SERIES 6000: BITUMINOUS SURFACINGS AND ROAD BASES

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DIVISION 6100 – BITUMINOUS PRIME COAT

6101 SCOPE

This Division covers the application of a bituminous prime coat to a prepared pavement layer.

6102 MATERIALS

(a) Priming material

The priming material shall be one of the following as specified or as directed by the Engineer:

MC-30, MC-70, or MC-250 cutback bitumen complying with AASHTO M 81 or M 82, as applicable;

Invert bitumen emulsion complying with SABS 1260

(b) Mineral Aggregate for Blinding

The aggregate used for blinding the primed surface shall consist of crushed rock or river sand, with 100% passing the 6.7 mm sieve and not more than 10% passing the 2.36 mm sieve. The aggregate shall be clean, hard and free from excessive dust. It shall contain no clay, loam, or other deleterious matter.

6103 SAFETY

The handling and application of bituminous binders are hazardous operations. Attention is drawn to the risk of fire and toxic fumes, which may cause extensive damage to the equipment and injury to the equipment operators.

Precautions are partly dependent on the design of equipment but suitable training and rehearsal of the crews handling bituminous binders is essential. Suitable fire extinguishers shall be provided and shall be readily accessible during all operations involving the handling, transportation, storage or heating of bituminous binders.

Crewmen shall wear heat-resistant gauntlet gloves. Facemasks shall be worn when a spray lance is used because of possible rupture of the armoured hose.

Bitumen distributors and storage tanks shall not be flushed by means of splash filling with petroleum products. The flushing hose shall be inserted in the bottom of the tank.

6104 EQUIPMENT

The following equipment shall be available and in good working order:

(a) Bitumen Distributor

The bitumen distributor shall comply with the following requirements:

The distributor shall be so designed, equipped, maintained and operated that bituminous material at a constant temperature may be applied uniformly on various widths of surface from 1.5 to 7.6 m at the specified rate of application;

All dial gauges related to the control of the bitumen pump and spray equipment shall be at least 100mm in diameter and be accurate to ± five (5) per cent;

The distributor shall be furnished with a sampling system complying with AASHTO T 40;

The distributor shall be free from binder or fuel leaks;

The distributor shall be fitted with a rigid adjustable guide clearly visible from the driving seat so that the distributor may be driven accurately to ensure regularity of edge lines and overlaps;

The distributor shall be fitted with an accurate means of measuring and indicating the road speed of the vehicle at operational speeds. The road speed indicator shall be independent of the normal vehicle speedometer. The indicator shall be so designed that the scale reading for five (5) metres per minute measured on the periphery of a 100mm diameter scale shall be not less than 5mm. The indicator shall be accurate to within ± five (5) per cent and so placed that it can be easily read by the driver of the distributor while causing the least distraction from the efficient operation of the distributor;

Pipes shall be provided with suitable couplings to ensure the safe transfer of binder to and from the distributor for loading and unloading. In order to exclude suspended matter, which might cause partial or complete blockage of the pumping or spraying equipment, a suitable filter shall be provided through which all binder shall pass into the tank;

The bitumen tank shall have an inspection manhole and a calibrated dipstick registering the volume of the binder in the tank. Both the tank and the dipstick shall be stamped with a unique serial number. A working platform or catwalk of mesh steel shall be provided adjacent to the manhole to facilitate the reading of the dipstick. The dipstick shall be calibrated to an accuracy of not less than one (1) per cent of the nominal capacity of the tank and the calibration marks so placed as to indicate directly one (1) per cent of the nominal capacity of the tank. A calibration certificate issued by an approved testing authority shall be provided for the tank and dipstick. The calibration certificate shall record the serial numbers of the dipstick and the tank;

The type of spray nozzles, the spacing of the nozzles along the spray bar and the height of the spray bar above the road surface shall be such that the distribution of the binder over the sprayed width of the road is of the required uniformity. Nozzles must be so mounted that their alignment is positively set and maintained. All nozzles on the spray bar shall be of identical manufacture and rating. The size of nozzles shall not be modified. Nozzles shall be tested before each separate spray application to check that individual nozzles operate properly and produce a regular fan-shaped spray. Malfunctioning nozzles shall be cleaned or changed as necessary. The spray from the end nozzles shall be regulated by baffles to give a full spray across the whole width of the bar;

Before each separate application of binder, the spray bar shall be reset to the height required to ensure the necessary uniformity of nozzle spray overlap (double or triple) and distribution is maintained. For this purpose the distributor shall be fitted with accurately calibrated and easily read means of rapidly checking the spray bar height above the road. The spray bar shall be articulated to facilitate setting parallel to the road camber;

The spray bar shall be so designed that, while the distributor is in motion, the bar can be easily and rapidly moved up to 200 mm in a transverse direction to either side of the distributor;

The distributor shall be equipped with a spraying lance to undertake work on footways and irregularly shaped areas of carriageway, and other inaccessible areas where the use of the spray bar is not practicable;

The distributor shall be equipped with two pressure gauges and two filters. The filter apertures shall be not greater than half of the diameter of the smallest aperture of the nozzles. They shall be capable of rapid detachment and cleaning, which shall be carried out daily or more frequently if necessary;

Tests for uniformity of transverse distribution of binder shall be carried out according to the Depot Spray Test (described below) before the commencement of binder spraying works and at such other times as directed by the Engineer, without cost to the Employer. Road tray tests shall be carried out, to check the longitudinal and transverse distribution of the binder. In the event of the results of the tests being unsatisfactory the distributor shall be adjusted and satisfactorily retested before the spraying works may proceed;

The distributor shall carry a card showing the registration number, the date tested, the test pressure and temperature, height of spray bar and the type and viscosity of binder used in the test. It shall also carry a charts relating road speed to rate of application of binder so that the driver can accurately determine the speed required for the rate of application specified;

The distributor shall be fitted with suitable dial-type calibrated temperature indicators to show both the temperature at which the binder is being drawn off for application and, as accurately as possible, the maximum temperature of the binder in the tank. Such indicators shall be capable of measuring up to 200^{o} C and must be accurate to within $\pm$ 5^{o} C. They shall not be mounted on the spray bar or any position where they will be subject to damage or excessive vibration. They shall be mounted as low as possible near the heating line to limit any accidental excessive heating of the binder.

Each distributor shall have two serviceable fire extinguishers available at all times.

(b) Water Sprinkler

The water sprinkler shall have efficient spray equipment, capable of spraying a uniform film of water over the whole area to be primed.

(c) Mechanical sweepers

Mechanical sweepers shall be power operated, self-propelled or towed rotary brooms. All sweeping equipment shall be fitted with pneumatic tires.

(d) Air blowers

Air blowers or compressors shall be designed and operated to assist in the removal of loose or deleterious material from the surface of pavement layers.

(e) Other Equipment

Other equipment shall include hand brooms, reinforced paper for joints, string, nails, and all other ancillary equipment required to carry out the operation efficiently and neatly.

6105 WEATHER AND OTHER LIMITATIONS

No prime shall be applied under the following adverse conditions:

(a) during foggy or wet conditions;

(b) when rain is imminent;

(c) when wind is sufficiently strong to cause uneven spraying;

(d) when the surface of the layer is wet, i.e. more than damp;

(e) when at any position the moisture content of the top 25 mm of the layer to be primed is greater than 50% of the optimum moisture content of the material in the layer;

(f) when the temperature of the surface immediately prior to commencing the application of the prime is below or, in the opinion of the Engineer, likely to fall below 10^0 C;

(g) after sunset.

The Engineer's decision on whether or not to apply the prime coat under specific weather conditions shall be final.

6106 STORAGE OF PRIME COAT MATERIAL

All prime materials stored in a heated condition shall be stored in a container with a properly functioning circulation system and a securely fitting lid. Unless the prime material is intended for immediate use, no heat shall be applied to material delivered above storage temperature until the temperature is below those specified in table 6100/1. To prevent undue evaporation of volatiles, which will result in hardening of the material, prime shall not be heated to a temperature greater than 10^o C above the range specified. When prime has to be heated from the cold state, it shall be heated slowly to avoid overheating that part of the prime that is close to the source of heat. Heated storage tanks shall be fitted with suitable dial-type calibrated temperature indicators to show both the temperature in the tank close to the source of heat and, as accurately as possible, the maximum temperature of the binder in the tank.

Table 6100/1 – Recommended storage and application temperatures

Type of prime	* Maximum storage temperature ^{o} C		* Spraying temperature range ^{o} C
	Up to 24 hrs	More than 24 hrs	
Cut-back bitumen			
MC-30	50	30	45 - 60
MC-70	70	50	60 - 80
MC-250	90	70	75 - 90
Invert bitumen emulsion	60	Air	50 - 70

* Temperatures may be above the flash point of some materials. Care must be taken to prevent fire and explosion.

6107 PREPARATION OF THE LAYER TO BE PRIMED

Before any prime material is sprayed, the layer to be primed shall be checked for compliance with the surface and other requirements specified. All superficial laitance or "biscuits" of fine material and animal droppings shall be removed and may require the use of water, brooms and spades. Particular attention shall be paid to areas where traffic diversions have traversed the layer to be primed. Any sections not complying with the specified requirements shall be corrected as specified in clause 5211.

Not more than 24 hours before spraying, the layer to be primed shall be broomed and cleaned of all loose or deleterious material by means of a rotary broom and hand brooms. Surfaces that are open textured may require the use compressed air. Brooming and cleaning shall be done carefully so as to avoid any damage to the layer.

A light spray of water, sufficient to dampen the surface, shall be applied uniformly to the layer immediately before the application of the prime. If excess water is over applied, the layer shall be allowed to dry until a uniform damp surface is obtained.

If dust has been deposited, for whatever reason, on the surface to be primed between the time it has been broomed and the time considered for application, it shall be broomed and cleaned again to the satisfaction of the Engineer.

6108 APPLICATION OF THE PRIME COAT

The rate of application shall be as directed by the Engineer. The Engineer may direct that trial applications be conducted on short test sections to determine the optimum application rate for the various layer materials to which the prime shall be applied. In general, the rate of application of prime shall be in the range of 0.6 – 1.0 litre/m^2 residual bitumen. Recommended spraying temperatures are given in Table 6100/1.

Twine-reinforced paper or other suitable approved material shall be used at all joints at the beginning and end of all sprays in order to obtain a neat start and cut-off.

Wherever feasible, the prime shall be applied in one or more lanes evenly over the full width of the road and allowed to penetrate and cure until traffic can pass over the surface

without the wheels picking up the prime. All traffic shall be kept off the surface until this condition is obtained.

Unless otherwise shown on the drawings or directed by the Engineer, the total width of primed surface shall be 150 mm wider on each side than the specified width of the final surfacing and the edges of the prime shall be parallel to the centerline of the road.

Where it is not feasible for traffic to use bypasses, the prime shall be applied and allowed to penetrate for as long as is practicable before a blinding layer of mineral aggregate is applied at a rate of 0.0035 m^3/m^2. Care shall be exercised in this operation to avoid the mineral aggregate being applied too soon after spraying the prime. Where practicable two to four hours shall elapse as directed by the Engineer. Any "caking" of aggregate, which may take place and cause problems during the surfacing process and all loose aggregate, shall be removed before the final surfacing is commenced.

If prime is applied in more than one lane, allowance shall be made for overlapping the lanes by 100 mm.

Care shall be taken to protect any kerbing, guardrails, channeling, and gutters from the prime by covering with a suitable protective material when spraying. The contractor shall, at his own cost, replace all soiled items that cannot be properly cleaned. Painting the soiled surfaces will not be accepted as a suitable remedial measure.

After the prime has penetrated sufficiently, surplus prime shall be covered with damp crusher sand, which shall be worked into it by means of hand brooms in order to absorb the surplus prime. As soon as it is saturated with prime, the crusher sand shall be swept off the primed surface. The process shall be repeated until no surplus prime remains on the primed surface.

6109 MAINTENANCE AND OPENING TO TRAFFIC

As far as practicable, traffic will be kept away from the primed surface and redirected to bypasses. Where this is not feasible and a blinding layer has been applied to the primed surface as per Clause 6108, the Contractor shall maintain the blinding layer and the primed surface during the period when the surface is opened to traffic, and shall repair all damage caused to the blinding layer or the primed surface by such traffic, as directed by the Engineer, at no additional payment to the Contractor.

6110 DEPOT SPRAY TEST

The calibration method and the limits specified in the depot spray test are the same for all lengths of spray bar. The spray bar shall be calibrated for each length of bar which is to be used on the Works.

The conditions prevailing during the test shall be comparable to those occurring during normal operations as regards:

a. temperature of binder;
b. viscosity of binder;
c. height of spray bar above test surface;
d. pressure in the distribution system;

The apparatus for this test consists of a wheeled trolley carrying a set of removable containers. Each container is 50mm wide x 1,000mm long x 150mm deep, made of 0.9 mm

mild steel sheeting, and has a capacity of approximately seven litres. The containers extend to a width of 150 mm greater than the full spray width of the distributor, there being six containers per 300mm of spray width. The rim of each container is lipped on one side so that the containers will overlap and the binder will not escape.

Before each test, the containers shall be examined for damage and they are replaced if such damage is likely to affect the test.

The trolley runs on steel rails fastened to the top of a 1,500-litre catch tank, the rails being horizontal, parallel to the sides of the tank, and sufficiently long to allow the trolley to lie clear of the spray before the test. The top rim of each container, when fitted on the trolley, is parallel to the rails at the same distance below the nozzles or distributing gear, as the road surface would be under normal working conditions.

The distributor is backed into position with the spray bar over the catch tank, making sure that the spray bar is horizontal and at right angles to the rails. The trolley and containers rest on the rails clear of the spray hood. A short preliminary spray is made to ensure that all nozzles are functioning and that the machine is otherwise in normal working condition.

The trolley and containers are then pushed underneath the spray hood; spraying is commenced and maintained for a period of lime sufficient almost to fill the containers. The trolley is then withdrawn to the previous position.

The depth of binder in each container is measured by dipping in a steel ruler graduated in millimetres. Each container is placed in the same position for testing, a convenient place being some 300 mm from one end. Dipping is done when the froth has settled. The results are expressed as the percentage deviation from the mean over the effective width of the spray bar. (The effective of the spray bar is defined as the sprayed width less a 150mm margin at each end of the spray bar.)

Individual trays shall not deviate from the mean for transverse distribution by more than ten (10) per cent.

6111 TOLERANCES

The actual spray rates shall not deviate from the required spray rate as specified or ordered by the Engineer by more than 0.05 litre/m^2. No payment shall be made for any material sprayed in excess of 0.05 litre/m^2 more than the required spray rate.

6112 TESTING

The Contractor shall give the Engineer at least 24 hours notice of his intention to spray prime material so that the application process can be inspected and the Engineer can verify the actual spray rates. The Contractor shall only spray when the Engineer or his representative is present.

6113 MEASUREMENT AND PAYMENT

Item 61.01 Prime coat:

(a) MC-30 cutback bitumen.....litre (l)

(b) MC-70 cutback bitumen.....litre (l)

(c) MC-250 cutback bitumen.....litre (l)

(d) Invert bitumen emulsion ..... litre (l)

The unit of measurement shall be the litre of priming material measured at spraying temperature and sprayed as required.

The tendered rate shall include full compensation for supplying the priming material, cleaning and watering the layer to be primed, applying the priming material and maintaining the primed surface as specified.

Item 61.02 Aggregate for blinding .....square metre (m^2)

The unit of measurement shall be the square metre of prime coat blinded with aggregate on instructions from the Engineer.

The tendered rate shall include full compensation for procuring, furnishing and applying the aggregate for blinding where directed by the Engineer and for the maintenance of the blinding layer as specified.

DIVISION 6200 – TACK COAT

6201 SCOPE

This Division covers the specification of materials for, and the application of bituminous tack coats to prepared pavement layers or surfacings.

6202 MATERIALS

(a) Tack coat material

The material used for tack coats shall be one of the following as specified or as directed by the Engineer:

(i) RC-70 cutback bitumen complying with AASHTO M 81 or M 82, as applicable;
(ii) Bitumen emulsion complying with AASHTO M-140 or M-208.

(b) Water for the Production of Bitumen Emulsion (emulsified asphalt)

Water used for the production of bitumen emulsion (emulsified asphalt) shall comply with the requirements of water quality type A.

6203 SAFETY

The handling and application of bituminous binders are hazardous operations. Attention is drawn to the risk of fire and toxic fumes, which may cause extensive damage to the equipment and injury to the equipment operators.

Precautions are partly dependent on the design of equipment but suitable training and rehearsal of the crews handling bituminous binders is essential. Suitable fire extinguishers shall be provided and shall be readily accessible during all operations involving the heating of bituminous binders.

Crewmen shall wear heat-resistant gauntlet gloves. Facemasks shall be worn when a lance is used because of possible rupture of the armoured hose.

Distributors shall not be flushed by means of splash filling with petroleum products. The flushing hose shall be inserted in the bottom of the tank.

6204 EQUIPMENT

The following equipment shall be available and in good working order:

(a) Bitumen Distributor

The tack coat shall be applied by means of a bitumen distributor complying with the requirements of Clause 6104.

(b) Mechanical sweeper

Mechanical sweepers shall comply with the requirements of Clause 6104.

(c) Air blowers

Air blowers shall comply with the requirements of Clause 6104.

(d) Other Equipment

Other equipment shall include hand brooms, reinforced paper for joints, string, nails, and all other ancillary equipment required to carry out the operation efficiently and neatly.

6205 WEATHER AND OTHER LIMITATIONS

No tack coat shall be applied under the following adverse conditions:

(a) during foggy or wet conditions;

(b) when rain is imminent;

(c) when wind is sufficiently strong to cause uneven spraying;

(d) when the surface of the layer is wet or damp;

(e) when the temperature of the surface of the layer immediately prior to commencing the application of the tack coat is below 20^0 C;

(f) when the air temperature immediately prior to commencing the application of the tack coat is below or, in the opinion of the Engineer, likely to fall below 10^0 C;

(g) after sunset.

The Engineer's decision on whether or not to apply the tack coat under specific weather conditions shall be final.

6206 STORAGE OF TACK COAT MATERIAL

All tack coat materials stored in a heated condition shall be stored in a container with a properly functioning circulation system and a securely fitting lid. Unless the tack coat material is intended for immediate use, no heat shall be applied to material delivered above storage temperature until the temperature is below those specified in table 6200/1. The tack coat material shall not be heated to a temperature greater than 10^o C above the range specified. When tack coat has to be heated from the cold state, it shall be heated slowly to avoid overheating that part of the tack coat that is close to the source of heat. Heated storage tanks shall be fitted with suitable dial-type calibrated temperature indicators to show both the temperature in the tank close to the source of heat and, as accurately as possible, the maximum temperature of the material in the tank.

Table 6200/1 – Recommended storage and application temperatures

Type of tack coat	* Maximum storage temperature ^{o}C		* Spraying temperature ^{o}C	
	< 24 hrs	> 24 hrs	Range	Recommended
RC 70 Cutback Bitumen	70	50	27 - 65	60
Bitumen emulsion	60	Ambient	50 - 70	60

* Temperatures may be above the flash point of some materials. Care must be taken to prevent fire and explosion.

6207 PREPARATION OF THE SURFACE TO BE TREATED

Prior to the application of the tack coat, the surface to be treated shall be checked for compliance with the surface and other requirements specified. Not more than four (4) hours before application of the tack coat, the surface shall be cleaned of loose material, dust, animal droppings and other deleterious materials, which may require the use of water, approved mechanical brooms or blowers, hand brooms and spades. Particular attention shall be paid to areas where traffic diversions have traversed the layer to be treated. Any sections not complying with the specified requirements shall be corrected as specified in clause 52.11.

Surfaces that are open textured may require the use compressed air. Brooming and cleaning shall be done carefully so as to avoid any damage to the layer.

If dust has been deposited, for whatever reason, on the surface to be treated between the time it has been broomed and the time considered for application, it shall be broomed and cleaned again to the satisfaction of the Engineer.

The surface shall be dry. No traffic shall be permitted on the surface to be treated **after it has been prepared to receive the bituminous material.**

6208 APPLICATION OF THE TACK COAT

The rate of application shall be as directed by the Engineer. The Engineer may direct that trial applications be conducted on short test sections to determine the optimum application rate for the various layer materials to which the tack coat shall be applied. In general, the rate of application of tack coat shall be in the range of 0.1 to 0.2 kg/m^2 of residual bitumen.

The application of bituminous material shall not exceed the required amount. Any excess, which is applied, shall be removed by the application of blotting material approved by the Engineer.

Recommended spraying temperatures are given in Table 6200/1.

Twine-reinforced paper or other suitable approved material shall be used at all joints at the beginning and end of all sprays in order to obtain a neat start and cut-off.

Unless otherwise shown on the drawings or directed by the Engineer, the total width of treated surface shall be 100 mm wider on each side than the specified width of the final surfacing and the edges of the tack coat shall be parallel to the centerline of the road.

If tack coat is applied in more than one lane, allowance shall be made for overlapping the lanes by 100 mm.

Care shall be taken to protect any kerbing, guardrails, channeling, and gutters from the tack coat by covering with a suitable protective material when spraying. The contractor shall, at his own cost, replace all soiled items that cannot be properly cleaned. Painting the soiled surfaces will not be accepted as a suitable remedial measure.

6209 TRAFFIC

Except for vehicles transporting materials for the overlying layer, no traffic shall be permitted on the surface to be treated after it has been prepared to receive the bituminous material.

6210 TOLERANCES

The actual spray rates shall not deviate from the required spray rate as specified or ordered by the Engineer by more than 0.05 litre/m^2. No payment shall be made for any material sprayed in excess of 0.05 litre/m^2 more than the required spray rate.

6211 TESTING

The Contractor shall give the Engineer at least 24 hours notice of his intention to spray tack coat material so that the application process can be inspected and the Engineer can verify the actual spray rates. The Contractor shall only spray when the Engineer or his representative is present.

6212 MEASUREMENT AND PAYMENT

Item 61.01 Tack coat:

(a) RC-70 cutback bitumen ..... litre (l)

(b) Stable-grade bitumen emulsion (30%)..... litre (l)

The unit of measurement shall be the liter of bituminous material measured at spraying temperature and sprayed as required.

The tendered rate shall include full compensation for supplying the tack coat material, cleaning the surface to receive the tack coat and applying the tack coat material as specified.

DIVISION 6300A: SURFACE TREATMENTS: MATERIALS AND GENERAL REQUIREMENTS

63A01 SCOPE

This Division covers the materials, constructional equipment, and construction methods and requirements common to the construction of all surface treatments specified in these Specifications.

63A02 MATERIALS

(a) Bituminous Binders

The type and grade of bituminous binder to be used shall be that specified under the appropriate Division of these Specifications for each type of bituminous surface treatment, or in the Project Specifications, or as ordered by the Engineer.

Duplicate delivery slips shall accompany each load of bituminous material and shall contain the name of the producer and the supplier, the type and grade of material, the loading temperature of the material, and the lot number and date of approval of the material from which delivery is made. When considered necessary by the Engineer and at his sole discretion, a time limit may be imposed between the date of approval and the date of delivery, or between the date of approval and the date of use in the Works.

The Contractor shall provide to the Engineer certificates issued by all suppliers of bituminous binders to the effect that the binders delivered to the Site comply with the test requirements specified in the relevant specifications. The cost such tests shall be borne as specified in clause 10103.

The Engineer shall have the authority to order the Contractor to have the bituminous binders tested by an approved laboratory for compliance with all or any of the requirements specified and the results of such tests shall be submitted directly by the testing laboratory to the Engineer with copies if requested to the Contractor.

(i) Conventional Bituminous Binders

Bituminous binders shall comply with the following specifications:

(i) Penetration-grade bitumens	AASHTO M 20
(ii) Cutback bitumens	AASHTO M 82
(iii) Anionic bitumen emulsions (emulsified asphalts)	AASHTO M 140
(iv) Cationic bitumen emulsions (emulsified asphalts)	AASHTO M 208

Spray-grade bitumen emulsions shall be subject to the following viscosity requirements:

(1) Anionic spray-grade emulsion (60 %): **minimum 12 degrees Engler at 20^{O} C**

(2)) Cationic spray-grade emulsion (60, 65, 70 %): **minimum 80 seconds Saybolt Furol at 50^{O} C**

(ii) Non-homogeneous (heterogeneous) Modified Bituminous Binders (Summer grade)

Bitumen-rubber binders shall comply with the following requirements:

(1) Base bitumen

The bituminous binder used in the production of the bitumen-rubber shall be a 60/70, 80/100 or 150/200 penetration-grade bitumen or a blend of approved grades to provide a product with the required viscosity properties.

(2) Rubber

Rubber shall be obtained by processing and recycling pneumatic tyres. The rubber crumbs shall be produced by a mechanical comminuting process. Crumbs produced by cryogenic-mechanical techniques shall not be used. It shall be pulverized, free from fabric, steel cord and other contaminants. A maximum of 4% by mass of fine particle size calcium carbonate, or talc, may be added to the rubber crumbs to prevent the rubber particles coalescing. At the time of use the crumbs shall be free flowing and dry and comply with the requirements of table 6300A/1.

Table 6300A/1 Rubber Crumbs

Sieve Analysis		**Test Method**
Sieve Size (mm)	**% passing by mass**	
1.18	100	Sabita, BR6T
0.60	40 – 70	
0.075	0 - 5	
Other Requirements		
Natural rubber hydrocarbon content	30% (minimum)	BS 903, Parts B11 & B12
Fibre length (mm)	6 mm (maximum)	
Relative density (g/cm^3)	1.10 – 1.25	Sabita, BR9T

(3) Extender oils

Extender oil shall be petroleum-derived material of high aromaticity and shall comply with the requirements of table 6300A/2.

Table 6300A/2 Extender Oils

Property	**Requirements**
Flash Point	180^O C (minimum)
Saturated Hydrocarbons by mass	25% (maximum)
Un-saturated Hydrocarbons by mass	55% (minimum)

(4) Diluents

Diluents shall be a hydrocarbon distillate.

(5) Bitumen-rubber blend

The bitumen-rubber blend, including extender oil and/or diluent (if necessary), shall comply with the requirements of table 6300A/3.

Prior to commencement of the work, the supplier shall state in writing the percentage of rubber and the blending/reaction temperature he intends to use for his specific product. The actual percentage of rubber shall not deviate by more than 1% from the stated value and the actual reaction temperature shall not deviate by more than 10% from the stated value.

A continuous record of both percentage of rubber added and reaction temperatures shall be kept on site by the Contractor.

The bitumen-rubber binder shall comply with the requirements of table 6300A/4.

In order to determine the final process and the acceptance limits, the contractor shall provide the engineer with time-temperature ratios in regard to the above properties of the specific product before work may start.

The methods of testing bitumen-rubber material have been published in Manual 3 of the Southern African Bitumen and Tar Association.

If a diluent is used, an ageing test may be required in which the binder is placed in an oven for 5 hours at 150^{O} C, after which time it shall comply with the above specifications.

The contractor shall provide the performance record of the materials he intends to use for three recent projects in order to assess the successful use of the materials. The information shall include mean values obtained for the prescribed tests as well as any relevant comments. This information shall be submitted at tender stage.

Table 6300A/3 Bitumen- Rubber Blend

Property	Requirements
Rubber content of the total blend by mass	20% - 40%
Extender oil content of the total blend by mass	6% (maximum)
Diluent content of the total blend by mass	7% (maximum)
Blending/reaction temperature	170^{O} - 210^{O} C
Reaction time	0.5 – 4.0 hours

Table 6300A/4 Bitumen- Rubber Binder

Property	Requirements	Test Method
Compression recovery: after 5 minutes after 1 hour after 4 hours	 70% (minimum) 70% (minimum) 48% - 55% (minimum)	BR6T (Sabita)
Ring-and-ball softening point	55^{O} C (minimum)	ASTM D 36
Resilience (%)	13% - 35% (minimum)	Sabita, BR2T
Dynamic viscosity (Haake at 190^{O} C)	20 – 35 dPa.s	Sabita, BR5T
Flow	20 mm – 75 mm	Sabita, BR4T

(iii) Non-homogeneous modified binders (winter grade)

If non-homogeneous modified binders (winter grade) are required, they shall comply with the requirements in the project specifications.

(iv) Homogeneous cold applied modified binders

If any polymer other than the elastomer polymers styrene-butadiene rubber (SBR) or styrene-butadiene (SBS) is required for the manufacture of cationic modified bitumen emulsions it shall comply with the requirements in the project specifications.

Where applicable the following details will be indicated in the project specifications:

(1) elastomer polymer type: SBR or SBS. Unless otherwise specified SBR shall be used for tender purposes.

(2) base bitumen grade: 80/100 or 150/200 penetration-grade bitumen. Unless otherwise specified 80/100 penetration-grade bitumen shall be used for tender purposes.

(3) modified binder content: 65% or 70%. Unless otherwise specified 65% shall be used for tender purposes.

The aforementioned components together with polymer content will dictate the attributes attainable.

Unless otherwise specified, the properties of cationic modified bitumen emulsion containing SBR or SBS solids shall comply with the requirements in table 6300A/5.

Table 6300A/5 Cationic Modified Bitumen Emulsion

Property	Requirements				Test Method
	Polymer Modifier				
	SBR		SBS		
Base bitumen (penetration-grade)	80/100	150/200	80/100	150/200	
Minimum modified binder content (%)	70	65	70	65	ASTM D 244
Minimum viscosity at 50^{O} C Saybolt Furol (seconds)	80	70	80	50	ASTM D 244
Maximum residue on sieving (g/100 ml)	0.25	0.25	0.25	0.25	SABS 548
Particle charge	Positive	Positive	Positive	Positive	SABS 548
Sedimentation after 60 rotations	Nil	Nil	Nil	Nil	SABS 548

Note 1: Modified binder is bitumen plus polymer.

A volatile solvent flux content of up to 3% mass by mass of the bitumen may be added to enhance emulsion performance with regard to prevailing climatic conditions. Any expected change to specified values shall first be approved by the engineer prior to the addition of any such enhancer.

The properties of the modified bitumen recovered by using a rotary vacuum evaporation method or simple evaporation method as described in Technical Guidelines for Seals using homogeneous modified Binders, Sabita Manual 15, May 1994, shall comply with the requirements of table 6300A/6.

Table 6300A/6 Recovered Modified Bitumen

Property	Requirements				Test Method
	Polymer Modifier				
	SBR		SBS		
Grade of base bitumen (penetration-grade)	80/100	150/200	80/100	150/200	
Minimum softening point (^{O} C)	55	45	60	47	ASTM D 36
Minimum dynamic viscosity at 135^{O} C (Pa.s)	1.3	1.0	1.3	1.0	ASTM D 4402
Maximum residue on sieving (g/100 ml)	0.25	0.25	0.25	0.25	SABS 548
Minimum ductility at 10^{O} C (mm)	1,000	1,000	500	500	DIN 52013
Minimum elastic recovery (ductilometer) at 10^{O} C (%)	52	55	55	60	DIN 52013
Minimum adhesion at 5^{O} C (%) Minimum adhesion at 50^{O} C (%)	90 100	90 100	90 100	90 100	Modified Vialit

If there is any discrepancy in the test results on recovered modified binder, then the results on recovered binder obtained from the rotary vacuum evaporation method shall be binding.

(v) Homogeneous hot-applied modified binders (summer grades)

The requirements for any polymer other than the generic types listed in table 6300A/7 used for the manufacture of homogeneous hot-applied modified binders will be indicated in the project specifications.

Where applicable the following details will be indicated in the project specifications:

(1) Generic polymer type: (plastomer or elastomer). Unless otherwise specified elastomer type shall be used for tender purposes.

(2) Base bitumen grade: (80/100 or 150/200 penetration-grade bitumen). Unless otherwise specified 80/100 penetration-grade bitumen shall be used for tender purposes.

Table 6300A/7 Hot-applied Modified Binders

Property	Requirements					Test Method
	Plastomer Polymer (EVA)	Elastomer Polymer				
		SBR	SBS	SBR	SBS	
Grade of base bitumen (penetration-grade)	150/200	80/100		150/200		
Minimum softening point (Ring & Ball) (^{O}C)	48	47	49	45	47	ASTM D 36
Minimum dynamic viscosity at 135^{O} C (Pa.s)	0.5	1.0		0.5		ASTM D 4402
Minimum ductility at 10^{O} C (mm)	300	1,000	500	1,000	500	DIN 52013
Minimum elastic recovery (ductilometer) at 10^{O} C (%)	45	55	60	55	60	DIN 52013
Maximum stability difference (Ring & Ball) (^{O}C)	2	2		2		
Minimum adhesion at 5^{O}C (%) Minimum adhesion at 50^{O}C (%)	90	90 100	90	90	90 100	Modified Vialit

Note 1: The Vialit Method – see "Technical guidelines for seals using homogeneous modified binders", Sabita Manual 1994.

The aforementioned components together with polymer content will dictate the attributes attainable.

(vi) Homogeneous hot-applied modified binders (winter grade)

Where applicable the requirements for homogeneous modified binders (winter grade) will be specified in the project specifications.

(b) Water for the production of bitumen emulsion

Water used for the production of bitumen emulsion shall comply with the requirements of water quality type A.

(c) Chippings for Surface Treatments

The material for chippings shall consist of approved crushed stone, crushed boulders or crushed gravels. The crushing ratio shall be 100 %. The material shall be free from clay balls and adherent films of clay or other matter that would prevent thorough coating with bituminous material. It shall be of such nature that after being coated thoroughly with bituminous material of the type to be used in the work, over 95 percent of the bituminous material will be retained after being subjected to a stripping test in accordance with AASHTO T 182. The grading, hardness and shape shall be as follows for each nominal size of stone:

(i) Grading

The grading shall comply with the requirements set out in Table 6300A/8. The nominal size or sizes shall be as specified in these Specifications and the Project Specifications.

Table 6300A/8 Single Sized Crushed Aggregate Grades 1, 2 and 3

Sieve size (mm)	Grade	Percentage passing by mass						
		Nominal maximum size (mm)						
		26.5	19.0	13.2	9.5	6.7	4.75	2.36
37.5	Grades 1 & 2	100						
26.5		85 – 100	100					
19.0		0 – 30	85 – 100	100				
13.2		0 – 5	0 – 30	85 – 100	100			
9.5			0 – 5	0 – 30*	85 – 100	100		
6.7				0 – 5**	0 – 30*	85 – 100	100	
4.75					0 – 5**	0 – 30*	85 – 100	100
3.35							0 – 30	
2.36						0 – 5**	0 – 5	0 - 100
	Grade 3	As grades 1 & 2 except: * 0 – 50; ** 0 - 10						
0.425	Grade 1	< = 0.5	<= 0.5	<= 0.5	<= 0.5	<= 0.5	<= 1.0	<= 15.0
	Grade 2	<= 1.5	< = 1.5	<= 1.5	<= 1.5	<= 2.0	<= 2.5	<= 15.0
	Grade 3	N/A	N/A	<= 2.0	<= 2.0	<= 3.0	<= 3.5	<=15.0
0.075	Grade 1	N/A	N/A	N/A	N/A	N/A	N/A	<= 2.0
	Grade 2	<= 0.5	<= 0.5	<= 0.5	<= 0.5	<= 1.0	<= 1.0	<= 2.0
	Grade 3	N/A	N/A	<= 1.5	<= 1.5	<= 1.5	<= 1.5	<= 2.0

Table 6300A/9 Sands for Surface Treatments

Sieve Size (mm)	Percentage passing by mass		
	Texture Improvement	Sand seal	Grit Seal
6.7			
4.75			100
2.36		100	0 – 100
1.18	100	0 – 80	0 – 50
0.60	82 – 100	0 – 40	0 – 20
0.30	50 – 70	0 - 15	0 – 10
0.15	20 – 35	0 - 2	0 – 5
0.075	7 - 15		0 - 2
Sand Equivalent (%)	>= 35		

Note 1: Sand shall be Non Plastic

(ii) Hardness

The Los Angeles Abrasion value, determined by testing in accordance with AASHTO T96 shall not exceed 30 at 500 revolutions unless otherwise indicated in the project specifications.

The 10% FACT value (dry) shall be at least 210 kN and the wet to dry ratio shall be at least 75%.

The polished stone value (PSV) shall be at least 50 unless otherwise indicated in the project specifications.

(iii) Shape

The flakiness index, determined by testing in accordance with BS812, Part 105 or ASTM D 3398, shall not exceed the values in Table 6300A/10.

Table 6300A/10 Flakiness Index

Nominal Size (mm)	Maximum Flakiness Index %	
	Grade 1	Grades 2 & 3
19.0	25	30
13.2	25	30
9.5	30	35
6.7	30	35

If so required for special purposes the average least dimension (ALD) shall be as indicated in the project specifications.

(iv) Soundness

The sodium sulfate soundness value, determined by testing in accordance with AASHTO T 104, shall not exceed 12.

(d) Aggregates for Slurry Seal

The aggregate for slurry seal shall be approved crusher sand obtained from a parent rock having a Los Angeles Abrasion value not exceeding 40 or a mixture of crusher sand and approved clean natural sand where the mixture contains not more than 25% of natural sand. The aggregate shall be clean, tough, durable, angular in shape, and shall conform to the following grading requirements:

Table 6300A/11 Aggregates for Slurry Seals

Sieve size (mm)	Percentage passing by mass				
	Fine Slurry			Coarse Slurry	
	Fine	Medium	Coarse	Type 1	Type 2
13.2					100
9.5				100	85 – 100
6.7		100	100	85 – 100	70 – 90
4.75	100	90 – 100	70 – 90	70 – 90	60 – 80
2.36	90 – 100	65 – 90	45 – 70	45 – 70	40 – 60
1.18	65 – 90	45 – 70	28 – 50	25 – 45	25 – 45
0.60	40 – 60	30 - 50	19 - 34	15 – 30	15 – 30
0.30	25 – 42	18 - 30	12 - 25	10 – 20	10 – 20
0.15	15 – 30	10 - 21	7 - 18	6 – 15	6 – 15
0.075	10 – 20	5 - 15	5 - 15	4 – 10	4 - 10
Sand equivalent	**>= 35**				
ACV	**<= 30**				
Bitumen content (% by mass of dry aggregate)	**10.0 – 16.0**	**7.5 – 13.5**	**6.5 – 12.0**		

The optimum mix design for the aggregate, filler, water and bitumen emulsion mixture should be determined using ASTM D 3910.

Table 6300A/12 Aggregates for Rapid Setting Slurry Seals

Sieve size (mm)	Nominal maximum size (mm)			
	4.75	6.7	9.5	13.2
	Overlays		Rut Filling	
	Percentage passing by mass			
13.2				100
9.5			100	80 – 100
6.7		100	66 – 100	60 – 84
4.75	100	70 – 100	57 – 75	50 – 70
3.35	80 – 100	50 – 75	48 – 85	44 – 62
2.36	64 – 80	46 – 60	42 – 56	38 – 57
1.18	40 – 55	32 – 47	28 – 43	28 – 43
0.60	27 – 38	20 – 34	18 – 33	18 – 33
0.30	14 – 24	10 – 22	10 – 20	10 – 20
0.15	9 – 18	7 – 16	7 – 14	7 – 14
0.075	5 - 15	5 - 10	5 - 10	5 - 10
Sand Equivalent (%)	>= 35			
Modified Emulsion (litres/m^3)	200	190	160	150

(e) Cement Filler for Slurry Seal

Portland cement shall comply with the requirements of AASHTO M 85 or equivalent grade in accordance with ISO or Ethiopian Standards.

Road lime shall comply with the requirements of AASHTO M 216 (lime for stabilization).

One filler shall be used throughout in order to minimise co lour differences in the surface.

(f) Hydrophillic aggregates

Where hydrophillic or other problematic aggregates are encountered, the Engineer may order that the chippings be pre-coated as described below, or that a fog spray be applied as specified in sub-clause 63A11 (g).

(i) Pre-coating of aggregate for stockpiling or immediate use

The untreated aggregate shall be thoroughly wetted and allowed to drain off to a damp condition. An approved pre-coating fluid (containing an approved wetting agent (eg Duomene T or similar at a rate of 0.5 % by volume of the pre-coating fluid) shall be applied at the rate of 12 litres per cubic metre of aggregate. The mixture of pre-coating fluid and aggregate shall be suitably agitated, turned and mixed until the aggregate is uniformly coated with the pre-coating fluid.

(ii) Stockpiling

Areas used for stockpiling pre-coated aggregates shall be so sited to minimize the deposition of dust on the aggregates. Where necessary adjacent roads or diversions shall be watered or sealed. When there is a danger that the pre-coating fluid will be washed off by rain the stockpiles shall be covered with tarpaulins or similar protective coverings.

(iii) Binders

No pre-coating shall be applied where conventional and modified emulsion binders are to be used unless specified or ordered by the Engineer.

(iv) Time limit

The time between the pre-coating and the placing of the aggregate shall not exceed the time specified in the project specification or as agreed by the Engineer.

63A03 PLANT AND EQUIPMENT

(a) General

All plant and equipment used on the Works shall be of adequate rated capacity and in good working condition.

All plant and equipment that will be operated on the road during construction of the surface treatment shall be free of any binder, fuel or oil leaks and no refueling or servicing of any equipment will be allowed to take place while such equipment is on the road.

(b) Bitumen Distributor

The bitumen distributor shall comply with the requirements of Sub-clause 6104(a).

The binder distributed used for the spraying of non-homogeneous modified binders shall be suitably adapted for the purpose.

(c) Chip Spreaders

Chip spreaders, whether self-propelled or truck-mounted shall be capable of:

1) spreading the stone uniformly, both transversely and longitudinally, over widths from 1.5m to 4.0m;
2) adjustment to permit variation of the rate of application;
3) stopping and starting without forming a joint line; and
4) keeping pace with the binder distributor.

At least two chip spreaders shall be provided, one of which shall be self-propelled.

Any spreaders that are not self-propelled shall be of a type that can be attached quickly to the rear of trucks, and operated while being backed over the stone chips being spread.

(d) Rollers

The type and number of rollers shall be subject to the approval of the Engineer for each type of surface treatment and the proposed programme. Sufficient operational rollers of each of the following type shall be available on the Works to maintain the required tempo of work:

(i) Pneumatic-tired Rollers

Pneumatic-tired rollers shall be of the self-propelled type equipped with smooth flat profile pneumatic tires of uniform size and diameter. The mass of the roller shall not be less than 2 tons per wheel. The minimum compaction width shall be 1.5m with a minimum contact pressure of 275 kPa. The rollers shall be equipped with suitable devices for wetting and cleaning the wheels during operation.

The wheels of the roller shall be so spaced that one pass of the roller will provide one complete coverage equal to the rolling width of the machine and the tracks of the front wheels and rear wheels shall overlap. The Engineer, at his discretion, may vary the total operating mass and tire pressure (to a maximum of 600kPa). Individual tire pressures shall not differ any more than 35 kPa from one another.

(ii) Rubber-soled Flat Rollers

Rubber-soled flat rollers shall be self-propelled, equipped with smooth rubber-soled steel wheels or rolls. The rollers shall be between 6 and 8 tons mass and shall be equipped with suitable devices for wetting and cleaning the wheels during operation.

The wheels of the roller shall be so spaced that one pass of the roller will provide one complete coverage equal to the rolling width of the machine and the tracks of the front wheels and rear wheels shall overlap.

(iii) Steel-tired Flat Rollers

Steel-tired flat rollers shall be self-propelled, equipped with smooth steel-tired wheels or rolls. The rollers shall be between 6 and 8 tons mass and shall be equipped with suitable devices for wetting and cleaning the wheels during operation. The Engineer shall determine the mass of the roller required. No steel-tired roller shall be used without the written consent of the Engineer. Steel-tired rollers shall be used only on the first coat of a double surface treatment.

(e) Brooms

(i) Drag Brooms

Drag brooms shall be of a size, type and mass that will enable the chippings to be distributed evenly over the surface without dislodging chippings from the binder.

(ii) Rotary Brooms

An approved rotary broom, complete with towing vehicle fitted with smooth pneumatic tires, shall be available at all times during surfacing works.

(f) Trucks for transportation of chippings

The discharge opening of the trucks that transport the chippings shall be fitted with a low gate or barrier to traps fines and dust, which may settle from the mass of the chippings during transportation from the stockpiles, and prevent them being discharged into the chip spreader. Such accumulations of dust and fines in the bed of the truck shall be removed before the truck is reloaded.

(g) Mixer for Slurry Seal

No central mixing plant will be allowed. A mobile mixer of a type approved by the Engineer shall be provided. It may be either a batch type mixer or a continuous type mixer. The paddles of the mixer shall be so designed as to ensure a complete blending of the constituents of the slurry.

For rapid setting slurry seals, the mixing and application of the slurry shall be done by a mixer designed to provide a rapid mixing time, and sufficient agitation within the spreading system to prevent segregation or premature hardening. The mixer shall be capable of continuous mixing and application.

The purpose designed continuous type mixer shall be equipped with precise metering systems to enable the various constituents to be combined continuously in the prescribed formulation.

(h) Spreader Box for Slurry Seal

A spreader box of a type approved by the Engineer shall be used to spread the slurry. The spreader box for rapid setting slurry shall be of a proven and approved type, to ensure sufficient agitation within the spreader system.

The spreader box shall be so constructed that the weight is distributed on metal skids, in such a way that no damage is done to the surface when the box is in operation.

Soft rubber belting shall be attached to the framework in such a way that no spillage of slurry occurs past the sides of the spreader box when the box is in operation.

The spreader box shall be capable of spreading a uniform application of slurry seal in adjustable widths from 1.5 m to 4.0 m, at specified rates, and it must have efficient mechanical means of adjusting the rates and widths of application specified.

(i) Pre-coating Plant

Where specified, pre-coating of chips may be done in any suitable plant capable of uniformly coating the chips.

(j) Weighing Devices

Where payment per ton is specified, the contractor shall provide and install suitable gauged weighing devices on the site, in accordance with the Engineer's requirements. The devices shall provide a printed report of each measurement including Vehicle No. date , time, cargo type, tare weight, loaded vehicle weight, net cargo weight. Printed measurement tickets shall be verified on site by the Engineer's staff and shall be submitted to the Engineer on a daily basis.

(k) Miscellaneous Equipment

Sufficient equipment for handling and hauling chippings, other aggregate and binder shall be provided to ensure prompt and continuous covering of bituminous materials as specified. The Contractor shall have available all the necessary ancillary equipment and hand tools, thermometers etc. to carry out the work efficiently.

(l) Safety Equipment

Suitable fire fighting equipment for dealing with bitumen fires shall be available at the site of the bitumen works, together with suitable first-aid equipment for dealing with bitumen burns in accordance with Sabita Manual 8: Bitumen Safety Handbook.

(m) Reserve Equipment

The Engineer shall be entitled to request reserve equipment if he has reason to doubt the efficiency or capacity of the equipment provided.

63A04 GENERAL LIMITATIONS AND REQUIREMENTS

(a) Stockpiling of Aggregates

Sites for the stockpiling of chippings shall be prepared in such a manner that no grass, mud, dirt or other deleterious material will be included when the chippings are loaded for use.

Access to stockpile sites shall be prepared and maintained in such a way that no dirt is conveyed by vehicle wheels onto the areas to be surfaced or resurfaced whilst chippings are being transported to or from the stockpiles.

Stockpiles shall be so sited that they will not be exposed to excessive contamination with dust arising from traffic on the road or access roads. Chippings contaminated to the extent

that they contain more than the allowable percentage of material passing the 0.425 mm sieve shall not be used for surfacing.

(b) Weather limitations

The minimum road surface rising temperatures at which the spraying of the various types and grades of binder may be done shall comply with the requirements of table 6300A/13.

Table 6300A/13 Minimum Road Surface Temperatures for Spraying Binder

Material	Minimum road-surface temperature ^{O}C
(i) Conventional Binders	
Penetration-grade bitumens	
60/70	20
80/100	20
150/200	25
Cut-back bitumens	
RC-250	10
MC-800	10
MC-3000	10
Bitumen emulsions	10
(ii) Non-homogeneous modified binders (summer grade)	
Bitumen-rubber (spray application)	25
(iii) Non-homogeneous modified binders (winter grade)	
As specified in the project specification	
(iv) Homogeneous cold-applied modified binders	
SBR modified cationic emulsion	10
SBS modified cationic emulsion	10
(v) Homogeneous hot-applied modified binders (summer grade)	
Modified 150/200 penetration grade	21
Modified 80/100 penetration grade	25
(vi) Homogeneous hot-applied modified binders (winter grade)	
As specified in the project specification	

Spraying shall only be done at the minimum temperature when, in the opinion of the Engineer, the road surface temperature is rising.

Whenever, in the opinion of the Engineer, the road surface temperature is likely to fall below the minimum temperatures specified, before the commencement of spraying, no spraying shall be carried out.

No bituminous work shall be done during foggy or rainy weather and when a cold wind is blowing the specified temperatures shall be increased by 3^{O} C to 6^{O} C as directed by the Engineer.

Conventional slurry shall not be applied at an air temperature of less than 7^{O} C when temperatures are rising or less than 13^{O} C when temperatures are dropping.

Rapid setting slurry may, if so designed, be laid in air temperatures of 4^{O} C to 40^{O} C and in damp conditions.

During hot weather slurry operations shall be suspended when the spreader box or squeegees are displacing aggregate.

When strong winds are blowing and this is likely to interfere with the proper execution of the work, no surfacing, especially spraying of binder, shall be done.

When the breaking process is so accelerated as to render the product unworkable, eg. by high ambient temperatures, or as otherwise prescribed by the Engineer, no surfacing work shall be done.

(c) Moisture Content

No surface treatment shall be placed unless the moisture content of the upper 50 mm of the roadbase is less than 50% of the optimum moisture content of the roadbase as determined by the Engineer. To prevent the trapping of water in the pavement structure, after prolonged or intense rain no seal or reseal shall be placed on an existing partly cracked and/or highly permeable surfacing for a period of at least 24 hours or such extended period as determined by the Engineer.

(d) Curing Periods

Unless otherwise indicated in the project specification, the following curing periods shall apply to the various treatments listed prior to applying a seal or reseal:

Texturing using fine slurry ..... 6 weeks
Rapid setting slurry ..... 12 weeks
Crack sealing ..... 2 weeks
Repair of distressed patches ..... 6 weeks

(e) Spraying to cease at 15:00 hours

Unless otherwise agreed by the Engineer, and subject to the satisfactory outcome of a trial section, the Contractor shall programme all spraying operations to cease at 15:00 hours local time each working day.

(f) Traffic

The Contractor shall comply with the requirements of DIVISION 1500.

(g) Trial Areas

Prior to the commencement of normal working the Contractor shall construct a trial area of not less than 1000 square metres using the materials and equipment proposed for the work to demonstrate compliance with the requirements of this Clause.

63A05 CUTTING BACK OF BITUMEN

The cutting back of bitumen will only be allowed where authorised by the Engineer and in accordance with Engineer's requirements. Only approved kerosene shall be used for cutting back.

The temperature of the bitumen, when the kerosene is introduced, shall not be higher than 140^{O} C.

When cutting back is done in a bitumen distributor, the kerosene shall **NOT** be introduced into the distributor through the inspection manhole, which shall be kept closed. The kerosene shall be sucked from 200 litre drums in measured quantities through the bitumen pump and circulated with the bitumen for a minimum of 45 minutes. During this process all burners shall be shut off and no open flames shall be allowed near the distributor.

The following maximum amounts of kerosene shall be added to the basic 150/200 penetration-grade bitumen depending on the road surface temperature at the time of spraying. Lesser amounts than those indicated may be used if conditions on Site allow the development of sufficient adhesion between binder, chippings and existing surface.

Table 6300A/14 Addion of kerosene

Range of road surface temperatures ^{O}C	Approximate corresponding range of ambient air temperatures ^{O}C	Maximum addition of Kerosene by volume %
16 – 24	10 – 16	7
24 – 32	16 – 21	5
32 – 40	21 – 26	3
40 – 48	26 – 31	1
> 48	> 31	0

63A06 HEATING OF BITUMINOUS BINDERS

(a) Conventional Binders

The temperature ranges between which bituminous binders are to be heated shall be as given in Table 6300A/15.

Table 6300A/15 Storage and spraying temperature for bituminous binders

Materials	Maximum storage temperature ^{O}C		Heating and spraying temperature ^{O}C		
	< 24 hours	> 24 hours	Minimum	Maximum	Recommend
Penetration-grade bitumens					
60/70	175	125	170	190	180
80/100	175	125	165	190	175
150/200	165	115	150	175	165
Cut-back bitumens					
RC-250	90	60	90	115	100
MC-800	125	75	110	135	125
MC-3000	155	100	135	155	145
Bitumen emulsions					
60 %	60	Ambient	Ambient	60	60
65 %	60	Ambient	50	60	60
70 %	60	Ambient	55	65	65

Binders stored in a heated condition shall be kept in a container having a properly functioning circulatory system and a securely fitting lid. The container shall have a properly functioning built-in thermometer.

Binders that have been heated above the maximum temperatures indicated in Table 6300A/15 shall not be used and shall be removed from Site. During spraying, every effort shall be made to maintain the binder temperature within 5^{o} C of the recommended spraying temperature.

For surface treatment works the spraying temperature limits for 80/100 penetration-grade bitumen, cut back with the indicated amounts of kerosene in parts per 100 parts of bitumen by volume as described in Clause 63A05, shall be as given in Table 6300A/16

Table 6300A/16 Spaying temperature limits for bituminous binders

Quantity of Kerosene added (parts per 100 parts bitumen by volume)	Spraying temperature limits ^{O}C		
	Minimum	Maximum	Recommended
0.0	150	175	165
2.5	146	163	154
5.0	138	154	146
7.5	132	149	140
10.0	125	143	134
12.5	121	138	129
15.0	115	135	125
17.5	107	127	117
22.5	100	118	108

(b) Non-homogeneous (heterogeneous) modified binders (summer grade)

After completion of the bitumen-rubber reaction, the binder shall be cooled to less than 160^{O} C. The binder mixture shall be stored in a container having a properly functioning circulatory system and a securely fitting lid. The container shall have a properly functioning built-in thermometer. The binder mixture shall not be kept for more than 48 hours before use.

1) The spray and storage conditions of the bitumen-rubber binder shall be in accordance with the following requirements:

2) Spray temperature : As provided by the supplier

3) Maximum storage time at spray temperature : 4 hours

4) Maximum storage temperature (<48 hours): 35^{O} C less than the spray temperature but not more than 160^{O} C

5) Stored binder heated to a temperature above 160^{O} C shall not be used and shall be removed from site.

63A07 PREPARATION OF AREAS TO BE SURFACED

(a) General

The areas to be surfaced or sealed shall be cleaned of all dust, dirt, dung, oil, or any other foreign materials that may be deleterious to the surface treatment.

(b) New Construction

Where newly constructed roadbase or shoulder areas are to be surfaced, these areas shall be checked for compliance with the surface tolerances and all other requirements specified. Any portions that do not meet these requirements shall first be either corrected or removed and reconstructed, before they are surfaced.

(c) Existing surfaces that are to be resurfaced

Existing roads that are to be resurfaced and/or resealed shall, if so specified or ordered by the Engineer, be prepared for resurfacing in accordance with one or more of the methods described in Division 6800.

63A08 DEMARCATION OF WORKING AREA

(a) New Construction

The Contractor shall demarcate the area of the primed roadbase to be surfaced by means of setting out wire, or string lines down each edge of the proposed surfaced width. The control intervals for the setting out of horizontal curves shall be as agreed by the Engineer.

(b) Existing surfaces that are to be resurfaced

The centerline of the road or other reference setting out line, as agreed by the Engineer, shall be established immediately before the tack coat or bituminous binder is sprayed.

63A09 PROTECTION OF KERBS, CHANNELS ETC.

Kerbs, channels, guttering, manholes, guard rails, bridge railings and any other structures that may be soiled by bituminous binders during spraying operations shall be covered with suitable plastic sheeting during spraying operations. The sheeting shall be kept firmly in position by soil, stones or adhesive tape in such a manner that it will not lift or be blown away during windy conditions but will keep the areas to be protected fully covered.

The use of paper bags, sand or other materials will not be permitted in lieu of plastic sheeting and the Contractor shall replace at his own expense any items that have been soiled and cannot be cleaned entirely. The painting of soiled surfaces will not be acceptable as a suitable remedy.

63A10 DUST CONTROL

Any diversions and construction roads adjacent to any surfacing works shall be kept watered and damp during all surfacing operations and all dust shall be removed from surfaces before any binder, aggregate or slurry is applied.

The supply and application of water to diversions will be paid for separately as specified in Division 1500.

63A11 CONSTRUCTION OF SURFACE TREATMENT

(a) General

The Contractor shall give adequate advance notice of his intention to proceed with any surfacing works.

(b) Application of Binders

Bituminous binders shall be applied by means of a binder distributor unless otherwise approved. To prevent surging and spluttering, the tank of the bitumen distributor shall not be completely emptied during the spraying operation and the area to be sealed shall be limited to ensure that ten (10) percent of the nominal capacity of the tank is retained at the completion of spraying. When the tank contains less than twenty (20) percent of the nominal capacity of the tank spraying shall be done in an uphill direction, unless otherwise approved by the Engineer.

The quantity of bitumen sprayed in any single spray operation shall be governed by the quantity of chippings and the number of available trucks, which shall be sufficient to ensure the continuous application of stone behind the distributor.

(c) Joints between Binder Sprays

In order to prevent overlapping at transverse junctions of separate binder applications, the previous work along the joint shall be covered with twine-reinforced building paper for a sufficient distance back from the joint to ensure that the spray bar of the bitumen distributor is operating at the required rate before the untreated surface is reached, and also to prevent additional binder application onto the previously treated section. The same method shall be used to ensure a neat joint at the end of the run.

If in the opinion of the Engineer, the Contractor is unable to apply surfacing to the entire width specified in a single pass, the Contractor shall apply the surfacing in strips. Adjacent sprays shall overlap by 100mm. Chippings shall not be placed on the 100mm overlap before the adjacent strip has been sprayed. The adjacent strip may not be sprayed before the preceding strip, excluding the 100mm overlap, has been covered satisfactorily with chippings in compliance with the specifications. As far as is practicable, the contractor shall so place the strips that the joint between two adjacent chipping applications shall fall on the centre line of the road.

(d) Application of Chippings

Chippings shall be applied by means of chip spreaders as described in Clause 63A03 (c). Chip spreaders shall commence spreading the chippings as closely as possible behind the distributor. The chip spreader shall be operated in such a manner that the binder shall be covered with chippings and the wheels of the chip spreader or truck do not pass over the uncovered binder. All chippings shall be spread as soon as possible but no later than ten (10) minutes after the binder has been sprayed.

Any areas deficient in chippings shall have additional material added to leave the carpet with a single layer of chippings lying shoulder to shoulder. It is essential to ensure that only one layer of chippings is applied and every care shall be taken to avoid over-application of chippings.

The finished surface shall be well-knit and have a uniform appearance free of roller-tire marks. All chippings contaminated by oil, fuel or grease shall be removed and replaced by clean chippings.

All loose chippings shall be broomed off the surface with a rotary broom or hard brooms as directed by the engineer.

(e) Rate of application to be determined by the Engineer

The actual rates of application of binder and chippings to be used in construction will be determined by the Engineer, after testing of the chippings that the Contractor proposes to use for the surface treatment, and prior to any surfacing work being carried out.

(f) Single and double surface treatment

(i) First application of binder and chippings

A first application of binder consisting of the type and grade of binder specified in these Specifications under each of the appropriate Divisions for each type of bituminous surface treatment, or in the Project Specifications, shall be sprayed on the properly cleaned and prepared roadbase or existing surface over the full specified width of the surfacing.

Immediately after the binder has been sprayed, it shall be covered with chippings of the size specified in these Specifications under each of the appropriate Divisions for each type of bituminous surface treatment.

(ii) Initial Rolling of Chippings

As soon as the chippings have been applied, rolling shall commence with a self-propelled pneumatic-tired roller with a loading 2.0 tons per wheel working parallel to the center line

of the road from the shoulders towards the crown of the road until the whole surface has been covered at least three (3) times with the wheels of the roller, or five times in the case of the single surface treatment and surface treatments with chippings and slurry seal.

(iii) Broom Drag and Final Rolling of Chippings

This clause shall not be applicable to single surface treatments without a fog spray.

After the bituminous binder has set-up sufficiently to prevent any chipping from being dislodged, the surface shall be slowly dragged with a broom drag in order to ensure even distribution of the chippings. If there are areas that are deficient in stone chips, additional material shall be added by hand so as to leave the carpet with one layer of stone shoulder to shoulder.

If there are areas having an excess of stone chips, such excess shall be removed by hand so as to leave the carpet with one layer of stone shoulder to shoulder. The importance of applying only a single layer of stone is stressed. Every care shall be taken to avoid an over-application of stone.

When the spreading of stone chips is complete, the surface shall be rolled with a pneumatic-tired roller with a loading 2.0 tons per wheel until the whole surface has been covered at least four (4) times with the wheels of the roller. Except in the case of single seals, final rolling shall be done with a flat steel-tired roller of 6 to 8 tons mass, working parallel to the center line of the road from the shoulders towards the crown of the road, until every portion of the area concerned has been covered by two (2) passes of the roller, provided only a minor amount of crushing of the chippings takes place. If in the opinion of the Engineer general crushing occurs under the rollers, such rolling shall be stopped regardless of the number of passes completed by the roller.

The surface shall be well knit and have a uniform appearance free of roller tire marks; all chippings contaminated by fuel, oil or grease shall be removed and replaced with clean stone.

(g) Fog Spray

If required by the Project Specifications or if so directed by the Engineer, a fog spray of 60% or 30% anionic or cationic emulsion shall be applied to the surface of the chippings by means of a pressure distributor at the required rate.

(h) Blinding

If required in the Project Specifications or as may be directed by the Engineer, a light blinding layer of washed natural sand or crusher sand shall be applied by the Contractor to prevent chippings from being picked up by traffic. The blinding layer shall be spread evenly over the entire area indicated. If so required by the Engineer, the layer of sand shall be spread by means of hand brooms.

63A12 RATES OF APPLICATION

All binders, chippings and other aggregates and slurry used in the various types of bituminous surface treatment shall be applied at the rates of application as approved by the Engineer after tests on the materials proposed for use, within a tolerance specified in clause 63A18.

No payment will be made for bituminous binder material applied in excess of the specified rate plus the permitted tolerance or at a rate lower than the specified rate, minus the permitted tolerance, unless, in the opinion of the Engineer, such over-spray or under-spray can be satisfactorily corrected in the case of a first application by the adjustment of the application rate of the second spray, and if such correction is effected.

Whenever the terms “net bitumen” or “net quantity of bitumen” are used in these specifications to specify the rate of application of the binder for conventional or homogeneous modified binder, they shall mean net bitumen cold at a temperature of 20^{O} C, including any volatiles normally contained but shall not include any water, emulsifying agents or volatile oils added in the production of bitumen emulsions or cut-back bitumen. Non-homogeneous modified binders, however, shall be specified at spraying temperature.

Unless otherwise specified, the nominal rates of application of bituminous binders given in further sections shall be measured at spraying temperature, as will be the variations in application rate.

The nominal rates of application are for tendering purposes only and will not necessarily be used in construction. The actual rates of application to be used on the site shall in all cases be as instructed by the Engineer.

Appropriate approved conversion factors shall be used to for calculating net bitumen from binder at spraying temperature.

63A13 AREAS INACCESSIBLE TO MECHANICAL EQUIPMENT

Bituminous surface treatments shall be constructed by means of mechanical equipment, unless otherwise approved. Binders for surface treatments, and particularly bitumen-rubber binders, shall be applied using binder distributors which have been specially adjusted for accurately applying the binders in restricted areas in accordance with the specified requirements. Areas inaccessible to mechanical equipment shall be constructed as follows:

(a) Prime coat/Tack coat

The prime/tack coat shall be applied to the area to be surfaced by hand spraying under the close supervision of an experienced person. The application of prime/tack coat shall be controlled in order to achieve a uniform application at the rate specified. The type of prime/tack coat material and the rate of application thereof shall be subject to the engineer's approval.

Each area that is to be surfaced shall be screened off by means of fiber-reinforced paper, so that only the area to which the binder is to be applied will be exposed.

The binder shall be applied by means of hand-spraying equipment complying with the requirements specified in Sub-clause 6104(a) , paragraph 12.

(b) Bituminous Mixture

A pre-mixed bituminous mixture shall be prepared consisting of 9.5 mm and 6.7 mm nominal sized aggregate, and crusher sand which complies with the requirements of sub-clause 4302(c), together with a 60 % stable mix-grade emulsion prepared from 80/100 penetration-grade bitumen, in the following proportions by volume:

9.5 mm nominal sized aggregate :1 part

6.7 mm nominal sized aggregate : 1 part

Crusher sand (fine grade) : 1 part

Net quantity of bitumen between 75 and 90 litres per cubic metre of aggregate mix.

The ingredients shall be mixed in a suitable concrete mixer. While rotating in the mixer, the aggregates shall be heated to a temperature of 100^{o} C, after which the bitumen emulsion shall be added. Mixing shall continue until the aggregate is uniformly coated by bitumen.

Before placing the mixture the surface shall be prepared by painting it with one coat of bitumen emulsion, which shall be allowed to dry. The mixture shall then be placed on the area to be surfaced and screeded off to a uniform thickness sufficient, when compacted, to achieve a similar thickness to the adjacent surface treatment.

After the emulsion has broken and the mixture has attained sufficient stability the layer shall be rolled to the satisfaction of the Engineer with the most effective rollers that can be used in the area in question. The surface shall comply with the requirements of clause 63A17.

(c) Surface Treatment

Aggregate for the surface treatment shall be of the same size as the adjacent surfacing and shall be spread by hand. The chippings shall be rolled to the satisfaction of the Engineer with the most effective rollers that can be used in the area in question, and thereafter the excess chippings shall be removed by means of hand brooms. If a double surface treatment is required, the specified penetration spray shall be applied and the second layer of chippings applied, rolled and broomed. Any specified fog spray of bitumen emulsion shall be applied within 48 hours.

The Engineer may require a slurry to be applied to areas which will be subjected to traffic.

(d) Slurry

Where the surfacing layer consists of an application of aggregate with slurry, the slurry seal shall be applied to the surface of the layer constructed as described above, at a rate of between 0.003 and 0.004 m^3/m^2 or as the Engineer may direct. This shall be done at the same time as the final slurry application on the other portions of the work to obtain a uniform appearance.

63A14 OPENING TO TRAFFIC

The Engineer shall be responsible for determining when any surfacing is to be opened to public traffic.

The road shall not be opened to traffic until the binder has set sufficiently to retain the aggregate, or in the case of slurry seals, the slurry has set sufficiently that it will not be picked up by the wheels of passing traffic.

The Contractor shall not allow any construction equipment, which is likely to cause damage, over the completed surface treatment.

The Contractor shall display speed restriction signs in accordance with Sections 1500 and 5600, and the instructions of the Engineer.

63A15 DEFECTS

Where in the opinion of the Engineer, any excessive loss of aggregate or bleeding of the road surface, that may occur during the course of the Contract or during the Maintenance Period, can be attributed to the Contractor not observing any of the requirements of the Specifications, not using the correct rates of application, or any other omission or fault on the part of the Contractor, any corrective work ordered by the Engineer shall be at the Contractor's own cost including the supply, pre-coating, stockpiling at selected sites, and later removal if not used, of any chippings or other aggregate reserved for corrective work during the Maintenance Period or thereafter.

Before commencing any repair works, the Contractor shall obtain the approval of the Engineer for the proposed repair methods, which shall be based on the requirements of this clause.

Where the reason for loss of aggregate or bleeding cannot, in the opinion of the Engineer, be attributed to any fault or neglect on the part of the Contractor, the Employer shall pay at the tendered prices for the cost of any remedial measures taken on the instructions of the Engineer.

(a) Bleeding

Bleeding shall be corrected by one or more of the methods described below, as may be ordered by the Engineer:

(i) General

The remedial work shall be effected as soon as possible after bleeding occurs.

All operations to correct bleeding shall be carried out only when the road temperature is high enough to promote adherence of any aggregate that may be applied.

If only half the road width is to be treated, the application of the remedial works shall be finished in a neat line on the centre line of the road

Before opening any rectified work to traffic, all the loose aggregate shall be swept off the surface.

It is essential to use a heavy pneumatic roller for this work. Rolling shall continue until the Engineer is satisfied that the aggregate has been properly embedded. No rolling shall be done in wet weather, cold weather or early in the morning when the surface is cold.

Notwithstanding the following methods of treatment, the Engineer may order any surfacing, which has not been properly constructed to be removed and replaced. The removal of the surfacing shall be done so as avoid damaging the existing roadbase. All aggregate and binder shall be removed either by grader or by hand tools and any damage done to the surface shall be repaired to the satisfaction of the Engineer.

(ii) Single Seal with Slurry

The Engineer will determine the size of the aggregate to be applied to the bleeding portions, and for this purpose he may require ball penetration tests to be performed on the affected areas. The aggregate shall comply with the requirements of clause 63A02.

If the binder of the existing surface has an oxidised film or if the rood has been used by traffic for some time, it shall be treated either by brushing-in kerosene to soften the surface

of the binder, or the surface shall be softened with heating apparatus, if so ordered by the Engineer. The heating apparatus shall be of an approved type, which does not expose the surface of the road to naked flames.

This work shall only commence when the road surface temperature exceeds 30 ^{O} C. The aggregate shall be applied to the surface immediately at the rate determined by the Engineer and rolled with a pneumatic-tyred roller with a loading of at least 2.0 tons per wheel until the aggregate is firmly embedded. All loose aggregate not embedded shall be broomed off the rood before it is opened to traffic. When opening the road to traffic, the affected areas shall be demarcated with traffic cones and speed limit signs for the first two days, care being taken to remove all loose aggregate daily.

Areas where whip-off is excessive after the above treatment has been carried out shall be retreated in accordance with the Engineer's instructions.

(iii) Single or Multiple Surface Treatments

Where, in the opinion of the Engineer, severe bleeding occurs, the Engineer may prescribe one of the following treatments:

(1) Severe bleeding in limited areas

These sections shall be treated as specified in sub-clause 63A15 (a) (ii). The Engineer will determine the size of the aggregate.

(2) Severe bleeding in extensive areas

If the surface is non-uniform i.e. partly bleeding and partly coarse-textured, the surface shall be rectified by pre-treating the coarse areas in accordance with clause 5211 to obtain a uniform surface, which shall then be covered with a single seal in accordance with Division 6300C. The type of aggregate to be used shall be determined by the Engineer.

(3) Very severe bleeding

In these sections the surface treatment shall be removed from the surface of the roadbase by an approved method e.g. milling or blading. The removal work shall be executed while the surface temperature of the road is below 15 ^{O} C. If necessary the road surface shall be cooled with water during the execution of the work. Motor graders shall be fitted with new blades for this work.

The Contractor shall repair all damage to the surface of the roadbase to the satisfaction of the Engineer, whereupon a surface course or seal shall be applied in accordance with the Engineer's instructions.

(b) Loss of Aggregate

Where loss of aggregate occurs, the following measures shall be applied immediately:

The affected sections of the road shall be closed to traffic using appropriate roads signs in accordance with this Specification. All loose aggregate shall be removed from the road surface by brooming using stiff brooms.

The Engineer shall determine the extent and nature of the defective section and shall instruct the Contractor to execute one or more of the following measures:

(i) Slight loss of aggregate

If so ordered by the Engineer, slight loss of aggregate shall be treated by application of a fog spray. The surface to be repaired shall be clean and dry, and a spray grade emulsion shall be applied at a rate of 0.55 litres/m^2 or other such rate as may be ordered by the Engineer.

(ii) Loss of aggregate in limited areas due to low temperature

The areas to be treated shall be demarcated by the Engineer. If so ordered by the Engineer, any remaining aggregate within these areas shall be removed using hand-equipment. Heating apparatus as described in sub-clause 63A15 (a) (ii) may be used. Thereafter the areas shall be resurfaced as described in clause 63A13.

Loss of aggregate shall be corrected in accordance with the requirements of the Engineer, using a fog spray. The surface to be repaired shall be clean and dry and a 30 % anionic or cationic spray-grade emulsion shall be applied at the rate of 0.4 litre/m^2 or other such rate as may be approved by the Engineer.

(iii) Loss of aggregate in large areas due to low temperature

The remaining aggregate shall be bladed from the road surface as soon as possible and the affected area shall be resurfaced as prescribed by the Engineer.

(iv) Loss of aggregate in limited areas due to binder deficiency

The measures specified in sub-clause 63A15 (b) (i) shall be applied.

(v) Loss of aggregate in large areas due to binder deficiency

As soon as the temperature of the road surface is within the prescribed limits, a fog spray of diluted bitumen emulsion shall bed applied at the specified or approved by the Engineer. An additional layer of aggregate shall then be applied by a mechanical spreader at a rate sufficient to replace the loss of aggregate. The completed layer shall then be rolled to the satisfaction of the Engineer with pneumatic-tyred rollers as specified in sub-clause 63A03 (d). When the binder has set sufficiently, all surplus aggregate shall be swept off the road surface with brooms in accordance with sub-clause 63A03 (e).

63A16 MAINTENANCE

The Contractor shall maintain the bituminous surface until the Employer finally accepts the work. Any damage occurring to the surface or any defects which may develop before the maintenance certificate is issued, fair wear and tear excepted, shall be corrected by the Contractor at his own expense and to the requirements of the Engineer.

63A17 DAMAGE TO THE ROAD SURFACE BY THIRD PARTIES

The Contractor shall repair damage to the road surface caused by third parties. Such repair shall be carried out in accordance with the relevant sections of the Specifications as directed by the Engineer. Except and to the extent that the occurrence resulting in the damage is a consequence of an act or omission by the Contractor, the cost of such repairs, as determined by the Engineer, will be paid to the Contractor by the Employer.

63A18 TOLERANCES AND FINISH REQUIREMENTS

The completed bituminous work shall comply with the following requirements regarding surface tolerances and finish:

(a) New Construction

(i) General

Any areas, which show signs of bleeding after the section has been opened to traffic, shall be corrected as specified in Clause 63A15. Corrective work shall be carried out in such a manner as to blend in color, texture and finish with adjacent work.

The completed bituminous surfacing shall be free of corrugations or any other wave effect where depressions are preceded and followed by humps or ridges no matter how small the distance between the top of the hump to the bottom of the preceding or following depression.

(ii) Level and Grade

The requirements relating to the roadbase on which the surfacing is constructed shall apply.

(iii) Width

The edges of the surfacing shall be true to line with a maximum deviation from the specified edge line of 20 mm.

(iv) Cross Section

The requirements relating to the roadbase on which the surfacing is constructed shall apply.

(v) Surface Regularity

The requirements relating to the roadbase on which the surfacing is constructed shall apply.

(b) Resealing Work on Existing Surfaces

The completed surfacing shall be of uniform texture without gaps or patches and shall be free from any loose aggregate or bitumen spillage.

Any areas that show signs of bleeding after the section has been opened to traffic shall be corrected as specified in Clause 63A15. Corrective work shall be carried out in such a manner as to blend in color, texture and finish with adjacent work.

The completed seal shall be free from corrugations or any other wave effect where depressions are preceded and followed by humps or ridges no matter how small the distance between the top of the hump to the bottom of the preceding or following depression.

The edges of the completed seal shall be continuously true to line with a maximum allowable deviation from the specified edge line of 20 mm.

(c) Rate of Application

The maximum permissible variation from the rates of application of bituminous binders, chippings, other aggregates or slurry, as ordered by the Engineer, shall be plus or minus 5% of the rate of application required for the aggregates, and plus or minus 0.06 litres/m^2 net bitumen cold (20^O C) for conventional or homogeneous modified binders and within a tolerance of plus or minus 5% for non-homogeneous binders at spraying temperature.

Where the viscosity of the binder actually in use (at spraying temperature) varies from that at which the distributor was calibrated, or for any other reason, the Engineer may order the transverse distribution of the spray bar of the distributor to be verified in accordance with the Depot Tray Test, before the binder is applied. The coefficient of variation (100.s/x) of the spray applications calculated for 100 mm strips of the spray bar, excluding 300 mm strips on each side, shall not exceed 12% for any one such test ordered by the Engineer. In order to achieve minimum lot sizes the Engineer may combine sub-lots of the same population.

63A19 TESTING

(a) Process Control

The minimum testing frequency that will be required from the Contractor in terms of Clause 1202 for the purpose of process control shall be as given in Table 6300A-17

Table 6300A/17 Minimum testing frequencies

Test	Minimum Testing Frequency
Materials	
Chippings and other aggregates:	
Grading	One test every 250 m3
Los Angeles Abrasion	One test every 1000 m3
Flakiness	One test every 250 m3
Soundness	One test every 1000 m3
Bituminous binders	No testing required for process control, but the provisions for testing in Clause 63A02 shall apply upon delivery at the Site.
Application rates	Complete records to be kept of actual measurements made of quantities of materials applied and rates of application.
Construction Tolerances	
Width	One test every 100 m, after every spray run
Cross section	All rough areas to be checked
smoothness	

(b) Routine Inspection and Testing

Routine inspection and testing will be carried out by the Engineer to test the materials and workmanship provided, for compliance with the requirements specified in this Division.

Any materials or workmanship that do not comply with the requirements specified, shall be removed and replaced with materials and workmanship complying with the Specifications or, if the Engineer permits, be repaired as specified in Clause 1206, so that after being repaired it shall comply with the requirements specified.

63A20 MEASUREMENT AND PAYMENT

(a) Measurement and payment will be made under the various Divisions in which the various surface treatments are described.

(b) Surface treatments in areas inaccessible to mechanical equipment will be measured and paid under the various Divisions in which the adjacent surface treatment is described i.e.

Single surface treatments	Division 6300B
Double surface treatments	Division 6300C
Triple surface treatments	Division 6300D
Aggregate with slurry	Division 6300E
Sand seals	Division 6300F

(c) Where, in the opinion of the Engineer, the corrective work executed in terms of clause 63A15 is not for the Contractor's account, the Contractor will be remunerated at the applicable rates as determined by the Engineer in accordance with the Contract.

The following item of work shall also be measured and paid for as stated below:

Item 63A.01 Correction for bleeding using:

(a) Chippings:

(i) 13.2 mm chippings.....cubic metre (m^3)

(ii) 9.5 mm chippings.....cubic metre (m^3)

(iii) 4.75 mm chippings.....cubic metre (m^3)

(b) Pre-coating of chippings.....cubic metre (m^3)

(c) Treatment of surface.....square metre (m^2)

The unit of measurement for correction of bleeding shall be the cubic metre of chippings applied. The tendered rate shall include full compensation for procuring and furnishing the materials, including all transport and, if required, for stockpiling the material at selected sites indicated by the Engineer.

The unit of measurement for pre-coating of chippings shall be the cubic metre of material pre-coated. The tendered rate shall include full compensation for pre-coating the material as specified, for procuring and furnishing the pre-coating material regardless of the type of pre-coating material used, and for all handling, loading and offloading of all materials.

The unit of measurement for treatment of the surface shall be the square metre of surface treated. The tendered rate shall include full compensation for all labor, plant, and equipment and transport required treating the surfaces as specified including maintenance and all incidentals necessary for the completion of the work.

Item 63A.02 Application of a fog spray of 30% spray-grade or approved equivalent diluted stable-grade emulsion

(a) Spray-grade emulsion ..... litre (l)

(b) Stable-grade emulsion..... litre (l)

The unit of measurement shall be the litre of 30% spray-grade or approved equivalent diluted stable-grade emulsion measured at spraying temperature.

The tendered rate shall include full compensation for providing the material and applying the fog spray as specified.

Item 63A.03 Supplying and mixing of kerosene for cutback bitumen ..... litre (l)

The unit of measurement of kerosene used to cut back the basic 60/70, 80/100 or 150/200 penetration-grade bitumen shall be the litre, measured at ambient temperature.

The tendered rate shall include full compensation for furnishing the kerosene and mixing it with the bitumen and spraying, including all incidentals.

DIVISION 6300B: SINGLE SURFACE TREATMENTS

63B01 SCOPE

This division covers all the work in connection with the construction of single bituminous surface treatments for new road construction and for resealing of existing roads.

Note:

The provisions of Division 6300A "Surface Treatments: Materials and General Requirements" apply equally to the work covered by this division and will not necessarily be repeated or specifically referred to in this division.

63B02 MATERIALS

The materials shall comply with the requirements of section 6300A.

The average least dimension (ALD) of the chippings shall comply with the requirements in Table 6300B/1.

Table 6300B/1 Chippings - Average Least Dimension

Nominal size (mm)	Minimum ALD (mm)
19.0	12.0
13.2	8.2
9.5	5.9

63B03 CONSTRUCTION

(a) Application of Binder and Chippings

The binder and chippings of the grade and size specified in the Bill of Quantities or ordered by the Engineer, shall be applied in accordance with clause 63A11.

The nominal rates of application given in Table 6300B/2 shall be used for tendering purposes only. The actual rates of application shall be as determined by the Engineer.

Table 6300B/2 Nominal Application Rates for Chippings and Conventional Binders

Nominal Chipping Size (mm)	Nominal application rates	
	Chippings (m^3/m^2)	Conventional Binder (//m2) *
19.0	0.014	1.6
13.2	0.010	1.4
9.5	0.007	1.0
6.7	0.005	0.8
4.75	0.004	0.6

Note: * net cold bitumen

(b) Initial rolling

Initial rolling shall be carried out as specified in Sub-clause 63A11(f) (ii).

(c) Final rolling

The final rolling shall be done as specified in Sub-clause 63A11(f) (iii).

(d) Fog Spray

If required by the Project Specifications or if so directed by the Engineer, a fog spray shall be applied to the surface of the chippings in accordance with sub-clause 63A11 (g).

(e) Blinding

If required by the Project Specifications or if so directed by the Engineer, a light blinding layer of sand shall be applied to the surface of the chippings in accordance with sub-clause 63A11 (h).

(f) Pre-coating of Chippings

If required in the Project Specifications or as may be directed by the Engineer, the chippings shall be pre-coated with a pre-coating fluid as provided by Sub-clause 63A02(f) (i).

(g) Bitumen-rubber Surface Treatments

Nominal application rates for bitumen-rubber surface treatments shall be as indicated in table 6300B/3.

The total application of bitumen-rubber binder shall be applied in a single spray.

The chippings shall be applied immediately but not more than two (2) minutes after the application of the bitumen-rubber binder.

Table 6300B/3 Nominal Application Rates for Chippings and Bitumen-rubber Binders

Nominal size of chippings (mm)	Nominal Application Rates	
	Bitumen-rubber binder (l/m2) *	Chippings (m^3/m^2)
19.0	2.7	0.015
13.2	2.1	0.011
9.5	1.6	0.008

Note: * at spray temperature

(h) Resealing at Bridge Joints

The seal shall not be applied within 300 mm of concrete joint noses, and not over the joint nose itself under any circumstances.

Where specified in the Project Specifications, the existing surfacing shall be cut back on both sides of the bridge joint over a width of 300 mm in a tapered shape so that the resealed surface will be flush with the surface of the concrete joint nose.

All bridge joints shall be adequately protected against damage or blockage until all rolling and brooming work has been completed.

(i) Work in Areas Inaccessible to Mechanical Equipment

The provisions of Clause 63A13 shall apply.

63B04 OPENING TO TRAFFIC

Unless so approved by the Engineer, the road shall not be opened to traffic. In general, the road shall not be opened to traffic until the morning following the completion of the surface treatment when the binder is still stiff. In hot climates, the Engineer may instruct the Contractor to cool the binder by spraying with water before the road is opened to traffic.

63B05 MEASUREMENT AND PAYMENT

Item 63B.01 Single seal surface treatment (indicate grade of aggregate and type of binder):

(a) Using 19.0 mm chippings..... square metre (m^2)

(b) Using 13.2 mm chippings..... square metre (m^2)

(c) Using 9.5 mm chippings..... square metre (m^2)

(d) Using 6.7 mm chippings..... square metre (m^2)

(e) Using 4.75 mm chippings..... square metre (m^2)

The unit of measurement shall be the square metre of completed and accepted surface treatment.

The tendered rates shall include full compensation, inter alia, for furnishing all materials, marking the centerline or reference lines, spraying of binder, spreading of chippings, rolling, removing of dust or deleterious material, supplying of water and spraying of haul roads and

construction roads, trimming the edges of the completed surface, and all other incidentals necessary for completing the work as specified, except the application of a fog spray which shall be paid for separately.

Item 63B.02 Variations in the rate of application of Bituminous Binder:

(a) 60/70 penetration-grade bitumen ..... litre (l)

(b) 80/100 penetration-grade bitumen ..... litre (l)

(c) 150/200 penetration-grade bitumen ..... litre (l)

(d) 65% cationic spray grade emulsion ..... litre (l)

(e) 60% cationic spray grade emulsion ..... litre (l)

(f) 60% anionic spray grade emulsion ..... litre (l)

(g) Pre-coating fluid ..... litre (l)

(h) MC-3000 cutback bitumen ..... litre (l)

The unit of measurement for bituminous binder in respect of an increase or a decrease in the specified rates of application shall be the litre measured at spraying temperature (the Contractor must note that the nominal rates of application are specified in net bitumen cold).

Payment for variations shall be made as specified in the Conditions of Contract.

Item 63B.03 Variations in the rate of application of Chippings:

(a) 19.0 mm chippings..... cubic metre (m^3)

(b) 13.2 mm chippings..... cubic metre (m^3)

(c) 9.5 mm chippings..... cubic metre (m^3)

(d) 6.7 mm chippings..... cubic metre (m^3)

(e) 4.75 mm chippings..... cubic metre (m^3)

The unit of measurement for chippings in respect of an increase or a decrease in the specified rates of application shall be the cubic metre of chippings.

Payment for variations shall be made as specified in the Conditions of Contract.

Item 63B.04 Application of fog spray:

(a) 60 % spray grade emulsion (indicate type)..... litre (*l*)

(b) 30 % spray grade emulsion (indicate type) ..... litre (*l*)

The unit of measurement shall be the litre, measured at spraying temperature. The tendered rate shall include full compensation for furnishing the material and applying the fog spray as specified.

Item 63B.05 Pre-coating chippings (as specified) ..... cubic metre (m^3)

(state type of pre-coating fluid)

The unit of measurement for the pre-coating of chippings shall be the cubic metre of chippings so treated determined from the usage of the chippings at the specified chipping application rate.

The tendered rate shall include full compensation for furnishing the equipment and materials and pre-coating the chippings as specified, including the handling, stockpiling and protecting the stockpiles against inclement weather.

Item 63B.06 Addition of wetting agent

{state type of wetting agent}

(a) Providing and supplying ..... prime cost sum

(b) Handling, applying, profit and all other costs .....percentage of prime cost sum

The prime cost sum shall be paid for in terms of the general conditions of contract for providing and supplying an approved wetting agent to the pre-coating fluid as specified or as directed by the Engineer.

The tendered percentage of the prime cost sum shall include full compensation for handling the material, storing and introducing it into the mix, including any equipment required, and for all other costs and profit.

Item 63B.07 Aggregate for blinding

(a) Natural sand .....cubic metre (m^3)

(b) Crusher sand.....cubic metre (m^3)

The unit of measurement shall be the cubic metre of sand measured in the hauling vehicles.

The tendered rate shall include full compensation for providing the material and applying the blinding coat complete as specified, and, should it be required, stockpiling the sand at an approved locality.

Item 63B.08 Extra over item 63B.01 for surface treatment of areas inaccessible to mechanical equipment with pre-mixed bituminous material:

(a) 19.0 mm thick..... square metre (m^2)

(b) 13.2 mm thick..... square metre (m^2)

The unit of measurement shall be the square metre of completed treatment.

The tendered rate per square metre of treatment shall include full compensation for procuring and furnishing all materials, and for all labour, plant, transport and other incidentals necessary for completing the work as specified, including application of a tack coat and the slurry.

Item 63B.09 Extra over item 63B.01 for single surface treatment in areas inaccessible to mechanical equipment .....square metre (m^2)

The unit of measurement shall include full compensation for all additional costs for executing the work in areas inaccessible to mechanical equipment. Payment will not distinguish between the various types of binders or the various sizes or grades of chippings.

Item 63B.10 Resurfacing at bridge joints:

(a) Where the existing surface **is not removed** .....metre (m)

(b) Where the existing surface **is removed**.....metre (m)

The unit of measurement shall be the metre of bridge joint situated in the surface to be resurfaced, and which has been protected in accordance with the specifications to the satisfaction of the Engineer.

The tendered rate shall include full compensation for protecting the bridge joints against damage, blockage and soiling until the resurfacing has been completed including the procuring, placing and removing of all covering material, and all other incidentals required for executing the work in accordance with the specifications.

The tendered rate for sub-item (b) shall include full compensation for cutting back in the existing surfacing, treating and backfilling it, and disposing of excavated material, all as specified and to the Satisfaction of the Engineer.

DIVISION 6300C: DOUBLE SURFACE TREATMENTS

63C01 SCOPE

This Division covers the supplying and furnishing of materials for the construction of double bituminous surface treatments.

The double surface treatments shall be constructed using either:

(a) 19.0 mm and 9.5 mm or 6.7 mm chippings, or

(b) 13.2 mm and 6.7 mm or 4.75 mm chippings, as shown in the Bill of Quantities.

Note:

The provisions of Division 6300A "Surface Treatments: Materials and General Requirements", apply equally to the work covered by this division and will not necessarily be repeated or specifically referred to in this division.

63C02 MATERIALS

The materials shall comply with the requirements of Division 6300A.

The average least dimension (ALD) of the first layer of chippings shall comply with the requirements in Table 6300C/1.

Table 6300C/1 Chippings - Average Least Dimension

Nominal Chipping Size (mm)	Minimum ALD (mm)
19.0	12.0
13.2	8.2

The maximum ALD of the second layer of chippings shall be not more than 50% of the ALD of the respective first layer

63C03 CONSTRUCTION

(a) The First Layer

(i) Application of the First Layer

Binders and chippings, of the type and grade specified in the Bill of Quantities or ordered by the Engineer, shall be applied in accordance with Clause 63A11 (f) (i).

The nominal rates of application given in table 6300C/2 shall be used for tendering purposes only. The actual rates of application shall be as determined by the Engineer.

Table 6300C/2 Nominal Rates of Application for the First Layer

Nominal Chipping Size (mm)	Nominal rates of application		
	Chippings (m^3/m^2)	Conventional Binder (l/m^2) *	Bitumen-rubber Binder (l/m^2) #
19.0	0.013	1.0	1.8
13.2	0.009	0.8	1.6

Note: * net cold bitumen; # at spray temperature

(ii) Initial Rolling

Initial rolling shall be carried out as specified in Sub-clause 63A11 (f) (ii)

(iii) Broom Drag and Final Rolling of Aggregate

Dragging and final rolling of aggregate shall be carried out as specified in Sub-clause 63A11 (f) (iii).

After application of the steel-tyred roller, under no circumstances should the first layer be opened to traffic before application of the second layer. If for any reason traffic is allowed to pass over the first layer, the layer shall be re-rolled to the satisfaction of the Engineer before the application of the second layer.

(b) The Second Layer

(i) Application of the Second Layer

Binders and chippings, of the type and grade specified in the Bill of Quantities or ordered by the Engineer, shall be applied in accordance with Clause 63A11 (f) (i).

The nominal rates of application given in table 6300C/3 shall be used for tendering purposes only. The actual rates of application shall be as determined by the Engineer.

Table 6300C/3 Nominal Rates of Application for the Second Layer

Nominal Chipping Size (mm)	Nominal rates of application	
	Chippings (m^3/m^2)	Conventional Binder (l/m^2) *
9.5	0.006	1.0
6.7	0.005	0.8
4.75	0.004	0.6

Note: * net cold bitumen

The second application of binder shall preferably take place within 48 hours after the application of the first layer when penetration-grade bitumen is used for the first layer and not less than ten (10) days after the application of the first layer when cut-back bitumen is used in the first layer.

(ii) Initial Rolling of the Second Layer

Initial rolling of the second layer of aggregate shall be carried out as specified in Sub-clause Clause 63A11 (f) (ii).

(iii) Broom drag and Final Rolling of the Second Layer

Dragging and final rolling of the second layer of aggregate shall be carried out as specified in Subclause 63A11(f) (iii).

(c) Fog Spray

If required by the Project Specifications or if so directed by the Engineer, a fog spray shall be applied to the surface of the chippings in accordance with sub-clause 63A11 (g).

(d) Pre-coating of Chippings

If required in the Project Specifications or as may be directed by the Engineer, the chippings shall be pre-coated with a pre-coating fluid as provided by Sub-clause 63A02(f) (i).

63C04 OPENING TO TRAFFIC

Unless so approved by the Engineer, the road shall not be opened to traffic. In general, the road shall not be opened to traffic until the morning following the completion of the surface treatment when the binder is still stiff. In hot climates, the Engineer may instruct the Contractor to cool the binder by spraying with water before the road is opened to traffic.

63C05 MEASUREMENT AND PAYMENT

Item 63C.01 Double surface treatment using:

(a) 19.0 mm and 9.5 mm chippings (with specified binder) ..... square metre (m^2)

{state grade of chippings and type of binder}

(b) 19.0 mm and 6.7 mm aggregate (with specified binder)..... square metre (m^2)

{state grade of chippings and type of binder}

(c) 13.2 mm and 6.7 mm aggregate (with specified binder)..... square metre (m^2)

{state grade of chippings and type of binder}

(d) 13.2 mm and 4.75 mm aggregate (with specified binder)..... square metre (m^2)

{state grade of chippings and type of binder}

The unit of measurement shall be the square metre of completed and accepted surface treatment.

The tendered rate shall include full compensation for furnishing all materials, marking the centre line, spraying of binders, spreading of aggregate, rolling, removing of dust or deleterious material, supplying of water and spraying of haul roads and construction roads, trimming the edges of the completed surface and all other incidentals necessary for completing the work as specified.

Item 63C.02 Variations in the rate of application of Bituminous Binder:

(a) 60/70 penetration-grade bitumen ..... litre (l)

(b) 80/100 penetration-grade bitumen ..... litre (l)

(c) 150/200 penetration-grade bitumen ..... litre (l)

(d) 70% spray-grade emulsion {state type} ..... litre (l)

(e) 65% spray-grade emulsion {state type} ..... litre (l)

(f) 60% spray-grade emulsion {state type} ..... litre (l)

(g) 30% spray-grade emulsion {state type} ..... litre (l)

(h) MC 3000 cutback bitumen ..... litre (l)

(i) Bitumen-rubber {state type and composition} ..... litre (l)

(j) Homogeneous modified binder – hot applied {state type and composition} ... litre (l)

(k) Homogeneous modified binder – hot applied {state type and composition} ... litre (l)

(l) Pre-coating fluid ..... litre (l)

The unit of measurement of bituminous binder in respect of variations in the specified rates of application shall be the litre, measured at spraying temperature.

Payment for variations shall be made as specified in Clause 1212 of Division 1200.

Item 63C.03 Variations in the rate of application of Chippings:

(a) 19.0 mm chippings ..... cubic metre (m^3)

(b) 13.2 mm chippings ..... cubic metre (m^3)

(c) 9.5 mm chippings ..... cubic metre (m^3)

(d) 6.7 mm chippings ..... cubic metre (m^3)

(e) 4.75 mm chippings ..... cubic metre (m^3)

The unit of measurement for chippings in respect of an increase or a decrease in the specified rates of application shall be the cubic metre of chippings.

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

Item 63C.04 Application of Fog Spray:

(a) 60% spray-grade emulsion {state type} ..... litre (l)

(b) 30% spray-grade emulsion {state type} ..... litre (l)

The unit of measurement shall be the litre of emulsion sprayed as specified and measured at the application temperature.

The tendered rate per litre shall include full compensation for procuring and furnishing the binder and applying the fog spray as specified.

Item 63C.05 Pre-coating chippings (as specified) ..... cubic metre (m^3)

{state type of pre-coating fluid}

The unit of measurement for the pre-coating of chippings shall be the cubic metre of chippings so treated determined from the usage of the chippings at the specified chipping application rate.

The tendered rate shall include full compensation for furnishing the equipment and materials and pre-coating the chippings as specified, including the handling, stockpiling and protecting the stockpiles against inclement weather.

Item 63C.06 Addition of wetting agent

{state type of wetting agent}

(a) Providing and supplying ..... prime cost sum

(b) Handling, applying, profit and all other costs .....percentage of prime cost sum

The prime cost sum shall be paid for in terms of the general conditions of contract for providing and supplying an approved wetting agent to the pre-coating fluid as specified or as directed by the Engineer.

The tendered percentage of the prime cost sum shall include full compensation for handling the material, storing and introducing it into the mix, including any equipment required, and for all other costs and profit.

Item 63C.07 Extra over item 63C.01 for surface treatment of areas inaccessible to mechanical equipment with pre-mixed bituminous material:

(a) 19.0 mm thick..... square metre (m^2)

(b) 13.2 mm thick..... square metre (m^2)

The unit of measurement shall be the square metre of completed treatment.

The tendered rate per square metre of treatment shall include full compensation for procuring and furnishing all materials, and for all labour, plant, transport and other incidentals necessary for completing the work as specified, including application of a tack coat and the slurry.

Item 63C.08 Extra over item 63C.01 for double surface treatment in areas inaccessible to mechanical equipment .....square metre (m^2)

The unit of measurement shall include full compensation for all additional costs for executing the work in areas inaccessible to mechanical equipment. Payment will not distinguish between the various types of binders or the various sizes or grades of chippings.

DIVISION 6300D: TRIPLE SEAL SURFACE TREATMENT

63D01 SCOPE

This Division covers the supplying and furnishing of materials for the construction of triple bituminous surface treatments.

The double surface treatments shall be constructed using either:

- 26.5 mm, 13.2 mm and 6.7 mm chippings, or
- 19.0 mm, 9.5 mm and 6.7 mm chippings, as shown in the Bill of Quantities.

Note:

The provisions of Division 6300A "Surface Treatments: Materials and General Requirements", apply equally to the work covered by this division and will not necessarily be repeated or specifically referred to in this division.

63D02 MATERIALS

The materials shall comply with the requirements of Division 6300A.

The average least dimension (ALD) of the first layer of chippings shall comply with the requirements in Table 6300D/1.

Table 6300D/1 Chippings - Average Least Dimension

Nominal Chipping Size (mm)	Minimum ALD (mm)
26.5	16.5
19.0	12.0

The maximum ALD of the subsequent layers of chippings shall be not more than 50% of the ALD of the respective preceding layers.

63D03 CONSTRUCTION

(a) The First Layer

(i) Application of the First Layer

Binders and chippings, of the type and grade specified in the Bill of Quantities or ordered by the Engineer, shall be applied in accordance with Clause 63A11 (f) (i).

The nominal rates of application given in table 6300D/2 shall be used for tendering purposes only. The actual rates of application shall be as determined by the Engineer.

Table 6300D/2 Nominal Rates of Application for the First Layer

Nominal Chipping Size (mm)	Nominal rates of application		
	Chippings (m^3/m^2)	Conventional Binder (l/m^2) *	Bitumen-rubber Binder (l/m^2) #
26.5	0.020	1.4	2.5
19.0	0.013	1.0	1.8

Note: * net cold bitumen; # at spray temperature

(ii) Initial Rolling

Initial rolling shall be carried out as specified in Sub-clause 63A11 (f) (ii)

(iii) Broom Drag and Final Rolling of Aggregate

Dragging and final rolling of aggregate shall be carried out as specified in Sub-clause 63A11 (f) (iii).

After application of the steel-tyred roller, under no circumstances should the first layer be opened to traffic before application of the second layer. If for any reason traffic is allowed to pass over the first layer, the layer shall be re-rolled to the satisfaction of the Engineer before the application of the second layer.

(b) The Second and Third Layers

(i) Application of the Second and Third Layers

Binders and chippings, of the type and grade specified in the Bill of Quantities or ordered by the Engineer, shall be applied in accordance with Clause 63A11 (f) (i).

The nominal rates of application given in table 6300D/3 shall be used for tendering purposes only. The actual rates of application shall be as determined by the Engineer.

Table 6300D/3 Nominal Rates of Application for the Second and Third Layers

Nominal Chipping Size (mm)	Nominal rates of application	
	Chippings (m^3/m^2)	Conventional Binder (l/m^2) *
13.2	0.009	1.2
9.5	0.006	1.0
6.7	0.005	0.8

Note: * net cold bitumen

(ii) Initial Rolling of the Second and Third Layers

Initial rolling of the second and third layers of aggregate shall be carried out as specified in Sub-clause Clause 63A11 (f) (ii).

(iii) Broom drag and Final Rolling of the Second and Third Layers

Dragging and final rolling of the second layer of aggregate shall be carried out as specified in Subclause 63A11(f) (iii).

(c) Fog Spray

If required by the Project Specifications or if so directed by the Engineer, a fog spray shall be applied to the surface of the chippings in accordance with sub-clause 63A11 (g).

(d) Pre-coating of Chippings

If required in the Project Specifications or as may be directed by the Engineer, the chippings shall be pre-coated with a pre-coating fluid as provided by Sub-clause 63A02(f) (i).

63D04 OPENING TO TRAFFIC

Unless so approved by the Engineer, the road shall not be opened to traffic. In general, the road shall not be opened to traffic until the morning following the completion of the surface treatment when the binder is still stiff. In hot climates, the Engineer may instruct the Contractor to cool the binder by spraying with water before the road is opened to traffic.

63D05 MEASUREMENT AND PAYMENT

Item 63D.01 Triple bituminous surface treatment using:

(a) 26.5 mm, 13.2 mm and 6.7 mm chippings (with specified binder) square metre (m2)

{state grade of chippings and type of binder}

(b) 19.0 mm, 9.5 mm and 6.7 mm aggregate (with specified binder) .. square metre (m2)

{state grade of chippings and type of binder}

The unit of measurement shall be the square metre of completed and accepted surface treatment.

The tendered rate shall include full compensation for furnishing all materials, marking the centre line, spraying of binders, spreading of chippings, rolling, removing of dust or deleterious material, supplying of water and spraying of haul roads and construction roads, trimming the edges of the completed surface and all other incidentals necessary for completing the work as specified.

Item 63D.02 Variations in the rate of application of Bituminous Binder:

(a) 60/70 penetration-grade bitumen ..... litre (l)

(b) 80/100 penetration-grade bitumen ..... litre (l)

(c) 150/200 penetration-grade bitumen ..... litre (l)

(d) 70% spray-grade emulsion {state type} ..... litre (l)

(e) 65% spray-grade emulsion {state type} ..... litre (l)

(f) 60% spray-grade emulsion{state type} ..... litre (l)

(g) 30% spray-grade emulsion {state type} .....litre (l)

(h) Bitumen-rubber {state type and composition}.....litre (l)

(i) Homogeneous modified binder – hot applied {state type and composition}....litre (l)

(j) Homogeneous modified binder – hot applied {state type and composition}....litre (l)

(k) Pre-coating fluid.....litre (l)

The unit of measurement of bituminous binder in respect of variations in the specified rates of application shall be the litre, measured at spraying temperature.

Payment for variations shall be made as specified in Clause 1212 of Division 1200.

Item 63D.03 Variations in the rate of application of Chippings:

(a) 26.5 mm chippings .....cubic metre (m^3)

(b) 19.0 mm chippings .....cubic metre (m^3)

(c) 13.2 mm chippings .....cubic metre (m^3)

(d) 9.5 mm chippings .....cubic metre (m^3)

(e) 6.7 mm chippings .....cubic metre (m^3)

The unit of measurement for chippings in respect of an increase or a decrease in the specified rates of application shall be the cubic metre of chippings.

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

Item 63D.04 Application of Fog Spray:

(a) 60% spray-grade emulsion {state type} .....litre (l)

(b) 30% spray-grade emulsion {state type} .....litre (l)

The unit of measurement shall be the litre of emulsion sprayed as specified and measured at the application temperature.

The tendered rate per litre shall include full compensation for procuring and furnishing the binder and applying the fog spray as specified.

Item 63D.05 Pre-coating chippings (as specified) .....cubic metre (m^3)

{state type of pre-coating fluid}

The unit of measurement for the pre-coating of chippings shall be the cubic metre of chippings so treated determined from the usage of the chippings at the specified chipping application rate.

The tendered rate shall include full compensation for furnishing the equipment and materials and pre-coating the chippings as specified, including the handling, stockpiling and protecting the stockpiles against inclement weather.

Item 63D.06 Addition of wetting agent

{state type of wetting agent}

(a) Providing and supplying ..... prime cost sum

(b) Handling, applying, profit and all other costs .....percentage of prime cost sum

The prime cost sum shall be paid for in terms of the general conditions of contract for providing and supplying an approved wetting agent to the pre-coating fluid as specified or as directed by the Engineer.

The tendered percentage of the prime cost sum shall include full compensation for handling the material, storing and introducing it into the mix, including any equipment required, and for all other costs and profit.

Item 63D.07 Extra over item 63D.01 for surface treatment of areas inaccessible to mechanical equipment with pre-mixed bituminous material:

(a) 26.5 mm thick ..... square metre (m2)

(b) 19.0 mm thick ..... square metre (m2)

The unit of measurement shall be the square metre of completed treatment.

The tendered rate per square metre of treatment shall include full compensation for procuring and furnishing all materials, and for all labour, plant, transport and other incidentals necessary for completing the work as specified, including application of a tack coat and the slurry.

Item 63D.08 Extra over item 63D.01 for triple surface treatment in areas inaccessible to mechanical equipment .....square metre (m^2)

The unit of measurement shall include full compensation for all additional costs for executing the work in areas inaccessible to mechanical equipment. Payment will not distinguish between the various types of binders or the various sizes or grades of chippings.

DIVISION 6300E: SINGLE SURFACE TREATMENT WITH SLURRY (CAPE SEAL)

63E01 SCOPE

This Division covers the construction of a bituminous surface treatment consisting of a first application of a bituminous binder, spreading of 19.0 mm or 13.2 mm chippings as specified, a further application of bituminous binder coat and the application of a bituminous slurry in one or two coats.

Note:

The provisions of Division 6300A "Surface Treatments: Materials and General Requirements", apply equally to the work covered by this division and will not necessarily be repeated or specifically referred to in this division.

63E02 MATERIALS

The materials shall comply with the requirements of section 6300A.

(a) Chippings

The average least dimension (ALD) of the chippings shall comply with the requirements in Table 6300E/1.

Table 6300E/1 Chippings - Average Least Dimension

Nominal size (mm)	Minimum ALD (mm)
19.0	12.0
13.2	8.2

(b) Binder for First Application

The first application of binder shall consist of one of the following binders, whichever is specified in the Project Specifications or as ordered by the Engineer:

(i) 60/70 penetration grade bitumen
(ii) 80/100 penetration grade bitumen;
(iii) 150/200 penetration grade bitumen;
(iv) MC-3000 cut-back bitumen;
(v) 60%, 65% or 70% spray-grade emulsion

(c) Binder for Second Application

The second application of binder shall consist of one of the following binders, whichever is specified in the Project Specifications or as ordered by the Engineer:
(i) 30% spray-grade emulsion, or

(ii) 60% spray-grade emulsion.

(d) Binder for Slurry

The binder used for slurry shall be an anionic or cationic stable-grade emulsion (60% bitumen).

63E03 CONSTRUCTION BEFORE APPLICATION OF SLURRY

The nominal rates of application given in Table 6300E/2 shall be used for tendering purposes only. The actual rates of application shall be as determined by the Engineer.

Table 6300E/2 Nominal Application Rates for Chippings and Conventional Binders

Nominal Chipping Size (mm)	Nominal application rates		
	Chippings (m^3/m^2)	Conventional Binder (l/m2) *	
		1st Application	2nd Application
19.0	0.013	1.1	0.33
13.2	0.009	0.6	0.33

Note: * net cold bitumen

(a) Application of First Layer of Binder and Chippings

The binder and chippings of the grade and size specified in the Bill of Quantities or ordered by the Engineer, shall be applied in accordance with clause 63A11.

(i) Initial Rolling

Initial rolling shall be carried out as specified in Sub-clause 63A11(f) (ii).

(ii) Broom Drag and Final Rolling of Aggregate

The final rolling shall be done as specified in Sub-clause 63A11(f) (iii).

(iii) Second Application of Bituminous Binder

The second application of binder shall be done at least 2 days after the first application of binder and chippings.

63E04 APPLICATION OF SLURRY

(a) Condition of Surface

The surface shall be cleaned to remove all dust, mud, leaves, etc, and shall have a uniform closely knit appearance, with edges trimmed correctly to the specified width.

The surface shall be rolled once with a light flat-wheeled roller immediately prior to the application of the slurry in order to depress any chippings that may have been disturbed.

(b) Timing of Slurry Application

The slurry shall be applied only after the second application of binder described in sub-clause 63E03 (a) (iii) has cured but in any case not less than two (2) days after the second application.

(c) Composition of Slurry

The slurry shall consist of a mix of fine, medium or coarse slurry aggregate ordered by the Engineer and specified in Sub-clause 63A02 (d) together with a 60% stable-grade emulsion, filler and water in the proportions as directed by the Engineer. The following nominal proportions by volume shall apply for tendering purposes only:

Slurry aggregate (saturated volume) ..... 1 m^3

Stable-grade emulsion at mixing temperature {state type} .....260 l

Cement..... 0.01 m^3

Water .....235 l

If specified in the Project Specifications, the following nominal proportions by mass shall apply for tendering purposes only:

Slurry aggregate (dry) 100

Stable-grade emulsion 20

Cement.....1.5

Water.....15

The saturated volume of slurry shall be determined by applying a correction for bulking of moist aggregate, as described in Item 63E.04.

(d) Mixing of Slurry

The slurry shall be mixed in a mixer of a type described in Sub-clause 63A03 (g).

Material which, in the opinion of the Engineer, is not properly mixed or in which the emulsion shows signs of having broken during mixing shall not be applied to the road.

The slurry consistency when measured in accordance with ASTM D 3910 Section 6.1 shall be between 30 mm and 40 mm in order to achieve the required workability.

(i) Batch Mixing

All the constituents of the slurry shall be accurately proportioned and due care and attention shall be given to the sequence in which the ingredients are introduced into the mixer and to the period of mixing. Mixing shall be continued until the materials in each batch are thoroughly blended.

(ii) Continuous Mixing

Aggregate and filler contained in separate bins shall be fed through metering devices at controlled rates to the mixer. Water and bitumen emulsion contained in separate tanks shall similarly be pumped to the mixer at controlled rates through metering devices. The mixing

of the slurry shall be at a suitable rate adjusted to ensure complete blending of the ingredients and uniformity of mix.

(e) Application of Slurry

The method of application specified in the Project Specifications shall be used.

Before slurry is applied, the road surface shall be thoroughly cleaned and lightly sprinkled with water but no free water shall be present on the surface when the slurry is applied.

The slurry shall be applied in two layers in the case of 19.0 mm chippings and in one layer in the case of 13.2 mm chippings, unless otherwise specified in the Project Specifications or ordered by the Engineer.

The nominal rate of application of slurry shall be as follows for a seal using:

19.0 mm chippings (total for two layers) ..... 125 m^2/m^3

13.2 mm chippings (for one layer) ..... 166 m^2/m^3

If specified in the Project Specifications, the nominal rate of application of the slurry by mass shall be as follows for a seal using:

19.0 mm chippings (total for two layers).....9.5 kg/m^2

13.2 mm chippings (for one layer) .....7.5 kg/m^2

The rate of application of slurry shall be measured in cubic metres of fine aggregate (saturated volume) contained in the slurry applied, per square metre of surfacing.

The nominal rates of application given above are intended for tendering purposes only and the actual rates of application on the Site shall be as directed by the Engineer.

When the slurry is applied in two layers, the first layer of slurry shall be struck off level with the tops of the stones in the aggregate layer so that, after application, the tops of the stones will be just visible.

The second layer of slurry shall not be applied until the first layer has dried. If required by the Engineer, the Contractor shall open the road to traffic before the second layer of slurry is applied. Rolling of the slurry shall commence after the slurry has dried sufficiently unless otherwise approved by the Engineer. Each layer of slurry shall be roller-compacted by at least three roller passes with a 27-ton pneumatic-tired roller. However, the second layer shall be compacted until the required in-situ water permeability is less than 1.0 litre/h when measured by means of an approved method. The second layer shall be applied only after sufficient time has been allowed for the first layer to cure. The Engineer will decide on the time necessary for proper curing, which will in any case be not less than 24 hours.

The surface shall be thoroughly cleaned of all dust, dirt or foreign materials before the second layer of slurry is applied.

For seals using 13.2 mm nominal sized chippings, the slurry shall be applied in one layer only. The slurry shall also be struck off so that the tops of the stone chippings will be just visible after the emulsion has set and cured.

When the slurry is applied, the squeegee squad shall be allowed to complete the spreading of each batch discharged onto the road, using squeegees, before the next is discharged.

Slurry shall be spread only by hand and not with a spreader box. In order to adequately fill the voids with slurry, the squeegees shall be applied in a multi-directional fashion.

The Contractor shall ensure that either edge of the road surface is finished to the specified widths and lines. All stones dislodged in the process of applying the slurry shall be removed on the same day on which the slurry seal has been applied. All spillage of slurry or excess slurry shall be neatly removed from the road and buried. The second layer of slurry shall extend to the edge of the primed surface as indicated on the drawings.

The slurry batch shall be discharged onto the road in small increments by means of a chute. The rate of application shall be measured by mass in kilogram of fine aggregate, contained in the slurry applied, per square metre of surfacing.

The slurry shall be worked from side to side and crisscrossed with the aid of squeegees so as to fill as many voids as possible. In this case the final layer of slurry shall be struck off flush with the tops of the stone chippings so as to leave the chippings visible after the emulsion has stiffened and hardened.

The slurry shall be applied to the full road width in one application. If so ordered by the Engineer, the slurry may be applied in half-widths of road, provided that the work is so programmed that the slurry is applied to both half-widths on two successive days in order to complete a section of full road width in two days.

Any damage to the slurry seal by rain or traffic before the slurry has cured shall be rectified by the Contractor at his own expense.

63E05 MEASUREMENT AND PAYMENT

Item 63E.01 Single surface treatment and slurry using:

(a) 19.0 mm chippings {state type and grade of binder and aggregate).. square metre (m^2)

(b) 13.2 mm chippings {state type and grade of binder and aggregate} . square metre (m^2)

The unit of measurement for the complete bituminous single seal with aggregate and slurry shall be the square metre.

The tendered rates shall include full compensation, for furnishing all materials, demarcating the working area, spraying the binders, spreading the chippings, rolling, mixing and applying the slurry, and all other incidentals necessary for completing the work as specified, including the watering of haul and construction roads in and about the site.

Item 63E.02 Variations in the rate of application of Bituminous Binder:

(a) 60/70 penetration grade bitumen .....litre (l)

(b) 80/100 penetration grade bitumen .....litre (l)

(c) MC-3000 cut-back bitumen .....litre (l)

(d) Spray-grade emulsion (30% bitumen) .....litre (l)

(e) Spray-grade emulsion (60% bitumen).....litre (l)

(f) Spray-grade emulsion (65% bitumen) .....litre (l)

(g) Spray-grade emulsion (70% bitumen) .....litre (l)

(h) Anionic stable-grade emulsion (60% bitumen) .....litre (l)

(i) Cationic stable-grade emulsion (60% bitumen).....litre (l)

(j) Anionic stable-grade emulsion (60% bitumen) ..... litre (l)

(k) Rubber-bitumen (summer grade)..... litre (l)

(l) Rubber-bitumen (winter grade)..... litre (l)

(m) 5 % latex cationic emulsion..... litre (l)

The unit of measurement in respect of variations shall be the litre of binder measured at spraying (or mixing) temperature.

Payment for variations shall be made as specified in the Conditions of Contract Clause 1213.

Item 63E.03 Variations in the rate of application of Chippings:

(a) 19.0 mm nominal sized chippings ..... cubic metre (m^3)

(b) 13.2 mm nominal sized chippings ..... cubic metre (m^3)

The unit of measurement for chippings in respect of an increase or a decrease in the specified rates of application shall be the cubic metre of chippings.

Payment for variations shall be made as specified in the Conditions of Contract Clause 1213.

Item 63E.04 Variations in the rate of application of slurry ..... cubic metre (m^3)

The unit of measurement for slurry variations shall be the cubic metre of saturated fine aggregate.

Payment for variations shall be made as specified in the Conditions of Contract Clause 1213.

Every load of fine aggregate used for the slurry shall be struck off with a straight-edge at the stockpile, and the volume shall then be measured and corrected for bulking. The following method shall be used for calculating the corrected volume of fine aggregate when determining the application rate of the slurry:

The volume of a truck hopper filled with fine aggregate shall be carefully measured in cubic metres (say A cubic metres).

A representative sample of aggregate shall be obtained from the conveyor belt feeding the mixer. 1000 ml of the sample shall be placed in a plastic measuring cylinder and dropped ten times through a height of 50 mm onto a wooden table, after which the volume of aggregate in the cylinder shall then be measured in millilitres (say B millilitres).

The sample in the cylinder shall then be saturated with water and water shall be added until it covers the aggregate by 50 mm. The mixture shall be shaken well, and the cylinder containing the aggregate and water placed on a horizontal surface allowing the aggregate to settle until the liquid above the aggregate clears sufficiently for a reading to be taken of the volume of the saturated aggregate, in millilitres (say C millilitres).

The saturated volume of the aggregate in the hopper of the truck shall be calculated from the following formula, and payment for the slurry application variations shall be made in accordance with this formula:

True (saturated) volume carried by the truck hopper = A x (1-0.72(B-C)/C)

Item 63E.05 Variations in the rate of application of Slurry ..... ton (t)

The unit of measurement for variations in the slurry application rate shall be a ton of aggregate contained in the slurry.

Payment for variations shall be made as specified in the Conditions of Contract Clause 1214.

Item 63E.06 Variations in Active Filler content ..... ton (t)

The unit of measurement in respect of increases or decreases in the active filler content from that specified in the normal mix for tender purposes shall be the ton. No payment shall be made for inert filler added by the Contractor.

Item 63E.07 Extra over item 63E.01 for work in areas inaccessible to mechanical equipment .....square metre (m^2)

The unit of measurement shall include full compensation for all additional costs for executing the work in areas inaccessible to mechanical equipment. Payment will not distinguish between the various types of binders or the various sizes or grades of chippings or aggregates.

DIVISION 6300F: SAND SEALS

63F01 SCOPE

This Division covers the construction of bituminous sand seals on new pavements.

Note:

The provisions of Division 6300A "Surface Treatments: Materials and General Requirements", apply equally to the work covered by this division and will not necessarily be repeated or specifically referred to in this division.

63F02 MATERIALS

The materials shall comply with the requirements of Division 6300A.

(a) Binders

The types and grades of binder actually used shall be as specified in the project specifications, in the schedule of quantities or ordered by the engineer.

Amongst others, the following binders may be used:

- 80/100 penetration-grade bitumen
- 150/200 penetration-grade bitumen.
- MC-800 cut-back bitumen
- MC-3000 cut-back bitumen
- Spray-grade emulsion (65% or 70% of net bitumen);

(b) Sand

(i) Grading

The grading of the sand shall be in accordance with table 6300A/9 (See clause 63A02) shall be met.

63F03 CONSTRUCTION

(a) Equipment

The following equipment shall be readily available on the site:

(i) Pneumatic-tyred rollers

(ii) A rotary broom

(iii) A drag broom

(iv) Mechanical aggregate spreaders.

(b) Preparation of surface before application of seal

The surface of the layer that is to receive the sand seal shall be rolled and swept until a fine texture is obtained. The layer shall then be primed in accordance with the provisions of Division 6100 or as instructed by the engineer.

(c) Application of sand seal

The primed surface shall be cleaned of all loose or deleterious material before the sand seal is applied.
The binder tack coat shall be applied at 1.0 l/ m2 net bitumen cold, and, immediately after the binder has been applied, the aggregate shall be spread thereon at a rate of 0.007 m3/m2 and rolled with pneumatic-tyred rollers. Where bitumen emulsions are used, the aggregate shall be applied only after the emulsions have broken partially.

During the rolling process, any uneven application of sand shall be rectified with a light broom drag or other suitable apparatus.

Where an emulsion is required to be applied in two applications, the surface may be opened to controlled traffic after the first application of emulsion and sand, as soon as it is convenient to do so. The second application of emulsion and sand may be applied when the first application has cured sufficiently for it to take the traffic without requiring brooming back of the sand. All loose sand and deleterious material shall be removed from the surface and any damaged or defective areas rectified before the second application of binder and sand.

As wet sand is difficult to apply, the preparation of the sand should be done well ahead of the actual construction to allow the sand to be fairly dry when it is applied. If the sand is not cleaned to the engineer's satisfaction by one screening and washing operation, it shall be washed again at no extra payment.
Where required by the engineer, the sand shall be pre-coated with an approved pre-coating agent, applied at a rate of 7 ℓ/m3. No pre-coating will be allowed where emulsions are used as binders.

63F04 OPENING TO TRAFFIC

While the traffic is using the road, the sand shall be continuously broomed back onto the road until the binder has cured sufficiently to retain the sand and until traffic does not damage the surface. The sweeping-back process shall be done with a rotary broom or manually and may take as long as two months before the surface finally settles down. Tenders shall be based on brooming back for up to five (5) times.

63F05 MEASUREMENT AND PAYMENT

Item 63F.01 Application of tack coat:

(a) 80/100 penetration- grade bitumen .....litre (l)

(b) 150/200 penetration- grade bitumen .....litre (l)

(c) MC-800 cut-back bitumen .....litre (l)

(d) MC-3000 cut-back bitumen .....litre (l)

(e) Spray-grade emulsion (65%netbitumen) .....litre (l)

(f) Spray-grade emulsion (70%netbitumen) ..... litre (l)

(g) Other (specify type of binder) .....litre (l)

The unit of measurement shall be the litre measured at spraying temperature.

The tendered rates shall include full compensation for procuring and furnishing the material and applying the binder, including all preparatory work to the surface prior to application of the binder.

Item 63F.02 Sand:

(a) Applying the sand .....cubic metre (m^3)

(b) Brooming the sand back onto the paved surface:

(i) Mechanically ..... square metre ($m^{2)}$

(ii) Manually ..... square metre ($m^{2)}$

The unit of measurement for the application of sand shall be the cubic metre of sand applied to the road as specified. The unit of measurement for brooming back the sand shall be the square metre of authorized paved surface onto which the sand is broomed back.

The tendered rate for applying the sand shall include full compensation for supplying the sand, washing, screening and preparing the sand and applying the sand as specified.

The tendered rate for brooming the sand back onto the surface shall include full compensation for brooming the sand back onto the paved surface as often as is required, subject to a maximum of five (5) times.

Item 63F.03 Pre-coating the sand with pre-coating fluid ..... cubic metre (m^3)

{state type of pre-coating fluid }

The unit of measurement shall be the cubic metre of sand pre-coated as specified.

The tendered rate shall include full compensation for furnishing the equipment and materials and pre-coating the sand, complete as specified, including the handling, stockpiling and protecting of the stockpiles against inclement weather.

SECTION 6400: BITUMINOUS ROADBASES AND SURFACINGS

6401 SCOPE

This section covers all work in connection with the construction of asphaltic bases and surfacings. It includes the procuring and furnishing of aggregate and bituminous binder, mixing at a central mixing plant, spreading and compaction of the mixture, as specified for the construction of:

(i) Continuously graded asphalt base;
(ii) Semi-gap-graded asphalt base;
(iii) Continuously graded asphalt surfacing with or without rolled-in pre-coated chippings:
(iv) Gap-graded asphalt surfacing with or without rolled-in pre-coated chippings;
(v) Semi-gap-graded asphalt surfacing with or without rolled-in pre-coated chippings:
(vi) Open-graded asphalt surfacing;
(vii) Stone-mastic asphalt surfacing

The widening of asphalt bases and surfacing, placing asphalt in restricted areas and placing asphalt reinforcing where specified.

The recycling of asphalt by reprocessing recovered materials, adding fresh aggregate, bituminous binders and other agents for obtaining an asphalt mix which will comply with the specified requirements, and placing the recycled material. The provisions of section 6400 shall apply throughout to recycled asphalt, except where explicitly specified otherwise.

The construction of asphalt surfacing on bridge decks where shown on the drawings or ordered by the engineer.

6402 MATERIALS

(a) General

All materials shall be handled and stockpiled in a manner that will prevent contamination, segregation or damage. Cement and lime shall be used in the order in which it has been received.

The contractor shall. as often as necessary, test and control the materials produced by himself or the materials received by him from suppliers to ensure that the materials always comply with the specified requirements.

(b) Bituminous binders

The type and grade of bituminous binder to be used in each case shall be as specified hereinafter or in the project specifications.

(i) Conventional binders

The various conventional bituminous binders specified shall comply with the requirements of sub-clause 63A02 (a) (1).

(ii) Non-homogeneous (heterogeneous) modified binders

(The addition of rubber to the aggregate in a similar manner as the addition of filler, the so-called dry method, is not included in these specifications.)

The bitumen-rubber binder shall comply with the following specifications:

(1) Base bitumen

The bituminous binder used in the production of the bitumen-rubber shall be 60/70 or 80/100 penetration-grade bitumen or a blend of these grades to provide a product with a particular viscosity and other prescribed properties.

(2) Rubber

The rubber is obtained by processing and recycling pneumatic tyres. The rubber crumbs shall be produced by a mechanical comminuting process. Crumbs produced by cryogenic-mechanical techniques are not permitted. It shall be pulverized, free of fabric, steel cords and other contaminants. A maximum of 4% by mass of fine particle size calcium carbonate. or talc, may be added to the rubber crumbs to prevent the rubber particles from sticking together. At the time of use the crumbs shall be free flowing and dry and comply with the requirements in table 6400/1.

Table 6400/1 Rubber Crumbs

Sieve Analysis		**Test Method**
Sieve Size (mm)	**% passing by mass**	
1.18	100	Sabita, BR6T
0.60	50 – 70	
0.075	0 - 5	
Other Requirements		
Natural rubber hydrocarbon content	30% (minimum)	BS 903, Parts B11 & B12
Resilience (raw)	40% (minimum)	Sabita, BR7T
Loss in resilience	60% (maximum)	Sabita, BR7T
Relative density (g/cm^3)	1.10 – 1.25	Sabita, BR9T

(3) Extender oil

Extender oil shall be a resinous, high flash point aromatic hydrocarbon conforming with the requirements in table 6400/2.

The chemical composition of the base bitumen and the nature of the rubber will dictate the need to introduce an extender oil. The bitumen and extender oil, when combined shall form a material that is chemically compatible with the rubber.

Table 6400/2 Extender Oils

Property	Requirements	Test Method
Flash Point	180^{O} C (minimum)	ASTM D92
Viscosity at 40^{O} C	2,500 (minimum)	ASTM D88
Asphaltenes, content by mass	0.1 % (maximum)	ASTM D2007
Aromatics, content by mass	55.0 % (minimum)	ASTM D2007

(4) Bitumen-rubber blend

At least two weeks prior to commencement of the blending operation, the contractor shall provide the engineer with a written method statement, that shall include details of the proposed plant, the percentage of rubber, the blending/reaction temperature, reaction time and percentage of extender oil he intends to use, supported by graphs of time against ring and ball softening point and flow for the full reaction period, taking cognisance of the actual equipment and method to be used for the mass production of bitumen-binder. These shall be referred to as behaviour curves. The contractor shall not be allowed to deviate from the stated percentage of rubber crumbs by more than 1 per cent and from the stated reaction temperature by more than 10^{O} C without producing new behaviour curves.

Reaction time is defined as half the time required for adding the rubber to the bitumen plus the time required for acceptable reaction between the bitumen and rubber as determined from the behaviour curves in agreement with the engineer. No bitumen-rubber blend shall be used until it has complied with the reaction time.

The bitumen-rubber blend, containing where necessary extender oils, shall satisfy the requirements in table 6400/3.

The reconstitution of the bitumen-rubber blend will not be allowed unless approved by the engineer in writing.

Table 6400/3 Bitumen- Rubber Blend

Property	Requirements
Rubber content of the total blend by mass	18 - 24%
Extender oil content of the total blend by mass	4% (maximum)
Blending/reaction temperature	180 – 210 ^{O} C
Reaction time	1 – 4 hours

A continuous record shall be kept on the site by the contractor of the percentage rubber in the mix and the reaction temperatures and times. The bitumen-rubber binder shall be sampled not more than five minutes prior to the mixing of the asphaltic mix and shall comply with the requirements in table 6400/4.

Table 6400/4 Bitumen- Rubber Binder

Property	Requirements	Test Method
Compression recovery: after 5 minutes after 1 hour after 4 hours	 80 - 100% 70 - 95% 25 - 55%	Sabita, BR3T
Ring-and-ball softening point	55 – 62 ^{O} C	ASTM D 36
Resilience (%)	13 - 35%	Sabita, BR2T
Dynamic viscosity (Haake at 190^{O} C)	20 – 50 dPa.s	Sabita, BR5T
Flow	15 – 55 mm	Sabita, BR4T

The bitumen-rubber mixture after reaching the desired consistency shall not be held at temperatures in excess of 160°C (with no extender oil) or 190°C (with 4% extender oil) for more than 4 hours.

(iii) Homogeneous modified binders

Homogeneous modified binders are defined as industrial blends of polymer and bitumen where the blended components form a stable microscopic dispersion, or either or both form a stable continuous phase relative to each other. The properties of the homogeneous modified binders shall comply with the requirements given in the project specifications.

(c) Aggregates

Coarse and fine aggregate shall be clean and free from decomposed materials, vegetable matter and other deleterious substances and shall meet the requirements of Divisions 4600 and 6300A, unless otherwise provided in this Division.

(i) Resistance to crushing

The aggregate crushing value (ACV) of the coarse aggregate, when determined in accordance with BS 812-110, shall not exceed the following values for aggregate used for:

Open-graded surfacing 21%

Stone-mastic asphalt 21%

Rolled-in chippings 21%

Continuously graded surfacing 25%

Roadbases and levelling courses 29%

The minimum dry 10% FACT values of the -13.2 mm + 9.5 mm fraction shall be as follows:

Open-graded surfacing ..... 210 kN

Stone-mastic asphalt ..... 210 kN

Rolled-in chippings ..... 210 kN

Continuously graded surfacing ..... 160 kN

Roadbases and levelling courses ..... 160 kN

The wet/dry ratio shall not be less than 75%.

(ii) Shape of the aggregate

Roadbase:

The flakiness index when determined in accordance with BS 812-105.1 shall not exceed 35 for the minus 26.5 mm sieve plus 19.00 mm sieve and minus 19 mm plus 13.2 mm sieve fractions respectively.

In addition, at least 50% by mass of the individual fractions retained on each of the standard sieves with a square mesh size of 4.75 mm and larger shall have at least one fractured face.

Surfacing and rolled-in-chippings:

The flakiness index for asphaltic surfacing and rolled-in-chippings shall not exceed the values given in table 6400/5. The grades refer to the single-sized crushed stone grades as defined in sub-clause 6302(b).

Table 6400/5 Flakiness Index

Nominal Size (mm)	**Maximum Flakiness Index %**		
	Asphaltic Surfacing Aggregates		**Rolled-in Chippings**
	Grade 1	Grades 2	All Grades
19.0	25	30	20
13.2	25	30	20
9.5	30	35	
6.7	30	35	

In addition, at least 95% of all particles shall have at least three fractured faces.

(iii) Polishing

The polished stone value (PSV) of aggregates shall not be less than the following values when used for:

	PSV
Continuously and open-graded asphaltic surfacing	50
Stone-mastic asphaltic surfacing	50
Gap-graded asphaltic surfacing	45
Rolled-in chippings	50

Aggregates with PSVs below those stated above may be approved for use by the Engineer.

(iv) Adhesion

When tested in accordance with TMH1 method C5, the immersion index of a mixture of the binder and aggregate proposed for use shall not be less than 75%. The aggregate used for the test mixture shall have a grading within the actual limits for the mix concerned.

(v) Absorption

When tested in accordance with BS 812-105.2, the water absorption of the coarse aggregate shall not exceed 1 % by mass, and that of the fine aggregate shall not exceed 1.5% by mass, unless otherwise permitted.

(vi) Sand equivalent

The total fine aggregate used in all asphalt mixes shall have a sand equivalent of at least 50, when tested in accordance with TMH1 method B19, and the natural sand where it is permitted to be mixed with the aggregate shall have a sand equivalent of at least 30.

(vii) Design requirements

The contractor shall, by conducting the necessary tests, satisfy himself that he will be able to produce a mixture meeting the design requirements specified hereinafter, using the aggregate he proposes to supply, within the grading limits specified.

(viii) Grading

The grading of the combined aggregate including any filler added in an approved working mix as described in subclause 6402(c) shall be within the limits stated in tables 6400/6 to 6400/11 for the various mixes. The approved grading shall be designated as the target grading. The mean grading of each lot of the working mix (minimum of 6 tests per lot), determined from samples obtained in a stratified random sampling procedure, shall conform to the approved target grading within the tolerances specified in subclause 6413(c).

The target grading requirements for crushed-stone base as specified under subclause 5204(b) shall apply to all continuously graded asphalt bases. In addition, and for tender purposes and preliminary mix design, the target grading for 37.5 mm maximum aggregate size asphalt base shall be within the range derived from the formula:

$$P = (100 - F)(d^n - 0.075^n)/(D^n - 0.075^n) + F$$

where:

P = fraction passing a particular sieve, %
d = sieve size, mm
n = exponent which determines the shape of the grading curve
D = maximum aggregate size, mm
F = filler content, % using values of F = 5% with n = 0.45 and F = 7% with n = 0.4 (one percent being active filler).

The approved target grading shall be determined after laying a trial section on site.

Where mixes with coarser and/or other grading compositions are required for asphalt bases, it will be specified in the project specifications.

For recycled asphalt the nominal mix ratios of recovered asphalt, new aggregate, new bituminous binders, and active mineral filler to be used for tender purposes, shall be as specified in the project specifications.

Table 6400/6 Grading limits for combined aggregate and mix proportions for asphaltic roadbase

Type	**Semi-gap graded**		**Continuously graded**	
Nominal size	**37.5 mm**	**26.5 mm**	**37.5 mm**	**26.5 mm**
Sieve size (mm)	**Fraction passing by mass (%)**			
37.5	100	-	100	-
26.5	85 – 100	100	84 – 94	100
19.0	75 – 95	92 – 100	71 – 84	85 – 95
13.2		82 – 93	59 – 75	71 – 84
9.5	60 – 80	72 – 87	50 – 67	62 – 78
6.7		60 –75		
4.75	45 – 60	50 – 64	36 – 53	42 – 60
2.36	40 – 52	40 – 52	25 – 42	30 – 47
1.18	36 – 47	36 – 47	18 – 33	21 – 37
0.600	32 – 42	32 – 42		15 – 30
0.300	22 – 35	22 – 35	9 – 21	11 – 24
0.150	10 – 20	10 – 20	6 –17	8 – 19
0.075	4 – 10	4 – 10	4 – 12	5 – 12
Nominal mix proportions by mass (%)				
Aggregate	93.5	93.5	95.0	94.5
Bitumen	5.5	5.5	4.0	4.5
Active filler *	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0

* For tender purposes only Active filler shall be hydrated lime.

Table 6400/7 Grading limits for combined aggregate and mix proportions for asphaltic surfacings

Type	**Gap-graded ***			**Semi-gap-graded**	
Stone Content	**High**	**Intermediate**	**Low**	**-**	**-**
Nominal size	**-**	**-**	**-**	**26.5 mm**	**19.0 mm**
Sieve size (mm)	**Fraction passing by mass (%)**				
26.5	-	-	-	100	-
19.0	100	100	100	92 – 100	100
13.2	75 – 100	75 – 100	75 – 100	82 – 93	82 – 100
9.5	65 – 85	70 – 90	70 – 90	72 – 87	73 – 86
4.75	50 – 60	60 – 70	65 – 75	50 – 64	45 – 60
2.36	45 – 55	53 – 63	60 – 70	40 - 52	40 – 52
1.18	45 – 55	53 – 63	60 – 70	36 – 47	36 – 47
0.600	36 – 52	45 – 63	55 – 70	32 – 42	32 – 42
0.300	25 – 45	35 – 55	45 – 65	22 – 35	22 – 35
0.150	12 – 32	15 – 35	20 – 40	10 – 20	10 – 20
0.075	5 – 12	5 - 12	5 - 12	4 – 10	4 – 10
Nominal mix proportions by mass (%)					
Aggregate	92.0	92.0	92.0	93.0	93.0
Bitumen	7.0	7.0	7.0	6.0	6.0
Active filler *	1.0	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0

* The percentage passing the 4.75 mm sieve and retained on the 0.600 mm sieve shall not exceed 15%

Table 6400/8 Grading limits for combined aggregate and mix proportions for asphaltic surfacings

Type	**Continuously-graded**			**Semi-open Graded ***
Grading	**Coarse**	**Medium**	**Fine**	
Sieve size (mm)	**Fraction passing by mass (%)**			
26.5	100	-	-	-
19.0	85 – 100	-	-	100
13.2	71 – 84	100	-	70 – 100
9.5	62 – 76	82 – 100	100	50 – 82
4.75	42 – 60	54 – 75	64 – 88	16 – 38
2.36	30 – 48	35 – 50	45 – 60	8 – 22
1.18	22 – 38	27 – 42	35 – 54	4 – 15
0.600	16 – 28	18 – 32	24 – 40	3 – 10
0.300	12 – 20	11 – 23	16 – 28	3 – 8
0.150	8 – 15	7 – 16	10 – 20	2 – 6
0.075	4 - 10	4 – 10	4 – 12	1 – 4
Nominal mix proportions by mass (%)				
Aggregate	93.5	93.5	93.0	90.5
Bitumen	5.5	5.5	6	8.5
Active filler *	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0

* Dry method rubberised asphalt as specified in the project specifications.

Table 6400/9 Grading limits for combined aggregate and mix proportions for continuously graded asphaltic surfacings using non-homogeneous modified bituminous binders

Nominal size	**19.0 mm**	**13.2 mm**
Sieve size (mm)	**Fraction passing by mass (%)**	
19.0	100	-
13.2	84 – 96	100
9.5	70 – 84	80 – 100
4.75	45 – 63	50 – 70
2.36	29 – 47	32 – 50
1.18	19 – 33	
0.600	13 – 25	13 – 25
0.300	10 – 18	8 – 18
0.150	6 – 13	
0.075	4 - 10	4 – 8
Nominal mix proportions by mass (%)		
Aggregate	91.0	91.0
Modified binder (bitumen-rubber)	7.0	7.0
Active filler *	2.0	2.0
Total	100.0	100.0

Table 6400/10 Grading limits for combined aggregate and mix proportions for open graded asphaltic surfacings using conventional, non-homogeneous modified and homogeneous modified bituminous binders

The selected target grading for open-graded asphalt mixes shall be such that in the case of medium open-graded asphalt mixes of type 2 and 3, the void content of the compacted mix shall be between 18% and 22%, while for all other types, the void-content shall be between 20% and 25%.

Nominal size	**13.2 mm**					**9.5 mm**
Type	**Type 1**			**Type 2**	**Type 3**	
Sieve size (mm)	**Fraction passing by mass (%)**					
19.0	100	100	100	100	-	-
13.2	90 – 100	90 – 100	90 – 100	70 – 100	100	-
9.5	30 – 50	30 – 50	30 – 50	50 – 80	50 – 70	100
4.75	10 – 20	10 – 20	10 – 20	15 – 30	20 – 30	10 – 25
2.36	8 – 14	8 – 14	8 – 14	10 –22	5 – 15	5 – 15
1.18	-	-	-	-	-	-
0.600	-	-	-	6 – 13	-	-
0.300	-	-	-	-	3 – 8	-
0.150	-	-	-	-	-	-
0.075	2 - 6	2 - 6	2 - 6	3 – 6	2 – 5	2 - 6
Nominal mix proportions by mass (%)						
Binder type	**Penetration Grade**	**Polymer Modified**	**Bitumen-Rubber**	**Bitumen-Rubber**	**Bitumen-Rubber**	**As for type 1**
Aggregate	94.5	94.0	93.5	93.5	93.5	As for type 1
Bitumen	4.5	5.0	5.5	5.5	5.5	As for type 1
Active filler *	1.0	1.0	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 6400/11 Grading limits for combined aggregate and mix proportions for stone mastic asphaltic surfacings using conventional and homogeneous modified bituminous binders

Aggregate size	**13.2 mm**	**9.5 mm**	**6.7 mm**
Sieve size (mm)	**Fraction passing by mass (%)**		
13.2	100	-	-
9.5	67 – 90	100	-
6.7	41 – 65	50 – 80	100
4.75	30 – 50	30 – 55	80 – 100
2.36	21 – 32	22 – 32	34 – 44
1.18	17 – 27	17 – 27	24 – 34
0.600	14 – 24	14 – 23	18 – 30
0.300	11 – 23	11 – 22	13 – 25
0.150	9 – 17	9 – 19	9 – 19
0.075	7 - 12	7 - 12	7 – 12
Nominal mix proportions by mass (%)			
Aggregate	93.0	93.0	93.0
Binder	6.5	6.5	6.5
Binder stabiliser (cellulose fibres)	0.5	0.5	0.5
Total	100.0	100.0	100.0

(ix) Additional requirements for asphaltic roadbases

Unless otherwise specified in the project specifications, if approved by the engineer, the aggregate component may contain not more than 10% by mass of natural fines not obtained from the parent rock being crushed. The added fines shall have a liquid limit not more than 25% and a PI not more than 6. The contractor shall submit full details regarding the exact quantity and nature of such fine aggregate, before such permission will be considered. In the event of such added material being natural sand, its impact on dynamic creep properties should be assessed from laboratory briquettes and cores obtained in a trial section completed well in advance of any production runs. The natural fines shall be added to the mix from a dedicated cold feed bin.

(x) Rolled-in chippings

Rolled-in chippings for asphalt surfacing mixes shall comply with the grading requirements of table 6400/12.

Table 6400/12 Grading limits for rolled-in chippings

Nominal size	19.0 mm	13.2 mm
Sieve size (mm)	Fraction passing by mass (%)	
19.0	100	-
13.2	0 – 20	100
9.5	0 – 5	0 – 20
6.7	0 – 1	0 – 5
0.425	0 – 0.5	0 – 0.5

(d) Fillers

If the grading of the combined aggregates for asphalt surfacing mixes shows a deficiency in fines, an approved filler may be used to improve the grading. Filler may consist of active filler as defined hereinafter or of inert material such as rock dust having the required grading necessary to improve the grading of the combined aggregates. In no instance shall more than 2% by mass of active filler be used in asphalt mixes. Inert filler such as rock dust used to improve grading shall not be subject to this limitation.

The engineer may order the use of any active filler to improve the adhesion properties of the aggregate. Active filler shall consist of milled blast furnace slag, hydrated lime, ordinary portland cement, portland blast furnace cement, fly-ash, or a mixture of any of the above materials. Individual materials shall comply with the requirements of the relevant specifications for such material. Active filler shall have at least 70% by mass passing the 0.075 mm sieve and a bulk density in toluene between 0.5 and 0.9 g/m ℓ. The voids in dry compacted filler shall be between 0.3% and 0.5% when tested in accordance with BS 812.

Active fillers for use in asphalt bases shall be introduced to the mix prior to wetting with the binder. An active filler content of 1.0% by mass shall be used unless otherwise specified.

Only active filler added on the instructions of the engineer, for the purpose of improving adhesion, will be paid for. No payment will be made for filler added to improve the grading.

(e) Fibres

The use of fibres in asphalt mixes shall be subject to the provisions of the project specifications.

(f) Asphalt reinforcing

Asphalt reinforcing shall be of the type specified in the project specifications and shall be obtained from an approved manufacturer.

Where the use of reinforcing for asphalt has been specified, at least 3 months before the material is to be used the contractor shall submit to the engineer for approval samples of the type he intends to use, together with complete specifications of the material and the manufacturer's instructions for use. Where the material does not carry the verification mark of an approved authority, the engineer may instruct the contractor to have the material tested by an approved laboratory and to submit the results.

(g) Asphaltic materials for hot plant mix recycling

(i) Recovered asphaltic mixes

The engineer will test the existing asphaltic materials in any part of the project and determine its suitability for recycling before removal. He may instruct the contractor to drill additional cores at specified points. Recovered asphalt intended for recycling shall be stored separately from other asphalt, and the engineer may also direct different types of asphalt to be stored separately.

The recovered asphalt shall be free from any underlying base material and other foreign matter.

Asphalt milled out shall be of a maximum size of 37.5 mm, unless otherwise approved by the engineer.

Asphalt not milled out shall be broken down in any approved manner so that it can be properly remixed in a plant to the satisfaction of the engineer. Mixes of recycled asphalt containing fragments of recovered asphalt exceeding 37.5 mm in size, will not be accepted.

Payment for recovered asphalt will distinguish between milled out and non-rnilled out material.

Samples shall be taken from the recovered asphalt intended for hot recycled mixes in the stockpile and shall be tested for grading and quality of the aggregate, binder content, and properties of the binder.

(ii) Bituminous binders

The provisions of sub-clause 6402(b) shall apply.

The grade of new binder used in the recycled asphalt mix shall be such that the mix of new and residual binder will comply with the requirements of the project specifications.

Recycling agents such as blended oils and other additives may not be used without prior approval by the engineer.

(iii) New aggregate

New aggregate required for use in recycled asphalt mixtures shall comply with the requirements of sub-clause 6402(c).

(iv) Combined aggregate

The aggregate mix obtained from new aggregate and the aggregate in the recovered asphalt, including any mineral filler, an approved quantity of which may be added in accordance with sub-clause 6402(d), shall comply with the requirements specified in the project specifications for the relevant recycled asphalt layer.

(v) Storing material for recycling

The provisions of clause5306 shall apply to the storing of recovered asphalt.

In addition the following requirements shall apply:

(1) Stockpiles of milled or crushed asphalt shall be shaped and formed in a manner that will prevent segregation as far as possible. The stockpiling of the recovered asphalt shall be

done in a manner that will prevent consolidation as far as possible, and adequate covers shall be provided to prevent the ingress of water and contamination by dust.

(2) The recovered asphalt that is placed in the stockpile(s) shall be tested, carefully controlled and recorded with regard to origin and material properties to ensure a consistent recycled end product.

(3) The preparation of stockpile sites and the stockpiling of recovered asphalt for recycling will not be paid for directly but full compensation therefore shall be included in the rates for the recycled asphalt.

(h) Hot in situ surface recycling

Hot in situ surface recycling shall comply with the requirements in the project specifications with regard to new binder, recycling additives, new asphaltic mixes, new aggregate or combinations of these materials.

6403 COMPOSITION OF ASPHALTIC ROADBASES AND SURFACING MIXTURES

The rates of application and mix proportions of bituminous binder, aggregates and fillers which are given in tables 6400/6 to 6400/11, are nominal rates and proportions and shall only be used for tendering purposes. The rates and proportions actually used shall be determined to suit the materials used and conditions prevailing during construction and any approved variation on a nominal mix in the bitumen content or active filler content shall be the subject of an adjustment in payment for binder or active filler variations as described in clause 6415.

Before production or delivery of the asphalt the contractor shall submit samples of the materials he proposes to use in the mix, together with his proposed mix design as determined by an approved laboratory, to the engineer in accordance with table 10104/1, so that the engineer may test the materials and confirm the use of the proposed mix if he is satisfied that it meets the specified requirements. The engineer may change aggregate blends in order to allow the selection of any combined aggregate grading, within the specified grading envelope(s) for the proposed mix.

As soon as the materials become available the contractor shall produce a working mix in the plant in accordance with the design mix. The working mix shall be tested by the Contractor for compliance with the design requirements. Samples of the working mix and the test results shall also be made available to the engineer, who will authorise the use of the working mix proportions approved for use in the trial section. Final approval of the working mix will be subject to the approval of the trial section. The composition of the approved working mix shall be maintained within the tolerances given in sub-clause 6413(c).

The nominal mix proportions (by mass) of the various asphalt mixes are set out in tables 6400/6 to 6400/11.

The design of the asphalt mixes shall be in accordance with the design guidelines of AASHTO R 12 and appropriate research results, and the mix properties and requirements shall be as specified in the project specifications. In addition to the design guidelines of AASHTO R 12, the asphalt mixes shall also comply with the requirements in table 6400/13 unless otherwise stated in the project specifications.

Table 6400/13 Design requirements for asphaltic mixes

	Roadbase (37.5 mm aggregate)	Continuously - graded and stone mastic wearing courses	Continuously -graded bitumen-rubber wearing courses	Open-graded asphaltic wearing courses	Semi-gap-graded asphaltic wearing courses
Design guidelines	**AASHTO R 12, Sabita M13, TRH 8,**	**AASHTO R 12, TRH 8,**	-	**AASHTO R 12, Sabita M16, TRH 8,**	**AASHTO R 12, TRH 8,**
Voids in mix (%)	3 - 6	3 - 6	2 - 6	9.5 mm: 20 – 25 type 1: 20 - 25 type 2: 18 – 22 type 3: 18 - 22	3 - 6
Voids in mineral aggregate (%) (minimum)	12	Continuously - graded: 14 Stone mastic: 17	17	-	26.5 mm: 14 19.0 mm: 15
Indirect tensile strength at 25^{O} C (kPa)	800	800	550	-	800
Cantabro abrasion loss at 25^{O} C (maximum)	-	-	-	25 (type 2: 20) (type 3: 20)	-
Dynamic creep at 40^{O} C for laboratory briquettes (MPa) (minimum)	15	15 (for stone mastic see project specifications)	10	Not applicable	12

Note: See project specifications for dynamic creep requirements for cores from trial sections and from the road working sections.

6404 PLANT AND EQUIPMENT

(a) General

All plant and equipment shall be so designed and operated as to produce a mixture complying with the requirements of this specification. The plant and equipment used shall be of adequate rated capacity, in good working order and subject to the approval of the engineer. The use of obsolete or worn-out plant or equipment shall not be permitted on the works.

Prior to the start of the work the contractor shall supply the engineer with copies of the manufacturer's handbooks and copies of check lists prepared in terms of ISO 9002 where

applicable pertaining to the mixing, remixing and paving plant and equipment, containing details of the correct settings and adjustments of the plant and equipment.

Any alteration which has been effected to any constructional plant or equipment, and which does not comply with the specifications of the manufacturer, shall be brought to the notice of the engineer.

(b) Mixing plant

(i) Conventional binders

Asphalt shall be mixed by means of an approved type mixer of proven suitability for producing a mixture complying with all the requirements of the specifications.

The mixing plant may be either automatically or manually controlled but in the latter case, two control operators shall be provided.

The heating system of the tanks storing the binder shall be so designed that the binder will not be degraded during heating. A circulating system for the binder shall be provided which shall be of adequate size to ensure the proper and continuous circulation between storage tanks and mixer during the entire operating period.

Binder storage tanks shall be fitted with thermometers designed to provide a continuous record of the temperature of the binder in the tank. Copies of these records shall be supplied to the engineer on a daily basis.

Satisfactory means shall be provided to obtain the proper amount of binder in the mix within the tolerances specified, either by weighing or volumetric measurements. Suitable means shall be provided for maintaining the specified temperatures of the binder in the pipelines, weigh buckets, spray bars and other containers or flowlines.

In the case of a drum type mixer, the system shall control the cold feeding of each aggregate fraction and of the filler by mass, by means of a load cell or another device regulating the feed automatically, and by immediately correcting any variation in mass which results from moisture or from any other cause. The cold feed shall be regulated automatically in regard to the binder feed so as to maintain the required mix proportion.

Suitable dust collecting equipment shall be fitted to prevent pollution of the atmosphere in accordance with the provisions of Ethiopian EPA Reguations.

The fuel chosen and control of the burner shall be such as to ensure the complete combustion of the fuel in order to prevent pollution of the atmosphere and the aggregate.

(ii) Non-homogeneous modified binders (bitumen-rubber)

In the event of on-site blending adequate and suitable heating tanks and acceptable blending equipment shall be provided in addition to the mixing plant for conventional binder.

(iii) Homogeneous modified binder

In addition to the mixing plant requirements for conventional binder, refer to the requirements of the project specifications.

(iv) Recycling

Before work is commenced, the contractor shall submit full details of his mixing equipment to the engineer for his approval.

In addition to the requirements set out in sub-clause 6404 (b) (i), the mixing equipment shall be specially adapted for recycling in accordance with the manufacturer's recommendations. The recovered asphalt portion of the mix shall not be exposed directly to the heating source.

(c) Spreading equipment

(i) Paver

The mixture shall be laid by an approved type of self-propelled mechanical spreader and finisher capable of ii laying to the required widths, thicknesses, profile, camber or cross-fall, without causing segregation, dragging or other surface defects.

All pavers shall be fitted with automatic electronic screed controls to maintain the required levels, cambers and cross-falls.

Where levelling beams on multiple skids or sliding beams I are used they shall be at least 12.0 m long, or as specified by the engineer.

(ii) Chip spreader

Wherever feasible, a machine straddling the full paved width shall be used for spreading the pre-coated chippings. Such a mechanical spreader must be self-propelled and be able to follow immediately behind the paver.

When coated chippings are spread by hand special care shall be taken to prevent bunching of the chippings.

(d) Rollers

(i) General requirements

Compaction shall be done by means of approved steel-tired flat rollers, vibratory rollers or pneumatic-tired rollers. The frequency as well as the amplitude of vibratory rollers shall be adjustable. Vibratory rollers shall be used only where there is no danger of damage being done to the asphalt, structures of bridge decks, or other layers. The project specifications will be indicating whether vibratory compaction equipment may be used on bridge decks and what the constraining parameters will be. The rollers shall be self-propelled and in good working condition, free from back lash, faulty steering mechanism and worn parts Rollers shall be equipped with adjustable scrapers to keep the drums clean and with efficient means of keeping the wheels wet to prevent mixes from sticking to the rollers.

No leakages of any nature may occur in the rollers.

The mass and/or tyre pressures shall be such as to ensure proper compaction to comply with the specifications of surface finish and density.

(ii) Non-homogeneous modified binder asphalt

For continuously graded asphalt the use of an approved pneumatic-tyred roller shall be assessed in a trial section The contractor shall take adequate precautions to eliminate pick-up.

For open-graded asphaltic mixes and/or stone-mastic asphaltic mixes, only approved static steel-tired flat rollers having a total mass of 7 to 10 tons shall be used.

(iii) Homogeneous modified binder asphalt

The general requirements shall apply. However, for open graded asphalt and/or stone-mastic asphalt the requirements as specified for non-homogeneous modified binder asphalt shall equally apply.

(e) Binder distributors

Where bituminous binders are to be sprayed onto areas before the asphalt is placed. the binder distributors shall comply with sub-clause 6104 (a).

(f) Trucks for transporting asphaltic mixes

The asphaltic mixes shall be transported from the mixing plant to the spreader in trucks having cargo trays with beds and sides, which are clean and smooth, without gaps, holes or openings. The bed and sides shall be treated to prevent adhesion of the mixture to the truck bodies. A thin film of soapy water or vegetable oil may be used to prevent adhesion but petroleum products shall not be used for this purpose.

All trucks used for transporting hot asphalt shall be equipped with waterproof canvas covers, insulated metal sheets or other suitable approved covers to minimise temperature loss from the asphaltic mix. Such covers shall be securely fixed over the hot asphaltic mix from the time of loading at the mixing plant until immediately prior to the discharge of the asphaltic mix into the paver.

(g) Mass-measuring device for asphalt mixes

Where payment per ton is specified, the contractor shall keep available at the mixing plant or on the site a suitable gauged mass-measuring device for measuring the asphalt mixes. The device shall be provided with a printer for printing the type of mix, the mass, the time and the date. The printed data shall be submitted to the engineer.

6405 GENERAL LIMITATIONS AND REQUIREMENTS AND THE STORAGE OF MIXED MATERIAL

In general the contractor will not be expected to construct layers in which the nominal maximum aggregate size exceeds two-thirds of the compacted layer thickness.

(a) Weather conditions

Asphaltic mixes may be mixed and placed only under favourable weather conditions, and shall not be mixed or placed when rain is imminent or during misty or wet conditions.

The following wind and temperature conditions are deemed to be suitable for asphaltic paving work:

(1) While the air temperature is rising, ambient air temperature not less than 6O C and a wind velocity of less than 25 km/h

(2) While the air temperature is rising, ambient air temperature not less than 10O C and a wind velocity of less than 55 km/h, or for compacted thicknesses of less than 30 mm, with a wind velocity of less than 25 km/h.

(ii) With falling air temperatures, work must stop when the temperature reaches 6O C regardless of the wind velocity and may not be restarted before the temperature is definitely rising.

(b) Moisture

The mixing and placing of asphaltic mixes will not be allowed if:

(i) the moisture content of the aggregate affects the uniformity of temperature;

(ii) free water is present on the working surface;

(iii) in the opinion of the engineer, the moisture content of the underlying layer is too high, or the moisture content of the upper 50 mm of the roadbase exceeds 50% of the optimum moisture content as determined by the engineer

No overlay shall be placed immediately after a rainy spell on an existing partly cracked and/or highly permeable surfacing resulting in the trapping of moisture in the pavement structure. In such events, a minimum delay of 24 hours or such extended period as ordered by the engineer shall apply.

(c) Surface requirements

(i) Correction of roadbase (and subbase in the case of asphaltic roadbase)

(1) The roadbase (after the prime coat has been applied) or the subbase, as the case may be, shall be checked for smoothness and accuracy of grade, elevation and cross section. Any portion of the roadbase or subbase, which does not comply with the specified requirements, shall be corrected with asphaltic material, at the contractor's own expense, until the specified requirements are met. However, the engineer may, at his sole discretion, allow minor surface irregularities to remain, provided they can be taken up in the following asphaltic layer without adversely affecting that layer.

(2) The asphalt used for the correction of the roadbase or subbase shall be the same mixture as specified for the surfacing or as directed by the engineer, and the maximum size of aggregate used shall be dictated by the required thickness of the correction in each case.

(3) Notwithstanding these provisions for the correction of the base or subbase, the engineer may order the removal and reconstruction of the layer or of portions of the base and subbase layers not complying with the specified requirements, instead of allowing the correction of substandard work with asphaltic material.

(4) Where a prime coat is applied it shall be dry before further coats or layers are applied. The contractor shall not commence with the application of the tack coat and/or the paving without the written approval of the engineer.

(5) The contractor's programme shall allow for delays that are a function of the type of prime, rate of application, base porosity and moisture content, and climatic conditions.

(ii) Cleaning of surface

Immediately before applying the tack coat, or where there is no tack coat, before the application of the asphaltic layer, the surface shall be broomed and cleaned of all loose or deleterious material.

Where the prime coat (if any) has been damaged, it shall be repaired by hand-brushing or spraying priming material over the damaged portions.

Where the surfacing is to be constructed on bridge decks, the concrete deck shall be thoroughly cleaned by washing and brushing to remove all loose material and allowed to dry.

(iii) Tack coat

Where required in these specifications or the project specifications, or where indicated by the engineer, a tack coat shall be applied to the surface to be paved.

The tack coat shall consist of a stable-grade bituminous emulsion diluted to have a 300;0 bitumen content and shall be applied at a rate of 0.55 l/m2 or as directed by the engineer.

For bridge decks a tack coat consisting of 30% stable-grade bituminous emulsion shall be applied to the surface at a rate of 0.4 l/m2. The tack coat shall then be allowed to dry.

The use of hand operated equipment for the application of tack coats shall be at the sole discretion of the engineer and his approval shall be obtained timeously for this purpose.

All exposed portions of kerbing, channelling and bridge railing, shall be protected in terms of division 3300 when the tack coat is applied.

The tack coat shall not be applied more than 24 hours before intended commencement of the paving.

(iv) Preparation for placing the overlays

The provisions of Division 6800 shall apply to any surface to be covered with overlays. The type of treatment to be applied, if any, will be specified in the project specifications or instructed in writing by the engineer.

(v) Preparation where asphalt layers are to be widened or where surfacing over a section of the road width requires replacement

The existing asphalt shall be removed as described in section 5300, where applicable, or as instructed by the Engineer.

Where a road has to be widened, the overlay shall be cut back not less than 100 mm from the existing edge. Unless otherwise indicated on the drawings or instructed by the engineer, asphalt joints may not fall within a wheel track.

(d) Storage

Mixing shall not be allowed to take place more than four hours before paving begins unless provision has been made for storage. Storage of mixed material will only be permitted in approved hoppers, which are capable of maintaining the temperature of the mix uniformly throughout In any case, storage will not be permitted for a period longer than 8 hours after mixing, unless otherwise approved by the engineer. Open-graded mixes and stone-mastic asphalt shall not be stored or mixed ahead of paving operations but shall be laid directly following mixing.

6406 PRODUCING AND TRANSPORTING THE MIXTURE

(a) Mixing and storage temperatures of binder and asphaltic mixes

Bituminous binders shall be stored at temperatures not exceeding those given in table 6400/14 or as specified in the project specifications and the aggregate and bituminous binders shall be heated at the mixing plant to such temperatures that the mixed product shall have a temperature within the range given in table 6400/14.

Table 6400/14 Temperature requirements for asphaltic mixes

Binder type	Maximum storage temperature of binder (°C)		Temperature range of asphaltic mixes (°C)	
	More than 24 hours	Less than 24 hours	Continuously, Semi-gap graded, Gap-graded mixes	Open graded mixes
40/50 penetration grade bitumen	145	175	140 - 165	110 - 140
60/70 penetration grade bitumen	135	175	135 – 160	105 – 135
80/100 penetration grade bitumen	125	175	130 – 155	100 - 130
150/200 penetration grade bitumen	115	165	125 - 150	-
Non-homogeneous modified binders, bitumen-rubbers	See clause 6402 (a) (ii) 4		160 - 180	160 - 180
Homogeneous modified binders	See project specifications			

(b) Production of the mixture

(i) Using batch plants

(1) Heating the aggregate

The aggregate shall be dried and heated so that. when delivered to the mixer. its temperature shall be between O°C and 20°C lower than the maximum temperature indicated in table 6400/14 for the mixture. The moisture content of the mix shall not exceed 0.5%.

(2) Batching

Each fraction of the aggregate and binder shall be measured separately and accurately in the proportions by mass in which they are to be mixed. If filler is used it shall be measured separately on a scale of suitable capacity and sensitivity. The error in the weighing apparatus used shall not exceed 2% for each batch.

(3) Mixing

The aggregate filler and binder shall be mixed until a homogeneous mixture is obtained in which all particles are uniformly coated Care shall be taken to avoid excessively long mixing times which can cause hardening of the

(ii) Using drum-type mixer plants

The aggregate and filler shall be accurately proportioned and conveyed into the drum-mixing unit. The calibrated amount of binder shall be sprayed onto the aggregates at the correct position so that no hardening of the binder shall take place. A homogeneous mixture and uniform coating of binder must be achieved and the moisture content of the asphalt mixture shall not exceed 0.5%. Once the final mix temperature has been agreed upon it may not be altered without the prior consent of the engineer.

The moisture content of the asphalt mixture shall be tested according to method BS EN 12697-14.

(c) Transporting the mixture

The mixture shall be transported from the mixing plant to the works in trucks complying with the requirements of sub-clause 6404(f). Loads shall be covered by waterproof canvas or insulated metal sheets when the haul exceeds 10 km or during cold, windy or rainy weather. Deliveries shall be made so that spreading and rolling of all the mixtures prepared for a day's run, can be completed during daylight, unless artificial lighting, as approved by the engineer is provided Any asphalt which has become wet due to rain or any other cause shall be rejected.

Hauling over freshly laid material is not permitted.

(d) Small quantities of asphalt

Extra payment will be made for the special production of a quantity of asphaltic mix of less than 10 tons, if such special production has been deemed by the engineer to be necessary:

(i) in accordance with the approved working programme of the contractor, and/or

(ii) for the safety of the work or the travelling public on account of weather conditions or abnormal traffic conditions.

No extra payment will be made where small quantities of asphaltic mixes are required in consequence of the negligence of the contractor, or of poor work or bad planning by the contractor, or because the contractor did not execute the works in accordance with his approved programme.

(e) Recycled asphalt

The provisions of sub-clauses 6406 (a) to 6406 (d) shall apply mutatis mutandis.

At least 4 weeks before paving with recycled material will commence, the contractor shall submit to the engineer full particulars regarding the recycling methods he intends to use.

Where recovered asphalt material is taken from a stockpile, it shall be done by excavating from the pile over its full depth and the feeding rate and proportioning at the mixing plant shall be accurately controlled.

Segregated material shall not be fed into the mixing plant. The engineer may order the Contractor to remix segregated stockpiles, retest the mixed material and redesign the asphaltic mixture all at the cost of the Contractor.

6407 SPREADING THE MIXTURE

(a) General

The mixture shall be delivered to the paver in such a manner that the paver will never be forced to stop for lack of asphalt. The temperature of the mixture shall be controlled by measuring in a random pattern in the truck immediately before emptying and shall not be more than 10° C below the minimum temperature specified for mixing in table 6400/14. The adjustment of the screed, tamping bars, feed screws, hopper feed, etc, shall be checked frequently to ensure uniform spreading of the mix. If segregation or tearing occurs the spreading operations shall immediately be suspended until the cause is determined and corrected.

The addition and removal of material behind the paver shall normally not be allowed and the paver shall be capable of spreading the mixture to the correct amounts that will provide the required compacted thickness without resorting to spotting, picking-up or otherwise shifting or disturbing the mixture.

Only minimal hand-working of the open graded asphalt shall be permitted after discharge from the paver and before rolling and shall only be carried out with wooden spreaders. Operatives shall not be permitted to walk on uncompacted open graded asphalt.

Paving shall, if possible, commence at the bottom of the grades and the lower edges of superelevated curves. Paving shall be done upgrade on grades steeper than 5%.

Spreading shall be so arranged that longitudinal joints do not coincide with joints in lower layers of asphalt base, paver laid crushed stone bases or surfacing.

Continuity of placing is especially important for open- graded asphalt. Cutting of longitudinal joints shall be avoided when paving open-graded asphalt, but where cutting is essential, only sawing shall be permitted. The existing layer shall be heated to assure adequate longitudinal bonding of the asphalt in the two lanes.

Unless otherwise specified in the project specifications the paver shall be equipped to provide automatic control of levels and cross section. In the case of asphaltic roadbase construction, automatic control shall be run off guide wires and in the case of surfacing and overlays skids or guide wires shall be used.

On restricted areas, inaccessible to the paving equipment used, the mixture may be placed by hand or other means to obtain the specified results. Paving shall be carried out in a manner which will avoid segregation and which will allow control of levels.

The mixer capacity and the operating speed of the paver are to be so co-ordinated as to ensure continuous laying and to avoid intermittent stopping of the paver.

Paving shall cease when rain starts falling or when, in the opinion of the Engineer, the surfaces to be paved are visibly wet.

(b) Overlays

In the case of overlays, guide wires will normally not be required during the placing of the mix unless specified in the project specifications. In all cases, including levelling courses, the paver shall be provided with approved skid beams with electronically controlled equipment, which can ensure a constant crossfall and can even out local irregularities.

(c) Restricted areas

Asphaltic mixes shall be placed in restricted areas with the aid of smaller specially equipped pavers, hand tools or other approved equipment. The space concerned shall be properly filled with asphalt, without leaving any gaps between the fresh asphalt and the existing pavement layers.

All the provisions in regard to temperature, mix composition, uniformity, etc. shall remain applicable but layer thickness and control shall be such that the requirements for compaction and surface tolerances can still be attained.

(d) Recycled asphaltic mixes

The provisions of sub-clauses 6407(a) to 6407(c) shall apply mutatis mutandis to recycled asphalt.

Where the average thickness of a completed asphaltic layer exceeds the specified thickness, and /or recovered asphalt has been wasted indiscriminately, and if, in the opinion of the engineer, it has resulted in a deficiency of recovered material, the contractor shall supplement such deficiency at his own cost with a quantity of similar or better material equal to the quantity wasted, as determined by the engineer.

(e) Surfacing of bridge decks

The type and nominal thickness of the surfacing shall be as indicated on the drawings and specified in the schedule of quantities.

Before commencing with the construction of the surfacing, the actual levels of the bridge deck shall be determined by means of accurate levelling. The levels and grades to which the surfacing is to be constructed shall be as shown on the drawings or as indicated by the engineer. If the levels of the concrete deck as constructed by the contractor deviate by more

than the specified tolerances from the specified levels, he shall construct a levelling layer at his own cost. The nominal size of the aggregate in the levelling layer shall be 9.5 mm.

6408 JOINTS

All joints between adjacent sections of the work shall be made by cutting back the layer against which the material is to be placed except for open-graded asphalt where the requirements of clause 6407 shall apply. All loose and incompletely compacted material shall be removed. A cutting wheel shall be used for cutting longitudinal joints.

The joints of adjacent sections shall normally not be cut in the case of open-graded surfacing, but shall be formed by placing hot asphalt in the adjacent lanes.

Joints shall be either at right angles or parallel to the centre line, and unless otherwise approved joints in the final layer of the surfacing shall correspond with the lane markings. Joints in lower layers shall be offset not less than 150 mm on either side of the edges of the traffic lanes.

Before a new layer is placed next to an existing layer, except in the case of open-graded mixes, if so directed by the engineer, the cut edge of the existing layer shall be painted with a thin coat of bituminous emulsion of the same type used for the tack coat.

Joints shall be neat and shall have the same texture and density as the asphalt course. All joints shall be marked out with chalk lines prior to cutting.

The outside edges of the completed asphalt layer shall be trimmed along the shoulder and parallel to the centre line to give the finished width shown on the drawings, within the tolerances specified.

Any fresh mixture spread accidentally onto existing work at a joint shall be carefully removed by brooming it back with stiff brooms onto the uncompacted work so as to avoid the formation of irregularities at the joint. Whenever the paving operation is stopped due to lack of mixture, the contractor shall form a proper joint as specified above, if so directed by the engineer.

The requirements of clause 6408 apply mutatis mutandis to joints in recycled asphalt layers.

6409 PRE-COATED CHIPPINGS FOR ASPHALT SURFACING

Aggregate for pre-coated chippings shall be coated using 1.7% +/- 0.3% by mass of the same bitumen used in the asphaltic surfacing, provided that the bitumen shall not be softer than 60/70 penetration-grade. One per cent by mass of active filler shall be added to the mixture.

The active filler shall be hydrated lime, and shall comply with the requirements of sub-clause 6402(d).

The aggregate shall be dried and fed into the mixer at a temperature of between 130° C and 185° C followed by the bitumen (at a temperature not exceeding 175° C) and filler. Immediately after the aggregate has been coated and discharged from the mixer it shall be rapidly cooled to ambient air temperature by hosing down with water.

Coated chippings shall be stockpiled in heaps not exceeding 1.0 meter in height and, if necessary, protected to prevent its temperature from exceeding 60° C during storage.

The pre-coated chippings shall be spread on the asphaltic surfacing at the rate of 6 to 8 kg/m2 when using 13.2 mm nominal size chippings, 7 to 9 kg/m2 when using 19.0 mm

nominal size chippings, depending on the relative density of the aggregate. The chippings shall be laid by a mechanical spreader, which straddles the paved width and follows immediately behind the paver. The chippings shall be spread to give a uniform texture free from clusters and open patches and rolled in as described in clause 6410. The desired surface texture shall be demonstrated in the trial section as described in clause 6411, and it shall have a texture depth of between 0.6 and 1.0 mm when tested according to method BS EN 13036-1, and thereafter the spread rate shall be determined by the engineer.

In restricted areas the contractor may use hand tools for spreading chippings or, if so instructed by the engineer, after compaction of the asphaltic surfacing, the contractor shall place a bituminous seal as specified in sub-clause 63A13 or in the project specifications. The rate of application and requirements for evenness of the spread chippings shall remain applicable.

Where extra over payment is made for work in restricted areas, no distinction shall be made between placing the conventional chippings and placing the bituminous seal as specified in clause 63A13 or in the project specifications.

The provisions of clause 6409 shall apply mutatis mutandis to surfacings of recycled asphalt, but the rate of application of the stone chippings will be determined by the engineer after the grading of the recovered asphalt and the mix ratios of the recycled mix have been determined.

6410 COMPACTION

(a) General

The following requirements shall apply to rolling and compacting generally:

(i) The material shall not be excessively displaced in a longitudinal or transverse direction especially when changing gears, stopping or starting rollers.

(ii) No cracks or hair cracks shall be formed and the bond with the underlying layer shall not be broken.

(iii) The density shall be uniform over the whole area of the layer and extend over the full depth of the layer.

(iv) Rollers shall not be left standing on the asphalt layer before it has been fully compacted and before the layer surface temperature has dropped below 60cc.

(v) In restricted areas where the specified rollers cannot be used, compaction shall be carried out with hand-operated mechanical compaction equipment or approved smaller vibratory rollers. The prescribed density requirements remain applicable throughout over the full layer thickness irrespective of the method of compaction.

Note:

The provisions of clause 6410 shall apply mutatis mutandis to recycled asphalt.

The mix shall be rolled as soon as possible after it has been laid by a combination of vibratory and non-vibratory steel-tired flat rollers and pneumatic-tyred rollers in a sequence

predetermined and approved during the laying of trial sections. Such rolling shall commence and be continued only for so long as it is effective and does not have any detrimental effect. Only non-vibratory steel-tired flat rollers will be permitted for the compaction of open-graded mixtures although rubber-tyred rollers shall be on standby if required. The use of pneumatic-tyred rollers for continuously-graded asphalt with modified binders shall be assessed in the trial section.

As many rollers shall be used as is necessary to provide the specified pavement density and the required surface texture. During rolling of asphalt surfacing, the roller wheels shall be kept moist with only sufficient water to avoid picking up the material.

After longitudinal joints and edges have been compacted, rolling shall start longitudinally at the sides and gradually progress towards the centre of the pavement, except on superelevated curves, or where the area to be paved has a cross-fall, when rolling shall begin on the low side and progress to the higher side, uniformly lapping each preceding track, covering the entire surface. During breakdown-rolling the rollers shall move at a slow but uniform speed (not to exceed 5 km/h) with the drive roller nearest the paver, unless otherwise specified on account of steep gradients.

No movement of the asphalt layer shall occur under steel-tired rollers once the asphalt temperature has dropped to below 100° C. Three-wheeled steel-tired rollers, with large diameter rear wheels are preferable to tandem rollers and may be used in conjunction with pneumatic tyred rollers, provided pick-up of the asphalt on the wheels does not occur.

The contractor shall take adequate precautions to eliminate pick-up.

The sequence of rollers used in compaction is at the discretion of the contractor provided the completed pavement shall have a density as measured on recovered core equal to or greater than 97 per cent, minus the percentage voids in the approved production mix, of the theoretical maximum density, determined as described in BS EN 12697-5.

For thin layer asphalt (less than 25 mm) the compaction requirements shall be specified in the project specifications.

For open graded asphalt the degree of compaction can be controlled indirectly by means of in-situ permeability tests calibrated during the trial section and by visual evaluation of the aggregate to prevent crushing.

The contractor shall utilize a calibrated nuclear gauge for process control during compaction operations. (See subclause 10107(f)) Notwithstanding this requirement, the acceptance control carried out for compaction by the Engineer, shall still be based on cores taken from the compacted layer.

When constructing asphalt surfacing with rolled-in chippings the asphalt shall be paver compacted and thereafter pre-coated chippings shall be spread at the specified rate. When the asphalt has reached the correct temperature the chippings shall be rolled in so that they are firmly bedded in the asphaltic mix. Care shall be taken to avoid rolling the chippings flush with the surface of the asphaltic layer but to leave them slightly proud. The procedure for compacting the asphaltic material and rolling in the chippings to produce the desired surface texture and specified degree of compaction shall be determined on a trial section as described in clause 6411.

The portion of trial section having the desired surface texture shall be designated as a reference section for the requirement of the permanent work.

6411 LAYING TRIAL SECTIONS

No experimentation by the contractor regarding the equipment and processes that he proposes to use for the construction of asphaltic layers shall be allowed on the permanent work, unless so approved by the Engineer.

Before the contractor commences with the construction of any asphaltic roadbase or surfacing layer, he shall demonstrate, by laying a trial section of at least 400 m2 and 600 m2 in area, as specified, depending on the required layer thickness, that the equipment and processes that he proposes to use, will enable him to construct the particular asphaltic course in accordance with the specified requirements.

The engineer may require that up to three (3) different binder contents be incorporated in one such trial section to verify the laboratory design phase.

Amongst others test results the contractor shall submit dynamic test results obtained from the testing of cores extracted from the completed trial section in locations determined by stratified random sampling methods, and/or, if specified, dynamic test results obtained from briquettes prepared from material obtained by stratified random sampling methods at the manufacturing plant or behind the paver as directed by the engineer.

A maximum period of 10 days shall be allowed to verify dynamic creep test results unless otherwise specified in the project specifications.

Only when such a trial section has been satisfactorily laid and finished, and complies with the specified requirements, will the contractor be allowed to commence with construction of the permanent work.

If the contractor should make any alterations in the methods, processes, equipment or materials used, or if he is unable to comply consistently with the specifications, the engineer may require that further trial sections be laid at the contractor's cost before allowing the contractor to continue with the permanent work.

The trial sections shall be laid where indicated by the engineer. The contractor shall prepare the surface on which to lay the trial section and shall also, if required, remove the trial section after completion and restore the surfaces on which it was constructed, all at the contractor's cost.

Provision is made for payment of the first approved trial section of any particular mix type, but subsequent trial sections with the same mix type shall be at the contractor's own cost. Payment will be made for the specified area of each approved first trial section for any particular mix type.

The construction equipment and techniques as well as the mix properties applicable to the approved trial section shall not be changed without prior approval by the engineer.

6412 PROTECTION AND MAINTENANCE

The contractor shall protect asphaltic base and asphaltic surfacing from all damage until the work is finally accepted by the engineer and he shall maintain the surfacing work until the issue of the maintenance certificate. Excepting fair wear and tear on the surfacing, any damage occurring to the completed base or surfacing during the maintenance period, or any defects which may develop due to faulty workmanship, shall be made good by the contractor at his own expense and to the satisfaction of the engineer.

6413 CONSTRUCTION TOLERANCES

(a) Construction tolerances

(Refer to sub-clause 6413(f) for construction tolerances for overlays)

The completed sections of asphaltic base and surfacing shall comply with the requirements for grade, width, thickness, cross section and smoothness stated below.

(i) Level and grade

The level tolerances referred to in clauses 10205 and 10305 shall be as follows:

H_{90} ..... + / - 15 mm
H_{max} ..... + / - 20 mm

Deviation from the specified longitudinal grade due to deviations from the specified levels shall not exceed the values given below:

Length of variation in grade (m)	**Maximum variation from specified grade (%)**
2	0.354
5	0.224
10	0.158
20	0.112
30	0.091

(ii) Width

The average width of both asphalt base and surfacing shall be at least equal to that shown on the drawings and nowhere shall the outer edge of the layer be inside the lines shown on the drawings by more than 15 mm in the case of both asphaltic base and asphaltic surfacing.

(iii) Thickness

The thickness tolerances referred to in clauses 8205 and 8305 shall be as follows:

	Base	**Surfacing**
D_{90}	15 mm	5 mm
D_{max}	20 mm	8 mm
D_{ave}	5 mm	2 mm

Thickness shall be determined from carefully controlled levels taken before and after construction in exactly the same position and/or from cores drilled from the completed layer.

(iv) Cross section

When tested with a 3 m straightedge laid at right angles to the road centre line the surface shall not deviate from the bottom of the straight-edge by more than 6 mm for freeways and by more than 10 mm for other roads.

At any transverse section the difference in level between any two points shall not vary from their difference in level computed from the cross section shown on the drawings by more than 15 mm for freeways and 20 mm for other roads.

(v) Surface regularity

When tested with a rolling straight-edge as described in clause 10111 the number of surface irregularities shall not exceed those given below (applied to base and surfacing)

(1) Average number of irregularities per 100 m equal to or exceeding the specified value when taken over 300 m - 600 m lengths:

Freeways (3 mm irregularities)

Asphaltic mixes with rolled-in chippings 5
Stone-mastic asphaltic mixes 4
Other asphaltic layers 3

Other roads (5 mm irregularities)

Asphaltic mixes with rolled-in chippings 4
Other asphaltic layers 2

(2) Number of irregularities equal to or exceeding the specified value when taken over 100 m sections:

Freeways (3 mm irregularities)

Asphaltic mixes with rolled-in chippings 8
Stone-mastic asphaltic mixes 6
Other asphaltic layers 5

Other roads (5 mm irregularities)

Asphaltic mixes with rolled-in chippings 6
Other asphaltic layers 3

(3) The maximum value of any individual irregularity when measured with the rolling straight-edge or a 3 m straight-edge laid parallel to the road centre line:

Freeways

Asphaltic mixes with rolled-in chippings ..... 5 mm
Stone-mastic asphaltic mixes..... 6 mm
Other asphaltic layers ..... 4 mm

Other roads

Other roads..... 8 mm

(vi) Multiple-layer base

Where the base is constructed from more than one layer, the requirements specified shall apply to the combined layers in respect of width and thickness. The requirements for cross-section, smoothness and grade shall apply to the final layer only but the lower layers shall be constructed so as to ensure that these requirements in the final layer can be met.

(vii) Surfacing of bridge decks

The completed surfacing shall comply with the requirements for base in section 5211 in respect of surface tolerances for grade, smoothness, cross section and width.

(b) Spread rate of rolled-in chippings

The tolerance in the spread rate of rolled-in chippings shall be + / - 10% of the specified spread rate.

(c) Gradings

The combined aggregate and filler grading shall not deviate from the approved target grading for the working mix by more than that given in table 6400/15. The mean grading of each lot of the working mix (minimum of 6 tests per lot) shall be determined from samples obtained in a stratified random sampling procedure.

Table 6400/15 Deviation from approved target grading

Material passing sieve size (mm)	Permissible deviation from approved target grading (%)
26.5	+ / - 5.0
19.0	+ / - 5.0
13.2	+ / - 5.0
9.5	+ / - 5.0
6.7	+ / - 5.0
4.75	+ / - 4.0
2.36	+ / - 4.0
1.18	+ / - 4.0
0.60	+ / - 4.0
0.30	+ / - 3.0
0.15	+ / - 2.0
0.075	+ / - 1.0 *

* When statistical methods are applied the permissible deviation for the 0.075 mm fraction is + / -2.0%.

(d) Binder content

The binder content shall be within the limits specified in the applicable statistical judgement scheme in clause 10206 or clause 10305.

(e) Voids

The voids in the mix shall be within the limits specified in the applicable statistical judgement scheme in clause 10206.

(f) Construction tolerances for overlays

When the overlay is constructed to specified levels on a layer that has also been constructed or milled to specified levels by the contractor, all the tolerance requirements of sub-clause 6413(a) shall be applicable.

When the overlay is constructed to specified levels on an existing layer, or on a layer which has been constructed or milled by the contractor, but which has not been constructed or milled to specified levels, all the tolerance requirements of sub-clause 6413(a) shall be applicable except those of sub-clause 6413(a)(iii) which relate to thickness.

When the overlay is not constructed to specified levels and no guide wires are used, but an electronically controlled paver and a skid beam, the following tolerances shall apply:

The outer edges of the overlay shall nowhere be more than 15 mm inside or outside the lines shown on the drawings, and shall be parallel to the road centre line.

The minimum thickness shall be the specified nominal thickness.

The maximum thickness shall be the specified nominal thickness +/- 10 mm.

The surface regularity shall be measured with a 3.0 m straight-edge in accordance with sub-clause 10111 (b), and no irregularity may exceed a value of 6 mm.

6414 QUALITY OF MATERIALS AND WORKMANSHIP

(a) Sampling

Sampling of asphalt mixes shall be carried out according to method BS 598, or as prescribed by the engineer.

Sampling for acceptance control for bitumen content and grading shall be carried out immediately behind the paver or as otherwise prescribed by the engineer.

Sampling of bitumen shall be carried out at the discharge point of the delivery vehicle or adjacent to the discharge point into the mixer. Bitumen sampling shall comply with the relevant procedure as described in ASTM D140.

(b) Coring of asphaltic layers

If required in the project specifications, the contractor shall provide suitable coring machines capable of cutting 100 mm diameter cores from the completed asphaltic layers. The contractor will be paid in accordance with item 64.08 for cutting cores ordered by the engineer. The cost of extracting cores for process control shall be included in the contractor's prices for the construction of asphaltic pavement layers and will not be paid for separately. The coring equipment, the programme, and the procedures must be approved by the engineer.

If the contractor does not adhere to the approved programme, the engineer may temporarily suspend the paving operations.

All core holes shall be neatly repaired with asphalt and compacted to the specified density. Wherever possible the cores shall be filled with the same mix as used for the layer tested.

(c) Routine inspection and tests

Routine inspection and tests will be carried out by the engineer to determine the quality of the materials and workmanship for compliance with the requirements of this section.

Tests results and measurements will be assessed in accordance with the provisions of section 10200 or section 10300 as specified in the project specifications.

6415 MEASUREMENT AND PAYMENT

Items 64.13, 64.14 and 64.16 are applicable solely to work that has to be executed in a restricted area of which the width is less than 3.0 m or the length is less than 150.0 m.

Item 64.01 Asphaltic roadbase

{state thickness, type of bitumen and maximum size of aggregate}

(a) Continuously graded..... square metre (m^2)

(b) Semi-gap-graded ..... square metre (m^2)

The unit of measurement shall be the square metre of asphaltic base constructed to the thickness specified When specified in the project specifications and/or indicated in the schedule of quantities, the unit of measurement shall be the ton of asphaltic mix constructed as specified and measured according to certified weighbridge tickets issued in respect of mixture used. No payment will be made for material wasted.

The tendered rates shall include full compensation for procuring, furnishing, heating, mixing, placing and compaction of all materials as well as process control testing, protecting and maintaining the work as specified.

When the unit of measurement is a ton of asphaltic mix the tendered rate shall also include full compensation for supplying and installing a weighbridge, and for weighing the material.

Item 64.02 Asphaltic surfacing

{State thickness and type of bitumen}

(a) Continuously graded {state grade} .....square metre (m²)

(b) Gap-graded {state stone content} .....square metre (m²)

(c) Open-graded {state grade}.....square metre (m²)

(d) Semi-gap-graded {state maximum size of aggregate} .....square metre (m²)

(e) Semi-open-graded.....square metre (m²)

(f) Stone-mastic asphaltic {state maximum size of aggregate} .....square metre (m²)

The unit of measurement shall be the square metre of asphaltic surfacing constructed to the thickness specified. When specified in the project specifications and/or indicated in the schedule of quantities, the unit of measurement shall be the ton of asphalt constructed as specified and measured according to certified weighbridge tickets issued in respect of mixture used. In the case of resurfacing using asphaltic mixes, measurement by ton shall be obligatory. No payment will be made for material wasted

The tendered rates shall include full compensation for procuring, furnishing, heating, mixing, placing and compaction of all materials as specified as well as process control testing, protecting and maintaining the work as specified. When the unit of measurement is a ton of asphaltic mix, the tendered rate shall also include full compensation for supplying and installing a weighbridge, and for weighing the material.

Rolled-in chippings will be paid for separately under item 64.03.

Item 64.03 Rolled-in chippings in surfacing ..... ton (t)

{State nominal size}

The unit of measurement shall be the ton of rolled-in chippings applied at the specified rate, measured loose in hauling vehicles.

The tendered rate shall include full compensation for the procuring, furnishing, pre-coating, spreading and rolling-in of pre-coated chippings and for any additional costs resulting from more difficult construction of the asphalt surfacing with rolled-in chippings

Item 64.04 Tack coat of 30% stable-grade bitumen emulsion..... litre (l)

The unit of measurement shall be the litre of 30% stable- grade emulsion applied as specified.

The tendered rate shall include for the procuring, furnishing and application of the material as specified.

Item 64.05 Binder variations ..... ton (t)

{state type}

The unit of measurement in respect of increases or decreases in the bituminous binder from that specified in the nominal mix shall be the ton.

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

Item 64.06 Variation in active filler content

(a) Cement .....ton (t)

(b) Lime .....ton (t)

(c) Milled granulated blast-furnace slag .....ton (t)

(d) Fly-ash .....ton (t)

The unit of measurement in respect of increases or decreases in the active filler content for base and surfacing mixtures from that specified in the nominal mix shall be the ton. No payment shall be made for inert filler added by the contractor.

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

Item 64.07 Trial sections.....square metre (m^2)

{state nominal thickness}

The unit of measurement shall be the square metre of trial section using asphaltic mix constructed as ordered.

The tendered rate shall include full compensation for the construction of the trial section of asphaltic layer complete as specified, for the application of a prime coat as in item 61.01 and for the application of rolled-in pre-coated chippings, if specified.

Item 64.08 100 mm diameter cores in asphaltic layers..... number (No)

The unit of measurement shall be the number of 100 mm diameter cores drilled and recovered as instructed by the engineer for his own testing. No separate payment shall be made for cores drilled as part of the contractor's obligations under process control, the cost of which shall be included in the prices tendered for the various items of asphaltic paving

The tendered rate shall include full compensation for drilling the cores as directed, for all plant, fuel, labour and other incidentals necessary and for refilling the core hole with an approved mix and compacting the mix as specified.

Item 64.09 Asphaltic surfacing on bridge decks

{state nominal thickness and type of bitumen}

(a) Continuously graded {state grade} .....ton (t)

(b) Gap graded {state stone content}.....ton (t)

(c) Open graded {state grade} .....ton (t)

(d) Semi-gap graded {state maximum size of aggregate} .....ton (t)

(e) Semi-open graded.....ton (t)

(f) Stone-mastic asphalt {state maximum size of aggregate} ..... ton (t)

The unit of measurement shall be the ton of surfacing completed to the nominal thickness indicated, and measured according to certified weighbridge tickets issued in respect of the mixture used.

The tendered rate shall include full compensation for procuring and furnishing all materials, heating the binder and aggregate, mixing, transporting, placing and compacting the material, and the provision and application of the slurry. The rate shall also include full compensation for variations in thickness within the specified tolerance for bridge deck levels and for the application of a tack coat

Rolled-in chippings will be paid for separately under item 64.03.

Item 64.10 Asphaltic layer constructed for rehabilitation purposes in accordance with the provisions of sub-clause 6413(f)

(a) Base constructed with new asphaltic mix {state thickness, type of bitumen and maximum size of aggregate}

(i) Continuously graded .....square metre (m^2)

(ii) Semi-gap graded .....square metre (m^2)

(b) Surfacing or overlay constructed with new asphaltic mix {state thickness, type of bitumen and maximum size of aggregate}

(i) Continuously graded .....square metre (m^2)

(ii) Semi-gap graded .....square metre (m^2)

(c) Base constructed with recycled asphaltic mix .....square metre (m^2)

{state thickness, type of bitumen and maximum size of aggregate}

(d) Surfacing or overlay constructed with recycled asphaltic mix .....square metre (m^2)

{state thickness, type of bitumen and maximum size of aggregate}

The unit of measurement for sub-items (a) and (b) shall be a square metre of asphaltic base. surfacing or overlay constructed to the specified thickness. The quantity shall be calculated from the authorized dimensions.

The unit of measurement for sub-items (c) and (d) shall be a square metre of asphaltic base, surfacing or overlay constructed with recycled asphalt consisting of recovered asphalt and new materials mixed in the prescribed ratio. The quantity shall be calculated from the authorized dimensions.

The tendered rate for sub-items (a) and (b) shall include full compensation for procuring, providing, heating, mixing, placing and compacting the material, process control tests, and protection and maintenance, all complete as specified. Rolled-in chippings will be paid for separately under item 64.03, and the additional cost for applying rolled-in chippings in restricted areas will be paid for under item 64.16.

The tendered rate for sub-items(c) and (d) shall include full compensation for supplying the new materials, taking recovered asphalt from stockpile, blending the materials in accordance with the nominal mix ratios specified in the project specifications, heating, mixing, placing and compacting the material, process control tests, and protection and maintenance, all complete as specified. Payment will distinguish between different types of recycled

asphaltic mix in accordance with the project specifications. No extra payment will be made for small quantities of recycled asphalt.

Item 64.11 Asphaltic layer constructed for rehabilitation purposes in accordance with the provisions of sub-clauses 6413(f) :

(a) Base constructed with new asphaltic mix {state thickness, type of bitumen and maximum size of aggregate}

(i) Continuously graded .....ton (t)

(ii) Semi-gap graded .....ton (t)

(b) Surfacing or overlay constructed with new asphaltic mix {state thickness, type of bitumen and maximum size of aggregate}

(i) Continuously graded .....ton (t)

(ii) Semi-gap graded .....ton (t)

(c) Base constructed with recycled asphaltic mix.....ton (t)
{state thickness, type of bitumen and maximum size of aggregate}

(d) Surfacing or overlay constructed with recycled asphaltic mix.....ton (t)
{state thickness, type of bitumen and maximum size of aggregate}

The unit of measurement for sub-items (a) and (b) shall be a ton of asphalt placed. The quantity shall be determined by means of certified weighbridge tickets issued in respect of the asphalt mix used. No payment will be made for asphalt placed outside the tolerances specified.

The unit of measurement for sub-items (c) and (d) shall be a ton of recycled asphalt consisting of recovered asphalt and new materials mixed in the prescribed ratio. The quantity shall be determined by means of certified weighbridge tickets issued in respect of the asphalt mix used. No payment will be made for asphalt placed outside the tolerances specified.

The tendered rate for sub-items (a) and (b) shall include full compensation for procuring, providing, heating, mixing, placing and compacting the material, process control tests, and protection and maintenance, all complete as specified. Rolled-in chippings will be paid for separately under item 64.03, and the additional cost for applying rolled-in chippings in restricted areas will be paid for under item 64.16.

The tendered rate for sub-items (c) and (d) shall include full compensation for supplying the new materials, taking recovered asphalt from stockpile, blending the materials in accordance with the nominal mix ratios specified in the project specifications, heating, mixing, placing and compacting the material, process control tests, and protection and maintenance, all complete as specified.

Payment will distinguish between different types of recycled asphalt in accordance with the project specifications. No extra payment will be made for small quantities of recycled asphalt.

Item 64.12 Extra over items 64.01, 64.02, 64.10 and 64.11 for placing small quantities of asphaltic mixes of less than 10 tons, specially produced as specified in sub-clause 6406(d) ..... ton (t)

The unit of measurement shall be a ton of asphalt of a specified composition, less than 10 tons of which is produced on occasion, as specified, and measured in accordance with the certified weighbridge tickets issued in regard to the mix used.

The tendered rate shall be paid as extra over the rates tendered for the items mentioned above, and shall include full compensation for all additional costs to produce and place small quantities of asphalt on the instruction of the engineer.

Payment will not distinguish between various types of asphalt or various types of asphalt layers.

Item 64.13 Placing and compacting asphaltic mixes in restricted areas:

(a) Extra over items 64.01, 64.02 and 64.10 .....square metre (m^2)

(b) Extra over item 64.11 ..... ton (t)

The unit of measurement shall be a square metre or a ton of asphalt (in accordance with the unit of measurement for the item concerned), placed in restricted areas, the quantity of which shall be measured as specified for the item of payment concerned.

The tendered rates shall include full compensation for additional costs for executing the work in restricted areas.

Item 64.14 Extra over item 64.04 for applying tack coat in restricted areas ..... litre (l)

The unit of measurement shall be a litre of 30% stable- grade emulsion applied in restricted areas.

The tendered rate shall include full compensation for additional costs for applying the tack coat in restricted areas, irrespective of the method of application.

Item 64.15 Application of prime coat and/or tack coat to the edges of a layer ..... litre (l)

The unit of measurement shall be a litre of 30% stable-grade emulsion applied to the edge of a layer against which asphalt has to be placed.

The tendered rate shall include full compensation for obtaining, procuring and applying the material, irrespective of the layer thickness, the method of application, or the size of the area over which it has to be applied.

Item 64.16 Extra over item 64.03 for applying rolled-in chippings in restricted areas..... ..... ton (t)

The unit of measurement shall be a ton of rolled-in chippings applied in restricted areas at the specified rate.

Payment will not distinguish between rolled-in chippings and bituminous seals referred to in clause 6409.

The tendered rate shall include full compensation for the additional cost for executing the work in restricted areas.

Item 64.17 Asphalt reinforcing complete (state type).....square metre (m^2)

{state thickness, type of bitumen and maximum size of aggregate}

The unit of measurement shall be a square metre of asphalt covered with reinforcing placed. complete as specified and accepted by the engineer.

The tendered rate shall include full compensation for procuring, providing, placing and fixing all materials (irrespective of the quantity of reinforcing required) overlapping and cut-offs included, and for all transport, equipment, tools, labour, supervision and all other costs necessary for installing and protecting the reinforcing until the asphalt prime coat has been placed. The tendered rate shall also include full compensation for all special preparatory work required. If it is necessary to repair cracks in the underlying seal or asphalt layer, separate payment will be made therefore under the appropriate items of payment.

Item 64.18 Variations from nominal mix ratios in recycled asphaltic mixes

(a) New binder {state penetration-grade of bitumen} .....ton (t)

(b) New aggregate .....ton (t)

(c) New active mineral filler .....ton (t)

The unit of measurement for an increase or decrease in the content of new binder, aggregate or mineral filler in the recycled asphalt mixture, in relation to the content specified in the nominal mixture, shall be a ton of binder, aggregate or filler.

Where payment for recycled asphalt is per square metre, the varied quantity shall be calculated by converting volume to mass using the average density of the asphalt layer measured after compaction.

Payment for variations shall be made in accordance with the provisions of clause 1214.

Payment will not be made for an increase in the quantity of new material required where this results from recovered asphalt being wasted. The contractor is warned that the quantity of recovered material available for recycling will be determined in accordance with the authorized quantities excavated, and the tendered rates shall include full compensation for making good losses in recovered materials.

Item 64.19 Variations in cellulose fibre content of stone mastic asphaltic mixes..... ton (t)

The unit of measurement for an increase or a decrease in the cellulose fibre content of stone-mastic asphaltic mixes in comparison with the specified nominal cellulose fibre content shall be a ton of cellulose fibres.

Payment for variations shall be made in accordance with the provisions of clause 1214.

Item 64.20 Backfilling of excavations for patching with :

(a) Asphaltic base .....ton (t)

(b) Asphaltic surfacing.....ton (t)

The unit of measurement shall be a ton of asphalt placed in accordance with the specified requirements. The quantity will be computed in accordance with the certified weighbridge tickets issued in respect of the asphalt mix. Payment will not be made for wasted material.

The tendered rate shall include full compensation for procuring and providing all materials, irrespective of its origin for all mixing placing, compacting and finishing as specified, for all transport, work in restricted areas, and also for all machinery, equipment, labour, supervision and, other incidentals for executing the work, complete as specified.

Payment for asphalt base and surfacing will not distinguish between the various types of asphalt.

Item 64.12 for small quantities of asphalt shall not apply to patching

Screeds where required shall be measured and paid for under item 68.04

DIVISION 6700: SURFACING OF BRIDGE DECKS

6701 SCOPE

This section covers the construction of a bituminous surfacing on bridge decks where shown on the Drawings or ordered by the Engineer. Bituminous concrete surfacing of bridge decks is specified in Division 6400.

Note:

The provisions of Division 6400 "Bituminous Roadbases and Surfacings", apply equally to the work covered by this division and will not necessarily be repeated or specifically referred to in this division.

6702 MATERIALS

Bituminous binders and aggregate shall comply with the requirements of Division 6400 for bituminous concrete and Division 6300A-F for other bituminous surface treatments and seals.

6703 PREPARATION OF SURFACE

Before the surfacing is constructed, the concrete deck shall be thoroughly cleaned by washing and brushing to remove all loose material. After drying, a tack coat consisting of 30 % bituminous emulsion shall be applied to the surface at a rate of 0.4 liter/m2. The tack coat shall then be allowed to dry.

6704 TYPE AND THICKNESS OF SURFACING

The type and nominal thickness of the surfacing shall be as indicated on the Drawings and specified in the Project Specifications.

Before commencing with the construction of the surfacing, an accurate survey of the actual levels of the bridge deck shall be made. The levels and grades to which the surfacing is to be constructed shall be as shown on the Drawings or as indicated by the Engineer. If the levels of the concrete deck, as constructed by the Contractor, deviate by more than the specified tolerances from the specified levels, the Contractor shall construct a levelling layer at his own cost. The nominal size of the aggregate in the levelling layer shall be 9.5 mm.

6705 CONSTRUCTION

Irrespective of the type of surfacing on the road on both sides of the bridge, bituminous concrete surfacings for bridge decks shall be constructed in accordance with Division 6400, and surface treatments for bridge decks in accordance with Divisions 6300A-F.

6706 SURFACE TOLERANCES

The completed surfacing shall comply with the requirements for base of Clause 63A18 in respect of surface tolerances for grade, smoothness, cross section and width.

6707 MEASUREMENT AND PAYMENT

Item 67.01 Surfacing on bridge deck.....square metre (m^2)

{state type and thickness}

The unit of measurement shall be the square metre of surfacing completed to the nominal thickness indicated.

The tendered rate shall include full compensation for procuring and furnishing all materials, heating the binder and aggregate, mixing, transporting, placing and compacting the material, and the provision and application of the slurry. The rate shall also include full compensation for variations in thickness within the specified tolerance for bridge deck levels and for the application of a tack coat.

Item 67.02 Rolled-in chippings (nominal size indicated) in surfacing .... cubic metre (m^3)

The unit of measurement shall be the cubic metre of rolled-in chippings applied at the specified rate, measured loose in hauling vehicles.

The tendered rate shall include full compensation for the procuring, furnishing, pre-coating, spreading and rolling in of pre-coated chippings and for any additional costs resulting from more difficult construction of the asphalt surfacing with rolled-in chippings.

DIVISION 6800: TREATMENT OF CERTAIN DEFECTS IN EXISTING BITUMINOUS SURFACING

6801 SCOPE

This section covers the work in connection with the treatment of certain defects of bituminous surfacings of existing road surfaces. It covers the treatment of existing surfacings where:

(a) The existing surface is deficient in binder.
(b) Marked differences in texture occur over the surface.
(c) The existing surface is open-textured.
(d) The surface is uneven on account of bumps, slacks, etc.
(e) Edges require trimming and/or repairs

It also covers planing of the road surface, fog spraying, texturing, slurry sealing, screeding, sealing cracks and building up broken edges with bituminous concrete.

Note:

The provisions of Division 6300A "Surface Treatments: Materials and General Requirements", apply equally to the work covered by this division and will not necessarily be repeated or specifically referred to in this division.

6802 MATERIALS

(a) Bituminous binders

Unless otherwise specified in the project specifications or the Bills of Quantities, or directed by the Engineer, the following types and grades of binder shall be used:

Bituminous binders shall comply with the appropriate requirements of Divisions 6300A-F.

(i) Primer for sealing cracks

Invert bitumen emulsion manufactured from 80/100 penetration-grade bitumen such as MSP/1 or similar.

(ii) Emulsion for crack treatment

Anionic stable-grade bitumen emulsion.

Synthetic modifiers shall be added to the emulsion so that the binder will have a net rubber content equal to 10% of the net bitumen content.

(iii) Fog spray

30%, 40%, 50% or 60% cationic or anionic spray-grade emulsion shall be used in accordance with the requirements.

(iv) Tack coat for texturing

60% anionic or cationic spray-grade emulsion shall be used.

(v) Slurry-seal

Tack coat: 30% stable-grade emulsion

Slurry seal: 60% slurry-grade emulsion

(vi) Screed

Tack coat: 30% bitumen emulsion;

Bituminous concrete: 80/100 penetration-grade bitumen.

(vii) Binder in asphalt for patching

Tack coat: 60% stable-grade emulsion

Bituminous concrete: 80/100 penetration-grade bitumen

(viii) Bitumen rubber

Bitumen rubber shall comply with the requirements of clause 63A02. The softening point shall be at approximately 65 C.

(b) Rubber crumbs

Rubber crumbs used for crack sealing shall be obtained by processing rubber tyres The rubber shall be granulated and free from fibres, steel wire and other impurities. The rubber crumbs shall pass through a 2.0 mm sieve.

(c) Herbicide

Herbicide shall be Hyvar X or similar non-selective herbicide approved by the Engineer.

6803 PLANT AND EQUIPMENT

(a) Planing machine

The machine shall be of a design, which will be suitable for planing the existing surfacing in order to remove any irregularities and to leave an even surface without tearing the underlying material. An approved milling machine may be used.

Before planing may start, the contractor shall demonstrate to the Engineer that the machine is in fact capable of executing the work in accordance with the specifications.

(b) Equipment for crack-sealing

In addition to the equipment normally used for surface treatments, the following equipment will be necessary for the sealing of cracks:

(i) A vibratory roller having a mass approximately equal to that of a Bomag 905 or similar, with an adjustable amplitude and frequency of vibration.

(ii) A mobile pneumatic pump capable of producing at least 3 m3/min at 750 kPa for blowing out cracks.

(iii) Special spraying equipment with 2 mm nozzle openings.

(iv) Special heating equipment where appropriate for cleaning cracks, and

(v) Custom-built applicators for applying sealants to cracks.

(c) Other equipment

All equipment shall be suitable for the specified use and working areas and shall be capable of obtaining the specified results.

6804 CONSTRUCTION

Before any treatment is carried out, the area to be treated shall be cleaned and prepared as specified in sub-clause 63A07(c), and any major failures shall be repaired as specified in this section and in the project specifications.

(a) Treatment with diluted bituminous emulsion (fog spray)

This treatment will be applied where in the opinion of the Engineer the existing surface is deficient in binder.

The treatment shall consist of the application of a fog spray of the specified grade of bituminous emulsion to the existing surface by means of a pressure distributor at the rates of application as directed by the Engineer, in widths that may vary from 0.5 m to 4.0 m. A 30%, 40%, 50% or 60% cationic or anionic spray grade emulsion, as specified, shall be used.

(b) Texturing

A tack coat of cut-back bitumen, 80/100 or 150/200 penetration-grade bitumen, or the specified type and grade of emulsion shall be applied to the surface as specified in sub-clause 6207 followed by an application of double-washed crusher sand. The crusher sand shall be the medium grade specified for slurry in sub-clause 63A02(d), but shall be on the coarse side of the grading envelope, and shall be subject to the Engineer's approval.

The nominal rates of application shall be:

80/100 or 150/200 penetration-grade bitumen:	0.70 l/m^2 (net bitumen)
Cut-back bitumen:	0.70 l/m^2 (net bitumen)
Emulsion:	0.70 l/m^2 (net bitumen)
Aggregate.	0.0045 m^3/m^2

The actual rates of application shall be as instructed by the Engineer.

It is anticipated that spraying and spreading may have to be carried out in narrow strips varying in width from 0.5 m to 2.0 m. The emulsion shall be allowed to break before the aggregate is applied.

As soon as the aggregate has been spread, patches where it has not been spread evenly shall be corrected by brooming the patch with a hand broom or a light drag broom.

Rolling shall be done as specified in sub-clause 63A11(f)(ii). Any excess aggregate remaining on the road after it has been opened to traffic for two days or more shall be removed.

This treatment, or a sand seal as specified in Division 6300F is intended for application where marked differences in texture occur in the existing surfacing, in order to obtain a uniform texture before resealing.

(c) Slurry seal

Slurry seal shall comply with the requirements of Division 6300E. This treatment shall be used when an existing surface treatment, which is open-textured, requires treatment with bituminous slurry.

Prior to treatment with a slurry, the surface shall be sprayed with a tack coat of 30% bitumen emulsion of the type and at the rate prescribed by the Engineer.

A distinction shall be made in respect of payment for the following two methods of construction:

(i) Where the slurry can be applied by hand methods only or where the Engineer so directs or where it is specified that the slurry shall be applied by hand methods.
(ii) Where the slurry can be applied mechanically with a spreader box.

The slurry shall be prepared, mixed and applied as specified in sub-clauses 63E04(c))(d) and (e), except that slurry to be applied by hand can be mixed in a suitable concrete mixer and worked into cracks or other open patches with brooms or squeegees until the surface is smooth and even; and where a spreader box is used for applying the slurry, it shall be applied in one layer.

A nominal rate of application of 0.0040 m^3/m^2 shall apply for tender purposes.

(d) Screed

This treatment is used where the road surface is uneven and where depressions, humps or small grooves occur, which, in the opinion of the Engineer, are the result of the deformation of the pavement layers, but not of structural failure of the pavement.

Where both planing and screening are specified, the screed shall be placed after the planing has been completed.

Where milling is required, it shall be done in accordance with the requirements of division 5300.

The existing surface shall be swept clean or cleaned by other approved methods of dust, soil, gravel, loose stones or any other undesirable material. A tack coat of 30% anionic stable-grade emulsion shall then be applied at a rate prescribed by the Engineer.

The bituminous material used for the screed shall be bituminous concrete or coarse slurry as specified in the project specifications.

(i) Bituminous Concrete

The bituminous concrete shall consist of a medium or fine-grade continuously graded mix, proportioned as specified in table 6400/8. The actual grade of the mix used shall be in

accordance with the instruction of the Engineer or as determined by the required thickness of the screed.

The bituminous concrete shall be produced, transported, placed and compacted as specified in division 6400, as applicable. The paver shall be so adjusted that the straight-edge blade will screed off high spots on the existing surface and the bituminous concrete will therefore be placed only in depressions. Where high spots have been planed down, the straight- edge blade shall operate over the planed surface. The screed shall nevertheless comply with the specified standards for evenness. Where the required bituminous concrete thickness exceeds 25 mm at any position, such sections of the screed shall be placed in more than one layer if so instructed by the Engineer. Such layer thicknesses shall be in accordance with the instructions of the Engineer.

Where the surface of the screed breaks up, a slurry-seal treatment shall be applied in accordance with sub-clause (c) above, or the screed shall be removed and replaced, all at the cost of the contractor.

(ii) Coarse slurry

The aggregate for coarse slurry shall comply with the requirements for coarse grading in sub-clause 63A02(d) The slurry shall be prepared and applied in accordance with the requirements in the project specifications.

(iii) Requirements for evenness

When a completed screed surface is tested, it shall not deviate by more than 6 mm from the bottom edge of a 3 m straight-edge placed in any direction.

(e) Repairing edge breaks in surfacing

This treatment shall be used for restoring the road edges to the true edge lines of the original road or to such other edge line as may be required.

The existing surfacing shall be cut back and the pavement material shall be excavated as specified in clause 5305.

Where the surfacing, after having been cut back, requires building up to bring it to the required width, the surface so exposed shall be swept clean, watered, and if so instructed, compacted. It shall then be tack coated as specified. The edges shall then be built up with medium continuously-graded bituminous concrete in accordance with table 6400/8. The built-up edges shall be properly compacted and finished in accordance with the required lines and levels.

(f) Sealing cracks

(i) General

The types of cracks treated will be specified in the project specifications. The Engineer will instruct the contractor regarding the type of treatment to be used in the various cases.

(ii) Preparation

The cracks shall be blown clean with compressed air, and all foreign and loose matter shall be removed from the cracks.

A supply of approved herbicide diluted in accordance with the requirements of the project specifications shall be prepared. The solution shall be sprayed into cracks on the surfaced shoulders of the road or on such extended area as specified in the project specifications by means of rucksack type of sprayers, and allowed to dry.

Twenty-four (24) hours after application of the herbicide, the cracks shall be penetrated with MSP/1 or a similar suitable primer.

(iii) Cracks smaller than 3 mm

Cracks smaller than 3 mm shall be treated with an emulsion or by means of resealing of the surface.

(iv) Cracks of 3 mm and wider

After the primer has been applied, anionic stable-grade emulsion shall be mixed with synthetic modifiers, as specified in the project specifications, and applied by means of pneumatic spraying equipment or other approved equipment at the rate specified in the project specifications.

Where the cracks are to be rolled, the contractor, in accordance with the provisions of the project specifications or the prescriptions of the Engineer, shall treat the cracks as follows:

The surface shall be heated in an approved manner along the full length of the crack and over a width of 250 mm on each side of the crack and then rolled with approved rollers until an even surface has been obtained.

Depending on the instructions of the Engineer, the cracks shall be treated with cold rubber slurry, hot bitumen rubber, or any other approved sealant.

Where, in the opinion of the Engineer, the cracks are too wide for this type of treatment, the contractor shall treat the cracks in accordance with the instructions of the Engineer.

(1) Rubber slurry

The rubber slurry mixture shall be proportioned as follows (by volume):

- 8.0 parts of rubber crumbs 2.0 parts of crusher dust
- 4.5 parts of 60% cationic stable grade bitumen emulsion 0.2 parts of ordinary portland cement 1,1 part of SBR (net rubber).

Water may be added to improve workability. The mixture shall be neatly worked into the cracks by rubber squeegees. Excess slurry shall be removed from the surface as soon as the emulsion has broken.

(2) Bitumen rubber

Bitumen rubber may be used only where the contractor is able to convince the Engineer that he is able to mix, heat and apply the material satisfactorily.

The bitumen rubber shall be mixed on the site or at another approved locality on condition that the contractor is able to propose efficacious methods for controlling both the mixing process and the end product.

Approved heating equipment and mechanical equipment for mixing and applying the mixture shall be used.

The rubber content of the mix shall be at least 25% by mass of the total bitumen-rubber mix.

(3) Other sealants

Other approved sealants shall comply with and be applied in accordance with the requirements of the project specifications.

(v) Restrictions

Cracks may be sealed only where the temperature of the road surface exceeds 10° C. Crack sealing may not be done within 3 days after rain has fallen on the site, unless otherwise instructed by the Engineer.

The contractor shall note that a single application of crack sealant is usually insufficient and that the application will have to be repeated.

(g) Pre-treatment of the road surface by means of planing

(i) Planing

Planing shall be done with an approved planing or milling machine. The areas of the road to be planed shall be as directed by the Engineer and may include limited sections or the entire width of the surface. The work shall involve the planing high spots or ridges in the existing asphalt surfacing in accordance with specified level requirements.

The planed surface shall be even without any ridges or steps between the longitudinal cuts. Where planing is required over a portion of the road width, the edge of the planed section shall be vertical and straight. The planed surface shall be suitable for immediate opening to traffic if so required by the Engineer.

Material planed off shall be transported to stockpiles for recycling, or to spoil dumps, whichever is required.

Material removed beyond the specified limits shall be replaced by the contractor at his own cost and to the satisfaction of the Engineer.

After planing has been completed, depressions over which the planing machine has moved without touching the surface, and which fall outside the specified smoothness requirements, shall be filled in as specified, or, if so instructed by the Engineer, a screed shall be placed as specified in subclause 6804(d).

Payment will be made only for filling in depressions which existed in the original surface. Depressions formed as a result of the activities of the contractor shall be filled in at his own cost.

Upon completion, the entire treated surface, or where depressions have not been filled in, then the planed surface, shall be tested for shape, and, unless otherwise specified in the project specifications, the surface shall not deviate by more than 6 mm when tested using a 3 m straight-edge placed in any direction.

(ii) Fog spraying of planed surfaces

After the planing operation has been completed, the planed surface or, if so directed by the Engineer, the entire levelled surface, shall be sprayed with a 30% spray-grade emulsion, which may be further diluted if necessary, in accordance with the instructions of the Engineer, at a rate of application to be determined by the Engineer. The surface shall then be

rolled with approved pneumatic rollers until it has dried off sufficiently and, in the opinion of the Engineer, can be opened to traffic.

6805 OPENING TO TRAFFIC

The opening of the road to traffic shall be subject to the requirements of clause 63A14.

The road shall be left open to traffic for such period as the Engineer may direct before further surface treatment work is carried out.

6806 MEASUREMENT AND PAYMENT

Item 68.01 Treatment with diluted bituminous emulsion (fog spray)

(a) 30% bitumen emulsion ..... litre (l)

(b) 40% bitumen emulsion ..... litre (l)

(c) 50% bitumen emulsion ..... litre (l)

(d) 60% bitumen emulsion ..... litre (l)

The unit of measurement for treatment with diluted bituminous emulsion (fog spray) shall be the litre of bituminous emulsion sprayed, measured at spraying temperature.

The tendered rates shall include full compensation for cleaning and preparing the existing surface, for furnishing the material and applying the fog spray and for all other incidentals necessary for completing the work as specified.

Item 68.02 Texturing

(a) Tack coat {state type of binder} ..... litre (l)

(b) Application of slurry seal with double-washed aggregate ..... cubic metre (m^3)

The unit of measurement for binder application for the tack coat shall be the litre of net bitumen cold as specified in clause 63A12.

The unit of measurement for the slurry seal with double-washed aggregate shall be the cubic metre of aggregate applied, measured loose in the truck and corrected for bulking as described in item 63E.04.

The tendered rates shall include full compensation for furnishing all materials, demarcating the areas to be sprayed, spraying the binder and applying the aggregate. rolling, sweeping and all other incidentals necessary for completing the work as specified.

Item 68.03 Slurry seal

(a) Tack coat using 30% bitumen emulsion ..... litre (l)

{state type and rate of application }

(b) Slurry applied by hand ..... cubic metre (m^3)

(c) Slurry applied by spreader box ..... cubic metre (m^3)

(d) Slurry applied by hand ..... ton (t)

(e) Slurry applied by spreader box ..... ton (t)

The unit of measurement for tack coat shall be the litre of emulsion measured at spraying temperature and applied as specified.

The unit of measurement for slurry shall be the cubic metre of saturated fine aggregate used, measured as described in item 63E.04, or the ton of saturated fine aggregate used, as specified.

The tendered rates shall include full compensation for procuring and furnishing all the materials, for mixing and applying the slurry, demarcating all areas to be treated and for all plant, labour and incidentals necessary to complete the work as specified.

Item 68.04 Screed of bituminous concrete or coarse slurry:

(a) Tack coat using 30% stable-grade bitumen emulsion .....litre (l)

(b) Continuously-graded bituminous concrete (specify grade) .....ton (t)

(c) Coarse grade slurry .....cubic metre (m^3)

The unit of measurement for the tack coat shall be the litre of emulsion applied, measured at spraying temperature.

The unit of measurement for bituminous concrete shall be the ton of bituminous concrete placed according to the specifications. The unit of measurement for coarse grade slurry shall be the cubic metre of aggregate mix used in the slurry.

The tendered rate for tack coat shall include full compensation for procuring, furnishing and applying the tack coat and demarcating the areas to be sprayed. and for all incidentals necessary for completing the work as specified.

The tendered rate for bituminous concrete shall include full compensation for procuring. furnishing and mixing all the materials. for placing the bituminous concrete and for all transport and other incidentals necessary to complete the work as specified.
The tendered rate for slurry shall include full compensation for all materials, equipment and labour for producing and applying the slurry, irrespective of the number of applications required to attain the required thickness.

Item 68.05 Repairing edge breaks in surfacing:

(a) Tack coat using 30% bitumen emulsion .....litre (l)

{state type and rate of application }

(b) Reconstructing edges using medium continuously-graded bituminous concrete ....ton (t)

The unit of measurement for the tack coat shall be the litre of specified emulsion applied as specified and measured at spraying temperature.

The unit of measurement for reconstructing pavement edges shall be the ton of medium continuously-graded bituminous concrete furnished and compacted as specified.

The tendered rate for reconstructing pavement edges shall include full compensation for compacting the surface on which the new edge is to be constructed and procuring, furnishing and mixing all materials and placing, compacting and trimming the bituminous concrete to the required lines and levels It shall also include full compensation for applying a tack coat of emulsion to the surface to be treated.

The tendered rates shall include full compensation for all transport, handling, labour, material and all incidentals necessary to complete all the work, as specified.

Item 68.06 Cleaning the cracks with compressed air. ..... kilometre (km)

The unit of measurement for cleaning the cracks with compressed air shall be a kilometre of road along which all the cracks have been blown clean.

The tendered rate shall include full compensation for providing all equipment. labour. supervision and incidentals for blowing clean the cracks over the full width of the road to the satisfaction of the Engineer.

Item 68.07 Applying bituminous binders and herbicides for sealing cracks:

(a) Herbicide..... litre (l)

(b) MSP/1 or similar primer ..... litre (l)

(c) Anionic stable-grade emulsion mixed with synthetic modifiers ..... litre (l)

(d) Hot bitumen rubber ..... litre (l)

(e) Other specified agents (type indicated) ..... litre (l)

The unit of measurement shall be a litre of material applied as specified or as instructed by the Engineer.

The tendered rates shall include full compensation for providing, mixing, heating (where required) and applying all the materials as specified, and for all equipment, labour, supervision and incidentals for completing the work. No additional payment will be made for multiple applications of material, and payment will not distinguish between the various types, widths or lengths of cracks.

Item 68.08 Cold rubber-slurry mix for sealing cracks ..... cubic metre (m^3)

The unit of measurement for crack treatment with rubber slurry shall be a cubic metre of fine rubber crumbs used for preparing the mix.

The tendered rate shall include full compensation for procuring and providing all the material, including emulsion, synthetic modifiers, cement and water, and for mixing and applying the mixture, and for all equipment labour, supervision, and incidentals for executing the work in accordance with the specifications.

Payment will not be made for redundant rubber pellets or redundant mixture or for mixture which. in the opinion of the Engineer, has been wasted.

Item 68.09 Rolling the cracks ..... metre (m)

The unit of measurement shall be a metre of crack rolled to the satisfaction of the Engineer.

The tendered rate shall include full compensation for rolling the cracks complete as specified.

Item 68.10 Planing ..... square metre (m^2)

The unit of measurement shall be a net square metre of road surface planed in accordance with the specifications.

The tendered rate shall include full compensation for planning, for obtaining the required surface regularity to a maximum depth of 25 mm, collecting, loading and removing the planed material over a free-haul distance of 1.0 km, for all plant movement over the site as instructed by the Engineer, and for providing planing and other equipment, labour, supervision and incidentals for completing the work in accordance with the specifications, including filling up irregularities caused by the contractor. Any planing of deeper than 25 mm will be classified as milling.

Item 68.11 Fog spraying on planed surfaces:

(a) Hand spraying .....litre (*l*)

(b) Spraying with mechanical equipment .....litre (*l*)

The unit of measurement shall be a litre of 30% spray-grade emulsion sprayed on planed surfaces on the instruction of the Engineer.

The tendered rate shall include full compensation for fog spraying on planed surfaces complete as specified.

Item 68.12 Rolling planed surfaces .....square metre of roller passes (m^2-pass)

The unit of measurement shall be a square metre of roller-pass with an approved pneumatic roller on planed surfaces as may be directed by the Engineer.

The tendered rate shall include full compensation for the rolling of planed surfaces complete as specified.

Item 68.13 Filling depressions in planed surfaces (bituminous concrete) ..... ton (t)

The unit of measurement shall be a ton of bituminous concrete of the specified composition placed in depressions in planed surfaces. Measured in accordance with certified weighbridge tickets The tendered rate shall include full compensation for the filling of depressions in planed surfaces complete as specified.

No extra payment will be made for small quantities of bituminous concrete.

Where a screed is placed, payment will be made under item 68.04.

DIVISION 6900: BITUMINOUS ROAD-MIX SURFACING

6901 SCOPE

This work shall consist of aggregate and bituminous material mixed in place on a prepared surface and constructed in accordance with these Specifications and in conformity with the lines, grades, and typical cross section shown on the Drawings. Aggregate shall consist of either new aggregate (Case 1), or aggregate present in the existing road (Case 2), whichever is called for in the Project Specifications.

The percentage of bituminous material, by weight, to be added to the aggregate will usually be between 3.5 and 7 percent of the weight of the dry aggregate. The exact percentage to be used shall be fixed by the Engineer based on preliminary laboratory tests and field sieve analyses of the aggregates furnished or in place.

6902 MATERIALS

(a) New Aggregate (Case 1)

New aggregate (Case 1) shall consist of coarse aggregate of crushed gravel, crushed boulder, or crushed rock, composed of hard, durable particles and a filler of finely crushed stone, sand, or other finely divided mineral matter. The portion of the material retained on a 5 mm sieve shall be known as coarse aggregate, and that portion passing a 5 mm sieve shall be known as fine aggregate. The total mineral aggregate shall be graded within one of the gradations shown in Table 6900/1, whichever is called for in the Project Specifications, when tested in accordance to AASHO T 11 and T 27.

Table 6900/1 Grading Requirements for Road Mix Bituminous Surface Courses

Sieve Size (mm)	Percentage passing (by weight)			
	A	B	C	D
28	100	100	-	-
20	85-100	75-100	100	-
14	-	-	40-65	100
5	45-65	30-60	25-50	50-70
2	30-50	20-50	12-40	30-50
0.425	10-25	-	3-20	-
0.075	3-10	3-10	0-10	3-10

If crushed gravel is used, not less than 50 percent by weight of the coarse aggregate particles retained on the 5 mm sieve shall be particles having at least one fractured face.

The coarse aggregate shall have a percentage of wear of not more than 40 at 500 revolutions, as determined by AASHTO T 96. That portion of the aggregate passing a 5 mm sieve shall have a plasticity index of not more than 6, as determined by AASHO T 90 or a liquid limit not greater than 30, as determined by AASHTO T 89.

The fine aggregate shall be in accordance with AASHTO M 29, and the mineral filler in accordance with AASHTO M 17.

The material shall be free from clay balls and adherent films of clay or other matter that would prevent thorough coating with bituminous material.

(b) Aggregate from the Existing Surface (Case 2)

Where aggregate required for the road-mix surface course is already in place, the Contractor shall not be responsible for its grading or quality except for removal of oversize pieces. In general, salvaged aggregate to be used for road-mix surface course will consist of material meeting the requirements given above for new aggregate or may consist of selected granular material of other gradings. Any particles of salvaged aggregate appearing in the surface at the time of lay-down and finishing that will not pass a 37.5 mm sieve shall be removed by the Contractor as directed by the Engineer.

(c) Bituminous Materials

Bituminous materials shall be of the type and grade called for in the Project Specifications.

6903 EQUIPMENT

The equipment used by the Contractor shall include scarifying, mixing, spreading, finishing, and compacting equipment, a self-powered bituminous material distributor, and equipment for heating bituminous material.

The pressure distributor shall be equipped with pneumatic tires and shall be so designed and operated as to distribute the asphaltic material in a uniform spray without atomisation, in the amount and between the limits of temperature specified. It shall be equipped with a fifth wheel speedometer registering in meters per minute and so located as to be readable by the truck driver. The distributor pump shall be motor-driven and shall be equipped with an accurate metering device registering litters per minute passing through the nozzles, which shall be so located as to be readable by the operator. A thermometer well shall be so placed in the distributor tank as not to be in contact with a heating tube. Suitable means for accurately indicating at all times the temperature of the asphaltic material shall be provided. The distributor spray bar shall be adjustable, both for height and for the normal width of application (3.5 meters) or less with a hand spray attachment. The distributor heating attachments shall be so equipped and operated that the asphaltic material shall be circulated or agitated throughout the entire heating process.

Rollers for compacting the surface shall be self-powered tandem or 3-wheel rollers weighting between 5 and 8 tonnes and having a minimum weight of thirty-six (36) kg/cm. of rear wheel width, or a pneumatic tired roller with tire pressures in the range of 5-9 kg per square centimetre.

Either travelling or stationary mixing plants or other equipment of proved performance may be used by the Contractor in lieu of the specified equipment if the Contractor complies with such requirements as the Engineer may consider necessary to insure results that shall be at least equal to results which would be obtained by use of the specified equipment.

6904 CONSTRUCTION

(a) Weather Limitations

Bituminous material shall be applied to the aggregate when the atmospheric temperature in the shade is above 10°C and rising or above 15°C if falling, when the weather is not foggy or rainy, and when the moisture content of the aggregate conforms to the requirements in Sub-clause 6904 (e).

(b) Preparation of Roadbase and New Aggregate (Case 1)

When new aggregate is to be used for the road-mix surface course, the existing roadbase shall be scarified lightly and bladed to uniform grade and to the cross section shown on the Drawings and shall then be rolled, or watered and rolled, as directed. If so ordered by the Engineer, depressions shall first be filled and weak portions of the roadbase strengthened with new aggregate.

New aggregate shall be uniformly spread on the road by the use of spreader boxes, or other approved mechanical spreading devices. It shall then be windrowed. The aggregate shall be so deposited that each windrow will be of uniform section and will contain the correct quantity of aggregate to provide surfacing of the required width and thickness.

(c) Preparation of Roadbase and Salvaged Aggregate (Case 2)

When material in the existing road surface is to be used for mixing, the surface shall first be scarified lightly and bladed to uniform grade and to the cross section shown on the Drawings. The reshaped surface shall then be scarified again to such depth as is ordered by the Engineer and in such manner as to leave a foundation stratum of undisturbed material parallel, both in profile and cross section, to the proposed finished surface. The loosened material shall be bladed aside into a windrow at the side of the road, and the undisturbed under-stratum rolled, or watered and rolled, as directed.

(d) Windrowing and Sampling

Care shall be exercised to prevent the aggregate, whether new or salvaged, from becoming mixed with earth or shoulder material. Windrows of aggregate shall be shaped uniformly and trimmed so that accurate measurements of volume may be taken by the Engineer. The uniform windrows shall be left undisturbed until measuring and sampling are completed. At least 1 day shall be allowed for measuring and sampling each run.

(e) Additive

If the aggregate contains more than 2 percent but not more than 5 percent of moisture, the Contractor may, at his own expense, use an additive to facilitate coating of the wet aggregate in lieu of additional manipulation for drying purposes. The additive shall be approved by the Engineer and it shall be added to and uniformly mixed with the bitumen in the amount specified by the Engineer but not to exceed 2 percent by weight of the bituminous material if a commercial grade of additive is used or 1 percent if a concentrated grade is used.

(f) Mixing

Bituminous material shall be applied at the rate designated by the Special Provisions, with a tolerance of 0.01 litters per square meter. The method of bituminous material application shall be such that it will not allow liquid bituminous material to flow on the prepared surface. Mixing shall immediately follow and shall be continued until complete, with the bituminous material uniformly distributed throughout the mass and the aggregate particles as uniformly and completely coated as possible.

At the end of each day's work, or when operations are interrupted by the weather conditions, all loose material shall be bladed into a windrow, whether the mixing is complete or not, and shall be retained in a windrow until operations can be resumed.

Before it is spread, the windrowed mixture shall be examined by the Engineer who shall determine whether the mixing is complete, the bituminous content correct, and the moisture removal satisfactory. Should the mixture show an excess, deficiency, or uneven distribution of bituminous material, the unsatisfactory condition shall be corrected by the addition of the required aggregate or bituminous material and by remixing. If the mixture contains more than 50 % of the original volatile matter or if the moisture content exceeds 1.5 % of the dry weight of aggregate, the mixture shall be bladed and aerated or otherwise manipulated until the above maximum percentages have been reached as determined by AASHO T 110. If necessary, the material shall be harrowed or disked and all compressed masses of material broken up. No spreading shall be done, except when authorized by the Engineer. Spreading on a wet roadbase will not be permitted.

Where approved travelling plants are used, final mixing may be accomplished by such additional passages of the travelling mixing plant as may be required for complete mixing.

When stationary mixing plants are used, at the option of the Contractor, the production of surface-course material shall be in accordance with standard practice for the plants, and the depositing and spreading of the material shall be as directed by the Engineer.

(g) Laying, Compacting and Finishing

(i) Spreading and blade finishing.

After the mixing has been completed, the mixed material shall be spread from the windrow to the required width by a self-powered, pneumatic-tired blade grader. In spreading from the windrow, care shall be taken to prevent cutting into the underlying roadbase. If necessary to prevent such cutting, a layer of the mixture approximately 1.25 centimeters thick shall be left at the bottom of the windrow.

(ii) Rolling finished surface.

After the mixture has been spread, the surface shall be rolled. Rolling shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center, except that on superelevated curves rolling may progress from the lower to the upper edge. Blading shall continue during the rolling only if so ordered by the Engineer. Rolling shall continue until the surfacing is of uniform texture and degree of compaction, and is true to grade and cross section. Under no circumstances shall the center of the surface course be rolled first. Initial rolling shall be performed with a pneumatic tired roller and final rolling with a 3-wheel or tandem type roller.

Where the compacted thickness of road-mix material is to be more than 5.0 cm, the material shall be spread from the windrow and compacted in 2 layers, with the first layer to be bladed and rolled before the second layer is spread.

(iii) Shaping edges.

While the surface is being compacted and finished, the Contractor shall trim the edges neatly to line.

(h) Improving Unsatisfactory Areas

If at any time after the Engineer has authorized spreading of the mixture, unsatisfactory areas develop that require additional bituminous material, additional aggregate, or additional road mixing and consequent re-laying, re-compacting, and refinishing, the work shall be done by the Contractor when ordered in writing by the Engineer.

6905 TOLERANCES

(a) Thickness Requirements

The thickness of the completed surfacing shall not vary more than 1.25 centimetres from the thickness shown on the Drawings. The thickness shall be controlled by measurements taken immediately after laying the material and before compacting. Sufficient measurements of thickness shall be taken before and after compacting to establish the relationship between the thickness of the uncompacted material and the completed work. The thickness shall then be controlled by measurements taken of the uncompacted material immediately behind the paver.

When the measurements indicate that an area will not be within the allowable tolerance for the completed work, the uncompacted area shall be corrected while the material is still in workable condition.

(b) Seal Coat

If called for in the Project Specifications, a seal coat of the type called for shall be applied to the finished road-mix surface. In such an event, the surface shall be opened to traffic for at least 2 weeks before the seal coat is applied.

(c) Surface Requirements

When tested by a crown template conforming to the typical cross section shown on the Drawings, or called for in the Project Specifications, and a 3 meter straightedge applied at right angles and parallel, respectively, to the centreline of the surface being tested, the variation of the surface from each testing edge between any two contacts with the surface shall at no point exceed 1.0 cm for the crown template and 0.5 cm for the straight edge.

(d) Stockpiling

When indicated on the Drawings, road-mix aggregate shall be stockpiled in the amounts and at the locations so indicated. Stockpiles shall be shaped as directed by the Engineer. Stockpile sites shall be cleared, cleaned, and levelled by the Contractor.

6906 MEASUREMENT AND PAYMENT

The quantities shall be paid for at the contract price per unit of measurement, respectively, for each of the particular pay items listed below that is shown in the Bill of Quantities, which prices and payment shall be full compensation for furnishing and placing all materials, including all labour, equipment, tools, and incidentals necessary to complete the work prescribed in this Division.

When the Engineer orders in writing the reworking and refinishing of unsatisfactory portions of previously approved surface, as provided in Sub-clause 6904 (h), the areas in square meters shall be added to what would have been paid for had no reworking and refinishing been ordered.

Item 69.01 Road-mix surfacing, Case 1.....Square meter (m^2)

Item 69.02 Road-mix surfacing, Case 2.....Square meter (m^2)

The quantity of road mixing to be paid for shall be the number of square meters of road-mix surfacing placed and accepted.

Item 69.03 Road-mix aggregate.....Cubic meter (m^3)

The quantity of aggregate including filler, to be paid for shall be the number of cubic meters, measured in the vehicles, placed and accepted.

Item 69.04 Asphalt (grade indicated) ..... Tonne (t)

The unit contract price per tonne of bituminous material shall be full compensation for furnishing, hauling and storage. The quantity to be paid for shall be the number of tonnes, ordered in the accepted work.