not be affected by variations of pressure in the water supply line and will be accurate under all construction conditions encountered.

Methods and equipment for adding air-entraining agent or other admixtures into the batch, shall be as recommended by the manufacturer.

(iv) Mixing the Concrete

1. Batch mixing

All concrete shall be mixed in mechanically operated batch mixers. The concrete may be mixed at the site of the work in a central-mix plant, in truck mixers when allowed, or in a roadside paver.

The mixing period shall be at least 90 seconds, but may be reduced to as little as 50 seconds by or increased by the Engineer if necessary, to produce a homogeneous mass.

The production capacity of the mixing plant shall be in accordance with the capacity of the paver used. Where the mixing plant is supplied with more than one drum, the same unit shall be used for proportioning the components.

The drums shall always be kept clean, and all build-up shall be removed. The total period between the times that the cement is placed in the drums until mixing starts shall not exceed 15 minutes.

An overload up to 10% above the mixers nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency is satisfactory and no spillage of concrete occurs.

Concrete shall not be mixed when either the coarse or fine aggregate contains frozen particles.

No more concrete shall be mixed than can be placed, finished, and covered during daylight, unless the Engineer approves an artificial lighting system.

2. Transit-mixing

The Contractor will be permitted to use appropriate truck mixers, which agitate previously mixed concrete in transit.

Mixed concrete from the central - mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited in place shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators.

7103 PREPARING THE UNDERLYING LAYERS

(a) Preparation of sub-base

The underlying layers shall be constructed in accordance with the Standard Specifications and the Project Specifications up to the level of the underside of the concrete slab.

The Contractor shall note the provisions regarding the construction tolerances for underlying pavement layers and shall make provision in his prices for any additional concrete, which may be necessary in respect of irregularities in the layer underlying the concrete pavement.

The Sub-base shall be brought to reasonably close conformity to the lines, grades and typical sections as shown on the plans or as designated by the Engineer.

The Sub-base shall include an area three 900 mm in width extending beyond the edges of the base course or pavement unless shown otherwise on the plans.

When curb and gutter is constructed contiguous with the pavement the sub-base shall include an area two 610 mm in width extending beyond the back of the curb and gutter.

The Sub-base shall be completed for at least 800 meters in advance of concrete placing operations when this distance is available.

(b) Conditioning of sub-base or base course

(i) Compaction

The entire sub-base or base layer shall be thoroughly compacted. Any portion of the sub-base that is not accessible to a roller shall be compacted with hand tampers to obtain the density requirements for the material.

(ii) Wetting the sub-base

The sub-base shall be kept continuously wet for a period of at least one hour before the concrete is placed. Immediately before the concrete is placed, the excess water shall be broomed off the road ahead of the paver so as to ensure that the sub-base will still be damp when the concrete is placed, but no puddles of water or deleterious matter shall be left on the road.

(iii) Protection

Before placing any surfacing material on any section, ditches and drains along that section shall be completed to drain the subgrade effectively. Until the sub-base or base has been checked and approved, no material shall be deposited thereon.

(c) Applying a bituminous prime coat or placing a separating membrane

Unless otherwise specified in the Project Specifications, a bituminous prime coat shall be applied to the completed and approved sub-base or capping layer as specified in Division 6100 at a rate of application ordered by the Engineer, or, where shown on the Drawings, a separating membrane shall be placed.

Before any pavement concrete is placed, the bituminous prime coat shall be checked and any areas having deficient or poor coverage, or where the bituminous coating has been damaged, shall be repaired as directed by the Engineer. The sprayed surface shall then be thoroughly cleaned. The bituminous prime coat shall be dry before any reinforcing steel, tie bars, dowels or concrete may be placed.

Separation membranes, to be used between jointed reinforced concrete surface slabs or unreinforced concrete surface slabs and the sub-base, shall be laid flat without creases. Where an overlap of plastic sheets is necessary, this shall be at least 300 mm.

7104 PLACING OF CONCRETE

(a) Compacting

The concrete shall be fully compacted by means of approved equipment and shall be free from honeycombing and planes of weakness. The average amount of air voids as measured in concrete cores shall not exceed 3% without air-entrainment when measured by ASTM C 173.

Over-vibration resulting in segregation, surface laitance, or leakage (or any combination of these) will not be acceptable.

No paving in the downhill direction will be allowed if tearing of the concrete occurs. The Contractor shall take the necessary measures to the satisfaction of the Engineer to prevent tearing of the concrete for example by carrying out the paving in the uphill direction.

(b) Time for placing and compacting

The placing, compacting and finishing of the concrete shall be carried out as quickly as possible, and the operations shall be so arranged that in any transverse section of the pavement the concrete shall be fully compacted and finished within 2.5 hours of having been mixed. This time shall be reduced by half an hour for every 5°C by which the concrete temperature is above 20°C at the time of placing, unless otherwise permitted by the Engineer.

Unless adequate lighting facilities, approved by the Engineer, are provided beforehand by the Contractor, the placing of concrete pavement shall cease in good time so that the finishing operation can still be completed during daylight hours.

(c) Adverse weather conditions

(i) Protection against rain and hail

No concrete shall be placed during rainy weather. For the concrete to be properly protected against rain and hail before it has sufficiently hardened, the Contractor shall have available at all times frame-mounted waterproof covers for protecting the surface of the unhardened concrete. In addition, when slip forms are used, the Contractor shall also provide acceptable emergency protection for the slab edges.

When rain appears to be imminent, all paving operations shall cease and the Contractor shall take the necessary steps to protect the unhardened concrete. The Contractor shall be responsible for the repair of any damage to the concrete, the texturing or the curing compound that may occur.

(ii) Cold-weather paving

All reasonable precautions shall be taken to prevent the temperature of the pavement concrete from failing below 5°C during the first 48 hours after casting.

When prevailing temperatures are low or when cold weather is forecast and there is a danger that the temperature of the freshly constructed concrete pavement will fall below the prescribed limits, the Contractor shall either cease all pavement operations or he may be permitted to proceed, provided that the Engineer is satisfied that adequate protective measures are available and will be taken to ensure that the temperature of the pavement will be maintained above 5°C for the period stated.

The Contractor will be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured shall be removed and replaced without additional compensation.

Concrete shall not be mixed when either the coarse or fine aggregate contains frozen particles.

(iii) Hot-weather paving

When paving is done during hot weather and when the temperature of the fresh concrete can be expected to exceed 25°C, the Contractor shall implement appropriate precautionary measures to place the concrete at the coolest temperature practicable.

Paving operations shall cease when the concrete temperature as discharged at the paver exceeds 32°C.

(iv) Responsibility for protection

The Contractor shall be responsible for the quality and strength of the concrete placed and for its protection, and any concrete damaged by adverse weather (e.g. any combination of high ambient temperature, low humidity, wind, rain and hail) shall be removed and replaced at the Contractor's expense.

(d) Maintaining continuity during placing

The Contractor shall make adequate advance arrangements for preventing delay in delivering and placing the concrete.

An interval of more than thirty minutes between the placing of any two consecutive batches or loads of concrete shall constitute sufficient reason for the Engineer to have the paving operations stopped, and the Contractor shall then, at his own expense, make a construction joint in the concrete already placed, at the location and of the type directed by the Engineer.

Paving operations shall be continuous, and the rate of paving shall be adjusted to suit the rate of delivery of the concrete.

(e) Width of placing

The width of concrete pavement strip to be placed in a single uninterrupted operation shall be as shown on the Drawings or specified in the Project Specifications.

7105 SIDE-FORMS, RAILS AND GUIDE WIRES

(a) Side-forms

Side-forms and rails shall be so designed, manufactured, set and supported that the completed concrete pavement will comply with all the requirements of Clause 7118.

Where the forms are tested with a 3 m straightedge, the top edge shall not deviate by more than 3 mm at any place, neither the sides by more than 6 mm. The sides shall not deviate by more than 3 mm from the vertical. The height of the side-forms shall not be less than the nominal thickness of the concrete slab less 15 mm, and the resulting opening between the side-forms and the layer on which it is supported shall be caulked with a stiff mortar consisting of one part of rapid-hardening cement and 3 parts of sand by volume and finished vertically on the inside, and the mortar shall have hardened before any concrete may be cast against it.

The rails, side-forms and running surface shall be kept clean in front of the wheels of all paving equipment.

Side-forms shall not be removed before the concrete has hardened sufficiently to prevent damage being done to the sides and loosening of tie-bars or dowels, if any, and not earlier than 6 hours after the completion of the construction of the slab. The side-forms shall also be removed in a timely manner to permit the sawing of transverse joints up to the edges of the concrete slab.

Projecting tie-bars and/or the concrete shall not be damaged during removal of the side-forms.

Before any side-forms may be ordered or brought onto the site, particulars regarding the side-forms shall have been approved by the Engineer.

(b) Rails

The wheels of spreading and finishing machines and frame-mounted covers shall not run directly on the top surface on the side-forms but on rails rigidly attached to the forms, unless the forms are specially made to double as rails.

(c) Electronic control systems

Where a slipform paver is used, the alignment levels for placing the concrete shall be controlled automatically from guide wires by sensors attached at the four corners of the slipform paving machine. The alignment and level of ancillary machines for finishing, texturing and curing shall be automatically controlled relative to the guide wires and to the surface and edges of the slab.

Guide wires shall be so designed, manufactured and fixed that the paver will be capable of producing a completed slab, which will comply with the requirements of Clause 7118.

Other control methods will also be considered, and should the Engineer be satisfied that they will produce satisfactory results, their use will have to be approved in writing.

(d) Inspection of side-forms, guide wires and rails

Before any concrete may be cast, the Engineer shall approve all assembled side-forms, guide wires and rails. For this purpose, the Engineer shall be given sufficient notice and opportunity.

Approval by the Engineer will not relieve the Contractor of any of his obligations to construct the concrete slab in accordance with the specified dimensions and tolerances.

7106 PLACING, COMPACTING AND FINISHING WITH SIDE-FORMS

The paving train shall consist of several powered machines that spread, compact, finish, texture and cure the concrete in a continuous operation.

(i) Placing and Spreading

The concrete shall be spread uniformly by means of a purpose-made mechanical hopper spreader running on rails and capable of spreading the concrete uniformly to a specified level and to a uniform uncompacted density over the entire surface of the slab. The machines shall be capable of being rapidly adjusted for changes in slab thickness or crossfall.

(ii) Compaction

The concrete shall be fully compacted by vibration or by a combination of mechanical surface vibration, internal vibration and tamping. The power supply to the vibrators shall cut out automatically as soon as the compaction equipment stops moving.

Suitable internal vibrators shall be used against the sideforms and at joint assemblies to ensure compaction throughout the pavement layer.

(iii) Final Finishing

The surface of the concrete shall be finished smooth and true to grade and level by means of an initial finishing machine equipped with a transverse or oblique oscillating beam.

The final finish of the surface of the slab shall be carried out by a machine that incorporates twin oblique oscillating finishing beams. The beams in the case of both machines shall be readily adjustable for both height and tilt. The leading beam shall be vibrated. The beam shall be supported on a carriage with two wheels on either side, at least 4 metres apart in the longitudinal direction. The oscillating beams shall be of rectangular section, spanning the full width of the slab and each weighing not less than 170 kg/m.

Hand-finishing of the concrete surface shall be reduced to the absolute minimum and shall be used only to correct minor imperfections and marks on the surface.

Before the concrete starts setting, all pavement edges and the edges of joints shall be rounded off to the prescribed radius.

After finishing, the Contractor shall test the concrete surface with a straightedge of at least 3 metres in length. Irregularities indicated by the straightedge shall be removed with a long-handled hand-operated scraping straightedge of at least 3 metres length. A gangplank shall be used when walking on the concrete.

(iv) Constructing the Concrete Pavement in More than One Contiguous Strip

Where concrete is placed adjacent to an existing pavement, that part of the paving equipment running on the existing pavement shall have flanged wheels on flat-bottom section rails weighing not less than 15 kg/m or by replacing the flanged wheels on that side of the machines by smooth flangeless wheels. Before the paving operation commences, the surface regularity of the existing pavement shall comply with Division 10100 of these specifications and be thoroughly cleaned and brushed to remove all extraneous materials. The wheels shall run at a distance of not less than 300 mm from the edge of the pavement to prevent the pavement edge from spalling or cracking.

No equipment shall be run on the existing pavement until the concrete is strong enough to prevent damage from occurring, but in any case not earlier than 14 days after the construction of the slab.

Where visible cracks occur or any other damage is done to the pavement, further work involving the paver shall be suspended immediately.

The Contractor shall repair all damage at his own cost.

7107 PLACING, COMPACTING AND FINISHING WITH SLIPFORM EQUIPMENT

(a) General

Slipform paving equipment shall be used for spreading, compacting, floating and finishing the concrete in a continuous operation and in such a manner that a minimum of finishing by hand will be required and a dense and homogeneous concrete to the proper level and grade will be produced.

(b) Placing and spreading the concrete

The concrete shall be deposited without segregation ahead of the paver across its whole width and to a height, which at all times is in excess of the required surcharge.

The deposited concrete shall be struck off to the necessary average and differential surcharge by means of a strike-off plate or screw auger device extending across the entire width of the slab. The strike-off equipment shall be capable of being rapidly adjusted for changes in slab thickness or crossfall.

(c) Compacting and finishing

The slipform paver shall compact the concrete over the full paved width by means of internal vibration only or by a combination of internal and surface vibration. The vibration shall be variable with a maximum energy output of at least 2.5 kN per meter width of slab per 300 mm depth for a laying speed of up to 1.5 metres per minute or prorata for higher speeds.

The level and grades of the surface shall be automatically controlled within the prescribed tolerances by means of a sensing device running on guide wires as specified.

The consistence of the concrete shall be so controlled that the edge slump will not exceed the tolerance specified in Division 10100 of these specifications.

If approved by the Engineer, metal side-forms of sufficient thickness may be used to maintain the proper shape and line.

After the concrete has been finished by the finishing devices incorporated in the slipform paving equipment, the surface of the concrete shall be checked by means of a straight-edge of not less than 3.0 metres in length. High spots indicated by the straightedge shall be removed by hand floats.

After the final finishing and texturing of the concrete, but before curing, the pavement edges shall be rounded to the prescribed radius.

(d) Constructing the concrete pavement in more than one contiguous strip

Except for the wheels, which are in the case of slipform pavers to be replaced with rubber cushioned crawler tracks; the provisions of Sub-clause 7106(iv) shall apply when concrete is being placed in more than one contiguous strip.

(e) Track support

The Contractor shall at his own cost ensure that adequate track support is provided to suit the needs of the slipform paver, either by extending the upper pavement layers or by providing alternative support layers.

7108 PLACING, COMPACTING AND FINISHING WITH HAND EQUIPMENT

(a) General

Where the slabs are too small or irregular, or the site is so restricted as to render the use of the methods described in Clauses 7106 and 7107 impracticable, concrete shall be placed, compacted and finished by means of hand-guided twin vibratory beams and poker vibrators. If necessary, the consistence of the concrete shall be adjusted so as to be suitable for placing with hand operated equipment.

(b) Forms

Side forms complying with the requirements of Clause 7105 shall be used.

(c) Placing, spreading, compacting and finishing the concrete

The concrete shall be placed and spread uniformly to a surcharge of about one-fifth more than the final pavement thickness and shall then be compacted, struck off and finished to the level of the side forms.

The concrete shall be compacted by means of vibrating finishing beams. In addition, internal poker vibrators shall be used for slabs thicker than 150 mm. where used, the pokers shall be inserted at points not more than 500 mm apart over the whole area of the slab, and adjacent to sideforms or the edge of a previously constructed slab.

The surface shall be regulated and finished to the level of the sideforms or adjacent slabs by using twin vibrating beams. The beams shall be of metal with a contact surface at least 50 mm wide and a vibrating unit having a minimum centrifugal force of 4 kN with a frequency recommended by the manufacturer or an equivalent compactive effort. The vibrating beams shall be moved forward at a steady speed of 0.5 m to 1.0 m per minute while vibrating over the compacted surface, to produce a smooth finish.

The surface shall then be further smoothed by at least two passes of a scraping straightedge with a blade length of not less than 2.4 m.

The final surface finish of the concrete shall be effected by means of hand-operated floats. The finishing of the concrete surface shall be to the same standard as specified in Division 8200 of these specifications.

7109 STEEL REINFORCEMENT

(a) General

Spacing of bars shall be as indicated on the Drawings or specified in the Project Specifications.

Laps in longitudinal bars shall not be less than 35 bar diameters or 450 mm whichever is greater. In continuously reinforced concrete slabs, only one third of the laps may be in any one transverse section, except in single bay width construction where half the laps may be in any one transverse section. There shall be a minimum of 1.2 m longitudinally between groups of transverse laps or laps in prefabricated reinforcement sheets. Alternatively, the reinforcement may be butt welded.

Laps in any transverse reinforcement shall be a minimum of 300 mm.

Where prefabricated reinforcement sheets are used and longitudinal and transverse laps would coincide, no lap is required in the transverse bars within the lap of the longitudinal

reinforcement. These transverse bars may be cropped or fabricated shorter so that the requirements for cover are met. Alternatively, prefabricated sheets incorporating splices (i.e. flying ends) may be used to provide nesting of reinforcement in both directions at lap positions. The lengths of the laps shall be the minimum values previously stated.

If the reinforcement is positioned prior to concreting, it shall be fixed on metal supports and retained in position at the required depth below the finished surface and distance from the edge of the slab so as to ensure that the required cover is achieved.

Reinforcement assembled on site shall be tied, or firmly fixed, at sufficient intersections to provide sufficient rigidity to ensure that the reinforcement remains in the correct position during construction of the slab.

Alternatively, when a reinforced concrete slab is constructed in two layers, the reinforcement in the form of prefabricated sheets may be placed on or into the bottom layer, which shall be spread and compacted to such a level that it will support the reinforcement without distortion at the required position in the slab. The sheets shall be tied together at overlaps and after the second layer has been spread and compacted, the reinforcement shall have the required cover.

When a reinforced concrete slab is constructed at maximum width of 6 m or more, the transverse reinforcement in the center of the slab shall be a minimum of 12 mm nominal diameter bars at 600 mm center to center. This reinforcement shall be at least 600 mm longer than one third of the width of the slab and be lapped to other transverse reinforcement bars or sheets, or be continuous across the whole width of each slab.

(b) Jointed reinforced concrete slabs

The reinforcement shall be so placed that after compaction of the concrete, the cover below the finished surface of the slab is as indicated on the Drawings, with a tolerance of +/- 10 mm for slabs less than 270 mm thick and +/- 20 mm for slabs 270 mm thick or more.

The vertical cover between any longitudinal joint groove forming strip and any reinforcement shall be a minimum of 300 mm.

Any transverse bars shall be at right angles to the longitudinal axis of the carriageway. Any transverse reinforcement shall terminate at the specified distance from the edge of the slab and longitudinal joints as shown on the Drawings, with a tolerance of +/- 25 mm. No longitudinal bar shall lie within 100 mm of a longitudinal joint. The reinforcement shall terminate 300 mm +/- 50 mm from any transverse joint, excluding emergency construction joints.

(c) Continuously reinforced concrete slabs

The reinforcement shall be positioned with the diameters and spacings as shown on the Drawings. Except where otherwise shown on the Drawings, the longitudinal bars shall be parallel to the centreline of the road.

The reinforcement shall be positioned so that, after compaction of the concrete, it shall be at mid-depth of the specified thickness of the slab +/- 25 mm. No longitudinal bar shall lie within 100 mm of a longitudinal joint. In reinforcement assembled on site, longitudinal bars shall be placed immediately above any transverse bars, which shall be at right angles to the longitudinal axis of the carriageway or as otherwise specified or shown on the Drawings.

Any transverse reinforcement shall terminate at the specified distance from the edge of the slab and longitudinal joints as shown on the Drawings, with a tolerance of +/- 25 mm.

7110 SURFACE TEXTURE

(a) General

After the concrete has been placed, spread, compacted, finished and completed and before the curing membrane is applied, the surface of the concrete shall be provided with a surface texture.

The direction of texturing shall be at right angles to the longitudinal axis of the pavement.

The surface texture shall be applied and completed before the concrete is so hard that the surface will be torn and coarse aggregate unduly loosened during texturing.

(b) Equipment

The required texturing shall be effected by means of a machine which spans the full width of the concrete pavement and which is guided in regard to both level and direction by the rails in the case of sideform construction or by the paver guide wires in the case of slipform construction.

(i) Burlap Drag Equipment

Unless otherwise authorized by the Engineer, the burlap drag shall be attached to the front of the texturing machine or to an additional machine which spans the full width of the concrete pavement and is placed in such a way that the full width of the concrete pavement is covered in one operation and, when not in use, the entire drag can be lifted clear off the pavement.

The dimensions of the burlap drag shall be such that at least 1.0 m of the material is in contact with the surface of the concrete pavement measured in the direction in which the drag is being moved. The burlap drag shall consist of at least two layers of approximately 340 g/m^2 burlap with the bottom layer at least 150 mm longer than the top layer at the dragging end; however, at the discretion of the Engineer, the number of layers may be increased to four. The transverse threads of the trailing 150 mm to 300 mm of the burlap drag shall be removed.

(ii) Tine Grooving Device (Grooving Comb)

The pavement shall be grooved by means of a metal tine grooving device. The tines shall be made from flat spring steel approximately 0.6 mm in thickness and 3 mm in width, 125 mm in length and spaced at between 12 mm and 25 mm in an approved random pattern. The Engineer may, however, require a different random pattern or equal spacing of the tines during the course of the work, and provision shall be made to supply different sets of combs as required. No additional payment will be made for the first two changes in the spacing of the tines.

The combs for applying the texturing shall be at least 3.0 m wide. It must also be possible to adjust the combs to a lower position in order to compensate for wear.

(iii) Burlap-Drag-and-Grooved Texture

This texture shall be obtained by first applying a burlap-drag finish to the concrete surface and then by grooving it with a grooving comb.

The first pass of the burlap drag shall be made as soon as construction operations permit and before the wet sheen has disappeared from the surface. Burlap dragging shall be repeated until a gritty and uniform texture having the required depth of texture has been obtained.

Every morning the burlap drag shall be wetted and kept moist throughout the day. At the end of each day's pour the burlap mats shall be cleaned or discarded and replaced with new burlap if cleaning is not possible.

After the concrete has hardened, all loose particles generated by the cutting of the grooves shall be broomed off the surface with stiff hand brooms or mechanically operated rotary brooms.

When measured with a suitable depth gauge, the grooves shall be not less than 2 mm and not more than 4 mm in depth.

The Engineer may permit the use of texturing equipment other than the grooving comb, provided that it produces a texture similar to that produced by the metal tines.

(c) Hand texturing

Texturing the surface with hand-held brooms or combs shall be allowed only where the pavement is so small or irregular, or the site is so restricted as to make the use of the texturing machine impracticable, or in cases of mechanical breakdown of the texturing machine, in which case it may be used for the required texturing of concrete already placed. The brush or comb to be used then shall be of the same type and width used in the machine.

In order to ensure straight grooves, the comb shall be operated against a straight-edge placed at right angles to the pavement centreline.

The same requirements regarding groove dimensions or texture depth as for machine-texturing will apply.

7111 CURING

The exposed surfaces, including the sides of the slab, shall be treated immediately after the required texturing of the surface has been effected and after the side formwork has been removed by the application of a white-pigmented curing compound as specified in sub-clause 7102.8 above in accordance with the directions of the manufacturer.

The curing compound shall be sprayed onto the surface at a rate of 0.35 liter/m^2 or as approved by the Engineer by means of a mechanical distributor capable of producing a fine fog-type of spray, which will not damage the surface of the concrete. The curing compound shall be applied in two layers with the distributor moving in opposite directions for the two applications. Coverage shall be uniform over the entire surface and the rate of application of the curing compound shall be carefully controlled.

During spraying operations, the curing compound shall be continuously stirred mechanically to keep the pigmentation in suspension. The spray nozzles shall be adequately protected against wind.

After shutting off the spray nozzles, no dripping of curing compound on the concrete surface may occur. If necessary, the Contractor shall provide drip pans suspended below the nozzles to prevent dripping of the curing compound onto the pavement.

The curing membrane shall be maintained intact for at least seven days after the concrete has been placed. Any damage to the curing membrane, caused by the Contractor's activities, shall be repaired by hand-spraying the affected areas.

Areas inaccessible to the mechanical distributor such as odd shaped areas, or those with varying widths or shapes, shall be sprayed with curing compound by means of approved hand spraying equipment, at the specified rate of application.

7112 TRANSVERSE JOINTS

(a) General

Transverse joints shall be provided in unreinforced and jointed reinforced concrete slabs and shall be contraction, expansion or warping joints at the spacings shown on the Drawings or as specified in the Project Specifications.

Transverse joints shall be straight within the following tolerances along the intended line of the joint, which is the straight line transverse to the longitudinal axis of the carriageway except where otherwise shown on the Drawings.

(i) Deviations of the filler board or bottom crack inducer from the intended line of the joint shall not be greater than +/- 10 mm;
(ii) The best fit straight line through the joint groove as constructed shall not be more than 25 mm from the intended line of the joint;
(iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10 mm.

Transverse joints on each side of a longitudinal joint shall be in line with each other and of the same type and width.

Concrete pavement layers shall be isolated from fixed structures by expansion joints, or earthworks or a granular layer over the structure, or by bridge-type expansion joints, or by lengths of fully flexible pavement construction. End of pavement surface slabs shall have a transition bay as shown on the Drawings, leading into the fully flexible construction.

(b) Contraction joints

Contraction joints shall consist of:
(i) A sawn joint groove
(ii) Dowel bars
(iii) A sealing groove

(c) Expansion joints

Expansion joints shall consist of:
(i) A joint filler board
(ii) Dowel bars
(iii) A sealing groove

The filler board shall be positioned vertically within the prefabricated joint assemblies along the line of the joint within the tolerances given in Sub-clause 7112(a) above, and at such depth below the surface as will not impede the passage of the finishing beams on the paving machines.

The joint filler board together with the sealing groove shall provide a complete separation of adjacent slabs and any spaces around dowel bars and between the layer underlying the slab and the filler board shall be packed with a suitable compressible material after fixing the joint assembly.

(d) Warping joints

Warping joints shall consist of:
(i) A sawn groove
(ii) Tie bars

(iii) A sealing groove

(e) Construction joints

Construction joints made at the end of a working day in unreinforced concrete slabs and jointed reinforced concrete slabs shall be contraction joints. In the event of mechanical breakdown of the concreting machinery, or at the onset of adverse weather, emergency joints may be formed.

Emergency joints in unreinforced concrete slabs shall be contraction joints not less than 2.5 m from the preceding or succeeding joint position.

Emergency joints in jointed reinforced concrete slabs shall be not less than 2.5 m from the preceding or succeeding joint position. The stop end formwork shall be sufficiently rigid to ensure that dowel bars, tie bars or reinforcement will be held in position in compliance with the Specification, and placed in such a position that it permits the longitudinal reinforcement to project through the joint for a distance of at least 750 mm.

Construction joints in continuously reinforced concrete slabs at end of day or in an emergency shall not be constructed within 1.5 m of any lap in the longitudinal reinforcement. The stop end formwork shall be sufficiently rigid to ensure that the longitudinal reinforcement and the tie bars, which project through the joint, are held in the correct position.

7113 LONGITUDINAL JOINTS

(a) General

Sawn or wet-formed longitudinal joints shall be provided in surface slabs at the positions as shown on the Drawings. Generally, bay widths are not to be greater than 4.2 m (or 5.0 m with limestone aggregate) for unreinforced slabs, or 6 m (or 7.6 m with limestone aggregate) for reinforced concrete surface slabs with transverse reinforcement.

Wet-formed longitudinal joints shall consist of wet-formed joint grooves, a bottom crack inducer and tie bars except where transverse reinforcement is permitted in lieu.

Longitudinal joints shall be constructed within the following tolerances:

i) Deviations of the bottom crack inducer from the intended line of the joint, parallel to the axis of the road shall be not greater than ± 13 mm;
ii) The joint groove shall be located vertically above the bottom crack inducers within a horizontal tolerance of ± 25 mm;
iii) The best fit line along the constructed joint groove shall be not more than 25 mm from the intended line of the joint;
iv) Deviations of the joint groove from the best fit line of the joint shall not be greater than 10 mm.

Sawn longitudinal joints shall consist of joint grooves.

Tie bars may be replaced by continuous transverse reinforcement across the joints in continuously reinforced concrete slabs which are constructed in more than one lane width in one operation, provided that the transverse reinforcement is a minimum of 12 mm diameter bars at 600 m centers. The transverse reinforcement in these circumstances shall be protected by suitable bituminous paint or equivalent coating for a distance of at least 75 mm either side of the joint.

(b) Longitudinal construction joints

Longitudinal construction joints between separate slabs shall have tie bars with a joint groove. Alternatively, if split forms are used, the transverse reinforcement, if 12 mm diameter or more, may be continued across the joint for a minimum of 500 mm or 30 times the diameter of the transverse reinforcement bars, whichever is the greater. The transverse reinforcement in these circumstances shall be protected by suitable bituminous paint or equivalent coating for a distance of at least 75 mm either side of the joint. Where the edge of the concrete slab is damaged, it shall be made good before the adjacent slab is constructed.

7114 JOINT GROOVES

(a) General

Transverse contraction or warping joint grooves shall be sawn in the hardened concrete.

Transverse joint grooves, which are initially constructed less than the full width of the slab shall be completed by sawing through to the edge of the slab and across longitudinal joints as soon as any forms have been removed and before an induced crack develops at the joint.

(b) Sawn transverse and longitudinal joint grooves

Sawing shall be undertaken as soon as possible after the concrete has hardened sufficiently to enable a sharp edged groove to be produced without disrupting the concrete and before random cracks develop in the slab.

The grooves shall be between ¼ and 1/3 of the specified depth of the slab and of any convenient width not less than 3 mm.

The sealing groove may be sawn to the required width later. Expansion joint sealing grooves shall be sealed as soon as practical after sawing.

(c) Wet-formed longitudinal joint grooves

When slabs are constructed in more than one lane width in one operation, a joint groove shall be formed by inserting a groove former ahead of the finishing beams from dispenser. The concrete so displaced shall be recompacted by a vibrating compactor or similar device, at least 300 mm wide operating symmetrically along the line of the joint.

After finishing the concrete, the groove-forming strip shall be in the correct position and alignment, within 10□ of the vertical, and to sufficient depth below the surface to allow for the passage of the finishing beam within the range of 0-3 mm below the finished level of the slab. Groove forming strips in wet-formed longitudinal joint grooves shall be left in place.

(d) Construction joint grooves in surface slabs

The grooves shall be formed by fixing a groove former or strip or cork seal along the top edge of the slab already constructed, before concreting the adjacent slab.

Where the edge of the concrete is damaged, it shall be ground or made good before fixing the groove-forming strip.

Alternatively, the subsequent slab may be placed adjacent to the first and a sealing groove sawn later in the hardened concrete to the minimum depth specified or to the manufacturer's instructions if greater, and to sufficient width to eliminate minor spalling of the joint arris, up to a maximum of 25 mm for longitudinal joints and 40 mm for transverse joints. The joint shall be sealed in compliance with Clause 7116.

(e) Groove formers and bottom crack inducers

Except where joint grooves are sawn, a bottom crack inducer shall be provided at each longitudinal joint position. The bottom crack inducer shall be triangular or inverted Y-shaped fillet, with a base width not less than the height, made of timber or rigid synthetic material. It shall be firmly fixed to the sub-base so as to remain in position during the whole process of constructing the slab.

The combined depth of groove formers and bottom crack inducers shall be between ¼ and 1/3 of the depth of the slab and the difference between the depth of the groove former and the height of the bottom crack inducer shall not be greater than 20 mm.

Groove forming sealing strips for wet-formed longitudinal joints shall be inserted continuously along the joint.

7115 TIE BARS AND DOWELS

(a) Tie bars

Tie bars at the time of use shall be free from oil, dirt, loose rust and scale.

Tie bars in warping joints and wet-formed longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during the construction of the slab.

Alternatively, tie bars at longitudinal joints may be mechanically inserted by vibration from above using a method which ensures recompaction of the concrete around the tie bars.

At longitudinal construction joints, tie bars may be adequately fixed to side forms or inserted into the side of the slab by a method which ensures recompaction of the concrete around the tie bars and adequate bond.

Tie bars in warping joints shall be positioned from the top surface of the slab within □20, -10 mm of the mid depth of the slab.

Tie bars in other joints shall be positioned and remain within the middle third of the slab depth, approximately parallel to the surface and approximately perpendicular to the line of the joint, with the centre of each bar on the intended line of the joints within a tolerance of 50mm, and with a minimum cover of 30 mm below any top crack inducer of joint groove for slabs 200 mm thick or more, or 20 mm for slabs up to 200 mm thick.

At transverse construction joints in continuously reinforced concrete, tie bars shall be fixed at twice the normal spacing midway between the longitudinal reinforcement bars so that 750 mm extends each side of the joint at the same level as the longitudinal reinforcement and be tied to the transverse reinforcement. Where paving from a construction joint is not resumed within 5 days, an extra longitudinal reinforcement bar 8 m long shall be lapped and tied to each tie bar. These extra bars may be combined with the tie bars. Where the spacing between longitudinal reinforcement and the extra 8 m long bars is less than 90 mm, the nominal size of aggregate shall be 20 mm for a sufficient number of concrete batches to complete that section of pavement.

Where tie bars are used in longitudinal joints in continuously reinforced concrete they shall be placed at the same level as the transverse reinforcement and tied to the longitudinal reinforcement.

(b) Dowels

Dowel bars shall be free from oil, dirt, loose rust and scale at the time of concreting.

Dowel bars shall be rigidly supported, both in vertical and horizontal alignment, on cradles in prefabricated joint assemblies positioned prior to construction of the slab. For contraction joints, as an alternative to prefabricated assemblies, dowel bars may be mechanically inserted with vibration into the concrete by a method, which ensures full recompaction of the concrete around the dowel bars, and the surface finished by a diagonal finishing beam, or a longitudinal oscillating float travelling across the slab.

Dowel bars shall be positioned at mid-depth from the surface level of the slab ±20 mm. They shall be aligned parallel to the finished surface of the slab, to the centreline of the carriageway and to each other within the following tolerances after construction of the slab:

(i) all bars in a joint shall be within ±6 mm per 300 mm length of bar;
(ii) two thirds of the bars shall be within ±4 mm per 300 mm length of bar;
(iii) no bar shall differ in alignment from an adjoining bar by more than 6 mm per 300 mm length of bar in either the horizontal or the vertical plane;
(iv) bars shall be equally positioned about the intended line of the joint within a tolerance of 25 mm.

Cradles supporting dowel bars shall not extend across the line of the joint.

7116 SEALING OF JOINT GROOVES

(a) General

All transverse joints in surface slabs, except for construction joints in continuously reinforced concrete slabs shall be sealed using one of the joint seals described in sub-clause 7102 F. Additionally, longitudinal joints, which are sawn or widened, shall be sealed.

(b) Preparation of Joint Grooves for Sealing

That part of the groove former used to form the sealing groove or any temporary seal shall be removed cleanly without damaging the joint arrises to a minimum depth of 25 mm where compression seals are used or otherwise to such depth as will provide an applied seal to the dimensions shown in the Drawings after allowing for any necessary caulking material.

If joint grooves are not initially constructed to provide the minimum dimensions for the joint seals as given in the Drawings, they shall be widened by sawing. Joint grooves formed by tapered formers need not be widened. The sealing grooves shall be cleaned out immediately after sawing using high-pressure water jets, to remove all slurry from the joint, before the slurry hardens.

If rough arrises develop when grooves are made, they shall be ground to provide a chamfer approximately 5 mm wide. If the groove is at an angle up to 10^0 from the perpendicular to the surface, the overhanging edge of the sealing groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10^0 the joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects up to a maximum width, including any chamfer, of 40 mm for transverse joints and 25 mm for longitudinal joints.

For applied sealants, the sides of the joint sealing groove shall be scoured by dry abrasive blasting. This shall not be carried out before the characteristic compressive strength of the

concrete is expected to reach 15 MPa. When compression seals are used, the sides of the groove may be ground or wire brushed.

For hot and cold applied sealants, compressible caulking material, debonding strip or tape or cord compatible with the sealant, of a suitable size to fill the width of the sealing groove, shall be firmly packed or stuck in the bottom of the sealing groove to such a depth so as to provide the correct depth of seal as shown in the Drawings with the top of the seal at the correct depth below the surface of the concrete.

All groves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. The groove shall be clean and dry at the time of priming and sealing.

For applied sealants, the joint grooves shall be primed with the relevant primer for the hot or cold applied sealant in accordance with the manufacturer's recommendations. When necessary, the joint grooves may be primed and sealed earlier than 14 days after construction, as soon as the grooves have been grit-blasted and cleaned.

(c) Sealing with applied sealants

Sealing shall be carried out continuously along the full length of joint in any one rip, except for remedial areas. When hot or cold applied sealants are used, the sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed is below 10^0C, except that between 8^0 and 10^0C it may be carried out when the temperature is rising.

Hot-applied sealants shall be heated in and applied from a thermostatically controlled, indirectly heated dispenser with a recirculating pump. The sealant shall not be heated to a temperature higher than the safe heating temperature nor for a period longer than the safe heating period, both as specified by the manufacturer. The dispenser shall be cleaned out at the end of each day and reheated material shall not be used.

The components of cold-applied sealants shall be thoroughly mixed in the correct proportions in an automatic metering and mixing dispenser or, for hand application, using a power operated paddle mixer for sufficient time to produce a homogenous mix and without entrapped air. As soon as possible after mixing and within the work life of the sealant, the material shall be dispensed into the joint, or applied using a caulking gun, to the concrete below the concrete surface. The tack-free time shall be achieved within 3 hours for machine dispensed material, or within 12 hours for hand applied material.

(d) Sealing with compression seals

When compression seals are used, the widths of the seal shall be selected in relation to the width of the sealing groove, the bay lengths and the manufacturer's recommendations so that the estimated maximum width of the joint opening shall be not more than 70% of the original width of the seal, the estimated maximum width being calculated on the basis of a movement of 4 mm per 10 m run of slab. The maximum calculated width of sealing groove shall be 30 mm. The depth of groove shall be such that the contact face of the seal shall be a minimum of 3 mm below the surface of the concrete.

Compression seals shall be inserted into the grooves without prior extension or rotation and, where recommended by the manufacturer, with a lubricant adhesive which is compatible with the seal and the concrete. The adhesive shall be applied to both sides of the sealing groove or the seal, or to both. The seal shall be positioned with its axis perpendicular to the concrete surface. Excess adhesive on top of the seal shall be removed to prevent adhesion of the top

faces of the seal under compression. Except when compression seals are used in longitudinal joints, the transverse joint seal shall be continuous across the slab and the longitudinal joint groove forming strips shall be cut to the required depth after the concrete has hardened for the transverse seal to be inserted. If compression seals are used in longitudinal joints where the grooves have been sawn after construction of the slab, they shall be continuous across transverse joints, with the transverse seals butted and fixed to the longitudinal seals with adhesive.

7117 TRIAL PAVEMENT

(a) General

When commencing with paving operations, the Contractor shall construct a trial section of pavement, in a position approved by the Engineer, to demonstrate the capability of the Contractor to construct the pavement in accordance with the Specifications.

The trial section shall be constructed with the same materials, concrete mix, plant and equipment as those intended for use by the Contractor for the pavement, and he shall also demonstrate the methods he proposes to use for applying the required surface texture, the construction of joints and the placing of tie-bars, dowels, etc.

Before the Contractor commences with the construction of the trial section, he shall demonstrate to the Engineer that all items of his paving equipment are in a satisfactory working order.

An initial trial section of not less than 150 m in length for mechanical construction, and at least 30 m in length for manual construction, shall be constructed in one continuous operation and be submitted for approval.

The Engineer shall also be entitled to call for a new trial section to be constructed at any stage of the contract when changes by the Contractor in the approved equipment, materials, mix or rate of paving warrant the construction of another trial section.

The Contractor will be paid for the actual length of trial pavement constructed as initial trial section and trial sections constructed in consequence of changes in mixes, techniques, materials, etc, effected by the Contractor, up to a maximum total length of 300 m for mechanical construction, and 60 m for manual construction. In addition, he will be paid for any trial lengths necessary as a result of similar changes required by the Engineer, notwithstanding the fact that the trial section built by the Contractor complied with the specified requirements.

(b) Further trial sections and permission to start constructing the pavement

The Contractor may, unless advised of any deficiencies in the trial section, proceed with the construction of the pavement ten days after the completion of the trial section or such earlier time as the Engineer may determine.

In the event of deficiencies in the trial section, the Engineer may order the Contractor to construct a further trial section, which will again be regarded as the initial trial section. The Contractor may then proceed with the construction of the pavement ten days after the satisfactory completion of the second or subsequent trial section.

7118 CONSTRUCTION TOLERANCES

The Construction tolerances shall be as specified under Division 10100 of these specifications.

7119 PROCESS CONTROL

The Contractor shall conduct a sufficient number of tests necessary for ensuring compliance with the requirements specified in this Division during all phases of the work.

Accelerated early compressive-strength shall be conducted regularly with a view to predicting the 28-day compressive strength of the concrete. Test procedures and methods for the prediction of 28-day compressive strength shall be determined in consultation with the Engineer.

Where the accelerated tests indicate that the required 28-day compressive strengths will not be attained, the Contractor shall immediately effect the necessary changes to the materials and/or mix proportions in order to ensure that further work will comply with the requirements.

7120 QUALITY CONTROL AND WORKMANSHIP

(a) General

Routine inspection and testing will be carried out by the Engineer to determine whether the quality of materials and workmanship complies with the requirements of this Division.

The assessment of test results and measurements, and the acceptance of the work, shall be done in accordance with a procedure developed by the Engineer.

The following shall also apply:

(b) Compressive-strength control

The Engineer may, at his discretion, decide to use the Contractor's test results in the acceptance plan, if he is satisfied that the Contractor has complied with all the process control requirements.

(c) Relationship Between the Compressive and Flexural Strengths of Concrete

The relationship between the 28-day compressive and the 28-day flexural strengths of the concrete established by the preliminary tests shall be monitored during paving operations by regular tests at the discretion of the Engineer.

For this purpose, sets of three samples each for both flexural and compressive strength tests shall be manufactured from the same batch of concrete and tested for flexural and compressive strength respectively.

If the test results indicate a relationship which deviates from that established by the preliminary tests, the specified compressive strength, as specified in Sub-clause 7102(j)(i) shall be adjusted accordingly.

(d) Air Content of Concrete

If any test for air content shows a value falling outside the specified limits, the quantity of air-entraining agent added to the concrete mix shall be adjusted, until the air content of the concrete is within the specified limits.

(e) Unacceptable Work or Materials

Any work or materials which do not comply with the specified requirements shall be removed and replaced with work or materials which comply with the requirements or, if the Engineer so permits, shall be repaired as specified in Clause 7121, so that it shall comply with the specified requirements after having been repaired.

(f) Acceptance of Concrete of Inferior Strength or Thickness at Reduced Payment

In lieu of requiring the removal of work that has been rejected on account of insufficient strength or thickness, the Engineer may accept such work, at his sole discretion, at reduced payment for the pavement concrete, on the following conditions:

Where concrete is deficient in thickness or in strength, the reduced payment shall be calculated in accordance with the following formula:

$$P = \frac{(dw)^5(fw)^4}{(ds)^5(fs)^4} \times 100$$

where:
P= percentage of normal compensation
dw= actual average thickness of slab
ds= specified average thickness of slab
fw= actual 28-day compressive strength of slab (average of 28-day compressive-strength tests)
fs= specified 28-day compressive strength of slab

The above shall be subject to the rejection of a pavement with an average thickness of less than 93.1% of the specified thickness or strength of less than 91.5% of the specified strength, as determined above.

Where both thickness and strength are deficient, it will be rejected if P is less than 70%.

Where P exceeds 100%, normal compensation only will be payable.

7121 REMEDIAL WORK

In addition to the requirements specified in Clause 1208, the following shall apply specifically to concrete pavements:

(a) Removing concrete

Where any section of the pavement which does not comply with the specified requirements is to be removed and reconstructed, the entire portion of the slab shall be removed and reconstructed as prescribed by the Engineer in writing.

(b) Removing high spots

Where the Engineer so permits, high spots may be removed by approved power chisels and planers. After the high spots have been removed, the Contractor shall, if required, grind the surface up to the nearest longitudinal and transverse joint in order that all the ground areas will be neat rectangular areas with a uniform texture.

On all portions of the pavement where the surface texture has been destroyed or reduced in depth by grinding, the surface texture shall be restored by grooves being cut into the concrete

surface. The grooves shall be approximately of the same size and spacing as specified in Sub-clause 7110(b).

(c) Repairing joints

Joints along which spalls occur that exceed 5 mm in depth at any point measured from the top surface of the pavement, or any other joints, which in the opinion of the Engineer are unacceptable, shall be repaired with an approved epoxy resin mortar. The method of repairing joints requires the prior approval of the Engineer.

(d) Repairing the cracks

The Contractor shall be responsible for constructing a pavement which will not exhibit any cracks.

Where cracks occur in the pavement which, in the opinion of the Engineer, do not warrant the removal and reconstruction of the particular section of pavement, the Contractor shall, if so required by the Engineer, repair such cracks, in accordance with a method approved by the Engineer.

(e) Rehabilitation of concrete pavements

Where concrete pavements have to be widened or where long continuous sections of concrete pavement have to be replaced and, in the opinion of the Engineer, the concrete can be placed with pavers, the work shall be regarded as, and shall be measured and paid for as, new work under the applicable items for new work.

(i) Removal of existing concrete

Where any section of the concrete pavement has to be removed, the whole panel between longitudinal and transverse joints shall be removed, unless it is specified in the Project Specifications or ordered by the Engineer that only part of the panel be removed. In such cases, the concrete shall be removed either over the full length or over the full width of the panel between joints. Where the edge of the section to be removed coincides with an existing joint, the edge shall be accurately demarcated in a straight line and sawn with an approved concrete saw to a depth of at least 50 mm before the removal of the concrete may commence.

Existing concrete may be broken up in any approved manner, but strict control shall be exercised to ensure that the adjacent concrete is not damaged in any way. The Contractor shall repair any damage to the adjacent concrete at his own cost in accordance with the instructions of the Engineer. Such remedial work may involve the partial or complete replacement of the damaged panel should it be deemed necessary by the Engineer.

Care shall be taken at existing joints to ensure that tie bars or dowels are not damaged or bent so as to render them useless.

Broken-up concrete shall be removed to approved spoil dumps.

(ii) Placing new concrete

Before concrete is placed, the underlying surface or layer shall be prepared as specified.

Except where concrete is placed in continuous lengths exceeding 50 m, placing, compacting and finishing with hand equipment shall be carried out as specified in Clause 7108. Where new concrete is placed next to existing concrete, the edge of the existing pavement shall be properly cleaned and all bituminous and other jointing material shall be removed.

Where various adjacent panels are constructed, the concrete in every alternate panel shall first be placed. The concrete in the rest of the panels may be placed only after the concrete in the first panels has sufficiently hardened so that no damage will be done to the first panels during construction activities. All formwork shall remain in position for at least 24 hours.

(f) Surface texture

Unless otherwise specified in the Project Specifications, the Contractor shall produce a surface texture on the new concrete panels which shall be the same as that on the existing panels.

(g) Joints, tie bars and dowels

Joints shall be shaped and tie bars and dowels shall be placed where indicated on the Drawings and as specified in Clauses 7112 up to and including 7116.

At joints in new concrete, the tie bars and dowels in the existing concrete shall be cleaned, and the tie bars shall be straightened, should any such bars be indicated on the Drawings.

In regard to bent dowels, the Contractor shall follow the instructions of the Engineer. Before concrete is placed, all the bars shall be accurately aligned as indicated on the Drawings and specified in Clause 7115. Where the sliding end of a dowel occurs in existing concrete, the dowel shall be extracted, cleaned and treated in accordance with the Specifications and then replaced.

Where tie bars or dowels are shown on the Drawings at joints between existing and new concrete, but no such bars occur in the existing concrete, holes shall be drilled in the existing concrete and fresh bars placed and fixed as prescribed in the Project Specifications. In such cases, the dowels shall be placed with their sliding ends in the new concrete.

Where no bars are required between the existing and new concrete but such bars do occur in the existing concrete, such bars shall be cut off flush with the concrete edge.

All joints between the existing and new concrete shall be sawn after the new concrete has hardened sufficiently to prevent splintering or other damage from occurring. Sawing the joints may normally be done from two to five days after the placing of the concrete. The width and depth of the sawn grooves shall comply with the requirements set in the Project Specifications and on the Drawings.

(h) Repairing joints and cracks in existing concrete pavement

Repairing the joints and cracks in the existing concrete pavement shall be done in accordance with the requirements set out in the Project Specifications and on the Drawings, and as required by the Engineer.

(i) Retexturing

Where in the opinion of the Engineer the skid resistance of the concrete pavement surfaces is too low, or the texture is too irregular, and where so specified in the Project Specifications, such surfaces shall be provided with a fresh texture.

The depth of texture and groove spacing shall comply with the requirements of the Project Specifications. The work shall be done with approved sawing equipment.

7122 OPENING TO TRAFFIC

No vehicle with an axle load exceeding 20 kN shall travel over the completed surface within 14 days after it has been completed, or such longer period as may be directed by the Engineer.

7123 MEASUREMENT AND PAYMENT

No extra over payment shall apply to work in restricted areas, or for work requiring hand placing, for work carried out in terms of Division 7100. The rates tendered for the payment items of Division 7100 shall include full compensation for work in restricted areas or for work requiring hand placing.

Item 71.01 Concrete trial pavement

(a) Mechanical construction ..... square meter(m^2)

(b) Manual construction..... square meter (m^2)

The unit of measurement for the trial pavement shall be the square meter of completed trial section. Not more than a total length of 300 m of mechanically constructed trial pavement and not more than 60 m of manually constructed trial pavement will be measured for payment as described in Clause 7117.

The tendered rate shall include full compensation for constructing the trial pavement complete as specified.

Item 71.02 Concrete pavement (thickness indicated).....square meter(m^2)

The unit of measurement shall be the square meter of concrete pavement placed and finished in accordance with the Specifications and the Project Specifications.

The quantity shall be calculated from the authorized dimensions of the completed surface, except when the Engineer requires or the Drawings show local deviations from the specified thickness, such as at bridge approach slabs. The volume of concrete in such cases shall be converted into an equivalent area in square meters based on the specified thickness of the slab.

The tendered rate shall include full compensation for procuring and furnishing all the materials, storing the materials, providing all plant and equipment, determining the mix proportions, mixing, transporting, placing and finishing the concrete, texturing and curing, including formwork, repairs done to defective work, protecting the pavement against damage, construction joints and process control.

The tendered rate shall also include full compensation for the provision of any additional width required by the Contractor to the earthworks and/or pavement layers to suit the particular requirements of the paving equipment. It shall also include full compensation for the removal of the additional widening which extends beyond the limits of the specified cross-section.

In the case of rehabilitation work, the tendered rate shall also include full compensation for cleaning existing joints where new concrete has to join up with existing work, for straightening existing dowels and tie bars, and for cutting off existing bars as specified.

The tendered rate shall also include full compensation for constructing concrete pavements which cannot be constructed with conventional plant, as envisaged in Division 7100.

The tendered rate for concrete pavement shall also include full compensation for constructing joints, furnishing and placing all appurtenant materials, all in accordance with the Specifications.

The tendered rate for concrete pavement shall also include full compensation for furnishing and placing all steel reinforcement, tie bars and dowels, and for drilling and testing cores, conducting tests and process control, all in accordance with the Specifications.

Item 71.03 Extra over item 71.02 for concrete pavement requiring hand placing .... Square metre (m^2)

The tendered rate for hand-placed concrete shall be extra over the rate tendered for Pay item 71.02 and shall include full compensation for the more difficult work, and incidentals required for placing the concrete by hand where placing cannot be done by normal slipform or sideform equipment. It shall also include compensation for all the required formwork.

Payment item 71.03 does not apply to rehabilitation work.

Item 71.04 Texturing and curing the concrete pavement

(a) Burlap-dragged and grooved texture ..... Square metre (m^2)

(b) Curing ..... Square metre (m^2)

The unit of measurement for texturing and curing shall be the square metre of completed pavement which has received the specified surface texturing, and which was cured as specified. The quantity shall be calculated from the specified horizontal dimensions of the completed concrete surface in the case of texturing and from the specified horizontal dimensions of the completed concrete surface, plus the surface area of the slab sides, in the case of curing.

The tendered rate for texturing shall include full compensation for providing the plant and equipment required and for applying the specified surface texture.

The tendered rate for curing shall include full compensation for providing the curing compound and its application as specified at the specified nominal rates of application by means of an approved pressure distributor. The tendered rate shall also include compensation for spraying the curing compound in unsealed joints after the sawing has been completed.

Item 71.05 Variation in the rate of application of the curing compound .....litre(l)

The unit of measurement in respect of increases or decreases in the rate of application of the curing compound shall be the litre.

Payment for variations shall be made as specified in clause 1214.

Item 71.06 Joints

(a) Expansion joints complete (excluding dowels) .....metre (m)

(b) Longitudinal hinge joints:

(i) Sealed hinge joints (type indicated with reference to drawings)..... metre (m)

(ii) Unsealed hinge joints (type indicated with reference to drawings)... metre (m)

(iii) Hinge joints between existing and new concrete in rehabilitation work..... .....metre (m)

(c) Sealed transverse contraction joints sawn in two separate operations (widths as shown on the drawings).....metre (m)

(d) Dowel bars (mild steel) (diameter and length indicated):

(i) Installed in new concrete .....number (No)

(ii) Installed in existing concrete in rehabilitation work. ..... number (No)

(e) Tie-bars (diameter and length indicated):

(i) Installed in new concrete ..... number (No)

(ii) Installed in existing concrete in rehabilitation work. ..... number (No)

(f) End caps for dowels at expansion joints ..... number (No)

(g) Forming and sealing the joints between asphalt and concrete pavements ..... metre (m)

(h) Cleaning of tie-bars and dowels in existing concrete pavement and Straightening tie-bars in existing concrete pavement in rehabilitation work..... number (No)

The unit of measurement for joints in the pavement shall be the metre of completed joint, except that dowel bars and tie-bars across joints shall be measured separately by the numbers of each type installed.

Construction joints as such shall not be measured for payment and their cost shall be deemed to be included in the rate tendered for the concrete pavement. However, if the position of a longitudinal construction joint coincides with that of a hinge joint, the contractor will be paid at the rate tendered for the type of hinge joint replaced by the construction joint, provided that the requisite number and sizes of tie bars for the hinge joints are installed. Where the hinge joint replaced by the construction joint is a sealed hinged joint, the construction joint shall be sawn and sealed, in which case the contractor will be paid at the tendered rate for sawn and sealed hinge joints.

The tendered rates for expansion joints shall include full compensation for forming the joint complete with joint filler, rounding or chamfering the corners (if required) and installing a compression seal.

The tendered rates for longitudinal hinge joints shall include full compensation for sawing the joint (if required) and supplying and inserting the seal (if required).

The tendered rate for transverse contraction joints shall include full compensation for sawing the joint and installing the specified type of seal, including appurtenant materials, and for temporarily sealing the joint with paper rope.

The tendered rates for dowel bars and tie-bars shall include full compensation for supplying, cutting, placing, holding the bars in position, including a supporting framework or cradles where required, and fixing the end caps and bond breaking materials to dowels.

The tendered rate for forming and sealing the joints between asphalt and concrete pavements shall include full compensation for supplying all the necessary plant and materials, for forming a joint to the required dimensions in the asphalt seal, cleaning the joint and sealing it as specified in Clause 7116.

Item 71.07 Drilling and testing of cores:

a) 100 mm cores drilled from the pavement..... number (No)

(b) 150 mm cores drilled from the pavement and tested for compressive strength .... number (No)

The unit of measurement shall be the number of cores drilled or drilled and tested on the instruction of the engineer. Cores drilled by the contractor at his own initiative as part of his process control or for testing cracks sealed at the contractor's own cost, will not be measured for payment.

The tendered rates shall include full compensation for drilling the test cores and, where applicable, having them tested by an approved laboratory, and for all labour, transport, testing charges and other incidentals, save only the cost of providing a core-drilling machine on the site, which is paid for separately. It shall also include compensation for restoring the concrete pavement where holes were drilled.

Item 71.08 Steel reinforcement in concrete pavement:

(a) Mild steel bars..... ton (t)

(b) High tensile steel bars..... ton *(t)*

(c) Welded steel fabric .....kilogram (kg)

The unit of measurement for steel bars shall be the ton of reinforcing steel in place in accordance with the drawings or as authorized.

The unit of measurement for welded steel fabric shall be the kilogram of welded steel fabric in place in the special panels of concrete paving which require reinforcement, the quantity of which shall be calculated from the area of the mesh used in accordance with the drawings or as authorized.

The tendered rates shall include full compensation for supplying, delivering, cutting, bending, welding, placing and fixing the steel reinforcement, including all tying wires, spacers and waste.

Item 71.09 Removing existing concrete in rehabilitation work:

(a) Concrete without reinforcement ..... cubic metre (m^3)

(b) Reinforced concrete .....cubic metre (m^3)

The unit of measurement shall be a cubic metre of concrete broken up and removed to approved spoil dumps as specified. The quantity shall be determined in accordance with the authorized horizontal dimensions and the average depth of the part removed.

The tendered rate shall include full compensation for breaking up the concrete, loading, transporting over a free- haul distance of 1.0 km, and placing it in approved spoil dumps. The tendered rate shall also include full compensation for the protection of adjacent concrete and its repair should it be damaged.

Dowels and tie bars in existing concrete and stays used to keep the bars in position will not be regarded as reinforcing.

Item 71.10 Sawing existing concrete in rehabilitation work.....square metre (m^2)

The unit of measurement shall be a square metre of saw- cut in the existing concrete as approved by the engineer and sawn to the required depth, measured once only irrespective of the number of times the sawing has to be repeated to obtain such depth. The quantity shall be the product of the authorized length and depth of the saw-cut.

The tendered rate shall include full compensation for demarcating the saw line, providing and applying water and other material, and for sawing the concrete to the satisfaction of the engineer.

This item shall not apply to the sawing of joints.

Item 71.11 Removing existing pavement layers in rehabilitation work:

(a) Uncemented material .....cubic metre (m^3)

(b) Cemented material..... cubic metre (m^3)

(c) Cemented crushed stone..... cubic metre (m^3)

The unit of measurement shall be a cubic metre of material excavated and removed. The quantity shall be computed in accordance with the authorized dimensions for the excavation. The classification of the material shall be made in accordance with the provisions of Division 5300.

The tendered rate shall include full compensation for excavating the material and disposing thereof to approved spoil dumps, including transport over a free-haul distance of 1.0 km.

Item 71.12 Recompaction of underlying pavement layers of gravel

(Required density stated) in rehabilitation work ..... cubic metre (m^3)

The unit of measurement shall be a cubic metre of material reprocessed and compacted. The quantity shall be calculated in accordance with the authorized dimensions of the layer.
The tendered rate shall include full compensation for breaking up the layer, watering, mixing, compacting and finishing, and preparing the layer for placing the concrete.

Item 71.13 Rehabilitation work: Reconstructing underlying pavement layers with:

(a) Gravel material..... cubic metre (m^3)

(b) Crushed stone..... cubic metre (m^3)

(c) Asphalt ..... cubic metre (m^3)

The unit of measurement shall be a cubic metre of underlying pavement layer reconstructed. The quantity shall be computed in accordance with the authorized dimensions.

The tendered rate shall include full compensation for procuring and placing the material, transporting it over a free-haul distance of 1.0 km, and preparing the layer for placing the concrete.

Item 71.14 Extra over item 71.13 for stabilization of underlying pavement layers under reconstruction:

(a) Chemical stabilization of gravel layers ..... cubic metre (m^3)

(b) Chemical stabilization of crushed-stone layers..... cubic metre (m^3)

(c) Bituminous stabilization of crushed-stone layers..... cubic metre (m^3)

The tendered rate shall include full compensation for the additional costs for stabilizing the material, including mixing the material and the stabilizing agent in the plant, curing the layer, and providing the water and the curing agent. The provision of the stabilizing agent will be paid for separately under item 71.15.

Item 71.15 Stabilizing agents applied in rehabilitation work:

(a) Ordinary Portland cement ..... ton (t)

(b) Anionic stable grade bitumen emulsion (60% net bitumen)..... litre (l)

(c) Other chemical stabilizing agents (type indicated) ..... ton (t)

(d) Other bituminous stabilizing agents (type and grade stated)..... litre (l)

The provisions of Division 4600 shall apply mutatis mutandis.

Item 71.16 Preparing the underlying layers after the concrete has been removed in rehabilitation work:

(a) Cemented gravel or crushed-stone layer ..... square metre (m^2)

(b) Uncemented crushed-stone layer ..... square metre (m^2)

(c) Asphalt sub-base ..... square metre (m^2)

The unit of measurement shall be a square metre of existing underlying layer prepared in accordance with the requirements of sub-clause 7103 C. The quantity will be computed in accordance with the authorized dimensions of the prepared layer.

The tendered rate shall include full compensation for preparing the layer in accordance with the specified requirements, testing for level, cleaning the edge of the existing concrete, providing and applying water, and for removing any remaining loose material and waste. Separate payment will be made for providing and placing asphalt and slurry.

This item shall not apply to reconstructed or reprocessed layers.

Item 71.17 Placing fine asphalt and coarse slurry in preparing the underlying layers as specified in subclause 7106(d):

(a) Fine continuously graded asphalt for levelling the surface..... ton (t)

(b) Coarse slurry for levelling the surface ..... cubic metre (m^3)

The unit of measurement for sub item (a) shall be a ton of asphalt placed in accordance with the instructions of the engineer.

The unit of measurement for sub item (b) shall be a cubic metre of slurry placed in accordance with the instructions of the engineer.

The tendered rates shall include full compensation for procuring, providing, placing, compacting and finishing all the material, and for all transport.

Item 71.18 Retexturing existing concrete pavement in rehabilitation work .... square metre (m^2)

The unit of measurement shall be a square metre of existing concrete pavement, which has been retextured.

The tendered rate shall include full compensation for all equipment, labour and material required for executing the work, complete as specified.

Item 71.19 Repairing joints and cracks in existing concrete pavement in rehabilitation work:

(a) Joints ..... metre (m)

(b) Cracks ..... metre(m)

The unit of measurement shall be a metre of joint or crack actually repaired on the instruction of the engineer and in accordance with the requirements of the project specifications.

The tendered rate shall include full compensation for procuring, providing and applying all material, and for repairing, complete as specified. Payment shall distinguish between various types and sizes of joints and cracks.

Item 71.20 Drilling and placing dowels and tie bars in existing concrete in rehabilitation work:

(a) Dowels..... number (No)

(b) Tie bars ..... number (No)

The unit of measurement shall be the number of bars placed in existing concrete at the joints with new concrete.

The tendered rate shall include full compensation for providing all materials, cutting the bars, drilling the holes in the existing concrete, placing and fixing the bars with epoxy, and treating the sliding ends of the dowels, complete as specified.

Item 71.21 Re-treating existing dowels:

(a) Sliding end in existing concrete ..... number (No)

(b) Sliding end in new concrete ..... number (No)

The unit of measurement shall be the number of bars re- treated.

The tendered rate shall include full compensation for cleaning and re-treating the bars as specified and to the satisfaction of the engineer.

Notes:

(1) Where reinforcing steel, except tie bars and dowel bars, are used for reinforced concrete slabs, it shall be listed under this section in accordance with the pay items in Division 8300.

(2) The tendered rates shall include full compensation for the additional costs for executing the work in restricted areas where necessary.

(3) The items of payment in the following divisions shall apply where necessary and shall be listed under this section in the schedule of quantities.

Division 1700: Overhaul on material hauled in excess of 1.0 km

Division 6100: Prime coat

Division 6200: Tack coat of 30% stable-grade emulsion