

SECTION R10

Portland cement concrete pavement

R10 01 Scope

The work covered by this Section of the Specification consist in the furnishing of all plant, equipment, material and labor, and in performing all operations in connection with the construction of a Portland Cement Concrete Pavement, conforming to the lines, grades, and typical sections shown on the Drawings or as ordered by the Engineer, and in strict accordance with this Section of the Specification and the applicable Drawings.

R10 02 Materials

The Contractor shall advise the Engineer immediately after the award of the Contract of the source of all materials to be used in proportioning concrete for the work. If the Contractor later proposes to obtain materials from a different source, he shall notify the Engineer at least 30 days before such materials are to be used.

1. Cement: Cement for concrete pavement shall be ordinary Portland cement conforming to AASHTO M85-74 or complying in all respects with the requirements of BS 12 (1971). If the Contractor proposes to use more than one brand of cement in the work, written permission shall be obtained from the Engineer. When more than one brand is used, each brand shall be used in separate parts of the project as designated or approved by the Engineer's Representative. Bulk cement may be used subject to the approval of the Engineer's Representative and to such strict requirements as he may deem necessary.

At the site of the project the cement shall be stored in a suitable weather-proof building. Each shipment of cement shall be stored separately to provide for ready identification and inspection. Cement that has deteriorated during storage at the site of the project shall not be used. The Contractor shall keep suitable daily records of cement received and used. The records shall show in such details as the Engineer's Representative may require, the quantity used for each part of the project during the day, and copies of the records shall be furnished to the Engineer's Representative at the close of each day's work. Cement that has remained in store for a period exceeding 3 months shall not be used until it has been tested in the laboratory and found to be suitable for use.

2. Fine Aggregate: Fine aggregate shall consist of washed river or pit sand. Washed crushed stone sand may be used at the direction of or with the approval of the Engineer's Representative. Fine aggregate shall be moderately sharp and free from soft particles, clay, shale, loam, cemented particles, mica, salt, juss (calcium sulphate), and organic and other foreign matter. The surface of the particles shall be clean, and the sand shall contain not more than 4 per cent of elutriable material. The sand shall comply with the following grading shown in Table R10/1 when tested in accordance with AASHTO T27-74.

**TABLE R10/1
FINE AGGREGATE GRADING**

U.S. Sieve Size		Per Cent Passing By Weight
mm	Imperial	
9.5	3/8in	100
4.75	No. 4	95-100
1.18	No. 16	45-80
0.30	No. 50	12-30
0.15	No. 100	2-10
0.075	No. 200	0-3

The sand when subjected to five alternations of the sodium sulphate soundness test as outlined in AASHTO T104-74 shall have a weighted loss not exceeding 10 per cent by weight.

The effect of organic impurities in the fine aggregate on the strength of the cement mortar shall be determined in accordance with AASHTOT 71. The relative strength shall not be less than 95%.

The soluble sulphate (SO₃) Content shall not exceed 0.5% when tested in accordance with BS 1377 Test No.10.

The grading requirements given above represent the extreme which shall determine suitability for use from all sources of supply. The grading from anyone source shall be reasonably uniform and not subject to the extreme percentages of grading specified above. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made on representative samples, submitted by the Contractor from such sources as he proposes to use. Sand from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample submitted by the Contractor may be rejected. The fineness modulus of an aggregate is determined by adding the percentage by weight retained on standard sieves 75mm, 37.5mm, 19mm, 9.5mm, 4.75mm (No.4), 2.36mm (No.8), 1.18mm (No.16), 0.60mm (No.30), 0.30mm (No.50) and 0.15mm (No.100) and dividing by 100.

3. Coarse Aggregate: Coarse aggregate shall consist of either gravel or broken stone. The aggregate shall be separated into two sizes, 4.75mm (No.4) to 19.0mm and 19.0mm to 37.5mm. These two sizes shall then be combined at the proportioning plant in proportions by weight to produce an aggregate meeting the grading requirements shown in Table R 10/2 when tested by the method described in AASHTO T-27-74.

**TABLE R10/2
COARSE AGGREGATE GRADING**

U.S. Sieve Size		Per Cent Passing By Weight
mm	Imperial	
50 · 0	2in	100
37 · 5	1½in	90-100
19 · 0	¾in	35-70
9 · 5	⅜in	10-30
4 · 75	No. 4	0-5

The physical requirements of the coarse aggregate shall be within the limits given in Table R10/3

**TABLE R10/3
PHYSICAL REQUIREMENTS OF COARSE AGGREGATE**

	Maximum Permissible Limits. Per Cent By Weight
Soluble Sulphate Content(expressed as SO ₃) When tested in accordance with BS 1377 Test No. 9	0 · 5
Sodium Sulphate Soundness (AASHTO T104-74) Weighted Loss	12
Wear, L.A.Abrasion(AASHTO T96-74)	40
Friable Particles	3
Coal and Lignite(AASHTO 113-70)	0 · 25
Clay Lumps(AASHTO 112-74)	0 · 25
Material Passing the 0.075mm(No.200)sieve (AASHTO T11-74)	1
Elongation Index(determined in accordance with BS 812)	15
Flakiness Index(determined in accordance with BS 812)	25

4. **Mixing Water:** Mixing water shall be clean and free from oil, acid, salt, alkali, organic matter and other deleterious substances injurious to the finished product. The water shall be tested as prescribed in AASHTO T26-72. Where the source of water is relatively shallow, it shall be maintained at such a depth and the intake shall be so enclosed as not to include silt, mud, grass, or other foreign materials.

5. **Reinforcing Steel:** Concrete reinforcement shall consist of mild steel bars or wire mesh, as specified below and indicated on the Drawings.

(a) **Mild Steel Bars:** Mild steel bars for concrete reinforcement shall consist of round steel bars as specified in BS4449(1969) and manufactured by an approved process.

(b) **Steel Fabric:** Steel fabric for the reinforcement of concrete shall conform to either

AASHTO M55-73 or BS4483 (1969). It must be supplied in sheets and not in rolls.

6. **Polythene Sheeting:** Polythene sheeting for placing immediately below concrete slabs shall be 0.065mm thick made from polythene or other approved hydrocarbon thermoplastic resin (produced by the polymerization of ethylene under high pressure and density) and given an anti-static treatment to reduce dust attraction and reduce friction. The sheeting shall have the minimum mechanical properties shown in Table R 10/4: -

**TABLE R10/4
PROPERTIES OF POLYTHENE SHEETING**

	Machine Direction	Transverse Direction
Tensile Strength Method ASTM D882-73 Kgf/cm	140	105
Elongation at Break	150	500
Tear Strength Elmendorf Method ASTM D689-62(1974) g/0 · 0.25mm	390	310

7. **Joint Filler:** Joint filler shall consist of cane or other suitable long fibres of a cellular nature uniformly impregnated with asphalt. The asphalt content of the joint material shall be between thirty and fifty per cent. The joint material will not deteriorate under any weather conditions and is to be of such a character as not to be permanently deformed or broken by moderate twisting, bending or other ordinary handling. Strips of the joint filler which do not conform to the specified dimensions within the tolerance 0 to +2mm for thickness and ±12mm for depth are to be rejected. All damaged strips are to be rejected too. The performed expansion joint filler shall meet the requirements of ASTM D 99A, or D 1751, or D 1752.

8. **Joint Sealing Compound:** Joint sealing compound shall meet the requirements of ASTM D 1850 for cold application type, ASTM D 3406 for hot-applied elastomeric type and ASTM D 1854 for jet fuel resistant hot poured elastic type.

The compound is to be impermeable, is to withstand all weather conditions and is to be capable of adhering to the concrete without cracking, spalling or disintegrating and will not require an impracticable condition of dryness or cleanliness of the concrete slabs.

Where recommended by the manufacturer of the sealing compound, a primer supplied by him is to be used to improve adhesion.

9. **Dowel Bars:** Dowel bars shall be cut from mild steel bars complying with the requirements of BS4449 (J 969), excepting that dimensions shall be at least those shown on the Drawings where they differ from those of the BS. The Contractor's attention is directed to the requirement of Clause R10 10, that one end of each dowel bar in all joints, except bonded construction joints, shall be sawn and not sheared so that no irregularities likely to interfere with its sliding action in the concrete shall occur.

10. **Expansion Caps:** Expansion caps for dowel bars in expansion joints shall consist of cardboard or pressed metal sleeves plugged at one end by punching the specified joint filler

board or a wad of cotton waste of similar compressibility and sealed at the end against entry of mortar. The tube shall have an external diameter permitting sliding on the dowel bar but close enough to prevent entry of mortar.

The thickness of joint filler punching or cotton waste shall be twice the thickness of the joint filler in the joint. The tube shall be 5cm longer than the plug.

11. Darkening Agent: Darkening agent for the top course of concrete pavements if ordered and specified shall be a carbon black; either as an aqueous dispersion containing at least 25% of solids, to be added to the mixing water, or as a self-dispersing powder to be added to aggregate and cement. It shall be either the brand sold by Witco Chemical Company Limited (Bush House, Aldwych, London, W.C.2) as "Gatwick Black" or another brand approved by the Engineer's Representative as non-deleterious and as giving a grey color at least as dark and as even as that produced by "Gatwick Black" added at the rate of 0.1% by weight of the mixed concrete. The minimum amount of self-dispersing powder shall be 0.025% by weight of the concrete aggregate.

The darkening agent shall be free from sulphur trioxide and from any other matter deleterious to concrete.

12. Crack Inducing Battens: Crack inducing battens shall be of sound wood or of any other suitable material proposed by the Contractor at the time of tendering and approved of at the award of the Contract or approved by the Engineer at his discretion after the award of the Contract. Battens of highly absorbent wood or other material shall be treated to prevent absorption of water from the concrete. All battens shall be to the cross-sectional dimensions shown on the Drawings, and treated to prevent adhesion between them and the concrete.

13. Air Entraining Admixtures: Air entraining admixtures for concrete shall be in accordance with AASHTO M 154.

14. Concrete Additives: Chemical admixtures for water reduction, set retardation and set acceleration or their combinations shall be in accordance with AASHTO M 194.

15. Sulphates: The amount of sulphate in the concrete mass (expressed as SO_3) shall not exceed 4.5% of the weight of cement in the total concrete mass. The amount of sulphate shall be determined in accordance with BS 1377 Tests 9 and 10 on a representative sample that includes aggregate, cement, admixtures and water.

R10 03 Sampling and testing

All materials shall be approved by the Engineer's Representative prior to use in the work. Additional samples will be taken and tested by the Employer during the progress of the work to check on the quality of the materials being supplied and/or placed by the Contractor. The results of these tests will be available for the Contractor's use, however they are not intended for construction control purposes. The Contractor should set up his own test facilities or arrange the same from a private laboratory, to assure that his materials and workmanship comply with the Specification.

R10 04 Composition and compressive strength of concrete

1. Composition:

- (a) All concrete shall be proportioned by weighing and shall conform to the following strength and mix requirements:-

Compressive Strength, 28 days, when tested in accordance with B.S 881 Part 3	minimum	300 kg. f/cm ²
Cement Content, Sacks (50kg) per cubic meter, minimum		7 · 2
Water-Cement Ratio, maximum		0 · 45
Slump, maximum when tested in accordance with AASHTO T119		5cm
Entrained air, per cent when tested in accordance with AASHTO T196		4.5± 1 · 5%

- (b) At least 35 days prior to the start of paving operations and after approval of all materials to be used in the concrete, the Contractor shall submit for approval the mix design he intends to use based on proportioned weights of cement, air entrainment agent, saturated surface dry aggregates, and water. This mix design will be tested by the Engineer's Representative and approval will not be granted unless the average 28-days compressive strength exceeds the minimum strength requirement by at least 15 per cent.
- (c) The cement content given in the foregoing table is the minimum, if it is not sufficient to produce concrete of the compressive strength specified, it shall be increased as necessary, without additional compensation under the Contract.
- (d) The compressive strength of the concrete will be determined by testing standard cubes made from concrete taken from the mixer. The making, curing and testing of the specimens will be in accordance with BS 1881 part 3.
- (e) During the course of construction, when the source of any material for the concrete is to be changed, or if there is any variation in the quality of the materials furnished, additional tests and necessary adjustments in the mix shall be made as required to obtain the specified strengths.
- (f) IF the concrete mix needs to be more workable during the construction, then the workability of the mix should be adjusted by altering the grading or type of aggregate, or by using admixture, rather than by altering the water content. The water/cement ratio under no circumstances exceeds the value chosen to give the required strength.

2. **Consistency:** The required consistency of the concrete mixture shall be such that the mixture will be cohesive, uniform and plastic, permitting proper handling and finish. When deposited it shall not flow, but shall remain in a conical pile. There shall be minimized of segregation and surplus water during the process of handling and finishing.

The slump shall be determined by AASHTO T119-74.

The air content of the freshly mixed concrete shall be determined by AASHTO T152-74.

The cement content shall be determined by means of a yield test in accordance with AASHTO T121-74.

R10 05 Batching and mixing

Concrete shall either be batched and mixed at a central batching and mixing plant, or

batched at a central batching plant for either mixing in field mixers adjacent to the forms for slabs, or mixed in a truck mixer.

When cement is supplied in bags each batch of concrete shall contain a whole number of bags of cement.

1. **Batching equipment:** All aggregates and bulk cement for use in pavement shall be batched by weight by means of automatic devices of approved type conforming to the requirement; specified below:-

The batching shall consist of dividing the aggregates into three sizes, each stored in a separate bin, of placing the cement in another bin, and of recombining these ingredients as herein provided.

Material discharged from the several bins shall be controlled by gates or by mechanical conveyors. The means of withdrawal from the several bins and of discharge from the weigh box shall be so interlocked that not more than one bin can discharge at a time; that the order of discharge can be changed as desired by the Engineer's Representative; and that the weigh box cannot be tripped until the required quantity from each of the several bins has been deposited therein. Should a separate weigh box be used for each size of aggregate, all bins may be operated and discharged simultaneously. The discharge shall be so regulated that the amount of material discharged into the weigh hopper from any bin, with weighing devices at rest, will be within 3kg of the weight called for by the scale setting for the bin.

When the discharge from the several bins is controlled by gates, each gate shall automatically lock in an open or partially open position until the required weight is discharged into the weigh box, after which the gate shall automatically close and lock.

Scales utilized in the batching device may be of the springless dial type or of the multiple beam type.

If they are the dial type, the dial shall be of such size and so arranged that it may be easily read from the ground. The automatic weighing device of the dial scale shall be so marked that the number of proportions required may be set on the dial at the same time and that proportions may be changed without delay.

If they are the multiple beam type, the separate beams shall be automatically connected to the hopper or weigh box in sequence. Multiple beam scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or under weight. The indicator shall be so designed that it will be operated during the addition of the last seventy kilograms of any weighing. The over travel of the indicator hand shall be at least one-third of the loading travel. Indicators shall be enclosed against moisture and dust.

The beams or dial of automatic scales shall be so arranged that the weighing units will be in a compartment that may be locked at the requirement of the Engineer.

It is the intention of this Specification that the device shall be automatic to the extent that the only manual operation required for combining the ingredients for one batch shall be a single operation of a switch or a starter.

All receptacles used for weighing materials, together with the scales of any kind used in batching materials, shall be so insulated against the vibration or movement of the rest of the plant due to any operating equipment, that the error in weighing with the entire

plant running will not exceed two per cent for any setting nor exceed one and a half per cent for any batch.

Should separate supplies of aggregate materials of the same size group, but of different moisture content, be available at the batching plant, withdrawals shall be made from one supply exclusively and the material therein completely exhausted before starting on another.

The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the batching plant to the point of mixing. Aggregates containing excess moisture shall be stockpiled prior to use until sufficiently dry to meet the above requirement.

Except where small quantities of concrete only are to be used, when the Engineer's Representative may permit otherwise, the equipment for batching of concrete materials shall conform to the following requirements:-

The batching equipment shall be substantially constructed on a firm foundation, high enough above trucks being loaded to function properly. It shall have 3 bins and a weighing hopper. The bins shall have a total capacity of not less than 100 tons, and the partitions between them shall extend not less than 1m above the bins. The bins shall be equipped with baffle boards so as to assist drainage of the aggregates and prevent the drained-out water from passing through the outlet gate. A platform shall extend around the weighing hopper for easy means of inspection, adjustment and weighing.

The weighing hopper shall have a single compartment with arrangements for ready removal of excess material, and with a discharge gate opening parallel to the partitions of receiving trucks. The amount of opening of the discharge gate shall be readily controlled. There shall be sufficient clearance at all points for the weighing hopper to function properly. The weighing scales shall be of the beam or springless dial type of standard design and make, and shall be able to record the true weight within 2kg at maximum load. The beam type shall have separate beams for each size of aggregate, and each beam shall have an easily operated locking device. A dial which will show the weight when the load is within 45kg of that required and an approved signal device shall be provided. The weighing scales shall be arranged for ready standardization, and with each scale shall be furnished a set of standard weights including seven 25kg, two 10kg, two 5kg and two 2kg weights. For batchers of capacity of $1/2\text{m}^3$ or less, the standard weights to be furnished shall be as approved by the Engineer's Representative. The tolerance of these scales shall be within those listed in Table 3 of the US National Bureau of Standards NBS Handbook 44. The standard weights shall be protected against defacement and injury, and shall be easy to handle and attach. All parts of the weighing devices and appurtenances of the batching equipment shall be substantially made and shall be maintained in proper operating condition. If in the opinion of the Engineer's Representative any part or all of the weighing devices or other appurtenances are not satisfactory, they shall be replaced in a satisfactory manner at the Contractor's expense.

In lieu of the automatic devices for controlling the weighing of aggregates and bulk cement as described in the foregoing specifications for batching equipment, the Contractor may be permitted to substitute manually controlled devices, provided approval for such devices is granted by the Engineer's Representative in writing.

2. Unloading and Hauling Equipment: Aggregate shall be transported from the batching plant to field paver mixers in batch boxes, vehicle bodies or other containers of

adequate capacity and construction to carry the volume required properly.

Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or being dumped. Where cement is stored in bulk, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to mixer, with chute, boot or other approved device, to prevent loss of cement, and arrange to provide positive assurance of the actual presence in each batch of the entire cement specified.

Loose cement shall be transported to the mixer in waterproof compartments carrying the full amount of cement required for the batch or it may be carried in compartments covered by the aggregate. Batches where cement is placed in contact with the aggregates may be rejected unless mixed within one and a half hours of such contact. Cement in original shipping packages may be transported on top of the aggregates, each containing the number of bags required by the job mix.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer without loss of cement, and when more than one batch is carried on the truck, without spilling of material from one batch compartment into another.

3. Batching to Central Mixing Plant: At a central mixing plant, batches shall be discharged from the weighing hopper into the mixer either directly by gravity or by an elevating container large enough to contain the batch. The plant shall be arranged to ensure that there is no loss of cement during transfer from the weighing hopper to the mixer drum.

4. Field Mixing Equipment: The concrete mixer shall be a batch mixer so designed as to ensure positive, uniform distribution of materials throughout the mass. The size and type of mixer used on various classes of work shall be as specified below and shall be approved by the Engineer's Representative. For all work where the volume of concrete to be placed justifies it, the mixer shall have a capacity of not less than one cubic meter, shall be of approved make and acceptable to the Engineer's Representative, and shall comply with the following requirements: - Mixers shall have a locking device preventing the mixture from being discharged before the expiration of the specified mixing time; an automatic locking device preventing materials being placed in the mixer before discharge gate is closed; a regulator that will maintain the rate of speed for which the mixer has been designed; a signal device that will function when water is added; a vertical water tank with an automatic device that will measure and discharge the required volume of water; valves to prevent overflow into the mixing chamber or on to the ground when the discharge valve is closed and into the tank when open; and valves and piping in proper order to prevent any leakage. The automatic device for measuring and discharging the required volume of water shall be arranged to discharge a predetermined volume, to be easily adjusted to discharge a larger or smaller volume, and to register the volume discharged accurately on a gauge or dial, which shall be calibrated before the mixer is used and shall be kept properly calibrated. A by-pass valve shall permit the discharge of all the water into a measuring can for the purpose of calibration. The measuring of the volume of water required shall be done by means of the adjustable discharge device only. The use of wash water as a portion of the mixing water for succeeding batches shall not be permitted. The loading skip of the mixer shall be substantially made and shaped so that wet sand and other materials will not remain in it when it is being discharged. The mixer shall not be used when any of the devices above stated are not functioning properly, or when the blades of the mixer have worn down to 90 per cent of their original width. The Contractor shall furnish a certified statement from the manufacturer as to their

original width. The mixer shall be kept clean and free from hardened mortar.

5. **Truck Mixers:** Truck mixers shall be used only when permitted by the Engineer's Representative in writing. Each transit mixer shall have a watertight drum, suitably mounted and fitted with adequate blades capable of properly combing the mixture. A batch meter and a locking device to prevent discharge prior to completion of mixing shall be provided on each unit. Measuring tanks, equipped with outside taps and valves to facilitate checking their calibration, shall be provided for the mixing water. All water added to the mixer shall be passed through an approved water meter, located between the water tank and the mixer drum, equipped with indicating dials and totaliser, and capable of measuring and discharging a specified amount of water within an accuracy of one per cent. The device shall provide means of readily verifying the amount of water added to the mix. An electrically actuated revolution counter which shall indicate the amount of mixing shall be provided on each mixer. An inspection opening shall be provided on each mixer, to permit ready determination of the consistency of the concrete being placed in the forms. When pick-up and throw-over blades are worn down 2cm or more in depth, they shall be replaced with new blades. The Contractor shall furnish a certified statement from the manufacturer as to the original depth of the blades.

R10 06 Forms

Side forms shall be made of metal or other approved material: they shall be of approved construction and provided with adequate devices for secure setting so that when in place, they shall withstand the impact and vibration of the compacting and finishing equipment with settlement not exceeding 1.5mm in 3m. Form sections are to be tightly joined by a locked joint free from play in any direction.

Side forms for machine placing shall have rolled section steel rails which shall be of adequate stiffness to carry the laying, compaction and finishing machines. These machines shall not run on folded sheet metal form tops.

The rails and top faces of the forms shall not depart from a 3m straight edge by more than 1.5mm. The top faces of the forms are to be carefully cleaned and maintained in this condition.

Bent, twisted or battered forms are to be removed from the Site. Repaired forms are not to be used unless approved by the Engineer's Representative.

The depth of the forms used shall be the same as the thickness of the slab being laid.

The width of the bases of steel forms shall be not less than their height except that the steel forms having a base not less than two-thirds of their height and meeting all other requirements herein may be used for manual laying of non-rectangular bays. The forms shall be of approved section without horizontal joints and with flange braces extending outward on the base not less than two-thirds the height of the form, Each stake pocket shall be equipped with a positive non-detachable wedge. These forms shall be placed by using at least three steel pins of the size and length herein specified for each length of form. They shall be equipped with positive locking devices which will permit neat tight joints which will not deform under impact, vibration or thrust.

Pins for staking forms in place shall be made of steel at least 2cm in diameter and at least 75cm in length, except that shorter length pins may be used if permitted by the Engineer's Representative after demonstration that the 75cm pins are impractical for use, If it is found impractical to hold the forms securely in place by use of pins 75cm in length, longer pins, as may be required, shall be used.

Wooden forms may be used for curves having a radius of less than 50m. They shall be made of two 2 · 5cm well-seasoned surfaced planks fastened together and shall be attached securely to a wooden base 20cm in width. All wooden forms shall be braced at least every 60cm with steel pins of the size and length herein specified.

Straight forms shall be setout as chords to concave edges and as tangents to convex edges, but payment will not be made for concrete outside the curved edges shown on the Drawings,

The side forms shall be placed to true vertical alignment by reference to a piano wire stretched between level pins placed not more than 15m apart on a line adjacent to the forms.

The forms shall be held firmly in place and shall have no vertical or horizontal movement in excess of 2mm when subjected to the load of the finishing machine, or from any other-construction operation. The forms shall be checked for vertical alignment between the placing of the top course of concrete and the finishing of this course, and such adjustments shall be made as are necessary in order that the forms may conform thereto.

Special forms or other supporting devices, meeting the approval of the Engineer's Representative, shall be used to support the joint filler at transverse control joints when concrete is to be placed on only one side of the filler.

The support under the forms shall be firm and cut true to grade so that the form when set upon it will be firmly in contact for its entire length and width, and accurately set to line and grade. Any support which at the form line is found below the required grade shall be filled to grade with bitumen sand as specified for base-course for a distance of 40cm on each side of the base of the form and thoroughly re-rolled or, if the length of such low support is less than 90cm, it may be compacted, to the satisfaction of the Engineer's Representative, by pneumatic or vibratory tampers. Alternatively, and for a deficiency after patches, as described, hollows to 1cm depth under the forms may be filled with mortar made of Rapid Hardening Portland or Aluminous cement. Forms so supported shall not be used until the mortar is hard.

At all times sufficient forms shall be used and set to the required alignment and elevation to provide for a least 1,200m² of pavement, and in no case provide for less than 200lin. m of pavement, immediately in advance of the paving operations. The forms shall be shaded from the sun for several hours before the concrete is poured.

Forms shall not be removed until at least 12 hours after laying the concrete.

The forms shall be cleaned thoroughly and oiled each time they are used before concrete is placed against them.

R10 07 Base-course tester

The base course tester shall span the width being paved and be supported on the side forms. It may be power or hand operated with scratch teeth or pins which can be adjusted readily to the required section and supported in a frame of sufficient weight and strength to withstand the loads.

R10 08 Base-course planer

The base-course planer (if employed) shall span the width being paved and shall be supported on the side forms by rollers. It shall be mechanically or power drawn, of heavy,

rigid construction to withstand the loads required accurately to plane off the base-course to the section for the bottom of the pavement. Cutting blades shall be supported in a manner to permit ready adjustment at all times.

Base-course planing machine, which have unflanged wheels operating on the concrete surface of pavements shall have those wheels run on rubber belting 6mm in thickness, placed over the concrete to protect it from damage as the wheels pass. The plain wheels shall be so placed that they will operate at least 15cm from the edge of the concrete pavement. The wheels operating on side forms shall have two flanges in such cases.

The base-course planer shall be used as necessary to remove high spots from the base-course and this work shall be verified by use of the base-course tester, low spots in the base-course shall be brought to proper level as necessary with bitumen stabilized sand mixed and compacted in accordance with Section R7A, but containing no panicles retained on a 4.75mm (No.4) sieve

R10 09 Polythene sheeting

Immediately before any concrete is placed, polythene sheeting as specified above shall be laid on the base-course over the entire area, care being taken that the sheeting is not torn or damaged when the concrete is placed thereon. The sheeting shall be lapped at least 30cm and any damaged sheeting shall be replaced at the Contractor's expense.

At the time of placing polythene sheeting, the surface of the bitumen stabilized sand base-course shall be in accordance with the requirements of Sections R7 and R7A. Any stickiness of the surface shall be eliminated by dusting it with dry fine sand and/or silt, any surplus of which shall be removed before the polythene sheeting is laid.

R10 10 Joints

1. **Longitudinal Joints:** Longitudinal joints shall be of two types, namely- longitudinal construction joints (Type B) and longitudinal dummy joints (Type F).

- (a) Longitudinal construction joints are to be used wherever one longitudinal strip of the pavement is to be constructed against another separately laid strip of pavement.
- (b) Longitudinal dummy type joints are to be used only when the Contractor is permitted to construct the pavement to its full width in a single construction operation.

2. **Transverse joints:** Transverse joints shall be of five types: A, C, D, E and F, details of which are shown on the Drawings. Transverse joints shall be generally formed to the Type sequence E F F E F F E at 5m interval, Type E being replaceable by Type A, C and D and the interval being variable by 1m as necessary. No part of any slab shall be less than 1.5m wide and no angle shall be less than 70°.

Dummy construction joint Type E shall be provided by introducing a corrugated asbestos sheet, this sheet shall be held firmly by a special welded steel frame of 3mm thick plates.

3. **Crack Inducing Battens:** Crack inducing battens shall be laid for Type F joints on the polythene sheeting covering the base.

- (a) Without any gap underneath which will not close under the weight of the concrete mix.

- (b) Without any gap exceeding 1cm between the battens and form or adjacent slab, or between separate lengths of batten or between longitudinal and transverse battens.
- (c) In lengths of not less than 2m.
- (d) With ends at intersection of longitudinal and transverse joints mitred in plan (4 ends) or in elevation (2 ends).
- (e) In straight lines on the lines of joints with a tolerance of ± 1 cm.

4. **Dowel Bars:** All dowel bars shall be placed at the depth, spacing and position relative to the line of the joint in accordance with the Drawings with a tolerance of 1cm on each of these dimensions.

Dowel bars for expansion and contraction joints (Types A, C and D) shall be placed on an axis parallel to the surface of the slab and to the centre line of the slab (parallel to the side form in the case of transverse joints and at 90° to it for longitudinal joints) with a tolerance (measured at one end) of up to 0.042mm for each 10mm of length.

The parts of the lengths of straight dowel bars in expansion and contraction joints (Types A, C and D) which are to be in the slab of concrete laid second shall:

- (a) Be coated with oil, grease or bituminous paint immediately before laying the concrete.
- (b) Be straight and free from indentations or other deformations of cross-section.
- (c) Have sawn ends.
- (d) be coated with a corrosion inhibitor. Oil coat shall not be applied until the inhibitor has completely dried.

Tie bars for construction/bounded joints (Type B) shall be placed as specified above but with a tolerance up to 0.1mm for each centimeter of length.

Dowel bars for construction joints (Types A, Band C) shall be rigidly held by the form and rest on steel chairs during the laying of the concrete.

Dowel and filler boards for expansion joints (Type D) shall be rigidly held by the form during the placing of the concrete outlined by broken lines on the cross-section of this joint shown on the Drawings. This concrete, together with a folded strip of the mesh reinforcement, shall be placed 24 hours before the concrete of the slabs is due to be placed, and it shall be removed and replaced, with a similar delay, if the slabs are not cast within 36 hours of laying it. This preplaced concrete shall be of the same mix as the slab or as specified for hand placing; it shall be compacted by vibratory poker and plate (10-15cm diameter or square) compactors, and left with rough faces free from laitance and voids. Bottom course concrete of the slabs shall be placed carefully for at least 1m on both sides of the pre-placement concrete immediately before the normal placing of concrete reaches the joint.

Bottom course concrete shall be carefully placed and compacted by immersion vibrators between the dowel bars and for at least 1m on each side of the line of joints (Types C and D) immediately before the normal placing of concrete.

5. **Filler Boards:** Filler boards shall be placed:

- (a) vertically or perpendicular to the pavement surface with a tolerance of 1°
- (b) On the line of the joint with a tolerance approved by the Engineer's Representative.
- (c) Without any overlap, (excepting overlaps to stagger joints in assemblies of two or

more layers). and

- (d) With no gaps below it, between individual lengths, or between it and the form, or previously laid concrete, or with such gaps sealed by adhesive tape or other approved means to resist the entry of concrete or mortar.

Filler board shall extend to 1cm below the surface of the pavement in transverse expansion joints and to either the same surface or the underside of a groove-forming strip of wood or metal in longitudinal expansion joints. There shall be no gap between the filler and any such strip.

6. Sealing Grooves: Grooves for sealing construction joints shall be formed either by a strip of steel, hardwood or other approved material secured to the form or by cutting as described below.

Grooves for contraction and warping joints and for sealing transverse expansion joints (other than construction/expansion joints) shall be formed by cutting the concrete after it has hardened sufficiently for this to be done without risk of cracking or spalling. Grooves for transverse contraction joints shall be cut within 48 hours of laying the concrete and those for transverse and longitudinal warping joints shall be cut within 96 hours of laying the concrete. The position of each transverse joint shall be marked on the forms or form and the adjoining slab before the concrete is laid and it shall be marked on the plastic concrete by plucking a stretched piano wire.

A cut or groove may be made in the plastic concrete on the line of longitudinal warping joints provided that this does not result in any weakening of the concrete and provided that any disturbance of the adjacent surface is remedied.

All grooves shall have square corners.

The outside edges of pavements (except curbed edges) shall be finished with a 6mm radius.

As an alternative to the cut and sealed groove a premoulded synthetic rubber strip of cross-section similar to that shown on the Drawings may be used in transverse expansion joint (Type D), provided that details and a sample of the proposed strip are submitted to and approved by the Engineer's Representative, The strip shall be a tight fit on the filler board and there shall be no gap between separate lengths of strip, The concrete between the top fins shall be removed immediately after it has finally set.

R10 11 Protection from weather

Exposed tanks and pipes for water for concrete, cement storage buildings or silos, top and vertical walls of mixer discharge hoppers and sides of bodies of trucks carrying batched aggregate or mixed concrete shall be painted white or silver. Weighing hoppers, mixer drums and the tops of mixer discharge hoppers shall be shaded from the rays of the sun above (a temperature of 30 C°) and they shall be protected from drying winds by screens,

Mechanical concrete laying compaction and finishing operations and curing shall be carried out until at least 9 p.m. local time on the day of laying under a train of tents moving on the forms (or form and adjoining slab) with the compaction machine, but giving the spreading machine and any separate final finishing machine freedom for independent movement. Separate trains of tents may be used for all sets of machines

laying the layers of concrete, but they shall be linked by a flexible or telescopic section to provide continuous shade. The top and bottom surfaces of the roofs of tents shall be white or silver colored and excepting for gaps on one side for the entry of materials, they shall have side walls of the same color which shall be continuous in length and extend from the roof to not more than 3cm above the pavement surface level. Tents providing protection, but not working space, shall have their ceilings not more than 20cm and 50cm above the surface of the concrete at their sides and ridge respectively and they shall have two end walls,

R10 12 Weather conditions

1. **General:** Any concrete placed during hot weather or during cold weather shall be at the Contractor's risk and any damaged concrete shall be removed and replaced at the Contractor's expense.

2. **Work in Hot Weather:** The temperature of concrete shall not exceed 30°C at the time of laying, unless the Contractor incorporates in the mix a plasticizer, of a make and in a proportion which he has shown by laboratory tests and full scale trial to be to the satisfaction of the Engineer's Representative, to eliminate detrimental effects of high temperature without introducing any other detrimental effect, and for which he takes full responsibility in these two respects.

The following may be used to keep the temperature of concrete below the above limitations:

- (a) Chilling of concrete water by heat exchange coils or by addition of broken ice, provided that the water shall be free from ice at the time of entry into the mixer.
- (b) Cooling of coarse aggregate by watering, provided that the water content of the aggregate so cooled shall be uniform.
- (c) Reclaiming of aggregate from stockpiles by the tunnel method to avoid using the surface layer of the stockpile, with shade and wind protection of conveyor elevating to batching plant
- (d) night work provided that (a) and (b) and (c) are proved inadequate or unsatisfactory in their results and providing also that the Engineer's Representative has no other reason for refusing permission for night work.

The Engineer's Representative shall have power to order the suspension of concrete production and/or laying when the shade temperature exceeds 30°C if he is not satisfied that the precautions being taken or intended by the Contractor are adequate to (a) prevent the temperature of the concrete rising above 30°C or (b) avoid any detrimental effect in the use of a plasticizer. The possession of this power by the Engineer's Representative shall not relieve the Contractor of any of his responsibilities.

Under no circumstances will the Contractor be entitled to receive any additional payment for complying with the requirements of this Clause.

3. **Work in Cold Weather:** Except by written approval of the Engineer's Representative, concreting operations shall not be continued when a descending air temperature in the shade and away from artificial heat falls below 5° C, nor resumed until an ascending air temperature in the shade and away from artificial heat reaches 2°C. In such cases the mixing water and/or aggregates shall be heated to not less than 21cC nor more than 66°C, prior to being placed in the mixer, and may be heated after being placed in the mixer by an approved type of heating device so that the temperature of the concrete shall not be less than 10°C, nor more than 27°C, at the time of placing. The

materials shall be heated in such a manner as to preclude the possible occurrence of overheated areas. No materials containing frost shall be used. Cement or fine aggregate containing lumps or crusts of hardened materials shall not be used.

R10 13 Placing of concrete and mesh reinforcement

1. **Mechanical and Manual Spreading, Compaction and Finishing:** Concrete mixed in central plant shall be transported without delay from the mixing plant to the position for laying and any concrete which, in the opinion of the Engineer's Representative, has been mixed too long before reaching the work will be rejected and shall be removed from the Site.

Trucks delivering concrete shall not run on polythene sheeting nor shall they run on completed slabs until at least 14 days after placing the concrete.

When concreting operations are about to start, the polythene sheeting on the base shall be in a finished condition, shall be free of all foreign and unsuitable materials, shall not be muddy, and shall be free from dust and dry earth or any rucking.

Concrete is to be placed and compacted in two layers except that some hand-laid concrete is to be placed in three layers as specified hereafter. Different concrete mixes shall be used for the upper layer and for the lower layer or layers, as specified in Clause R10 04-1.

The lower layer(s) of concrete shall be deposited, spread and compacted so that the surface of this (these) layer(s) is at the depth shown on the Drawings for the fabric reinforcement. Care shall be taken to avoid damaging the polythene sheeting during the laying of the lower or lowest layer.

The surface of the lower layer, after compaction, shall be rough, free from laitance and free from surplus water to ensure complete bond with the upper layer. The sequence and method of operations shall be so timed and executed that the bond between the upper and lower layers of concrete is perfect with no laitance between the two layers and so that the joining of the two layers in no way creates a plane of weakness in the concrete pavement slab.

Concrete adjacent to expansion and construction joints shall be compacted with immersion vibrators inserted in the concrete unless the Engineer's Representative is satisfied that such concrete can be compacted by the vibratory compactor as dense as concrete away from such joints. This exception shall not apply to keyed joints. The vibrators are not to come in contact with the joint filler or the base.

Steel fabric reinforcement, as specified and shown on the Drawings, shall, where it is required by the Drawings, be placed on the surface of the lower layer of concrete with longitudinal and transverse overlaps not less than 40 times the diameter of the bars transverse to the overlapped edge of the sheet, or 15cm, whichever is the greater.

The upper layer of concrete shall be placed before initial set develops in the lower layer; lower layer concrete initially set before placing the upper layer shall be entirely replaced. The upper layer of concrete shall be deposited, spread and compacted, and finished to the required surface levels and finishes.

In order to secure adequate compaction, the concrete is to be spread with a surcharge above the finished level of the layer.

The concrete is to be deposited in such a manner as to require as little rehandling as

possible.

Spreading, compacting and finishing operations are to be completed without delay. Any concrete, which has been in place too long before completion of these operations, is to be removed from the Site.

The total time taken from the addition of the water to the mix until the completion of the surface finishing operations shall not exceed 30 minutes when the shade or mix temperature exceeds 27°C, or 40 minutes when less than 27°C.

The mixing and placing of the concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the pavement.

The top of the forms shall be kept free from accumulation of concrete or foreign material. The Contractor shall not permit the accumulation of laitance along the edge of a slab poured adjacent to one previously placed. Any accumulation of laitance shall be removed and replaced with fresh concrete.

As soon as the side forms are removed the edges of the slab shall first be inspected by the Engineer's Representative and any minor honeycombed areas shall then be filled in with mortar composed of one part of cement to two parts of fine aggregate, under the supervision of the Engineer's Representative.

2. Mechanical Laying: All slabs with parallel longitudinal sides, excepting those less than 3.33m wide in short lengths alongside slabs of irregular shape at junctions, shall be spread, compacted and mechanically finished by self-propelled machines, complying with and operated in accordance with the following requirements.

The machines shall consist of a spreader and a finisher for the lower layer (excepting as described below) and a spreader and one or two finishers for the upper layer. The exception is that the lower layer of lanes less than 100m long between two slabs of irregular shape, or one of these and one end of a road, may be laid with the spreader and a finisher used for the upper layer provided that this pair of machines alternates between the upper and lower courses sufficiently frequently to the approval of the Engineer's Representative.

The spreaders shall be of the hopper box type and of the paddle type designed to spread the concrete uniformly and without irregular pre-compaction across the entire width of the lane, with means of adjusting the strike-off height.

The finishers shall have (a) a distributor, either of the reciprocating, or preferably of the rotating paddle type, suspended from the frame with height adjustment means, and (b) a vibratory compactor, of either the screed type or of the pan type, suspended from the frame with means of adjusting the height at each end. The screed shall be at least 45cm wide and it shall have a front nose of at least 5cm radius. The vibratory compactor shall be vibrated at a frequency of at least 3,500 impulses per minute with a uniform force sufficient to compact the thickness of the layer concerned. A tachometer shall be provided to indicate the frequency of impulses.

The vibratory compactor shall not be permitted to come into contact with any joint assembly or the side forms. In no case shall the vibratory compactor be operated for more than five seconds in anyone location.

The finisher for the upper layer shall, in addition, have a shuttle smoother equipped with vibrators, and suspended, with means of adjusting its height, either (a) from an independent carriage running on the form rails, or (b) diagonally from a frame supported at one end on the main frame and at the other on an independent carriage running on the form rails. A shuttle smoother suspended as in (b) may be used as the final finisher, but a separate final finisher must be used if the shuttle smoother is suspended as in (a).

The final finisher, if it is a separate machine, shall be either (a) a diagonal shuttle smoother mounted between two carriages running on the rails, or (b) a longitudinal finisher with a float at least 30cm wide and at least 3· 5m long, mechanically operated to move transversely across the slab with adequate longitudinal lapping of traverses.

Shuttle smoothers and longitudinal floats shall be of sufficient weight and power to produce the required surface finish to the concrete.

All machines shall have a sufficient number of wheels to spread their weight so that excessive settlement of the form rails does not occur. After laying the first lane with the machines running on the rails of two rows of forms, the machines shall be operated with either solid rubber tyred wheels on one side running on the previously laid concrete at least 15cm from the edge of the slab or with flangeless steel wheels or one side running on either hard rubber belting or steel strips each at least 6mm thick laid on the earlier concrete.

Details of all machines intended for use shall be submitted by the Contractor with his Tender and only machines approved by the Engineer shall be used.

Machines shall be operated efficiently to produce concrete as densely compacted as possible, free from honeycomb voids, free from segregation, and with the surface either complying with the requirements concerning levels and smoothness, or sufficiently close to these requirements to necessitate the minimum of hand finishing to achieve the specified levels and smoothness.

The spreader shall be operated to strike off each layer of concrete uniformly to a level requiring a small amount of cutting down by the distributor of the spreader. The distributor of the spreader shall strike off each layer of concrete to the surcharge adequate to ensure that the vibratory compactor thoroughly compacts the layer. The vibratory compactor shall be set to strike-off the lower layer to the required level, but it shall be set to strike off the upper layer slightly proud so that it is cut down to the required level by the shuttle smoother if this is the final finisher or to a level still very slightly proud if this is necessary for efficient working. Concrete mix which is surplus after each striking-off process shall be removed and the Engineer's Representative may prohibit its re-use. The final finisher shall be used to finish the surface to the required level and smoothness to the best of its ability. The finishers shall make as many passes as are necessary to compact and finish the concrete as specified, but care shall be taken to avoid bringing mortar to the surface excessively by over-working; the vibratory compactor or the shuttle smoother shall be raised clear of the surface when only the other of them is required and the impulse frequencies of vibrators shall be reduced when necessary to avoid such over-working. The last movement over each area shall over-lap the previously finished concrete which is not yet initially set. Particular care shall be taken to eliminate any waves caused by joint materials.

3. Manual Laying: Concrete which is inaccessible to the self-propelled machines shall be dumped and spread manually in a manner which will minimize segregation and aeration, and will ensure even compaction. Flexible concrete junction slabs shall be laid in three layers. The first layer shall be the bottom half thickness of the slab; this shall be compacted by a vibratory beam or plate, but its surface shall be made rough after compaction to remove any laitance and ensure bond. The second layer shall be to the level described above for machine laying and the third shall be the top layer. The whole depth of the slab shall be compacted by vibratory beam tampers moved manually to compact and strike off the concrete to the required levels and contours.

If it is necessary to adjust the mix slightly to give increased workability, within the limits specified, any addition of water is to be accompanied by a corresponding increase

in the cement content as necessary to maintain a water/cement ratio not exceeding that specified in Clause R10 04,

Vibratory tamping beams are to be designed for the width of bay being laid and should a narrow bay be formed, a vibratory tamping beam designed for a wider bay will not be allowed,

The spare vibratory tamping beam of each required length shall be available at all times, The vibratory tamping beams shall be moved forward with a combined longitudinal and transverse shearing motion always in the direction in which the work is progressing, and so manipulated that neither end is raised from the side forms during the striking-off process,

Any cambered slabs shall be constructed manually by use of a cambered vibratory tamping beam used transversely or by a straight vibratory tamping beam used longitudinally on cambered transverse forms, according to the shape of the slab,

The dimensions of manually laid slabs in the direction of tamping shall not exceed 4m.

R10 14 Finishing and finishes

1. **Manual Finishing:** Immediately following finishing by machine or vibratory tamper, also after any subsequent joint construction operations, any minor irregularities and score marks remaining in the pavement surface shall be eliminated by removing surplus material or by adding and working in freshly mixed concrete and any laitance or surplus water shall be removed, and the surface shall be finished manually. Long handled wooden floats may be used to smooth and fill in open textured areas in the pavement surfaces, but the final finishing is to be made with scraping straight-edges.

Necessary hand finishing of joints and surface irregularities shall be performed from approved bridges which shall not rest on any concrete which has not attained the required strength.

The scraping straight-edges are to be of at least 3m blade length with flexible handles long enough to reach the other side of the slab when operated from the near side of the pavement. They are to be placed parallel to the forms at the side of the pavement and worked backwards and forwards uniformly across the width of the slab. After this operation is completed and the surface brought up to the required finish, the straightedge is to be moved forward by not more than half its length and the process repeated.

Care shall be taken to ensure that any low spots in the surface are not filled with surface grout during the finishing operation, but that fresh concrete is used to correct and fill all depressions. Successive transverse drags of either tool shall be lapped one half the length of the blade. The long-handled wooden float may be used behind the final finisher to correct surface unevenness not taken care of by the final finisher, but the wooden float shall not be used to float the entire surface of the pavement in lieu of, or supplementing the use of the final finisher, except that when the crown of the pavement will not permit the use of the final finisher, the surface shall be floated transversely by means of the wooden float; care shall be taken not to work the crown out of the pavement during the operation.

The foregoing work is to be carried out while the concrete is still plastic and workable and in such time sequence as to ensure the removal of water or laitance from the surface. Excess thin mortar, accumulating ahead of the finishing floats and straight-edges, shall be removed from the surface of the pavement, and shall not be used in filling depressions. Work with the straightedges shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the surface

requirements specified below. Straightedges shall be checked twice daily against a master straightedge maintained on the site by the Contractor.

After the smoothing of the pavement has been completed and tested for smoothness as described above, and whilst it is still soft enough to take an impression, the concrete shall be finished and textured by dragging a fight broom transversely across the concrete so that it makes shallow impressions without substantial disturbance.

2. Concrete Forming the Final Upper Surface of the Pavement:

- (i) **Accuracy of Surface Finish:** The surface is to be free from honeycombing and local protuberances.

The finished surface of the road shall be to the levels shown on the Drawings within a tolerance of plus or minus 1cm, and in addition the following smoothness tolerance shall apply.

The surface of the whole of the road is to be such that when tested with a test straightedge 3m long, placed in any position and direction, there shall not be any gap greater than 3mm between the bottom of the straightedge and the surface of the pavement anywhere below the straight edge. In addition to the above requirement, there shall not be any deflection exceeding 1cm from a straight line between any two points 30m apart longitudinally.

The above two deflections are absolute maxima and the Contractor's aim shall be to endeavor to achieve a longitudinal profile which does not depart vertically from a straight line between any two points by more than:

- (a) 1.5mm between any two points 3m apart, and
- (b) 4mm between any two points 30m apart.

These two requirements are referred to as the high standard of 5 surface profile in the Bill of Quantities items providing for extra over rates payable on their attainment.

No variation from the true level will be permitted across any joint in the pavement.

Isolated high spots in the final road pavements, not exceeding 2m² each, which depart by more than 1 cm from the levels indicated, or by more than 3mm from a 3m straightedge shall be ground down, if the total area to be ground does not exceed 10m² in any 1,000m² section of concrete surfacing. When correction of the surface in excess of this allowance is necessary to bring it within these specified limits, and where the longitudinal profile departs by more than 1 cm in 30m, the concrete shall be cut out and replaced by the Contractor at his own expense to the nearest joints (or edge) beyond the defective area.

The above smoothness tolerances apply to straight profiles, equivalent smoothness tolerance shall be applied on vertical curves.

- (ii) **Surface Texture:** The surface of the concrete shall have a smooth finish, textured by drag brooming as specified to produce the surface texture described.

R10 15 Removal of forms

Side forms shall not be removed within twelve hours after the concrete has been placed. As soon as the forms are removed any honeycombed areas shall be corrected to the

satisfaction of the Engineer's Representative. Transverse expansion joints shall be opened along pavement edges for the entire depth promptly after the side forms have been removed. After removal of the forms, the Contractor shall protect the base at the edge of the slab from erosion or any other damage and any damage which may occur shall be repaired as the Engineer's Representative may direct.

R10 16 Curing and weather protection

The concrete is to be thoroughly cured in the following manner:

Within ten minutes after the completion of finishing operations the surface of all concrete excepting concrete which is to receive bituminous surfacing, is to be sprayed with an approved curing compound so as to produce an impervious coating.

Immediately after the side forms are removed:

- (a) the curing compound if it fulfils the requirements on vertical surfaces, or
- (b) a bituminous compound,

shall be used on the vertical faces for the period of exposure before the next lane of concrete is laid.

Before new concrete of an adjacent slab is placed, the surface of the hardened concrete of the Type B joint shall be wire brushed, cleaned, and, if necessary, picked to within 10cm of the surface, to ensure a good bond between the old and the new concrete.

All joints which have eventually to be filled with sealing compound are to be protected in a manner which will ensure that no curing liquid enters the groove, e.g. by the use of wet Hessian, polythene sheeting, waterproof paper or other approved means, and the method used is to ensure proper curing of the portion of the slab adjacent to joints.

This protection is to remain in place until the covering specified below is laid, or for at least 7 days.

The liquid is to be applied by a mechanical sprayer which is arranged to traverse the concrete lanes both longitudinally and transversely. In order to prevent wind blown losses the nozzles are to be as close to the surface of the concrete as is convenient to ensure even coverage. The spraying of curing compound on concrete laid by machine shall be carried out in a traveling working tent in the train of low protective tents. Where such machines cannot operate due to irregular bay sizes, suitable hand-operated sprayers are to be used.

Approved stand-by facilities for curing concrete pavement are to be provided at a readily accessible location at the Site of the Work for use in the event of mechanical failure of the spraying equipment or any other conditions which may prevent correct application of the curing compound at the proper time.

Concrete which is to receive bituminous surfacing shall be cured by either:

- (a) spraying with bituminous emulsion to produce impervious coating within 10 minutes of completion of finishing operations; or
- (b) laying on it wet Hessian sheeting covered by polythene sheeting within 10 minutes of completion of finishing operations.

Such concrete shall be protected from non-bituminous curing compound. Bituminous emulsion cured concrete shall not be exposed to the sun until 28 days have elapsed.

Concrete laid by machine shall be protected by the traveling tents described in Clause

R10 11, until at least 9p.m. on the day of laying; thereafter these may be replaced by the movable covers described below.

Concrete shall be protected by traveling tents or movable covers for at least 7 days in the months November to March inclusive, and for at least 4 days in the months April to October inclusive. The movable covers shall consist of white or silver painted Hessian or other approved material supported by a frame which shall rest on the forms or form and adjoining slab, the roof sheeting shall be not more than 4cm and 35cm, above the concrete at the edges and ridge respectively. The Hessian or alternative shall extend down to the form or concrete on both sides of the lane and at both ends of a row of frames.

Loose straw at least 20cm thick or straw mats at least 10cm thick may be used in lieu of these frames from the second to the seventh day during the months November to March inclusive. Straw shall be removed from the Site after use and none shall be burnt on any pavement or sub-base

During the months April to October inclusive, the traveling tents or movable covers shall, after their removal at 4 days, be replaced by the following alternatives for the periods scheduled below:

- (a) a layer of loose sand or silt 5cm thick and free from gypsum and any other matter deleterious to the concrete;
- (b) Polythene or other approved clear or light colored waterproof sheeting laid with its edges over strips of material to retain with a freeboard of at least 1cm, a pond of water at least 1 cm deep at the high edge of the slab, and weighted against the wind.

When the shade temperature exceeds 20°C

- (i) the sand or silt shall be kept damp, or
- (ii) the ponds shall be kept filled to a depth of at least 5mm at the high edge until the following periods after laying the concrete have elapsed:

April and second half October - 14 days

1st May to 15th June and 15th September to 15th October - 21 days

15th June to 15th September - 28 days

Water shall not be permitted to now from sand or silt or ponds on to other slabs or the base or sub-base or adjoining earthworks. Sand or silt shall be removed after use; it shall not be permitted to dry sufficiently for it to be blown about by the wind, it shall be covered by polythene sheeting or building paper weighted down during the laying, compaction and finishing of adjacent concrete. The exposed vertical side of concrete sprayed with bituminous covering compound shall be shaded from the sun by paper or other light colored material.

Traveling tents, movable covers, sand or silt and ponds may be removed for the cutting and sealing of joint grooves only when the shade temperature is between 2°C and 35°C and it is not liable to change outside these limits. The slabs shall be exposed only for the minimum period required for the work. Any joints which are not sealed immediately after cutting shall be protected from entry of sand or silt and they shall be blown clean immediately before sealing.

The Contractor shall at his own expense cut out and replace any concrete damaged by

frost or by incomplete curing, or cracked on a line other than that of a contraction or warping joint before the groove of the joints is cut.

R10 17 Joint sealing

All joint grooves in the concrete pavement (excepting any joints incorporating synthetic rubber strip) shall be filled with a joint sealing compound as previously specified in Clause R10 02-8 according to the requirements and locations shown on the Drawings.

Before any sealing compound is poured:

- (i) Care is to be taken that the groove extends across the bays form to form in the case of transverse joints and is continuous in the case of longitudinal joints;
- (ii) In the case of expansion joints, the filler material is to be exposed for the full length of the joint;
- (iii) All joint grooves are to be dry and free from dust, concrete fragments or other deposited material and they shall be offered for inspection by the Engineer's Representative before they are filled. Compressed air jets, wire brushes and such additional equipment as may be necessary to clean openings and dry the contact faces of the joints shall be used.

The joints are then to be primed as necessary and filled with sealing compound as indicated in accordance with Clause R10 02-8. The compound is to be heated and poured in accordance with the procedure recommended by the manufacturer or his agent, particular care being taken not to exceed the maximum temperature specified by the manufacturer.

The compounds are to be melted in mobile appliances by indirect heating methods at the temperatures recommended by the manufacturer. These appliances are to incorporate mechanical agitation of the compound during heating and means of ensuring strict temperature control.

Pouring shall be done by the use of hand-pouring pots, mechanical methods or any other method which will give results satisfactory to the Engineer's Representative. Pouring shall be done in such a manner that the sealer will fill the prescribed space to the levels given below so that sealer will not be spilled on exposed surfaces of the concrete. Any excess sealer or any sealer on the surface of the concrete pavement shall be removed immediately and in a manner which does not discolor nor injure the concrete or the remaining sealer.

All joints are to be sealed as soon as practicable as the work progresses and in sufficient time for the seal to harden before traffic is permitted on the pavement. Expansion joints shall be sealed 6.5mm below surface level; contraction joints shall be sealed 3mm below surface level; tied construction and warping joints shall be sealed level with the surface.

R10 18 Tests for thickness of pavement and degree of compaction and compressive strength

1. **Thickness of Pavement:** The Employer will not be liable for payment of any excess in thickness or depth of pavement. During the progress of the work the thickness or depth of pavement will be determined by the Engineer's Representative from cores cut from the concrete pavement by the Contractor. The cost of cutting and recovering all the cores described in this Clause and the following paragraph 2 below shall be deemed to be included in the rates and prices for Portland Cement Concrete Pavement entered by the Contractor in the Bill of Quantities.

Cores, from the concrete pavement shall be taken in accordance with AASHTO T24. The measured length of the core shall be in accordance with AASHTO T148 and the compressive strength in accordance with AASHTO T24.

Unsatisfactory work shall be repaired, replaced, or will be paid for at an adjusted price, as follow:

- (a) One 15cm diameter core will be removed by the Contractor from each lane, at such locations as the Engineer's Representative may direct, and shall represent not more than 1000m² of pavement. A lane shall be considered the pavement surface between longitudinal joints, or a longitudinal joint, and pavement edge.
- (b) If any core measurement is deficient more than 6.5mm from the required thickness a core measurement shall be taken at each 30m interval in both directions longitudinal from the first deficient core in the same lane, as defined herein, until the thickness of the pavement is found to be not more than 6.5mm deficient from the required thickness. Each deficient core shall be considered as representing the condition in the same lane or longitudinal section, as above defined, for a distance of 15m, in each direction longitudinally from the core.
- (c) Sections of pavement which are deficient in thickness, as determined by cores, by an amount more than 1.3cm shall be removed and replaced with pavement of the specified thickness at the expense of the Contractor. The removal and replacement shall start at the determined point of deficiency and proceed longitudinally as hereinafter specified, until the pavement is found to be not more than 6.5mm deficient from the required thickness. The old reinforcing steel shall be left extended a sufficient distance so as to allow the new reinforcement steel to be lapped with the old the required distance specified in Clause R10 13 or to be welded to the satisfaction of the Engineer's Representative.
- (d) The removals and replacements of pavements shall extend transversely the full width of each lane in which such deficiency is found.
- (e) All pavements within 2m of the deficiency spot shall be removed, except that when any joint is more than 2m, all pavements shall then be removed to the next joint.
- (I) Sections of pavement which are deficient in thickness, as determined by measurement of cores in accordance with AASHTO T148-49, by an amount more than 6.5mm, but not more than 1.3cm, will be paid for at an adjusted price as specified in Table R10/5 below:

**TABLE R10/5
DEFICIENCY IN THICKNESS AS DETERMINED FROM CORES**

Thickness	Proportional Part Of Contract Price to be Allowed
0 · 0mm to 6 · 5mm	100%
6 · 5mm to 13mm	75%

2. Degree of Compaction: The cores that have been cut from the concrete pavement according to the requirements of I above shall be examined by the Engineer's Represen-

tative to check the degree of compaction achieved through the slab and to check the effectiveness of the bond between the top and bottom course concrete.

Should any core reveal that any part of the slab has not been adequately compacted by revealing honeycombed or segregated concrete and should the bond between the top and bottom layers of concrete be such that a plane of weakness is present, then additional cores shall be taken to check the areas of defective concrete pavement according to the procedure laid down in I above for determining the areas of concrete pavement deficient in thickness by more than 6.5mm.

Any areas of defective pavement concrete so found shall be replaced with new concrete in accordance with this Section.

The Engineer's Representative reserves the right to carry out crushing tests on any or all of the concrete cores taken in accordance with this Clause, and should these tests show that any area of pavement concrete has failed to meet the strength requirements of the Specification, then such areas of concrete shall be removed and replaced with new concrete, mixed, laid, compacted and finished to the requirements of this Section.

3. Refilling of Holes: Holes in the pavement created by the cutting of cores shall be thoroughly coated on the inside with a neat cement grout and shall then be filled with concrete of the same mix as used in the pavement. The filling shall be in two equal layers and each layer shall be rodded 25 times to its full depth. The surface shall be finished flush and broomed. The surface shall be kept thoroughly wet for 72 hours thereafter.

R10 19 Replacement of defective concrete

Any concrete not complying with the Specification shall be cut out and replaced in accordance with the Specification over the full width of the slab between longitudinal construction joints and over a length extending between two transverse joints each of a type other than a warping joint. The finished pavement should be protected against damage from the construction operations and traffic until final acceptance.

No traffic shall be permitted until the joints have been sealed.

R10 20 Measurements

The unit of measurement for payment shall be the square meters of the completed and accepted Portland Cement Concrete Pavement, as measured in place. The number of square meters of the completed Portland Cement Concrete Pavement shall be determined by the length measured along the centre line and upon the surface of the road, times the width as shown on the Drawings plus the areas of any widening on curves, turnouts and intersections, authorized and measured separately. Measurement of pavement thickness will also be made in order to determine the basis of payment.

The unit of measurement for Bridge Approach Slabs shall be the square meters of the area actually constructed in accordance with the Drawings or as directed in writing by the Engineer.

R10 21 Payments

The number of square meters of Portland Cement Concrete Pavement, measured as specified in Clause R10 20 above, will be paid for, at the price tendered per square meter

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in the Bill of Quantities, adjusted as specified for deficiency in thickness, which price shall include the cost of constructing, finishing, curing, protecting and cleaning the pavement as above described; the preparation of sub-base to receive the pavement; the construction of all joints of whatever type; cutting of cores and filling of holes therefore; all materials, including joint filler and other material, reinforcement steel; equipment, labor and all else necessary therefore, and all other work in connection therewith and incidental thereto in accordance with the Specification and Drawings.

The number of square meters of Bridge Approach Slabs, as specified in Clause R10 20 above, will be paid for at the price tendered per square meter in the Bill of Quantities, which price shall include the cost of constructing, finishing, curing, protecting and cleaning the slab as above described; the preparation of the sub-base to receive the slab; the construction of all joints of whatever type; all materials, including joint filler and other joint material, reinforcement steel; equipment, labor and all else necessary therefore, and all other work in connection therewith and incidental thereto in accordance the Specification and Drawings.