

## **SECTION R9**

### **Hot-Mix Asphalt Concrete Pavement**

#### **R9 01 Scope**

The work covered by this Section of the Specification consists in the furnishing of all plant, labor, equipment and materials and in performing all operations in connection with the construction of asphalt concrete pavement on a previously prepared course, complete subject to the terms and conditions of the Contract and in strict accordance with this Section of the Specification, the applicable Drawings and the directions of the Engineer's Representative.

#### **R9 02 Materials**

1. **Aggregate:** Aggregates shall be of uniform quality, crushed to size as necessary and shall be composed of sound, tough, durable particles, with or without natural or mineral fillers, as required. All materials shall be clean, free from injurious amounts of clay balls and clay coated particles, gypsum, organic matter and other deleterious substances. The aggregate coarser than (2.36 mm) shall have a percentage of wear not more than 30 for surface course, 35 for binder course and 40 for base course when tested in accordance with AASHTO T96. deleterious materials as determined in accordance with AASHTO T1112 shall not exceed 3% by weight.

The plasticity index shall not exceed 4 as determined by AASHTO T89 and T90 for total aggregate and mineral filler of the fraction passing No. 40 sieve (prepared in accordance with AASHTO – T146).

2. **Coarse Aggregate:** That portion of the combined aggregate retained on the 4.75 mm (No. 4) sieve used for asphalt concrete; binder and surface course shall be crushed stone or crushed gravel of such grading that when combined with other required aggregates fractions and filler in proper proportion, the resultant mixture shall meet the grading required under the composition of mixture for the specific type under contract. The coarse aggregate used for asphalt concrete base course may be crushed, uncrushed or combination of both. The degree of crushing shall be such that at least 90% by weight of the materials retained on the No. 4 (4.75 mm) sieve has one or more fractured faces, and shall not contain more than 10% of flat and elongated pieces with more than 5 to 1 between maximum and minimum dimensions (ASTM D4791).

The coating shall be above 95% when tested according to ASSHTO T182 or ASTM D2727. The coarse aggregate when subjected to the five cycles of the soundness test (ASTM C88) shall have a weighted loss not greater than 12% when sodium sulfate is used or 18% when magnesium sulfate is used.

3. **Fine Aggregate:** That portion of the combined aggregate passing the 4.75 mm (No. 4) sieve shall consist of stone screenings and natural sand. Natural sand shall not exceed 25% of the portion fines than 2.36 mm for surface and binder courses. The grading shall be such that when combined with other required aggregate fractions and fillers in proper proportions. The resultant mixture shall meet the grading required under the composition of mixture for the specific type under contract.

Fine aggregate shall be composed of clean, tough, rough-surfaced and angular grains. If natural sand is used the grains shall be sound, hard, dry and durable and shall not contain injurious amounts of foreign matter, and when tested in accordance with AASHTO T176 shall have a sand equivalent of not less than 45%.

4. **Mineral Filler:** Mineral filler shall consist of limestone or other stone dust. Portland cement, hydrated lime or other inert non-plastic mineral matter from approved sources. The use of specific type or types may be limited by the engineer's Representative. Mineral fillers shall be thoroughly dry and free from lumps or aggregations of fine particles. It shall conform to the grading requirements shown in Table R9/1.

The plasticity index as determined by ASSHTO T90 shall not be greater than 4.

The amount of filler to be added shall be only that amount which is necessary to the grading requirements for the completed mixture prescribed.

**TABLE R9/1**  
**MINERAL FILLER GRADING**

<b>U.S. Sieve Size Mm</b>	<b>Percentage Passing by Weight</b>
0.600 (No. 30)	100
0.300 (No. 50)	95-100
0.075 (No. 200)	70-100

5. **Asphalt Cement:** The asphalt cement shall conform with the requirements shown in Table R9/2A for viscosity-graded asphalt cement used in hot mix asphalt concrete. The requirements for penetration-graded asphalt cement is also shown in Table R9/2B for desired uses. The asphalt cement used shall be a product prepared by refining of crude petroleum, it shall be homogeneous, free from water and shall not foam when heated to 180° C.

The refinery which supplies the asphalt cement shall furnish a certificate of analysis signed by an authorized employee of the refinery for each shipment made to the project. The certificate of analysis shall show the test results for all the specified requirements and in addition the net weight for each shipment. The certificates of analysis shall be furnished to the Engineer's Representative.

**TABLE R9/2A**  
**REQUIREMENTS FOR VISCOSITY-GRADED ASPHALT CEMENT**  
**(GRADING BASED ON ORIGINAL ASPHALT)**

Property	Viscosity Grade		
	AC-40	AC-30	AC-20
Viscosity, 60 °C, poises	4000 ± 800	3000 ± 600	2000 ± 400
Viscosity, 135 °C, Cs-minimum	400	350	300
Penetration, 25 °C, 100g, 5sec. 0.1 mm-minimum	40	50	60
Flash Point, COC, °C-minimum	232	232	232
Solubility in trichloroethylene, percent-minimum	99	99	99
Tests on residue from Thin-Film Oven Test:			
Viscosity, 60 °C, poises-maximum	20000	15000	10000
Ductility, 25 °C, 5 cm per minute cm-minimum	25	40	50

**TABLE R9/2B**  
**REQUIREMENTS FOR PENETRATION-GRADED ASPHALT CEMENT**

Property	Penetration Grade of Asphalt		
	40/50	50/60	60/70
1. Penetration at 25 °C, 100gm, 5sec (1/10mm)	40-50	50-60	60-70
2. Ductility at 25 °C, 5cm/min, (cm)	>100	>100	>100
3. Flash point, °C	>232	>232	>232
4. Solubility in trichloroethylene, %	>99	>99	>99
5. Residue from thin-film oven test			
- Retained penetration, % of original	>55	>53	>52
- Ductility at 25 °C, 5 cm/min (cm)	>25	>40	>50

6. **Additives:** Hydrated lime or any other approved chemical admixture may be used as an antistripping additive, Hydrated lime shall conform to the requirement of AASHTO M216, and may be added dry at a percentage of about 1.5% by weight of aggregates. An approved system should be provided in the asphalt plant to uniformly feed the required quantities without arching or intermittent flow.

7. Source of Supply: Approval of sources of supply of aggregate and mineral filler shall be obtained from the Engineer's Representative prior to delivery of the material. Samples of each shall be submitted as directed.

Samples of the asphalt material that the Contractor proposes to use in the work shall be submitted and approved before construction begins. No asphalt material other than that represented by the sample submitted shall be used by the Contractor except with the written consent of the Engineer's Representative. Blending of asphalt materials from different refineries will not be permitted.

### **R9 03 COMPOSITION OF MIXTURES**

The asphalt concrete mixtures for base course (type I), binder course (type II) and surface course (type IIIA or IIIB) shall be composed basically of coarse aggregate, fine aggregate, mineral filler (if needed), and asphalt cement. The several mineral constituents shall be sized, uniformly graded and combined in such proportions that the resulting blend meets the grading requirements for the specific type under contract. To such composite blended aggregate (considered as 100% by weight) shall be added asphalt cement within the percentage limits set in the specifications for the specific type.

The requirements for the asphalt concrete mixtures shall conform to grading shown in Table R9/3.

TABLE R9/3  
ASPHALT MIXTURE ORADIGS

Sieve size	mm	Type I	Type II	Type IIIA	Type IIIB
		Base Course	Binder or Leveling Course	Surface or Wearing Course	
		% Passing by Weight of Total aggregate + Filler			
1 ½ in	37.5	100			
1	25.0	90-100	100		
¾	19.0	76-90	90-100	100	
½	12.5	56-80	76-90	90-100	100
⅜	9.5	48-74	56-80	76-90	90-100
No. 4	4.75	29-59	35-65	44-74	55-85
No. 8	2.36	19-45	23-49	28-58	32-67
No. 50	300 µm	5-17	5-19	5-21	7-23
No. 200	75 µm	2-8	3-9	4-10	4-10
Asphalt Cement (% weight of total mix)		3-5.5	4-6	4-6	4-6

The aggregate as finally used in the work shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, but shall be uniformly graded.

#### **R9 04 JOB-MIXFORMULA**

No asphalt concrete mixture shall be manufactured until a job-mix formula has been submitted by the Contractor and approved by the Engineer's Representative. The formula shall indicate the exact percentage of each sieve fraction and the exact percentage of bitumen to be used in the mixtures and the mix temperature. The Contractor will allowed the tolerances from the approved job-mix formula shown in Table R9/4

TABLE R9/4  
JOB-MIX FORMULA TOLERANCES

	Tolerance
Aggregate passing sieve 4.75mm (No. 4) or larger	±6%
Aggregate passing sieve 2.36mm (No. 8) to 0.3mm (No. 50)	±4%
Filler passing sieve 0.075mm (No. 200)	±2.0%
Asphalt cement	±0.3%
Mix temperature	±15°C

The asphalt concrete mixtures shall have the properties shown in Table R9/5 when compacted by 75 blows of a standard Marshall hammer on each face.

TABLE R9/5  
PROPERTIES OF ASPHALT CONCRETE MIXTURES

Property	Base Course	Binder Course	Surface Course
Resistance to plastic flow (ASTM D 1559) 75 Blows/End			
- Marshall Stability (KN), min	5	7	8
- Marshall Flow (mm)	2-4	2-4	2-4
Voids in Marshall specimen (%)	3-6	3-5	3-5
Voids in mineral aggregate (%), mm.	12	13	14
Immersion-Compression (ASTM D 1075) Index of Retained Strength (%), min.	70	70	70

The Marshall Stability of surface course for Expressway, all bridges and the approaches to bridges for a distance of 200 meters on each side shall be not less than 10 KN, if directed by the Engineer.

Should a change in sources of material be made, a new job-mix formula shall be established before the new material is used.

## **R9 05 EQUIPMENT**

1. **Equipment General:** All equipment, tools and machines used in the performance of the work covered by this Section of the Specification shall be either new or in top grade second hand condition and be subject to the approval of the Engineer's Representative and shall be maintained in satisfactory working condition at all times. All equipment, plant and transport shall be in harmony and with a balanced capacity.
2. **Mixing Plant:** The mixing plant shall be designed, co-ordinated and operated so as to produce mixture within the job-mix formula and shall have a sufficient capacity. The plant shall be a weight-batch type. A volumetric-proportioning, continuous mixing type may be substituted for the above type, provided the equipment has demonstrated that it is suitable for producing finished mixtures complying with the job-mix formula specified herein.

The plant shall have proper and approved thermometers and be equipped with a dust collector when located in any area where dust may be objectionable.

The asphalt mixing plants shall meet the requirements of ASTM D 995 (Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Asphalt Paving Mixtures).

The inspection of asphalt mixing plant is required to assure that all facilities, production operations, materials handling, required testing and mix product comply with the requirements of ASTM D 290 (Standard Practice for Asphalt Mixing Plant Inspection).

3. **Pavers:** The spreading and finishing equipment shall be by an approved self propelled paver equipped with electronic or mechanical leveling system to ensure perfect layer. The finishers shall be designed for executing the lane width specified of finished pavement in one working operation. For the executing of the standing lane and or widening additional auxiliary pavers of 4m operating width, working in staggered echelon shall be used. At least two pavers of each width required shall be available simultaneously on the site. All pavers shall be equipped with edging sleeves.

The main paver shall be equipped with a combined tamper and vibratory screed with an adjustable amplitude at 5 and 9mm. The frequency of tamper and vibratory screed shall be infinitely variable and independently adjustable from each other. The speed of the bar conveyers and the revolutions of the augers shall be infinitely variable and independently controlled for each side. The flow of material shall be additionally controlled by two hydraulically operated gates on the rear hopper wall. The finisher screed shall be heated by gasburner. The crawler unit shall be suspended at three points to permit independent vertical movement of each of the crawler tracks.

The smaller auxiliary paver shall be equipped with the compaction components of the same type as the larger paver and shall be capable of placing a layer of at least 10 cm compacted in one single pass.

4. **Compaction Equipment:** The specified compaction shall be carried out by approved smooth-steel wheeled; multi-wheeled pneumatic-tyred, and/or vibrating rollers as specified under Clause R9 11.

## **R9 06 CONTRACTOR'S PERSONNEL**

The Contractor shall employ only such personnel to operate the mixing plant, the self-propelled pavers and the compaction equipment that have had several years' experience in operating such machines and who are approved the Engineer's Representative.

## **R9 07 MIXING**

The asphalt mixture shall be produced in an approved plant. Crushed aggregates shall be furnished and stockpiled separately and delivered to the dryer in desired proportions. The aggregate shall be heated and thoroughly dried before entering the hot bins. The temperature shall be such that the finished temperature will be within the tolerances of the job-mix formula and always controlled. Filler shall be calibrated so that natural and mineral filler always have the same proportions. All components shall be accurately weighted and conveyed into the mixer and the required amount of bitumen introduced. In no case shall the aggregate be introduced into the mixer at a greater temperature than that of the bitumen. The temperature of both the aggregates and the bitumen at the time of mixing shall be in accordance with the job-mix formula and strictly controlled. All overheated and carbonized mixture or mixtures which foam or show indications of moisture will be rejected.

## **R9 08 TRANSPORTATION OF ASPHALT CONCRETE MIXTURES**

1. **Bin and Hopper:** The mixer shall be equipped with a heated bin for stocking the finished mix which shall be so designed that no segregation of mix can occur and no material remains attached to the walls. The mixer shall be equipped with a hopper at the discharge end, of such size and design that no segregation of mix occurs. Any elevator used for loading the mixture into vehicles shall have an equally satisfactory hopper.
2. **Trucks:** Trucks for hauling asphalt concrete mixtures shall have tight, clean and smooth metal floors that have been sprayed with a minimum amount of soapy water, thinned or emulsified fuel oil, paraffin oil, or lime solution to prevent the mixture from adhering to the floors. Each load shall be covered by canvas or other suitable material of such size as to protect the mixture from the weather. Any truck causing excessive segregation of material by its spring suspension or other contributory factors, that shows serious oil leaks or that causes undue delay shall upon the direction of the Engineer's representative be removed from the work until such faults are corrected. When necessary, in order that the mixture shall be delivered to the site at the specified temperature, all covers shall be securely fastened.

The temperature of the mixture when dumped in the spreader shall be in accordance with Clause R9 10.

Each vehicle shall be weighed before and after each loading at the mixer and a record kept

of the gross weight, tare and net weight of each load.

## **R9 09 PLACING**

1. **Preparation of existing surface:** Before applying the asphalt pavement the smoothness of the underlying course shall be tested with a 4m straight edge; it shall not vary by more than 10mm in the case of binder courses or 6mm in the case of surface courses and shall be corrected if necessary.

Where local irregularities in the existing surface are greater than 2cm when measured under a 4m straight edge, the surface shall be brought to uniform contour by patching with asphalt concrete and thoroughly tamping or rolling until it conforms with the surrounding surface. The mixture used shall be the same as that specified for the next course.

- a) Where the existing roadbed is broken or shows instability, the unstable material shall be removed and disposed of as directed by the Engineer's Representative and be replaced with the same mixture as specified for the next course, compacted to the level of the adjacent surface.
- b) If the existing course is established, asphalt, or a Portland cement concrete course, and if the edges of the course have become eroded, disintegrated or broken, the edges shall be trimmed back as directed by the Engineer's Representative, the debris removed and disposed of, and the space backfilled with asphalt concrete mixture, gravel or similar approved material, as directed by the Engineer's Representative, and then compacted.
- c) Immediately before applying the asphalt pavement, the existing surface (upon which the mixture is to be placed) shall be thoroughly cleaned (by sweeping or air blow) of all loose, dirt and other objectionable materials immediately before spreading the mixture.
- d) The primed binder course or each layer of the asphalt pavement shall only receive a tack coat if required and if so directed by the Engineer's Representative in accordance with Section R8B.
- e) The tack-coat shall be applied just sufficiently in advance of placing of the asphalt concrete mixture so that a thin adhesive film of asphalt cement ensures a good binding of the course. It shall be applied in accordance with Section R8B – asphalt Tack Coat.
- f) Contact surfaces of kerbs, gutters, manholes and other structures shall be painted with a thin uniform coating of hot asphalt binder (or asphalt cement dissolved in suitable solvent) or cut-back bitumen just before the mixture is placed against it, but after such a time as the solvent shall have evaporated completely. The condition of the existing surface shall have been approved by the Engineer's Representative prior to placing the mixture.
- g) Before spreading mixture upon a Portland cement concrete surface, all longitudinal and transverse joints and all cracks shall be sealed by the application of an approved asphalt joint sealing compound, such as in BS2499 (1973) Class A Grades I and II. If shown on the plans and called for in the Specification, a tack coat shall be applied to Portland cement concrete base, or approved metal or plastic fabric shall be used, to prevent cracks appearing above the joints or cracks in the cement concrete surface.



## **R9 10 SPREADING AND FINISHING**

The asphalt concrete pavement shall be placed by mechanical means in accordance with the required finished thickness as stated in the Bill of Quantities or shown on the Drawings.

The mixed material shall as soon as possible after arrival at the Site be supplied continuously to the paver and laid without delay. The rate of delivery of material to the paver shall be so regulated as to enable the paver to be operated continuously and it shall be so operated whenever practicable.

The rate of travel of the paver and its method of operation shall be adjusted to ensure an even and uniform flow of material across the full laying width, freedom from dragging or tearing of the material and minimum segregation.

The temperature of the mixed materials when dumped into the spreader shall be as directed by the Engineer's Representative =10 °C. Mixtures with a temperature of less than 120 °C for base course and binder course and 130 °C for surface course when dumped into the spreader will be rejected. The spreader shall be adjusted and the speed regulated so that the surface of the course will be smooth and the course of such depth that, when finally compacted, it will conform to the cross section shown on the Drawings. When placing a width in one continuous operation is specified or undertaken or where the width of the lane requires. Two finishers shall operate in staggered echelon, the main larger-width paver in front and the smaller auxiliary paver approximately 15m behind. When placing binder course, the larger width paver shall follow the smaller width paver. No single lane shall be laid in advance of the adjoining lane further than will permit a satisfactory hot longitudinal joint between lanes. Where forming a hot longitudinal joint the 15m strip along the edge against which additional material is to be laid shall not be rolled until such additional material is placed except when the work is to be discontinued. After the first lane has been placed and rolled, the adjacent lane shall be placed while the unrolled 15cm strip is hot and in a readily compatible condition. Rolling of the adjacent lane shall begin along the joint. Placing of the mixture shall be as continuous as possible. A sufficient number of experienced shovellers and rakers shall follow the spreading machine, dressing the surface as required to produce a course of uniform surface texture and the required smoothness.

Wherever practicable, road pavement materials having a bitumen binder shall be spread, leveled and tamped by approved self-propelled pavers.

Hand laying of any asphalt material will be permitted only in the following circumstances:

- (i) for laying regulating courses of irregular shape and varying thickness;
- (ii) in confined spaces where it is impracticable for a paver to operate;
- (iii) for footways;
- (iv) at the approaches to expansion joints at bridges or viaducts;
- (v) for mastic asphalt which shall be laid in conformity with BS 1447 (1973).

The loads shall not be dumped any faster than can be properly handled by the shovellers and rakers, Rakers shall not be permitted to stand in the hot mixture.

One layer or course of asphalt material shall not be superimposed upon another course without the approval of the Engineer's Representative.

Surface course shall not be placed in short sections, the length or the section to be executed

shall be as directed by the Engineer's Representative but not less than that specified for the particular lane width of the Contract.

## **R9 11 COMPACTION**

Immediately after the mixture has been spread and struck off, the surface shall be checked and irregularities adjusted and then compacted thoroughly and uniformly by rolling.

Materials shall be compacted as soon as rolling can be effective without causing undue displacement of the mixed material such as cracking or rippling and while it has at least the minimum rolling temperature specified.

The material shall be uniformly compacted by an 8,000 to 10,000 kg smooth steel-wheeled roller having a width of roll not less than 45 cm or by a multi-wheeled pneumatic-tyred roller of equivalent weight except that surface course and binder course material shall be surface finished with a smooth-wheeled roller.

Immediately following the initial rolling, the mixture shall be thoroughly compacted.

Rolling shall begin at the low side and progress toward the high side overlapping each preceding tack until the entire surface has been rolled. Alternative strips of the roller shall be terminated in stops at least 1m distant from any preceding stop. The rollers shall be in good condition, capable of reversing without back lash and shall be operated by experience roller-men and must be kept in continuous operation in such a manner that all parts of the pavement shall receive substantially equal compression.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

The roller shall not be permitted to stand on pavement which has not been fully compacted and whose temperature is still more than 70 °C. Necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing.

When a paver laying binder course or surface course material approaches an expansion joint at a bridge or viaduct, it shall be taken out of use as soon as there is a danger of the material being laid fouling the joint. In laying the remainder of the pavement up to the joint and the corresponding area beyond it by hand, the joint cavity shall not be fouled with surface material.

Hand-raking of surface course material which has been laid by a paver and the addition of such material by hand-spreading to the paved area for adjustment of level will be permitted only in the following circumstances:

- (i) at the edges of the layers of material and at gullies and manholes;
- (ii) at the approaches to expansion joints at bridges or viaducts;
- (iii) where otherwise directed by the Engineer's Representative.

Hand laid work shall conform to all the specification requirements of this clause except those relating to the manner of operating pavers.

Where joints between laying widths or transverse joints have to be made in surface courses, the material shall be fully compacted and the joint made flush in one or other of the following ways, method (iii) always used for transverse joints:

- (i) by heating the joint with an approved joint heater at the time when the additional width is being laid but without cutting back or coating with binder. The heater shall raise the temperature of the full depth of the surface course to a figure within the rolling temperature range specified for the material and for a width not less than 8cm on each side of the joint. In this case, however, the Contractor shall have available for use in the event of breakdown, equipment necessary for operating method (iii);
- (ii) by using two or more pavers operating in echelon where this is practicable and in sufficient proximity for adjacent width to be fully compacted by continuous rolling; or by using a multiple-lane width paver;
- (iii) by cutting back the exposed joints to vertical face of not less than the specified thickness, discarding all loosened material and coating the vertical face completely with a grade of hot bitumen suitable for the purpose before the next width is laid.

All joints shall be offset at least 15cm from parallel joints in the layer beneath.

For the surfacing of existing roads the Engineer may direct the application of a tack coat to the requirements of Section R8B to the surface on which laying is to take place.

Along forms, kerbs headers, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers or with mechanical tampers giving sufficient compression. Each hand tamper shall weigh not less than 15 kg and shall have a tamping face area of no more than 30 cm<sup>2</sup> skin patching of an area that had been rolled will not be permitted.

The compaction rate of each finished course shall be tested by bulk density (AASHTO T166) on core samples or by nuclear method (ASTM D2950-74). The bulk density of the finished mixture shall not be less than 97% of the laboratory bulk density of the mixture when compacted in Marshall moulds with 75 blows on each face. The bulk density of finished mixture for expressways, all bridges and their approaches for a distance of 200 meters on each side, and all at grade intersections shall not be less than 98% of the laboratory bulk density of the mixture when compacted in Marshall moulds with 75 blows on each face.

The deficient pavement shall be removed and replaced with satisfactory pavement by the Contractor at no additional cost.

## **R9 12 WEATHER LIMITATION**

The laying of asphalt courses shall be avoided as far as practicable during wet weather and shall be suspended when free standing water is present on the surface. Asphalt concrete shall not be laid on any surface which is frozen or covered with ice or snow and laying shall cease when the air temperature reaches 5 °C on a falling thermometer. Laying shall not commence until the air temperature is at least 5°C on a rising thermometer unless otherwise directed by the Engineer's Representative, and also if wet weather threatens to be prolonged the manufacture and laying of asphalt concrete shall be suspended.

When the air temperature falls below 15 oC special precautions shall be taken in controlling

the temperature of the delivered material up to and including the period of compacting.

## **R9 13 THICKNESS, FINISH AND SURFACE REGULARITY**

### **Smoothness of Pavement Course**

After the completion of the final rolling, the smoothness of the course will be checked and any irregularities that exceed the specified tolerances or that retain water on the surface shall be corrected by removing the defective area as specified and replacing with new pavement without additional cost to the Employer. The maximum tolerances of the cross-fall shall be  $\pm 0.4$  per cent.

### **Thickness of Pavement Course**

Courses with thickness less than those specified will be acceptable provided the deficiency does not exceed 3mm. Deficiencies between 3mm and 10mm will be acceptable, but account thereof will be taken in the payment, see Clause R9 17. Any areas with a deficiency in thickness exceeding 10mm shall be cut out and removed, and replaced by a satisfactory pavement without additional cost to the Employer.

### **Surface Conditions**

The surfaces shall be uniformly coarse textured, impermeable and with well compacted joints and smooth connection to existing pavements. Segregation will not be accepted. The pavement shall be stable and without rutting, bleedings, cracking and surface disintegration.

### **Surface Levels of Pavement Courses**

The surface levels of pavement courses shall be determined from the true pavement surface which shall be the surface of the surface courses or calculated from the carriageway vertical profile and crossfalls as shown on the Drawings. The vertical depth below the true pavement surface of any point on the constructed surface of the formation or pavement courses shall be within the appropriate tolerances stated in Table R9/6.

The surface level of the laid surface course at any point shall not deviate vertically from the true pavement surface by more than  $\pm 0.4$ mm. However, the combination of permitted tolerances in different pavement levels shall not result in a reduction of the surface and binder course thickness by more than that specified above in this Clause under "Thickness of Pavement Courses".

For checking compliance with Table R9/6 measurements of surface levels will be taken at point to be selected by the Engineer's Representative at 15m centers longitudinally, 7.5m on transition curves, and at 2m centers transversely. At junctions the grid point spacing shall be as described in the Contract. In any length of carriageway, compliance with the requirements of table R9/6 shall be regarded as met when not more than one measurement in any ten exceeds the tolerances permitted in the Table, but this one measurement shall not exceed the tolerance for the next course below the one being measured.

TABLE R9/6  
TOLERANCES IN SURFACE LEVELS OF PAVEMENT COURSES

	Tolerance
Surface Course	± 0.4mm
Binder Course	± 6mm
Base Course	+8mm – 20mm
Sub-base	+10mm – 20mm

### Surface Regularity

The longitudinal regularity of the surfaces of surface courses and binder courses shall be within the relevant tolerances stated in Table R9/7 within a distance of 300m.

TABLE R9/7  
MAXIMUM PERMITTED NUMBER OF SURFACE IRREGULARITIES

Irregularity* Course	4.0 – 5.9 mm	6.0 – 10.0 mm
Surface Course	20	2
Binder or base course	40	3

\* An irregularity is a variation in the profile of the road surface as measured by the rolling straight edge. No irregularity exceeding 10mm shall be permitted.

Compliance with Table R9/7 shall be tested by the rolling straight-edge, along any line or lines parallel to the center line to the carriageway.

Carriageway shall be measured transversely for irregularities at points decided by the Engineer's Representative by a 4 m long straight-edge placed at right angles to the center line of the road. The maximum deviation of the pavement surface below the straight-edge shall not exceed 3mm.

### Rectification

Where any tolerances in Table R9/6 or R9.7 are exceeded, the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the surface of the pavement course or formation in the manner described below.

### Base Course and sub-bases

With coated macadam or asphalt concrete base courses the full depth of the top layer as laid shall be removed and be replaced with fresh material laid and compacted to Specification.

Any area so treated shall be at least 5m long and the full width of the paving laid in one operation.

Alternatively for low areas in asphalt pavements the Contractor may make up with the material of the layer immediately above the one being rectified, when the subsequent layer is laid.

### **Binder and Surface Courses**

These shall have the full depth of the layer removed and replaced with fresh material laid and compacted to specification.

Where the surface level of a binder course or surface courses is too high or too low the area rectified shall be at least 5m long if binder course, or 15m long if surface course, and the full width of the paving laid in one operation.

### **R9 14 SAMPLING**

- (1) Sampling: The sampling shall be carried out as follows under the Engineer's Representative's control and supervision at the Contractor's expense.

- (a) Samples from plant: Samples of the plant mixtures will be taken in accordance with AASHTO T168 and tested as frequently as deemed necessary to determine if grading, asphalt content and all mixing conditions conform to the job-mix formula requirements.

The size or weight of the samples taken from the plant shall be as directed by the Engineer's representative, but there shall be a minimum of one sample for every day's run from each mixing plant.

- (b) Samples from Roadway: Suitably sized samples in accordance with AASHTO T168 for the determination of the compaction rate (density) of the completed pavement shall be cut from the finished work by the Contractor at his expense as often as deemed necessary by the Engineer's representative, but not less than two samples for each day's run. In addition, samples shall be taken whenever a substantial change is made in the job-mix formula. Where samples have been taken, new material shall be placed and compacted satisfactorily by rolling or tamping.

The size of sample shall be governed by the maximum size of particle of mineral aggregate in the mixture, but not less than 30 x 30 cm (900cm<sup>2</sup>). The samples from the Pavement may also be taken by core drilling at a minimum diameter of 10cm.

- (c) Identification of Samples: Each sample shall be accompanied by a description giving the following information:

- (1) Source of sample, name of owner or operator of plant, location of construction site with highway number and name and kilometer reference.
    - (2) Location of the point at which the sample was taken, the number of the car from which sampled, the point on the roadway measured transversely from the centerline in centimeters and on which side of the road.

- (3) By whom sampled and date of sampling.
- (4) By whom and to whom submitted with addresses.

## **R9 15 TESTING**

Aggregates, bitumen and asphalt concrete mixtures shall be tested as frequently as deemed necessary by the Engineer's representative to check compliance with Clause R9 02 Materials. Clause R9 03 Composition of Mixture and Clause R9 04 Job-Mix Formula. Samples of the plant mixtures shall be taken at the plant and/or on the working site as specified to determine if the mixtures conform to the job-mix formula requirements and all temperatures shall be checked.

Some quantitative testing (like asphalt content) may be affected by the age of the material tested, with older samples tending to yield slightly lower asphalt content. Best quantitative results are obtained when the tests are made on mixtures and pavements shortly after their preparation.

## **R9 16 MEASUREMENT**

The unit of measurement for payment shall be the square meters of the completed and accepted pavement for both binder course and surface course. The number of square meters of the completed asphalt pavements shall be determined by the length measured along the center line and upon the surface of the road, multiplied by the width as shown on the Drawings, plus the areas of any slip roads, widening, splays and intersections, authorized and measured separately.

## **R9 17 PAYMENT**

The square meters of completed and accepted pavement for the various thickness as called for in the Bill of Quantities, measured as specified in Clause R9 16, will be paid for at the contract price.

No additional payment will be made for any thickness of pavement in excess of the thickness specified in the Bill of Quantities or shown on the Drawings. Payment for pavements with a deficiency in thickness between 3mm and 10mm will be adjusted by multiplying by the square of the ratio of the actual and specified thickness.

Average thickness for one kilometer section is to be used. The number of cores for measuring of thickness depends on the variation in the measurements, but should not be less than two cores per kilometer per carriageway.

The actual thickness of any layer is to be increased by any surplus in the thickness of the upper layers.

Such payment and/or payments shall constitute full compensation for preparing the surface of the road base, furnishing all materials, equipment, plant and tools, handling, mixing, spreading, finishing, compacting, rolling, final finishing and testing, correcting unsatisfactory areas and all labour and incidentals necessary to complete the work required by this Section of the Specification.