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COTO

Committee of Transport
Officials

Standard Specifications for Road and Bridge Works for State Road Authorities

Committee Draft Final (CDF)

CHAPTER 10: SURFACE TREATMENTS

August 2019

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Comments

Comments on the Chapters must be provided in writing as per the format provided on the SANRAL website www.nra.co.za and e-mailed to cotorevision@nra.co.za no later than **04 October 2019**.

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CHAPTER 10: SURFACE TREATMENTS

A10.1 GENERAL REQUIREMENTS FOR SURFACE TREATMENTS

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PART B: LABOUR ENHANCEMENT

PART C: MEASUREMENT AND PAYMENT

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PART A: SPECIFICATIONS

A10.1.1 SCOPE

This Chapter covers all the material requirements and work in connection with the construction of surface treatments incorporating single seals, multiple stone seals, sand seals, Cape seals, graded aggregate seals, slurry seals and microsurfacing.

A10.1.2 DEFINITIONS

Surface treatments - encompass thin bituminous surfacings applied as wearing courses for new construction or as reseals.

Bitumen - is a dark brown to black viscous liquid or solid, consisting essentially of hydrocarbons and their derivatives. It is soluble in trichloroethylene, is substantially non-volatile, and softens gradually when heated. Bitumen is obtained by refining petroleum crude oil.

Penetration grade bitumen - is manufactured by straight-run distillation of crude oil or by blending two or more base components (one hard, such as 40/50 pen, and the other soft, such as 150/200 pen). Penetration grade bitumen is used either as a primary binder (70/100 pen for surface seal work in South Africa) or as a base bitumen for the manufacture of cut back bitumen, modified binders or bitumen emulsions.

Bitumen emulsions - are two-phase systems consisting of a dispersion of bitumen droplets in water which contains an emulsifier. The emulsifiers are added to assist in the formation of the emulsion, to render it stable, and to modify its properties. Different grades of emulsion are manufactured to allow slower and faster curing e.g. stable grade (Slow setting) is required for labour intensive work and manufacturing of conventional slurries. Spray grade (Rapid setting) emulsions are preferred for spray sealing. The terms cationic and anionic derive from the electrical charges on the bitumen globules. The positively charged cationic emulsions are preferred for construction of sprayed seals due to superior adhesive properties with the mostly negatively charged aggregate used for seal work in South Africa.

Cutback bitumens - are blends of penetration grade bitumen and slow, medium or rapid curing solvents. The choice of solvent determines the rate at which the bitumen will "set up" or cure when exposed to air. A rapid-curing (RC) solvent will evaporate more quickly than a medium-curing (MC) solvent, which in turn will cure more rapidly than a slow-curing (SC) solvent. The viscosity of the cutback bitumen is determined by the proportion of solvent added. MC-30 used for prime coats has a high percentage of medium curing solvent (45 %) with a very low viscosity. MC-3000 used for sprayed seal work has approximately 12 % solvent allowing application at low road surface temperature.

Modified binders - modification is achieved by the introduction of polymers, crumb rubber, aliphatic synthetic wax or naturally occurring hydrocarbons to a penetration grade bitumen. Modified binders for seal work are classified into:

- Hot homogeneous modified binder S-E1 and S-E2 for spray sealing and C-E1 for crack sealing (refer properties in TG1)
- Cold homogeneous modified binder SC-E1 and SC-E2 for spray sealing and CC-E1 for crack sealing
- Hot non-homogeneous modified binder S-R1 and S-R2 for spray sealing and C-R1 and C-R2 for crack sealing

Aggregate for seal work consists mainly of crushed rock with specified hardness, durability, polishing resistance, adhesion to bitumen and falling within selected grading envelopes. Screened natural gravels and sand as well as crushed slag, separated from metals during the smelting or refining of ore, are also used with success for specific seal types.

Sprayed seals - are constructed by spraying bituminous binder, spreading of aggregate and rolling. For purpose of this document sprayed seals are divided into sand/ grit seals, single stone seals (Including single stone and sand blinding layer), Multiple stone seals (Double or triple stone seals) and Graded aggregate seals e.g. Otta seals.

Combination seals - are defined as seal types consisting of at least two components of different character e.g. Cape seals (Single stone seal with one or two layers of slurry) and Slurry-bound Macadam seals.

Slurry - is a homogenous mixture consisting of fine aggregate (normally crusher dust), or where required to satisfy grading requirements and permitted, a blend of crusher dust and a limited percentage approved natural sand, stable grade bitumen emulsion (anionic or cationic) or a polymer modified stable grade emulsion, active filler (usually cement or lime), water, additive to retard the setting rate of rapid setting slurry) and Polymer (in case of microsurfacing).

Tack coat - is defined as the first application of binder for a sprayed seal or a Cape seal

Penetration coat - is defined as the second application of binder on a multiple stone seal

The **term cover spray** - refers to the application of a diluted emulsion as a final binder application on single or double seals or before application of the slurry, in case of Cape seals.

The term **fog spray or rejuvenation spray** - is used for the application of anionic emulsion, diluted anionic emulsion or invert emulsion rejuvenator for purposes of adding additional binder to the seal or rejuvenating the seal at a later stage of the seal life. Specifications for this type of treatment are provided in Chapter 8.

A10.1.3 GENERAL

A10.1.3.1 Requirements pertaining to all surface treatments

Adequate advance notice shall be given to the Engineer before the Contractor proceeds with any seal work. This notice shall include the program containing exact dates and sections to be sealed as well as the stockpile/s which will be used for each section.

Seal work shall not commence until a design has been submitted for each section and approved by the Engineer.

The areas to be sealed shall be cleaned of all dust, dirt, dung, oil or any other foreign matter that may be deleterious to the seal.

Sealing work shall not commence until the Engineer has approved all preparatory works ordered on that section of road.

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

The Contractor shall comply with the requirements of Chapter 1 regarding traffic over completed layers

Wherever reference is made to distance the measurements for length shall be taken as actual lengths measured along the road centreline.

All quantities of sprayed binder and variations, shall be measured at spray temperature of the applied binder.

A10.1.3.2 Weather limitations

The following general limitations shall apply:

- Whenever the temperature of the road surface falls below the specified temperature for the binder to be applied or will probably fall below the required temperature before spraying the binder, no binder shall be sprayed;
- No bituminous work shall be done during foggy or rainy weather and, when a cold wind is blowing, the above temperatures as specified in the sub-sections below, shall be increased by 3°C to 6°C.
- When strong winds (more than 30 km/h) are blowing which are likely to interfere with the proper execution of the work, no sealing, especially spraying of binder, shall be done;
- No sealing shall be done when rain or cold temperature is imminent;
- No sealing shall be done when the surface of the layer is visibly wet, i.e. more than damp;
- No sealing shall be done after sunset

Only emulsion products, MC3000 and cutback S-E1 binder shall be permitted during the embargo period stated in the Contract Documentation. Special formulated winter grade binders shall only be allowed if provision is made in the Contract Documentation.

The minimum road-surface rising temperatures at which the spraying of the different types and grades of binder shall be allowed are specified in Table A10.1.3-1.

Table A10.1.3-1: Minimum road-surface rising temperature

Bituminous binder type	Minimum rising road surface temperature
70/100 penetration-grade	25°C
MC 3000	10°C
Cationic emulsion	10°C
Anionic emulsion	10°C
S-E1	25°C
S-E2	25°C

S-R1	25°C
S-R2	25°C
SC-E1	10°C
SC-E2	10°C
S-E1 cut back with 4.5% MC30	23°C
S-E1 cut back with 9.0% MC30	21°C
Any special formulated binder not defined above	As specified in the Contract Documentation

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

During hot weather slurry operations shall be suspended when aggregate is being displaced by the spreader box or squeegees.

Rapid setting slurry or microsurfacing shall be sufficiently versatile to be laid in air temperatures of 4°C to 40°C as well as capable of being laid under damp conditions. When the breaking process accelerates to such an extent that it renders the product unworkable to attain the required end result, no further work shall be done until adjustments to the composition of the product have been proven through trial sections and approval by the Engineer.

A10.1.3.3 Areas inaccessible to mechanical equipment

a) Bituminous binder application

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

Bituminous binders shall be applied at the rate specified in the Contract Documentation by means of a binder distributor. Hand-spray or light appropriate equipment may be used only with the written approval of the Engineer and then only in accordance with approved methods under the strict supervision of experienced personnel and with equipment suitable for performing the work in accordance with specified requirements.

The application of binders shall be controlled to ensure that the specified application rates are obtained.

b) Aggregate

The aggregate shall be of the same size as the aggregate in the existing surrounding seal and shall be spread by hand.

c) Rolling and brooming

Each layer of the seal shall be rolled with the most effective rollers that can be used in the area in question and thereafter the excess aggregate shall be swept off the surface with hand brooms

d) Grit or slurry application

The Engineer may require Grit or a texture slurry to be applied to areas subjected to traffic turning actions. The slurry and application thereof shall comply with the requirements of Section A8.3 of Chapter 8. Grit shall conform to specifications in Clause A10.1.5.14. The Engineer may order pre-coating of the Grit and application of diluted cationic emulsion before spreading the Grit.

A10.1.3.4 Protection of kerbs, channels, etc.

Kerbs, channels, manholes, guard rails, bridge railings and any other structures, adjoining seals to be constructed, shall be protected from soiling. The Contractor shall replace at his own cost any items that have been soiled.

A10.1.3.5 Moisture content

No seal 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. A minimum delay of 24 hours shall apply.

Seal work shall not be permitted on new granular base layers of type G1, G2 or G3 if the moisture content in the upper 50 mm exceeds 50 % of the optimum moisture content as determined in accordance with SANS 3001 No GR30.

Seal work shall not be permitted on new granular base layers of type G4 or G5, if the moisture content in the upper 50 mm exceeds 60 % of the optimum moisture content as determined in accordance with SANS 3001 No GR30.

These limitations shall apply even if the layer has been previously primed.

A10.1.3.6 Pretreatment

New base layers shall be pre-treated if the volumetric macro texture depth varies with more than 40 % or if the macro texture exceeds the guideline values for different seal types as published in SABITA Manual 40.

Existing roads that require resealing shall, if so specified in the Contract Documentation, be given a pretreatment in accordance with one or more of the methods described in Chapter 8.

The following curing periods shall apply to the various treatments listed, prior to applying to seal/reseal unless otherwise specified in Contract Documentation:

Texture treatment using fine slurries.....	6 weeks
Coarse slurry, rapid setting slurry or microsurfacing applied as screed or rut filling	12 weeks
Crack sealing	2 weeks
Asphalt patches for pavement repair	6 weeks
Bitumen treated granular materials.....	4 weeks

Untreated granular and cement stabilised materials 2 weeks

The Engineer may reduce the specified curing period for slurry, microsurfacing and asphalt application, based on a representative corrected ball penetration (SANS 3001-BT10), at the expected operating road surface temperature (Refer SABITA Manual 40) of less than 2,0 mm.

A10.1.3.7 Demarcation of working area

The Contractor shall demarcate the area to be sealed by means of setting out string lines along each edge of the specified seal area. The intervals for setting out horizontal curves shall be as agreed with the Engineer.

Before the tack coat and first application of aggregate may be applied, the centreline of the road shall be demarcated by means of a clearly visible fibre rope, pegged down with nails driven into the existing surface or primed base at intervals of 15 m on straight sections and 3,0 m apart on curves. The demarcating rope shall be removed prior to the application of the tack coat and aggregate on the adjacent lane.

A10.1.3.8 Dust control

Any temporary deviations and construction roads shall be kept watered and damp during all sealing operations and all dust shall be removed from surfaces before any binder, aggregate or slurry is applied.

The supply and application of water on temporary deviations will be paid for separately as specified in Clause A1.5.7.10 of Chapter 1 but payment for watering the haul and construction roads shall be included in the unit rates tendered for the various types of seals used.

A10.1.3.9 Spray joints

a) Transverse joints

In order to prevent overlapping at junctions of separate binder applications the previous work along the joint shall be covered with removable reinforced paper for a sufficient distance back from the joint to ensure that the sprayer is operating at the required speed 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.

b) Longitudinal joints

Longitudinal joints shall be constructed meeting the following requirements:

- Unless specified differently in the Contract Documentation, the spraying of adjacent strips shall overlap by 200 mm i.e. 100 mm of 2/3 application and 100 mm of 1/3 application
- The string line on the joint shall demarcate the area sprayed at full application and 2/3 application
- No turning of the end nozzles or use of fish plates shall be allowed at longitudinal joints
- Aggregate shall only be applied on the area with full triple overlap binder application
- No longitudinal joints are allowed in the wheel tracks
- All aggregate applied on the 2/3 and 1/3 binder application shall be broomed back or chipped off in a neat straight line before the adjoining spray
- All stone-loss shall be made good by the Contractor at no additional cost

A10.1.3.10 Traffic limitations

Traffic shall not be allowed:

- On a single seal or double seal prior to application of the cover spray, if designed with a cover spray
- On the first layer of aggregate of a double seal, second layer of a triple seal (split application double seal) or Cape seal (single seal with slurry)
- On non-completed longitudinal joints

Stop/go positions shall not be allowed at steep grades.

Speed restriction of maximum 60 km/h shall be enforced for at least 24 hours after opening to traffic or for such time as determined by the Engineer. The Contractor shall not allow any construction equipment which is likely to cause damage, over the completed seal.

A10.1.3.11 Opening to traffic

The road shall not be opened to traffic until sufficient adhesion has developed between the binder and aggregate, cover sprays, fog sprays and rejuvenation sprays have lost its tackiness or in the case of slurry seals, the slurry has cured completely.

When non-fluxed binders are applied and cold temperatures are expected, the road shall only be opened to traffic when the surface temperature increases above 20°C.

During the specified embargo period, and unless MC3000 has been used, the road shall only be opened to traffic when the road surface temperature increases above 20°C. Closures are required for the first three days after sealing when the road surface temperature falls below 20°C

When rain is imminent, the road shall only be opened to traffic once the surface is dry.

The Contractor shall erect and maintain the necessary temporary traffic-control signs in accordance with the requirements in the Contract Documentation and the latest version of the South African Road Traffic Signs Manual.

Where a double application of slurry has been specified in case of single seals with slurry, the Contractor shall open the road to traffic before the second layer of slurry is applied.

Where road widths allow, traffic shall be directed through placement of delineators to compact the full width of the applied seal.

A10.1.3.12 Trial sections

Before the Contractor commences with the construction of any seal work he shall demonstrate that the equipment and processes he proposes to use will enable him to construct the seal in accordance with the specified requirements.

At the commencement of the surfacing operation, a 200 m lane section shall be considered as a trial. After completion of each phase of the seal on this 200 m section, the Engineer will review and then approve/reject the work method. If approval is granted for a specific operation i.e. application of tack coat, aggregate, fog or slurry, the Contractor shall proceed with that approved operation and document the approved method statement, which shall include aggregate spread rates, the timing, type, sequence and number of roller passes, as well as the approved strategy for opening to traffic.

Trial sections for sand seals and Grit seals, using emulsion, shall specifically be designed to evaluate the appropriate timing of aggregate application to prevent wave forming as well as the sequence and timing of rollers to prevent pick up.

Should the Contractor at any stage fail to deliver an accepted product, as adjusted, he shall rectify the problems at his own cost, demonstrate with a further trial section that he can carry out the operation successfully and revise the method statement. No specific payment shall be made for conducting these additional trials.

A10.1.3.13 Maintenance

The Contractor shall maintain the bituminous surface until the work is finally accepted by the Employer, after the specified Defects Notification Period. Any damage related to design, materials and workmanship or any defects which may develop before the issue of the Performance Certificate, fair wear and tear and 3rd party mechanical damage excepted, shall be corrected by the Contractor at his own cost.

Treatment of defects shall be carried out in accordance with Chapter 8.

Penalties in accordance with Part D of this Chapter shall apply, when applicable.

A10.1.3.14 Nominal rates of application for tender purposes

The nominal rates of application provided in these specifications are for tendering purposes only and will not necessarily be used in construction. Application rates for all bituminous binders shall be specified at spraying temperature.

All binders, aggregates and slurry used in the various types of seals shall be applied at the rates of application as approved by the Engineer after:

- Measurement of the existing surface characteristics
- Testing of the materials proposed for use
- Aggregate spread rate determination on site
- Construction and evaluation of a trial section
- Documentation of the method statement and approval thereof

a) Single seals

The nominal rates of application given in Table A10.1.3-2 shall be used for tendering purposes only.

The actual application rate shall be as approved by the Engineer after assessing the Contractor's design proposals.

Table A10.1.3-2: Nominal binder application rates for single seals

Nominal size of aggregate mm	Nominal rates of binder application for tack coat (l/m ²)				Nominal aggregate spread rate (m ² per m ³)	
	Conventional bitumen and emulsion. (Residual cold bitumen)	Homogeneous modified emulsion. (Residual cold binder)	Hot applied homogeneous modified bitumen at spray temperature.	Hot applied non-homogeneous modified binders at spray temperature	Aggregate spread rate for conventional and homogeneous modified binders	Aggregate spread rate for non-homogeneous modified binders
20	1.6	1.6	1.9	2.7	70	65
14	1.4	1.4	1.7	2.1	100	90
10	1.0	1.0	1.2	1.6	140	130
7,1	0.75	0.75	0.9	1.1	200	
5	0.6	0.6	0.7		250	

b) Multiple stone seals

The nominal rates of application given in Tables A10.1.3-3 and A10.1.3-4 shall be for the purposes of tendering only and the actual rates of application shall be approved by the Engineer.

The use of cut-back bitumen in the tack coat will only be permitted under special circumstances and if so specified in the Contract Documentation.

Table A10.1.3-3: Nominal rates of first application of binder and aggregate for multiple stone seals

Nominal size of aggregate mm	Nominal rates of binder application for tack coat ((l/m ²))				Nominal aggregate spread rate (m ² per m ³)	
	Conventional bitumen and emulsion. (Residual cold bitumen)	Homogeneous modified emulsion. (Residual cold binder)	Hot applied homogeneous modified bitumen at spray temperature.	Hot applied non-homogeneous modified binders at spray temperature	Aggregate spread rate for conventional and homogeneous modified binders	Aggregate spread rate for non-homogeneous modified binders
20	1.2	1.2	1.3	2.0	75	65
14	0.9	0.9	1.0	1.8	110	90
10	0.7	0.7	0.8	NA	150	130

Table A10.1.3-4: Nominal rates of application for second binder and final aggregate

Nominal size of aggregate mm	Nominal rates of binder application for penetration coat ((l/m ²))				Nominal aggregate spread rate (m ² per m ³)	
	Conventional bitumen and emulsion. (Residual cold bitumen)	Homogeneous modified emulsion. (Residual cold binder)	Hot applied homogeneous modified bitumen at spray temperature.	Hot applied non-homogeneous modified binders at spray temperature	Aggregate spread rate for conventional and homogeneous modified binders	Aggregate spread rate for non-homogeneous modified binders
10	1.0	1.0	1.2	1.8	165	140
7,1	0.8	0.8		-	170	
7,1 (1st layer)*	n/a	n/a		-	250	
7,1 (2nd layer)*	1	1	1.1	-	150	
5	0.6	0.6	0.9	-	230	

*Split application 20/7 double seal

Residual cold binder is defined as the net binder (bitumen, polymers and additives) cold at a temperature of 20°C. The hot applied binder is calculated by multiplying the residual cold bitumen by the "Cold to hot" conversion factors published in TRH3.

c) Nominal binder application and aggregate spread rates for sand and grit seals

The nominal rates of application given in Table A10.1.3-5 shall be for the purposes of tendering only and the actual rates of application shall be as approved by the Engineer.

Table A10.1.3-5: Nominal binder and aggregate application rates for sand and Grit seals

Seal Type	Hot applied 70/100 Pen bitumen at spray temperature.	Hot applied MC3000 at spray temperature.	Hot applied Emulsion at spray temperature.	Aggregate spread rate (m ² per m ³)
Grit precoated		1.1	1.1	200
Grit unprecoated		1.2	1.3	200
Sand	1.0	1.2	1.3	180

d) Nominal binder application and aggregate spread rates for Cape seals (Single seal component)

The nominal rates of binder and aggregate application provided in Table A10.1.3-6 shall apply for tender purposes only.

Table A10.1.3-6: Nominal application for binder and single sized aggregate application in Cape seals

Nominal size of aggregate (mm)	Conventional bitumen and emulsion. (Residual cold bitumen)	Homogeneous modified emulsion. (Residual cold binder)	Hot applied homogeneous modified bitumen at spray temperature.	Aggregate spread rate for conventional and homogeneous modified binders
20	1.2	1.2	1.5	75
14	0.9	0.9	1.2	110
10	0.65	0.65	0.8	150

Residual cold binder is defined as the net binder (bitumen, polymers and additives) cold at a temperature of 20°C. The hot applied binder is calculated by multiplying the residual cold binder by the "Cold to hot" conversion factors published in TRH3.

e) Nominal binder application and aggregate spread rates for Cape seals (Slurry component)

The following proportions per cubic metre of slurry shall apply for tendering purposes only:

- i) First or only slurry application
 - Slurry aggregate (saturated volume) 1,0 m³
 - Stable-grade emulsion at mixing temperature 230 /
 - Cement 16.5kg³
 - Water..... 210 /
- ii) Second slurry application
 - Slurry aggregate (saturated volume) 1,0 m³
 - Stable-grade emulsion at mixing temperature 260 /
 - Cement 16.5kg³
 - Water..... 200 /

The following spread rate of slurry (saturated aggregate volume) shall apply for tender purposes only:

Table A10.1.3-7: Nominal spread rate of slurry for Cape seals

Nominal size of aggregate (mm)	First layer of slurry (m ² per m ³)	Second layer of slurry (m ² per m ³)
20	140	185
14	150	
1	180	

f) Nominal binder application spread rates for Slurry-bound Macadams

The nominal rates of aggregate and slurry application provided in Table A10.1.3-8 shall apply for tender purposes only

Table A10.1.3-8: Nominal application rates of aggregate and Slurry for Slurry-bound Macadam

Layer Thickness (mm)	Nominal size of aggregate (mm)	Aggregate spread rate (m ² /m ³)	Slurry Spread rate (m ² /m ³)
25	14	40	16
30	14	33	13
30	20		
40	20	25	10
50	20		
50	28	20	10

The following proportions per cubic metre of slurry shall apply for tendering purposes only:

- Slurry aggregate (saturated volume) 1m³
- Stable-grade emulsion at mixing temperature 230 /
- Cement..... 0.01m³
- Water..... 200 /

g) Cover sprays

The nominal hot application rate of a diluted emulsion cover spray (50/50) as specified, shall for tender purposes be 0,8 l/m².

h) Slurry

The nominal rate for a void filling coat of diluted 60 % anionic stable-grade emulsion (50/50), before application of the slurry, for tender purposes, shall be 0,8 l/m².

The nominal binder content of the slurry (60 % anionic stable-grade emulsion), for tender purposes shall be taken as 235

l/m³. The nominal active filler content of the slurry, for tender purposes shall be taken as 16,5 kg/m³.

The nominal rate of slurry application is dependent on the thickness and shall be specified in the Contract Documentation.

i) Microsurfacing

The nominal binder content (emulsion) for tender purposes shall be taken as 180 l/m³.

The nominal rate of microsurfacing application is dependent on the thickness and shall be as specified in the Contract Documentation.

A10.1.3.16 Precoating fluid

For tender purposes the nominal quantity of precoating fluid for the relevant nominal aggregate sizes is specified in Table A10.1.3-9.

The nominal application rates as provided in Table A10.1.3-9 are for tender purposes only and must be verified in the site laboratory, with upward adjustment in case of precoating on stockpile by hand or front-end loader.

Table A10.1.3-9: Nominal rates for precoating fluid

Nominal aggregate size (mm)	Nominal precoating application on stockpile or by hand rate (l/m ³)	Nominal precoating application plant precoating rate (l/m ³)
20	12	10
14	14	12
10	16	14
7,1	18	16
5 or Grit	20	18

If required, an adhesion agent approved by the Engineer shall be added to the precoating fluid at a rate of 0,5 % of the volume of precoating fluid.

A10.1.4 DESIGN BY CONTRACTOR / PERFORMANCE BASED SYSTEMS

A10.1.4.1 SCOPE

This Section covers the requirements of surface treatments when the selection and design of the surfacing seal is executed by the Contractor in accordance with the Contract Documentation or when the Contractor's alternative is accepted.

A10.1.4.2 Performance period

A performance period of two years after issuing of the Taking-over certificate, or any other period as specified in the Contract Documentation, shall apply.

A10.1.4.3 Contractor's obligation before tendering

a) Condition assessment

Condition assessments of the road shall be carried out by the Engineer or Employer prior to tendering and the following information supplied to tenderers:

- Visual defect assessment according to TMH9 (Part A and B) per 100 m lane section
- Rutting according to TMH13 in each wheel track (Average per 10 m)
- Macro texture in wheel tracks according to TMH13 (Average per 10 m)
- Macro texture in-between wheel tracks according to TMH13 (Average per 10 m)
- Position, size and condition of existing patches

In addition to the condition assessment, the Contractor / Tenderer should also be obliged to recognise:

- Traffic loading and volumes
- Climatic conditions
- Up- and downgrades along the road
- Traffic accommodation requirements

all of which would impact on his design and construction activities.

b) Achievable specifications

When, in the opinion of the Contractor, the properties of the proposed materials do not adhere to the specifications set in this chapter and/or the prescribed performance over the specified period cannot be met, a set of achievable specifications shall be submitted as part of the tender or, if an alternative is proposed, to the Engineer for evaluation.

A10.1.4.4 General Specifications

a) Quality and Workmanship

Specifications regarding workmanship as defined in the relevant clauses in Part A of this Chapter, for each specific seal type, shall apply.

Prior to commencing with construction, the Contractor shall submit to the Engineer a Quality Management Plan detailing the tests and processes that will be followed during construction of the surfacing seal.

b) Material properties

(i) Aggregate

Aggregate properties shall be in accordance with the specifications for each individual seal type as stated in the relevant section of this chapter.

(ii) Binder

Binder properties shall be in accordance with the specifications for each individual seal type as stated in the relevant section of this chapter.

Should a proprietary product be used, the relevant properties of the selected product, not meeting the generic specifications shall be stated as well as the achievable specifications.

c) Performance Specifications

Performance specifications are provided in D10.1.

d) Remedial work

Requirements for remedial work are provided in D10.1.10.

A10.1.5 MATERIALS

A10.1.5.1 Conventional Bituminous Binders for seal work

Unless Performance Grade binder specifications SANS 4001 BT – 10 are specified in the Contract Documentation, conventional bituminous binders shall comply with the following specifications:

- Penetration-grade bitumen complying with SANS 4001-BT1
- Cut-back bitumen complying with SANS 4001 – BT2:
- Anionic bitumen emulsion complying with SANS 4001 – BT3
- Cationic bitumen emulsion complying with SANS 4001 – BT4

A10.1.5.2 Polymer Modified Bituminous Binders for seal work

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

The bitumen-rubber binder shall comply with the requirements as set out in the latest publication of TG1.:

The Contractor shall provide the Engineer with time versus temperature relationships in regard to the above properties of his specific product before work may start, in order to determine the final process and the acceptance limits.

If a supplier uses a diluent, an ageing test shall be required in which the binder is placed in an oven for 5 hours at 150°C, after which time it shall comply with the above specifications.

The Contractor shall provide the performance record for three recent projects of the materials he intends to use in order to prove 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 design stage.

b) Non-homogeneous modified binders (winter grade)

If non-homogenous modified binders (winter grade) are required, they shall comply with the requirements in the Contract Documentation.

c) Homogeneous cold applied modified binders

(i) Base Bitumen

The cationic emulsion shall be manufactured from bitumen complying with the requirements of SANS 4001-BT1:2012.

(ii) Polymer

The Contractor shall indicate, in the relative pay item in the Pricing Schedule, the type of polymer to be used in the blend.

(iii) Polymer modified emulsion blend

All blending shall be done at the factory. The modified binder for this project shall be specified in the Contract Documentation be as one of binder Class SC-E1 or SC-E2, with the range of binder content and with a "(t)" added to indicate if no fluxing agent or volatile solvent is allowed in the binder) and shall comply with the requirements of the latest publication of TG1.

The recovery binder residue shall be obtained using either the rotary vacuum evaporation or simple evaporation method. If there is any discrepancy in the test results, then the results on recovered binder obtained from the rotary vacuum evaporation method shall be binding.

The use of a volatile solvent flux added to the bitumen shall not be permitted unless approved by the Engineer.

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

(i) Base Bitumen

The base bitumen or blends thereof, shall comply with the requirements of SANS 4001-BT1 or, if specified in the Contract Documentation, with the PG binder specifications as prescribed in Chapter 9. In addition, the chemical composition of the bitumen shall be such as to permit blending with the proposed polymer to form a stable product.

(ii) Polymer

The type and percentage of polymer to be blended with the bitumen is not prescribed, however the Contractor shall indicate, in the relevant

pay item in the Pricing Schedule, the type of polymer to be utilised.

(iii) *Polymer modified blend*

The polymer modified bitumen shall be blended at the factory.

The polymer modified bitumen to be used on this project shall conform to a binder Class S-E1 or S-E2 and shall comply with the requirements of the latest publication of TG1.

The binder for the day's production shall be tested on site to determine the softening point before any seal work is commenced with. As a control, a hand-held spindle viscometer shall be used to monitor the viscosity of the binder at the spray temperature.

No claim for delays due to this requirement shall be considered.

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

The cutting back of the S-E1 binder shall only be allowed when specified in the Contract Documentation.

The percentage of cut back using MC30 shall be 4,5 % during the start and end of winter, with a maximum of 9 % during the coldest periods in the middle of winter.

A10.1.5.3 Bituminous binders for cover sprays

Undiluted or diluted cationic spray grade emulsion shall be used as cover sprays on single or multiple stone seals in accordance with the Contract Documentation.

Unless specified differently in the Contract Documentation, diluted cationic spray grade or anionic stable-grade emulsion (50/50) shall be used as cover sprays on Cape seals (single plus slurry seals).

A10.1.5.4 Bituminous binders for slurry seals

The following shall be used:

- Cover spray, if specified in the Contract Documentation, using diluted 60 % anionic stable-grade emulsion (50/50) in accordance with Clause A8.2.3.2 of Chapter 8.
- Slurry seal: 60 % anionic stable-grade emulsion.

A10.1.5.5 Bituminous binders for microsurfacing overlays

The binder shall be a quickset cationic bitumen emulsion, modified with an elastomer and conforming to AC-E2 specifications as given in the latest publication of TG1. The emulsion must be specially formulated to allow for a time of between 90 and 240 seconds when mixed with the selected aggregate, to ensure sufficient setting time of the mix during placing.

A10.1.5.6 Water for diluting emulsions

Water used for the dilution of emulsions on site shall be suitable potable water, and each source of water used shall be tested for compatibility with the emulsion before it is added to the bulk emulsion.

A10.1.5.7 Precoating fluid

Precoating fluid shall be manufactured from petroleum-based products. The use of tar based precoating fluids shall not be permitted.

If required, an adhesion agent approved by the Engineer shall be added to the precoating fluid at a rate of 0,5 % of the volume of precoating fluid.

A10.1.5.8 Cutting back of bitumen in a dedicated plant

The cutting back of bitumen shall only be allowed when specified in the **Contract Documentation**. The cutting back of bitumen shall be done with MC30 in accordance with SABITA: Guide for the control of HSE hazards associated with the field production of medium curing cutback bitumen. MC30 shall comply with the requirements of SANS 4001 – BT2.

The temperature of the bitumen, when the MC30 is introduced shall not be higher than 140°C.

A10.1.5.9 Heating and storing of bituminous binders

a) Conventional binders

The allowed temperature ranges between which bituminous binders are stored or heated for application shall be as given in SANS 4001_BT1

Binders stored in a heated condition shall be kept in a container with a securely fitting lid and the circulatory system of which is functioning properly. The container shall be provided with a built-in thermometer.

Binders which have been heated above the maximum allowed temperatures shall not be used and shall be removed from the site. Every effort shall be made to maintain the binder temperature for spraying to within 5°C of the recommended temperature.

For seals the temperature limits for 70/100 penetration grade bitumen, cut back with the indicated amounts of MC-30 in parts per 100 parts of bitumen by volume as described in Clause A10.1.5.9, shall be as set out in Table A10.1.5-1 to prevent degradation of the bitumen.

Table A10.1.5-1: Temperature/time limits for conventional binders cut back to specific proportions

Quantity of MC-30 added (parts per 100 parts of bitumen by volume)	Temperature limits	
	Lower limit °C	Upper limit °C
0	150	175
6	146	163
11	138	154
17	132	149
<u>22</u>	<u>125</u>	<u>143</u>

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

After completion of the bitumen-rubber reaction, the handling of the binder shall be in accordance with the latest published TG1.

c) Non-homogeneous modified binders (winter grade)

The Contractor shall comply with the requirements specified in the Contract Documentation with regard to the storage, heating and spraying temperatures.

d) Homogeneous cold applied modified binders

Modified bitumen emulsions may be stored at ambient temperature for long periods, provided that some circulation/mixing takes place from time to time. The spraying temperatures of these emulsions are the same as for conventional bitumen emulsions.

The requirements for short term handling, storage and application of these binders shall be in accordance with the latest published TG1.

e) Homogeneous hot-applied modified binders (summer grade)

Excessive temperature over extended periods will degrade all modified bitumen and negatively affect the enhanced properties of these binders.

The temperature limits for the storage and spraying of modified hot-applied binders shall be in accordance with the latest published TG1

Modified binders stored in a heated condition shall be kept in a container having a properly functioning circulation system and a securely fitting lid.

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

When S-E1 is cut back with MC30, the supplier shall provide temperature-viscosity relationships for the different percentages of MC30 addition and recommendations regarding spray temperatures.

g) Bituminous binders for Cape seals

The type of bituminous binder for the tack coat shall be specified in the Contract Documentation and shall conform to the specifications in Clause A10.1.5.1. No volatile solvents are allowed in the tack coat binder.

Cover spray for Cape seals (single seal plus slurry) shall conform to the specifications in Clause A10.1.5.1.

A10.1.5.10 Single sized aggregate

The aggregate for single, multiple and the first layer of Cape seals shall consist of approved crushed stone of the specified grade and size and shall comply with the following requirements in regard to grading, hardness and shape and durability.

a) Grading

The grade or grades of aggregate to be used must be specified in the Contract Documentation. Table A10.1.5-2 serves as a broad guideline for selection of the aggregate grade appropriate for the expected traffic volume.

Table A10.1.5-2: Aggregate grade

Traffic (AADT)	Less than 300	300 - 3000	More than 3000
Relevant Aggregate Grade	C	B	A

The grading shall comply with the requirements set out in Table A10.1.5-3 for grades A, B or C.

Table A10.1.5-3: Single-sized crushed aggregate grades A, B and C

Sieve size (mm)	Grade	Percentage by mass passing				
		Nominal size (mm)				
		20	14	10	7	5
37.5	A & B					
28		100				
20		85 - 100	100			
14		0 - 35*	85 - 100	100		
10		0 - 5**	0 - 35*	85 - 100	100	
7,1			0 - 5**	0 - 35*	85 - 100	100
5				0 - 5**	0 - 35*	85 - 100
3.35						0 - 35*
2.0					0 - 5**	0 - 5**

	C	Grading shall comply with the requirements for grades 1 and 2 with the following exceptions: * 0 – 50, ** 0 – 10,				
Fines content passing 0,425 mm sieve	A	0.5	0.5	0.5	0.5	1.0
	B	1.5	1.5	1.5	1.5	2.5
	C	2.0	2.0	2.0	3.0	3.5
Dust content: Material passing at 0,075 mm sieve (max)	A	0.2	0.2	0.2	0.5	0.5
	B	0.5	0.5	0.5	1.0	1.0
	C	1.5	1.5	1.5	1.5	1.5

Note: When determined on aggregate before treatment e.g. precoating

b) Hardness

When tested in accordance with SANS 3001 No AG10, the 10 % FACT value shall comply with the requirements in Table A10.1.5-4.

Table A10.1.5-4: Hardness

Relevant Aggregate Grade	C	B	A
Dry 10 % FACT [kN] (min)	130	180	210
Wet 10 % FACT [kN] (min)	100	135	160

c) Polishing stone value

Unless specified differently in the Contract Documentation, the polishing stone value, measured according to SANS 3001-AG11 shall comply with the requirements in Table A10.1.5-5.

Table A10.1.5-5: Polishing stone value

Relevant Aggregate Grade	C	B	A
Aggregate position in seal			
Exposed aggregate	48	49	50
Underlying aggregate	45	47	48

Underlying aggregate refers to the first aggregate layer of a double seal.

d) Shape

The maximum flakiness index, when tested in accordance with SANS 3001- AG4, shall comply with the requirements in Table A10.1.5-6.

Table A10.1.5-6: Flakiness

Relevant Aggregate Grade	C	B	A
20 mm nominal size	30	30	25
14 mm nominal size	30	30	25
10 mm nominal size	35	35	30
7,1 mm nominal size	35	35	30

Ninety-five (95 %) percent of the particles shall have at least three fractured faces. The Average Least Dimension (ALD) of the relevant nominal aggregate sizes, measured according to SANS-AG2 and 3, shall comply with the requirements of Table A10.1.5-7.

Table A10.1.5-7: Average least dimension

Relevant Aggregate Grade	C	B	A
Nominal Aggregate Size (mm)			
20	10.8	12	12
14	7.4	8	8
10 single	5	5.5	5.5
10 second layer	NA	5	5

e) Durability

Grade A aggregate used in seals shall show a durability index of less than 4 as determined by the test method specified in Section A20.1 of Chapter 20.

Should the durability index be higher, additional testing according to current best practice shall be conducted and the results submitted to the Engineer for evaluation.

A10.1.5.11 Aggregate for blinding single seals

The aggregate used for blinding a single seal shall consist of crushed aggregate or river sand complying with Table A10.1.5-9.

The aggregate shall be clean, hard and free from clay, silt or other deleterious matter.

A.10.1.5.12 Aggregate for Sand and Grit seals

The grading for sand and Grit seals shall comply with the requirements set out in Tables A10.1.5-8 and A10.1.5-9.

Table A10.1.5-8: Sand

Sieve size (mm)	Percentage passing by mass
7,1	100
0.300	0 - 15
0.150	0 - 2
Sand Equivalent [%] (min)	35
Plasticity Index: Non-Plastic	

Table A10.1.5-9: Grit

Sieve size (mm)	Percentage passing by mass
5	100
2	0 - 100
1	0 - 50
0,600	0 - 20
0,300	0 - 10
0,150	0 - 5
0,075	0 - 2
Sand Equivalent [%] (min)	35

A10.1.5.13 Aggregate for Graded Aggregate seals

The grading and material property requirements for Graded aggregate seals shall comply with the requirements set out in the Contract Documentation.

A.10.1.5.14 Precoating of Hydrophilic aggregates

Where hydrophilic or other aggregates which may cause problems are encountered, the stone chips shall be precoated, as described below.

a) General

No precoating shall be applied where conventional and modified emulsion binders are used unless specified in the Contract Documentation.

b) Plant precoating

Where plant precoating is specified, the requirements for the end product and environmental specifications shall be in accordance with the Contract Documentation. Adjustments to the nominal quantity of precoating fluid as indicated in Table A10.1.3-9 might be required to ensure that the final product is uniformly coated.

c) Precoating of aggregate stockpiles

The untreated stockpile of aggregate shall be thoroughly sprayed with water, which shall be allowed to drain off. The damp aggregate shall then be loaded into the bucket of a front-end loader with known capacity and a nominal quantity of an approved precoating fluid shall be sprayed evenly over the aggregate by means of a watering can.

The mixture of aggregate and precoating fluid shall then be dumped on a site prepared as specified in Clause A10.1.5.17. This process shall be repeated until a stockpile of approximately 15 m³ to 20 m³ has been built up.

This stockpile shall then be turned over with the front-end loader until the aggregate is uniformly coated with the precoating fluid. Three complete turnings of the stockpile will probably be required. Adjustments to the nominal quantity of precoating fluid as indicated in Table A10.1.3-9 might be required to ensure that the final product is uniformly coated.

The time between the precoating and the placing of the aggregate shall not exceed two weeks.

A10.1.5.15 Aggregate management

a) Stockpiles

The Contractor shall heed the environmental requirements of Section A1.2 of Chapter 1, as well as the Contract Documentation, in the preparation, operation and closure of stockpile sites. The positions for stockpiling of aggregate and the proposed operation methods shall be approved by the Engineer before delivery of the aggregate can commence.

Sites for the stockpiling of aggregates shall be located, prepared and maintained in such a manner that:

No grass, mud, dirt or other deleterious material will be included when the aggregates are loaded for use.

They are not exposed to excessive contamination with dust arising from traffic on the road or access roads. Where necessary, temporary deviations and access roads in the immediate proximity shall be watered or sealed

No dirt is conveyed by vehicle wheels onto the areas to be sealed or resealed whilst aggregate is being transported to or from the stockpiles.

Stockpiles shall always be covered with tarpaulins or similar protective coverings

Aggregates contaminated to the extent that it contains more than the allowable percentage of material passing through the 0.425mm sieve and 0.075mm sieve shall not be used for sealing.

b) Removal of excess aggregate

After application of the seal all loose stones swept off the road surface are to be heaped either in the drain or gravel shoulder, whichever is applicable, and removed in one operation. Under no circumstances shall the excess stone be swept over embankments. No sweepings are to be left on site for more than 24 hours.

A10.1.5.16 Geosynthetic membranes for seal work

The geosynthetic shall be a non-woven geofabric, double needle punched with with properties as specified in Table A10.1.5-10.

Table A10.1.5-10: Specifications for geosynthetic membranes

Property	Unit	Requirement	Test Method
Nominal mass	g/m ²	130	SANS 9864/ISO 9864
Thickness	mm	1,2	SANS 9863/ISO 9863
Tensile strength (min)	kN/m	7	SANS 1525/ISO 10319
Elongation at break	%	40 - 60	SANS 1525/ISO 10319
Penetration load (CBR)	kN	1.5	SANS 12236/ISO 12236
Puncture resistance (DART)	mm	30	SANS 13433/ISO 13433
Tear strength (Min)	N	215	ASTM D4533
Grab strength (Min)	N	400	ASTM D4632
Melting point	oC	>165	ASTM D276
Bitumen retention	l/m ²	>1,0	ASTM D6140

A10.1.5.17 Aggregate and fillers for slurry seals

a) Aggregate

The aggregate for slurry seals shall be an approved crusher sand obtained from a parent rock having a 10 % FACT value (dry) of at least 150 or a mixture of such crusher sand and an approved clean natural sand, where the mixture does not contain more than 25 % of natural sand. The aggregate shall be clean, tough, durable, and angular in shape and shall comply with the grading requirements given in Table A10.1.5-11 for the slurry and the grade or type of aggregate specified.

Aggregate for the particular application shall be specified in the Contract Documentation.

Table A10.1.5-11: Grading limits of aggregate for slurry seals

Sieve size (mm)	Percentage passing sieve, by mass				
	Fine slurry			Coarse slurry	
	Fine Grade	Medium grade	Coarse grade	Type 1	Type 2
14					100
10				100	85 – 100
7,1		100	100	85 – 100	70 – 90
5	100	82 - 100	70 – 90	70 – 90	60 – 80
2	90 - 100	56 – 95	45 – 70	45 – 70	40 – 60
1	65 - 95	37 – 75	28 – 50	25 – 45	25 – 45

0.600	42 - 72	22 - 50	19 - 34	15 - 30	15 - 30
0.300	23 - 48	15 - 37	12 - 25	10 - 20	10 - 20
0.150	10 - 27	7 - 20	7 - 18	6 - 15	6 - 15
0.075	1 - 15	4 - 15	2 - 8	4 - 10	4 - 10

The sand equivalent determined in accordance with SANS 3001 - AG5, shall be at least 35.

The immersion index of briquettes made with slurry aggregate and 70/100 penetration-grade bitumen at the specified net bitumen content for the slurry shall be not less than 75 when tested in accordance with Chapter 20.

In addition, unless otherwise specified, for rapid setting slurries the supplier shall assess the compatibility of the binder offered with aggregates from suitable sources nearest to the site prior to tender closure.

The slurry for Cape seals shall conform to the specifications in Table A10.1.5-11 for Fine Slurry, Fine or Medium as specified for each coat in the Contract Documentation.

b) Filler for slurry

Ordinary portland cement and portland blast-furnace cement (PBFC) shall be SANS 50197 certified.

Road lime shall be SANS 824 certified (Lime for Soil Stabilisation).

Only one of the above materials shall be used throughout in order to prevent undesirable colour differences in the surface.

A10.1.5.18 Aggregate for Microsurfacing

The aggregate shall consist of a continuously graded crusher dust, conforming to the specifications in Table A10.1.5-12.

Table A10.1.5-12: Aggregate grading limits for rapid setting slurries and microsurfacing

Sieve Size (mm)	Type II Percent Passing	Type III Percent Passing	Stockpile Tolerance
	Overlay or Rut fill (up to 12 mm)	Rut fill (more than 12 mm)	
10	100	100	
7,1	100	85 - 100	5%
5	90 - 100	70 - 90	5%
2	65 - 90	45 - 70	5%
1	45 - 70	28 - 50	5%
0.6	30 - 50	19 - 34	5%
0.3	18 - 30	12 - 25	4%
0.15	10 - 21	7 - 18	3%
0.075	5 - 15	5 - 15	2%

A10.1.6 CONSTRUCTION EQUIPMENT

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

A10.1.6.1 Binder distributor

The binder distributor used for distributing the bituminous binders shall-

- Comply with SANS 3001-BT20 and shall be covered by a valid certificate of compliance with SANS 3001-BT20, *not older than 12 months*, issued by an accredited testing organisation
- Not have any fuel, oil or binder leaks;
- Have a straight and clean spraybar, all the spray heads of which shall be of the same type which open simultaneously and shall not leak when closed;
- Have its spray heads all spraying at the same angle to the spraybar and the height adjusted to the correct level so as to obtain the required overlapping. The uneven application of binder shall be unacceptable.
- Have its sieve undamaged and clean;
- Be under the direct control of an operator approved by the Engineer on the grounds of a CV with experience and list of contracts completed with references, in writing or a certificate of competence signed by a representative of a road authority;
- Be fitted with a suitable cut-off spray-head (end nozzles) or fishplates to prevent over spraying onto gravel shoulders or staining of concrete elements on the edge of the surfacing of the road.

- Be capable of spraying the binder at the specified applications rates. The pump of the distributor shall be capable of delivering the binder at the spray bar nozzles at the correct pressure to obtain the specified application rates, irrespective of the viscosity properties of the prescribed binder and the number of nozzles open.
- Fitted with a suitable valve or other access gate for taking of samples of the binder for testing purposes.

The binder distributor, pumps and nozzles, used for non-homogeneous modified binder shall be adapted to spray the rubber modified binder satisfactorily. The Contractor shall provide proof by way of a test on the site that the binder distributor has sufficient reserve power to maintain the required constant speed up the steepest incline to which spray has to be applied and to obtain a uniform distribution of the binder.

The transverse distribution of the spray bar shall be field-verified by means of SANS 3001-BT24. Measurements of transverse distribution ('Bucket test') for a binder distributor. The maximum permissible tolerance permitted between the troughs (excluding the outer 300 mm) is dependent on the viscosity of the binder type being applied and shall be as follows:

- All emulsions, cutback and penetration grade bitumens – 5 %
- Hot homogeneous modified bitumens – 7 %
- Non-homogeneous binders (bitumen rubber) – 10 %

The spray bar shall be of such design as to allow for any adjustments to be made in order to meet the above tolerances. This procedure shall be carried out each time the distributor is first established on site and once a week thereafter or when a problem with transverse distribution is suspected. The distributor shall thus have a set of troughs available in order to allow the execution of the test. For limited quantities of spray-work, the Engineer may accept the results of a recently completed distribution test that has been recorded and approved by an independent supervisor on the distributor's test log book.

The transverse distribution of spray flairs shall be field verified according to SANS 3001-BT24 and Clause A20.1.5.9 of Chapter 20. The maximum permissible tolerance permitted for each trough from the average of the nine troughs is 10 %.

A10.1.6.2 Chip spreaders

The chip spreaders shall be capable of spreading stone of the specified size uniformly and shall be capable of adjustment to permit variation of the rate of application within the specified tolerances and uniform spreading in both the transverse and longitudinal directions.

The chip spreader shall be capable of delivering a proper and uniform transverse distribution of chips across the width of application. The chip distribution shall be tested by means of canvas patches, each 1,0 m by 1,0 m and placed side by side over the full width of application. The mass of chips spread onto each individual canvas patch shall not deviate by more than 10 % from the spread rate determined as part of the trial section and recorded in the approved method statement.

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

In cases where the sprayed width exceeds the maximum spread width of the chip spreader, an additional chip spreader shall be provided to apply aggregate on the remaining strip within twenty seconds of the first chip spreader.

Spreaders which are not self-propelled shall be of a type that can be attached quickly to the rear of trucks and operated while backed over the aggregate being spread.

A non-self-propelled chip spreader may only be used in the event:

- of a breakdown of the self-propelled chip spreader during a pull, and shall be limited to the completion of that pull. No further application of binder shall be permitted until such time as the self-propelled chip spreader is repaired or replaced.
- of spreading Class 3 aggregate, Graded aggregate, Sand- or Grit seals and Slurry-bound Macadam seals.

A10.1.6.3 Rollers

a) General

Sufficient operational rollers of each of the following types shall be available on the works to maintain the required tempo of work.

- Pneumatic tyred rollers (minimum two)
- Rubber-soled steel wheel rollers (as and when specified in the Contract Documentation)
- Light steel wheeled rollers of 2 – 4 tons (minimum two)
- Heavy steel wheel rollers of 5 – 12 tons (as and when specified in the Contract Documentation)

The timing, sequence of rolling and number of passes for each seal type shall be in accordance with the approved method statements following completion of the trial sections.

No seal work shall continue if the required rollers are not on site or not in an operational condition.

b) Pneumatic-tyred rollers

Pneumatic-tyred rollers shall be of a self-propelled type equipped with smooth flat profile pneumatic tyres of uniform size and diameter. The mass of the roller shall not be less than 2 ton per wheel.

The rollers shall be equipped with suitable devices for keeping the wheels wet and clean with water or non-petroleum-based products 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. The total operating mass and tyre pressure shall be in accordance with the manufacturer's recommendations. Individual tyre pressures shall not differ by more than 35 kPa from one another.

In case of sealing more than 12 000 m² per day, using hot binder, at least three pneumatic-tyred rollers are required.

c) Rubber-soled steel-wheeled rollers

Rubber-soled steel-wheeled rollers shall be self-propelled and have a mass of between 6 and 8 tons. It shall be equipped with suitable devices for cleaning and moistening the wheels using water or non-petroleum-based products. The wheels of the roller shall be so arranged as to give one or two complete coverage by one passage of the roller, over a width equal to the rolling width of the roller.

d) Steel-wheeled rollers

Steel-wheeled rollers shall be self-propelled tandem rollers of between 2 and 4 tons mass and shall be equipped with suitable devices for cleaning and moistening the wheels using water or non-petroleum-based products. Heavier rollers shall only be permitted when specified in the Contract Documentation and tested for excessive crushing during construction of the trial section. No steel-wheeled rollers shall be used on the final aggregate layer without the consent of the Engineer, unless a cover spray will be applied after brooming the surface.

A10.1.6.4 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.

A10.1.6.5 Rotary broom

The rotary broom shall be height adjustable self-propelled or a towed type supplied together with a suitable pneumatic-tyred towing vehicle. The minimum bristle length allowed shall be 70 % of the initial length.

A10.1.6.6 Drag broom

A triangular or "Z-shaped" drag broom shall be provided together with a suitable pneumatic-tyred towing vehicle and capable of being ballasted to distribute the specified seal aggregate size.

A10.1.6.7 Miscellaneous equipment

Sufficient equipment for handling and hauling aggregate, binder and slurry, and blending units for non-homogeneous modified binders, shall be provided to ensure prompt and continuous placing and application of bituminous materials as specified. The Contractor shall have available all the necessary ancillary equipment, which shall include hand brooms, mat or reinforced paper for joints, string, nails and hand tools to carry out the work efficiently.

Suitable protective clothing shall be worn at all times.

Suitable fire-fighting equipment for dealing with fires shall be available on site, together with suitable first aid equipment for dealing with injuries and evacuation transport in case of bitumen burns. (Refer to Sabita Manual 8: Bitumen Safety Handbook.)

The Engineer shall be entitled to request reserve plant should there be any doubt as to the efficiency or capability of the equipment provided.

A10.1.6.8 Batch mixer for slurry

A mixer shall be provided in a good working order capable of producing a uniform slurry of the constituent materials. 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. Volume batching will only be permitted with the written approval of the Engineer. Mixing shall be continued until the materials in each batch are thoroughly blended.

A10.1.6.9 Mass-measuring device for large batch mixers

Where payment per ton is specified, the Contractor shall provide and install suitable gauged mass-measuring device on the site. The device shall be provided with a printer for printing the mass, the time and date. The printed data shall be submitted to the Engineer on a daily basis.

A10.1.6.10 Loader for aggregate

A loader, or equivalent capacity labour force where so required in the Contract Documentation, compatible with the needs and capacity of the trucks or mixer, in the case of slurry, unit shall be available at the stockpiling site.

A10.1.6.11 Continuous slurry machine

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 precise metering devices to enable the various constituents to be combined continuously to the selected or prescribed formulation. The mixing of the slurry shall be at a suitable rate adjusted to ensure complete blending of the ingredients and uniformity of mix before depositing into the spreader box.

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

Soft rubber belting shall be attached to the framework in such a manner as to prevent slurry from being spilt 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 the slurry in adjustable widths from 1,5 m to 4,0 m, at specified rates, and it shall have efficient mechanical means of adjusting the rates and widths of application specified.

The mixing and application of microsurfacing 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 appropriate workability measured by the flow (Consistency test: ASTM 3910) shall be verified during the first application and recorded as part of a method statement.

A10.1.6.12 Spreader box for slurry

If the use of a spreader box has been permitted in the Contract Documentation, the type of spreader box used for spreading the slurry shall be submitted to the Engineer, in advance, for approval. The spreader box for rapid setting slurry shall be of a proven and approved type, fitted with a proven and approved device to ensure sufficient agitation within the spreader system.

A10.1.7 EXECUTION OF THE WORKS

A10.1.7.1 Single Seals

a) Preparation

All specifications as stated in Clause A10.1.3 shall be met.

b) Application of tack coat and aggregate

The actual rates of application of binder and aggregate to be used during the construction shall be determined after measurement and evaluation of the existing surface and testing of the aggregate properties the Contractor proposes to use for the seal. The designs shall be submitted to the Engineer for approval prior to any sealing being carried out.

Bituminous binders shall be applied by means of a binder distributor, unless otherwise approved.

If a choice can be exercised areas inaccessible to mechanical equipment shall preferably be restricted to areas that are not subjected to traffic.

A bituminous tack coat consisting of the type and grade of binder specified in these specifications or in the Contract Documentation for each type of bituminous sea, shall be uniformly sprayed on the properly cleaned and prepared base or existing surface over the full specified width of the seal.

Where the tank of the binder distributor could become empty during spraying against inclines, the spraying shall be done while the binder distributor is moving uphill. Should the Engineer be of the opinion that the Contractor is unable to place the sealant over the full specified width in one movement the Contractor shall execute the spraying and the distribution of the aggregate in strips.

Immediately after the binder has been sprayed it shall be covered with clean, dry or pre-coated aggregate of the size specified in these specifications under each of the appropriate sections for each type of seal. The only exception is the spread of sand or Grit after application of an emulsion. In this case the emulsion must start to break before application of the aggregate to prevent wave forming.

The aggregate shall be applied uniformly by means of self-propelled chip spreaders, unless otherwise specified. The spreading of the chips shall be done as closely as possible behind the distributor. The chip spreader shall be so operated that the tack coat shall be covered with aggregate before the wheels of the chip spreader or truck pass over the uncovered tack coat.

The quantity of bitumen sprayed in any single spray operation shall be governed by:

- The quantity of available aggregate. The number of trucks available shall be sufficient to ensure the continuous application of stone behind the distributor.
- Available roller capacity at normal operating speed. In case of hot penetration grade and hot modified binder, at least one roller pass is required within 5 minutes after application of the binder.

Areas with varying or narrowing widths on which binder distributors can be used shall be screened off by means of fibre-reinforced paper, so that only the area to which the binder is to be applied, will be exposed. The binder shall then be applied at the specified rate with a binder distributor. Immediately thereafter the fibre-reinforced paper shall be removed, the aggregate shall be applied and the seal shall be completed.

Where hot binders are used, all the aggregate shall be applied immediately but not more than 2 minutes after the application of the tack coat.

c) Application in case of geosynthetic membrane

Following compliance with all relevant specifications in Clause A10.1.3, a tack coat of cationic 65 % bitumen emulsion (without solvents) or SC-E1(t) shall be applied at a spray rate of 0,8l/m² by means of a hand applicator or distributor. The geosynthetic shall then be applied to the wet tack coat by hand or a suitable mechanical applicator and rolled with a suitable roller to ensure satisfactory bonding between the geosynthetic and the road surface. All wrinkles shall be smoothed out.

The nominal rate of the binder for the single seal shall be as specified in the Contract Documentation.

d) Initial rolling of aggregate

Immediately after the aggregate has been applied on any hot binder, rolling shall be commenced.

In the case of emulsions, immediate rolling by means of self-propelled 2-4 ton steel wheel rollers shall be only permitted if excessive crushing of aggregate does not occur and if another layer of binder will be applied. Pneumatic-tyred rolling shall be delayed until the emulsion has been allowed to break sufficiently to firmly secure the aggregate. Rolling shall be postponed if there is excessive pick-up of aggregate on the tyres of the pneumatic type roller.

Rollers shall operate parallel to the centre line of the road from the shoulders inwards towards the crown of the road until the entire surface has been covered at least four times with the wheels of the roller.

The process (sequence, timing and roller passes) for each seal type shall be finalised during construction of a trial section and documented in a method statement.

e) Broom drag and final rolling of aggregate

After the bituminous binder has set-up sufficiently to prevent any aggregate from being dislodged, and if directed by the Engineer, the surface shall be slowly dragged with a broom drag to ensure even distribution of the aggregate. If there are areas which are deficient in stone chips, additional material shall be added by hand to leave a single layer of chips lying shoulder to shoulder after rolling and traffic compaction.

The Contractor shall provide a back-chipping team, together with a pneumatic-tyred roller, of sufficient capacity to ensure that back-chipping and rolling of aggregate shall be completed within thirty minutes after initial application of the aggregate.

It is essential to ensure that only one layer of aggregate is applied and every care shall be taken to avoid over-application of aggregate.

After completing the spreading of the aggregate, the surface shall be rolled with a self-propelled pneumatic-tyred roller with a minimum load of 2,0 t per wheel for a minimum of four coverages. Except in the case of single seals, constructed without a cover spray, final rolling after brooming off loose aggregate, shall then be done with a steel-wheeled roller with a mass of 2-4 tons working parallel to the centre line of the road from the shoulders towards the crown of the road, until every portion of the surface concerned has been covered by at least four passes of the roller. If excessive crushing occurs

under the rollers, such rolling shall be stopped regardless of the number of passes completed by the roller.

All aggregate contaminated by fuel, oil or grease shall be removed and replaced with clean aggregate.

The process for each seal type shall be finalised during construction of a trial section and documented in a method statement.

All loose aggregate shall be broomed off the surface with a rotary broom or hard brooms before opening to traffic.

The finished surface shall be well-knit and have a uniform appearance free of roller-lyre marks.

f) Cover spray

When required by the Contract Documentation or if so directed by the Engineer in writing, a cover spray of diluted cationic spray grade emulsion shall be applied to the surface of the aggregate by means of a pressure distributor at the rate and dilution specified in the Contract Documentation or as directed by the Engineer.

g) Blinding

If required in the Contract Documentation or as may be directed by the Engineer, a light blinding layer of washed natural or crusher sand, conforming to Clause A10.1.5.11 shall be applied by the Contractor to prevent aggregate from being picked up by traffic. The blinding layer shall be spread evenly over the full indicated surface.

A10.1.7.2 Multiple stone seals

a) Preparation

All specifications as stated in Clause A10.1.3 shall be met.

b) Application of tack coat and first layer of aggregate

The binder of the type and grade and the aggregate of the size and grade specified in the schedule of quantities and according to the design approved by the Engineer, shall be applied as specified in Clause A10.1.7.1b).

c) Application in case of geosynthetic membrane

Following compliance with all relevant specifications in Clause A10.1.3, a tack coat of cationic 65 % bitumen emulsion (without solvents) or SC-E1(t) shall be applied at a spray rate of 0,8/m² by means of a hand applicator or distributor. The geosynthetic shall then be applied to the wet tack coat by hand or a suitable mechanical applicator and rolled with a suitable roller to ensure satisfactory bonding between the geosynthetic and the road surface. All wrinkles shall be smoothed out.

The nominal rate of the binder for the seal shall be as specified in the Contract Documentation.

d) Initial rolling

Initial rolling shall be carried out as specified in Clause A10.1.7.1d).

e) Broom drag and final rolling of aggregate

Dragging and final rolling of aggregate shall be carried out as specified in Clause A10.1.7.1e).

f) Second application of bituminous binder and aggregate

The second bituminous binder shall be applied and followed by the second layer of aggregate of the size specified, in accordance with the approved method statement.

Where hot binders are used, all the aggregate shall be applied immediately but not more than 2 minutes after the application of the tack coat.

The second application of binder shall preferably take place within 48 hours of the application of the tack coat.

Where a 20 mm + double 7,1 mm split application seal is to be constructed, the application of the 7,1 mm aggregate shall be carried out in two separate operations. The first application of the 7,1 mm aggregate shall be placed before application of the second binder application, at the application rate determined during construction of the trial section and then slowly dragged with a drag broom to ensure an even distribution.

g) Initial rolling of second and final layer

Initial rolling of the second layer of aggregate, or final layer in case of the 20 mm and double 7,1 mm split application seal, shall be carried out as specified in Clause A10.1.7.1d) or as per approved method statement

h) Broom drag and final rolling of second layer

Dragging and final rolling of the second layer of aggregate shall be carried out as specified in Clause A10.1.7.1e) or as per approved method statement.

i) Cover spray

When required by the Contract Documentation or if so directed by the Engineer in writing, a cover spray of diluted SC-E1 or diluted cationic spray grade emulsion shall be applied to the surface of the aggregate by means of a pressure distributor at the rate and dilution specified in the Contract Documentation or as directed by the Engineer.

A10.1.7.3 Sand and Grit seals

a) Application of sand seals or Grit seals

Application of sand and Grit seals shall be strictly in accordance with the best practice determined during the trial section and approved in the method statement.

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 can 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.

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 five times.

As wet sand with high dust and or fines content could be difficult to apply, the preparation of the sand should be done well ahead of the actual construction and the appropriate moisture content determined and tested during construction of the trial section.

Where required by the Contract Documentation, the Grit shall be pre-coated with an approved pre-coating agent.

A10.1.7.4 Graded Aggregate Seals (OTTA Seals)

a) Application of the graded aggregate seal

Requirements for the construction of graded aggregate seals shall be in accordance with the Contract Documentation.

A10.1.7.5 Slurry Seals

a) Application of slurry

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

In order to achieve the required workability, the slurry consistency when measured in accordance with ASTM D3910 section 6.1 shall be within the ranges of the target flow stated in Table A10.1.7-1 or the adjusted ranges, approved by the Engineer, after construction of the trial section.

Table A10.1.7-1: Slurry consistency requirements

Application	Target Flow
Slurry bound macadam	60 mm
Hand application of slurry for texture treatment or Cape seals	30 - 40 mm
Slurry overlay	20 - 30 mm
Micro surfacing	10 - 20 mm

A10.1.7.6 Microsurfacing

a) Application of Microsurfacing

Microsurfacing shall be applied using a continuous slurry machine as specified in Clause A10.1.6.11.

The applied thickness of the Microsurfacing, before compaction, should be 20-25 % more than the desired end thickness

The formulation of the product shall be such that complete curing will take place within a maximum of 4 hours, regardless of the climatic conditions during construction, to allow opening to traffic.

Ball penetration (SANS 3001-BT10), corrected for the expected road surface temperature (refer SABITA Manual 40), on the product shall reduce to less than 2,0 mm within a period of 4 weeks.

A10.1.7.7 Cape seals (Stone and slurry combination seals)

a) Application of tack coat and aggregate

The binder of the type and grade and the aggregate of the size and grade specified in the schedule of quantities and Contract Documentation, shall be applied as specified for single seals in Clause A10.1.7.1. If the bituminous binder used for the tack coat is of Class S-E1/S-E2 or 70/100 penetration grade bitumen, the large aggregate for the first layer shall be pre-coated with a bituminous based pre-coating fluid, according to Clause A10.1.5.14 at the rate approved by the Engineer.

If the bituminous binder used for the tack coat is the 70 % polymer modified spray grade emulsion of Class SC-E1(t)/SC-E2(t), no pre-coating of the large aggregate shall be required, unless specified in the Contract Documentation.

The aggregate of the single seal component shall be uniformly spread resembling the "Open Shoulder-to-shoulder" matrix (Refer TRH3) to allow the slurry to properly penetrate into the voids between the aggregate.

b) Initial rolling

Initial rolling shall be carried out as specified in Clause A10.1.7.1d).

c) Broom drag and final rolling of aggregate

Dragging and final rolling of aggregate shall be carried out as specified in Clause A10.1.7.1e).

d) Second application of bituminous binder (cover spray)

A cover spray of diluted emulsion shall be applied to the surface of the large aggregate at the rate approved by the Engineer.

In case of emulsion being used in the tack coat, the cover spray shall only be applied after the tack coat binder has completely cured.

e) Slurry application

(i) Condition of surface

The surface shall be rolled once with a light flat-wheeled roller early in the morning on the day of sealing to depress any loose stones that may have been displaced.

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.

(ii) Timing of slurry application

The slurry shall be applied only after the cover spray has completely cured or dried out

(iii) Mixing of slurry

Mixing of slurry shall be done in accordance with Clause A10.1.6.8.

(iv) Application of slurry

The method of application specified in the Contract Documentation shall be used.

The nominal rates of application given in Table A10.1.5-1 are intended for tendering purposes only and the actual rates of application on the site shall be as per approved method statement after completion of the trial section.

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 one or two layers in the case of 20 mm aggregate and in one layer in the case of 14 mm or 10 mm aggregate, unless otherwise specified in the Contract Documentation.

Both the first and second layer of slurry shall be spread to the full final width of the primed surface.

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.

For seals using 10 mm or 14 mm nominal sized aggregate and the final slurry layer in case of the 20 mm Cape seal, the slurry shall also be struck off so that the tops of the stone will be just visible after the emulsion has cured.

Rolling of the slurry shall commence after the slurry has dried sufficiently. Each layer of slurry shall be roller compacted by at least three roller passes with a pneumatic-tyred roller. However, the final layer shall be compacted until the required in situ water permeability is less than 1.0l/h when measured by means of method SANS 3001-BT12.

The second layer shall be applied only after sufficient time has been allowed for the first layer to cure. And shall not be 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.

Unless specified differently in the Contract Documentation both slurry layers shall be spread only by hand and not with a spreader box. The slurry shall be worked from side to side and criss-cross with the aid of squeegees so as to fill as many spaces as possible.

The slurry batch shall be discharged onto the road in small increments by means of a chute. 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.

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 discharged at an approved site.

The rate of application shall be measured by cubic metre of saturated aggregate, contained in the slurry applied per square metre of surfacing.

The slurry shall be applied to the full road width in one application. If approved 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.

A10.1.7.8 Slurry-bound Macadam Seal

a) Application of aggregate

The aggregate of size and grade specified in the schedule of quantities and Contract Documentation shall be spread evenly to the specified thickness. It is then levelled out with rakes, shovels, screed boards and compacted with a light pedestrian roller in static mode. The slurry is then mixed and evenly spread over the macadam aggregate by wheelbarrow, shovels and squeegees. A pedestrian type plate vibratory compactor is then used to achieve penetration of the slurry until all the voids within the Macadam are filled. A final slurry is then applied.

A moist burlap drag shall be drawn over the final slurry to ensure an overall and even texture. The burlap will be dragged perpendicular across the centre-line of the road. Should breaking of the emulsion, segregation of the mix or formation of the lumps occur during the application of the slurry, the slurry operations shall be discontinued at once and any defective material removed from the road. Successive strips of slurry shall overlap transversely by not less than 25 mm not more than 150 mm. Any overlapping and any omitted areas shall be rectified with squeegees. The contractor shall ensure that either edge of the slurry is finished to the prescribed widths and lines. All stones dislodged in the process of applying the slurry shall be removed from the road and spoiled. Where slurry is spread by hand, the squeegee squad shall be allowed to complete the spreading of each batch onto the road, using squeegees, before the next is discharged. The slurry shall then be worked from side to side criss-cross with aid of squeegees so as to fill as many voids as possible.

The finished slurry layer shall present a smooth, dense and homogenous surface, true to level and camber on the cross fall and from tear cracks, corrugation, rutting or any other irregularity. It shall be free from depressions or elevations and when a straight edge two meters long is laid on the treated surface parallel or at right angles to the centre of the road, the surface shall nowhere vary from the lower edge by more than 3,0 mm along the treated area, the outer edge of the slurry shall be formed neatly in a straight line to the widths ordered by the engineer.

In case a further surfacing layer is applied, the slurry shall be left open to the atmosphere to age and oxidize for a minimum period of 4 weeks, i.e. the slurry shall not be overlaid with any seal or asphalt for 4 weeks

No slurry shall be laid when the ambient temperature is less than 10 °C and in any event not during rain or when free water standing on the surface.

A10.1.8 WORKMANSHIP

A10.1.8.1 General aspects related to quality and workmanship

a) Surface tolerances

Where newly constructed base or shoulder areas are to be sealed, the surfaces shall be checked for compliance with the surface tolerances and all other requirements specified in Chapter 5. Any portions that do not meet these requirements shall first be either corrected or removed and reconstructed before they are sealed.

Surface tolerances specified for the base shall also apply to the sealed surface.

The edges of the completed seal shall be continuously true to line with a maximum allowable deviation from the specified edge line of 15 mm.

b) General appearance

The completed seal shall be free from corrugations or any other wave effect where depressions are preceded and followed by humps or ridges.

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

c) Repair of defects

Any areas which show signs of bleeding, aggregate loss, non-uniformity of texture and surface irregularities after the section has been opened to traffic shall be corrected as specified in Chapter 8. Corrective work shall be carried out in such a manner as to blend in colour, texture and finish with adjacent work.

In case of Cape seals, slurry or microsurfacing, any damage to the slurry by rain or traffic before the slurry has cured shall be rectified by the Contractor at his own expense.

d) Aggregate spread rate and binder application

The maximum permissible variation from the rates of application of aggregate, as approved by the Engineer after verification during the trial section, shall be plus or minus 5 %.

The maximum permissible variation in application rate from that specified (measured at spray temperature), shall be 5 % for all binders, except diluted emulsions. In case of diluted emulsions, the variation shall be calculated in terms of the emulsion before dilution.

A lot for acceptance control purposes shall be at least 600 litres. Lots smaller than 600 litres shall be combined with succeeding lots until a combined lot not less than 600 litres is obtained.

Provided that corrections to subsequent layers (penetration coat and/or cover sprays) could be applied in accordance with good practice, the Engineer could conditionally accept out of tolerance variations at the reduced rates of payment listed in Table A10.1.8-1.

Variations in binder application rates in excess of those tabled shall be deemed rejected. No payment will be made for bituminous binder applied in excess of the rate ordered plus the permitted tolerance.

Rejected sprays shall result in rejection of the total seal without any payment.

Conditional acceptance does not relieve the Contractor from his obligations related to the seal performance.

Table A10.1.8-1: Payment reduction factors for conditionally accepted binder application rates

Diluted emulsion. Deviation from specified spray rate Net emulsion. (%)	Hot applied binder and undiluted emulsion Deviation from specified rate. At spray temperature. (%)	% Payment of tendered rate for seal
±5.0	±5.0	100.00
±6.0	±6.0	97.56
±7.0	±7.0	94.32
±8.0	±8.0	90.28
±9.0	±9.0	85.44
±10.0	±10.0	79.80

The equation for determining the reduced payment per binder layer is provided below:

$$P = -0.004D^2 + 0.0196D + 1.002$$

Where

P = % Payment of the tendered rate for the seal

D = Deviation from the specified rate

In the case of single seals, where a diluted emulsion cover spray is not specified, the Engineer may permit the application of a diluted emulsion fog spray in instances where tack coat application rates are below the minimum allowable tolerances. In such instances, no additional payment over and above the unit rate tendered for the accepted seal, plus or minus any variation from the nominal to the rate ordered, will be made.

In the case of single seals, where a diluted emulsion cover spray is specified, no payment will be made for bituminous binder in the tack coat applied in excess or at a rate lower than the specified rate, plus or minus the permitted tolerance unless in the opinion of the Engineer, such overspray or any shortages can be satisfactorily corrected by the adjustment to the application rate of the cover spray, or an additional cover spray, if such correction is effected.

In the case of multiple stone seals, no payment will be made for any bituminous binder applied in excess of, or at a rate lower, than that specified, plus or minus the permitted tolerance. In such instances the Engineer may permit the adjustment to any subsequent spray applications to achieve the total net binder as determined and specified for the particular seal type. In the event of under application of binder, the Engineer may similarly approve the application, or an increased application, of an appropriate cover spray if the overall integrity/performance of the surface seal is deemed not to be compromised.

In the latter two cases, where some of the layers are conditionally accepted, a weighted payment adjustment shall be calculated based on the payment adjustment for the specific layer and the proportional cost of the binder layer to the total binder cost, as determined from the tendered variation for each binder. An example is provided in Table A10.1.8-2.

Table A10.1.8-2: Calculation of weighted payment adjustment

Binder layer	Binder	Specified hot application rate	Applied rate	% out	Adjustment factor %	Acceptance	Weighted adjustment	Variation (R/l) tendered	Cost of binder (R/l)	%Cost of layer
First application (tack coat)	Hot: S-R1	2.00	2.20	10.00	79.80	Conditional	46.49	6.00	12	58.25
Second application (penetration coat)	Hot: S-E1	1.30	1.20	7.69	91.61	Conditional	28.91	5.00	6.5	31.55
Cover spray	Diluted Cat 65	1.00	1.10							
% Emulsion in dilution	70 Cold: Cat 65	0.7	0.77	10.00	79.80	Conditional	8.13	3.00	2.1	10.19
						% Payment	83.53		20.60	
						Tendered price/m ²	62.00			
						Payment /m ²	51.79			

The weighted adjusted payment factor in the case of multiple binder applications could directly be calculated using the following equation:

$$P_w = P_1 \left(\frac{C_1}{(C_1 + C_2 + C_3)} \right) + P_2 \left(\frac{C_2}{(C_1 + C_2 + C_3)} \right) + P_3 \left(\frac{C_3}{(C_1 + C_2 + C_3)} \right)$$

Where

- P_w = Weighted adjusted payment factor
- P₁ = Payment adjustment factor for the tack coat
- P₂ = Payment adjustment factor for the penetration coat
- P₃ = Payment adjustment factor for the emulsion component of the cover spray
- C₁ = Cost of the tack coat,
calculated by multiplying the specified hot application rate with the tendered variation for the binder
- C₂ = Cost of the penetration coat,
calculated by multiplying the specified hot application rate with the tendered variation for the binder
- C₃ = Cost of the cover spray,
calculated by multiplying the specified application rate with the tendered variation for the emulsion

In the case of graded aggregate seals and sand seals the engineer may accept, an application of binder sprayed above the allowable tolerance subject to the contractor, at his own cost, applying and rolling any additional sand/aggregate necessary as a result of such over application.

B10.1 GENERAL REQUIREMENTS FOR SURFACE TREATMENTS

PART B: LABOUR ENHANCEMENT

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B10.1.1 SCOPE

All the preparation activities are suitable components for labour enhancement (sweeping and watering). The stone spray application is divided into two main activities namely the binder spray application and the stone spreading. The binder spray application is suitable only if bitumen emulsions are used, whilst the stone spreading is reasonably suitable using walk behind chip spreaders. Rolling the stone is a reasonably suitable labour component using pedestrian rollers.

In the interest of limiting the exposure of workers to the burns and inhalation of fumes associated with the application of penetration bitumen by hand, only bitumen emulsions are considered for labour intensive methods for spray seal work. Only emulsion products are suitable for binder applications by hand methods.

B10.1.2 DEFINITIONS

The provisions of PART A, shall apply.

B10.1.3 GENERAL

The provisions of PART A, shall apply.

B10.1.4 DESIGN BY CONTRACTOR/PERFORMANCE BASED SYSTEMS

The provisions of PART A, shall apply.

B10.1.5 MATERIALS

The provisions of PART A, shall apply.

B10.1.6 CONSTRUCTION EQUIPMENT

B10.1.6.1 Binder Distributor: Hand Sprayer

A motorised hot bitumen emulsion hand sprayer, complying with the following requirements, shall be used:

- **Engine:** 5kW diesel or 3,7kW petrol engine.
- **Pump:** Gear type pump, direct from the output shaft of the engine reduction gear through a flexible coupling, capable of delivering 17 to 18 litres of binder per minute.
- **Lance:** It shall have a 5,0 m oil resistant delivery hose fitted to a 1,0 m lance including handle grip, shut off valve and two 65° flat spray adjustable nozzles.
- **Heating:** Ideally sized burner ring, gas regulator, air control valve, heat deflector shield and gas bottle carrying bracket.

B10.1.6.2 Chip spreading equipment

a) Using spotting and hand spreading:

A half 210 litre drum (105 litre) with the bottom removed and two handles fitted to the side of the drum will be used for spotting of the chips prior to hand spreading by shovel.

b) Using a manually operated chip spreader:

When used in place of spotting and hand spreading, the manually operated chip spreader shall be capable of spreading stone of the specified size uniformly over the specified width. It shall be capable of adjustment to permit variation of the rate of application within the specified tolerances and uniform spreading in both the transverse and longitudinal directions.

B 10.1.6.3 Slurry mixer

Mixing of the slurry may be done with any suitable equipment capable of producing a uniform consistency.

B10.1.6.4 Rollers

Sufficient suitably sized (± 1 ton) tandem vibratory pedestrian rollers having two equally sized drums in tandem with both drums driven, each drum to have a separate eccentric shaft, shall be available and used to properly place the stone.

B10.1.6.5 Brooms

Sufficient hand-held brooms shall be available and used to further distribute the chips evenly as directed by the Engineer.

B10.1.6.6 Loader for aggregate

Aggregate may be loaded and transported either by wheelbarrows or containers for which the volume can be calculated.

B10.1.6.7 Pre-coating plant

The pre-coating of chips may be done with any suitable equipment capable of uniformly coating the chips.

B10.1.6.8 Miscellaneous equipment

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

Suitable protective clothing shall be worn at all times.

B10.1.7 EXECUTION OF THE WORKS

The provisions of PART A, shall apply.

B10.1.8 WORKMANSHIP

The provisions of PART A, shall apply.

C10.1 GENERAL REQUIREMENTS FOR SURFACE TREATMENTS

PART C: MEASUREMENT AND PAYMENT

(i) Preamble

The tendered rate for each item shall include full compensation for providing, maintaining and decommissioning upon completion, of all the plant, equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the item, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

(ii) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as he deems appropriate:

1. No separate payment will be made for setting out the works.
2. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
3. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
4. No separate payment will be made for the loading of any materials.
5. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to 1,0 km.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
7. No separate payment will be made for the removal or any surplus material imported to complete the works.
8. For all Works performed, precautionary measures required in terms of the Occupational Health and Safety Act (Act 85 of 1993) and the latest amendments thereof as well as the latest Construction Regulations shall be deemed included in the rates tendered for the relevant products.

(iii) Items to be measured and paid for using items specified elsewhere in the Specifications

None

(iv) Items specifically for this section of the Specifications

Item	Description	Unit
C10.1.1	Single seals including a cover spray, if specified (indicate grade of aggregate and type of binder):	
C10.1.1.1	Using 5,0 mm aggregate	square metre (m ²)
C10.1.1.2	Using 7,1 mm aggregate	square metre (m ²)
C10.1.1.3	Using 10 mm aggregate	square metre (m ²)
C10.1.1.4	Using 14 mm aggregate	square metre (m ²)
C10.1.1.5	Using 20 mm aggregate	square metre (m ²)
Item	Description	Unit
C10.1.2	Single seals including a cover spray, if specified (indicate grade of aggregate and type of binder) spreading the aggregate by (state: walk behind spreader or by hand):	
C10.1.2.1	Using 5,0 mm aggregate	square metre (m ²)
C10.1.2.2	Using 7,1 mm aggregate	square metre (m ²)
C10.1.2.3	Using 10 mm aggregate	square metre (m ²)
C10.1.2.4	Using 14 mm aggregate	square metre (m ²)
C10.1.2.5	Using 20 mm aggregate	square metre (m ²)

The unit of measurement shall be square metre of completed and accepted seal in accordance with the approved method statement and additional instructions.

The nominal rates for single seals indicated in Table A10.1.3-3 shall apply.

The tendered rates shall include full compensation, inter alia, for furnishing all materials, marking the centre line or reference lines, spraying of binder, 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, except the precoating of aggregate, which shall be paid for separately.

Item	Description	Unit
C10.1.3	Multiple stone seals including a cover spray, if specified using:	
C10.1.3.1	20 mm and 10 mm aggregate (state grade of aggregate and type of binder to be used for each layer)	square metre (m ²)
C10.1.3.2	20 mm and 7,1 mm aggregate (state grade of aggregate and type of binder to be used for each layer)	square metre (m ²)
C10.1.3.3	14 mm and 7,1 mm aggregate (state grade of aggregate and type of binder to be used for each layer)	square metre (m ²)
C10.1.3.4	14 mm and 5,0 mm aggregate (state grade of aggregate and type of binder to be used for each layer)	square metre (m ²)
C10.1.3.5	20 mm with a split application of 7,1 mm aggregate (state grade of aggregate and type of binder to be used for each layer)	square metre (m ²)

The unit of measurement shall be the square metre of completed and accepted seal in accordance with the approved method statement and additional instructions.

The nominal rates for multiple stone seals indicated in Tables A10.1.3-4 and A10.1.3-5 shall apply. The tendered rate shall include full compensation inter alia, for furnishing all materials, marking the centreline, spraying of binder 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, including the application of a fog spray, except the precoating of aggregate, which shall be paid for separately.

Item	Description	Unit
C10.1.4	Embargo period effects	
C10.1.4.1	Re-establishment of sealing team after embargo period	lump sum (LS)
C10.1.4.2	Extra-over for sealing during the specified embargo period (State seal type, binder for each layer)	square metre (m ²)

Payment for the rate tendered under item C10.1.6.1 only be applicable when sealing has to cease due to commencement of the embargo period as specified, and due to any approved extension of time not due to the to that originally specified. The tendered rate shall include for all costs associated with re-establishing all necessary plant and equipment in order to complete the works.

The rate tendered under item C10.1.6.2 shall only be applicable if the seal, as specified, cannot be constructed due to commencement of any winter embargo period and where such a situation is due to legitimate and approved extensions of time or sealing during the embargo period is specified in the Contract documentation. The rate tendered shall include for all costs associated with construction the surfacing with any appropriate binder type, reduced production rates, increased traffic accommodation measures and obligations.

Item	Description	Unit
C10.1.5	Sand or Grit seals using:	
C10.1.5.1	Sand seal (state grades of aggregate and types of binders to be used)	square metre (m ²)
C10.1.5.2	Grit seal (state grades of aggregate and types of binders to be used)	square metre (m ²)
Item	Description	Unit
C10.1.6	Sand or Grit seals using (state: walk behind spreader or by hand):	
C10.1.6.1	Sand seal (state grades of aggregate and types of binders to be used)	square metre (m ²)
C10.1.6.2	Grit seal (state grades of aggregate and types of binders to be used)	square metre (m ²)

The unit of measurement shall be square metre of completed and accepted seal in accordance with the approved method statement and additional instructions.

The nominal rates for sand and Grit seals indicated in Table A10.1.3-6 shall apply.

The tendered rate shall include full compensation inter alia, for furnishing all materials, marking the centreline, spraying of binder 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, except the precoating of aggregate, which shall be paid for separately.

Item	Description	Unit
C10.1.7	Graded aggregate (Otta) seals using:	
C10.1.7.1	Single minus 20 mm aggregate (state grades of aggregate and types of binders to be used)	square metre (m ²)
C10.1.7.2	Single minus 14 mm aggregate (state grades of aggregate and types of binders to be used)	square metre (m ²)

C10.1.7.3	Single minus 10 mm aggregate (state grades of aggregate and types of binders to be used)	square metre (m ²)
C10.1.7.4	Extra over for sand seal (state grades of aggregate and types of binders to be used)	square metre (m ²)

Item	Description	Unit
C10.1.8	Graded aggregate (Otta) seals, with aggregate applied by hand, using:	
C10.1.8.1	Single minus 20 mm aggregate (state grades of aggregate and types of binders to be used)	square metre (m ²)
C10.1.8.2	Single minus 14 mm aggregate (state grades of aggregate and types of binders to be used)	square metre (m ²)
C10.1.8.3	Single minus 10 mm aggregate (state grades of aggregate and types of binders to be used)	square metre (m ²)
C10.1.8.4	Extra over for sand seal (state grades of aggregate and types of binders to be used)	square metre (m ²)

The unit of measurement shall be square metre of completed and accepted seal in accordance with the approved method statement and additional instructions.

The nominal rates for Graded aggregate seals as indicated in the Contract Documentation shall apply.

The tendered rate shall include full compensation inter alia, for furnishing all materials, marking the centreline, spraying of binder 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	Description	Unit
C10.1.9	Bituminous binder variations:	
C10.1.9.1	70/100 Penetration grade bitumen	litre (ℓ)
C10.1.9.2	60 % Stable-grade emulsion	litre (ℓ)
C10.1.9.3	Cationic Stable grade emulsion ((indicate bitumen content)	litre (ℓ)
C10.1.9.4	Cationic Spray-grade emulsion (indicate bitumen content)	litre (ℓ)
C10.1.9.5	Homogeneous modified binder (indicate type and bitumen content) cold applied	litre (ℓ)
C10.1.9.6	Non-homogeneous modified binder (indicate class S-R1 or S-R2)	litre (ℓ)
C10.1.9.7	Homogeneous modified binder (indicate type) hot applied	litre (ℓ)
C10.1.9.8	Homogeneous modified binder S-E1 with 4,5% MC30	litre (ℓ)
C10.1.9.9	Homogeneous modified binder S-E1 with 9% MC30	litre (ℓ)
C10.1.9.10	MC-3000 cut-back bitumen	litre (ℓ)
C10.1.9.11	Precoating fluid (state type)	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 (except for diluted emulsions, where the variation is calculated in terms of the emulsion before dilution)

Where MC30 is used to cut back the penetration-grade bitumen, the rate for MC-30 variation shall include full compensation for providing the MC-30 and mixing it with the bituminous binder.

Item	Description	Unit
C10.1.12	Aggregate variation (state grade):	
C10.1.10.1	5 mm aggregate	cubic metre (m ³)
C10.1.10.2	7,1 mm aggregate	cubic metre (m ³)
C10.1.10.3	10 mm aggregate	cubic metre (m ³)
C10.1.10.4	14 mm aggregate	cubic metre (m ³)
C10.1.10.5	20 mm aggregate	cubic metre (m ³)
C10.1.10.6	Sand	cubic metre (m ³)

C10.1.10.7 Grit

cubic metre (m³)

The unit of measurement for aggregate in respect of an increase or a decrease in the rates of application determined during the trial sections and contained in the approved method statement, shall be the cubic metre of aggregate.

Item	Description	Unit
C10.1.11	Application of cover spray:	
C10.1.11.1	60 % Anionic Stable-grade emulsion	litre (ℓ)
C10.1.11.2	60 % Diluted Anionic stable-grade emulsion (indicate dilution in % emulsion/%water)	litre (ℓ)
C10.1.11.3	Diluted Cationic spray-grade emulsion (indicate % bitumen and dilution in % emulsion/%water)	litre (ℓ)
C10.1.11.4	Diluted SC-E1 (indicate % bitumen and dilution in % emulsion/%water)	litre (ℓ)

This pay item shall only apply when an additional cover spray is ordered by the Engineer. Cover sprays included as part of the seal design shall be deemed to be included in the total rate for the pay item of the specific seal.

The nominal rates for cover sprays seals indicated in Clause A10.1.3.15 shall apply.

The unit of measurement shall be the litre of undiluted/diluted emulsion as specified, measured at spraying temperature.

The tendered rate shall include full compensation for furnishing the material and applying the cover spray as instructed.

Item	Description	Unit
C10.1.12	Application of cover spray by hand:	
C10.1.12.1	60% Anionic Stable-grade emulsion	litre (ℓ)
C10.1.12.2	60% Diluted Anionic Stable-grade emulsion (indicate dilution in % emulsion/%water)	litre (ℓ)
C10.1.12.3	Diluted Cationic Spray-grade emulsion (indicate % bitumen and dilution in % emulsion/%water)	litre (ℓ)
C10.1.12.4	Diluted SC-E1 (indicate % bitumen and dilution in % emulsion/%water)	litre (ℓ)

This pay item shall only apply when an additional cover spray is ordered by the Engineer. Cover sprays specified as part of the seal are included in the pay item of the specific seal.

The nominal rates for cover sprays seals indicated in Clause A10.1.3.15 shall apply.

The unit of measurement shall be the litre of diluted/undiluted emulsion as specified, measured at spraying temperature.

The tendered rate shall include full compensation for furnishing the material and applying the cover spray as instructed.

Item	Description	Unit
C10.1.13	Precoating of aggregate using a dedicated plant	
C10.1.13.1	Product containing low flashpoint solvent (indicate precoating fluid)	litre (ℓ)
C10.1.13.2	Product containing no low flashpoint solvent (indicate precoating fluid)	litre (ℓ)

Item	Description	Unit
C10.1.13	Precoating of aggregate using a frontend loader	
C10.1.14.1	Product containing low flashpoint solvent (indicate precoating fluid)	litre (ℓ)
C10.1.14.2	Product containing no low flashpoint solvent (indicate precoating fluid)	litre (ℓ)

Item	Description	Unit
C10.1.14	Precoating of aggregate by hand	
C10.1.15.1	Product containing low flashpoint solvent (indicate precoating fluid)	litre (ℓ)
C10.1.15.2	Product containing no low flashpoint solvent (indicate precoating fluid)	litre (ℓ)

The unit of measurement for the precoating of aggregate shall be the litres of precoating fluid for treatment of the specified aggregate in accordance with the specified precoating method.

The nominal rates for precoating fluid as indicated Table A10.1.3-9 (non-plant) shall apply.

The tendered rate shall include full compensation for furnishing the equipment and materials and precoating the aggregate as specified, including the handling, stockpiling and protecting of the stockpiles against inclement weather.

Item	Description	Unit
C10.1.15	Addition of wetting agent:	
C10.1.15.1	Providing and supplying	prime-cost sum
C10.1.15.2	Handling, applying, profit and all other costs	percentage of prime-cost sum

Prime-cost sum will be paid for in terms of the general conditions of contract for providing and supplying an approved wetting agent to the precoating 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 charges and profit.

Item	Description	Unit
C10.1.16	Aggregate for blinding:	
C10.1.16.1	Natural sand	cubic metre (m ³)
C10.1.16.2	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	Description	Unit
C10.1.17	Aggregate for blinding by hand:	
C10.1.17.1	Natural sand	cubic metre (m ³)
C10.1.17.2	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	Description	Unit
C10.1.18	Extra over item for work in areas inaccessible to mechanical equipment:	
C10.1.18.1	Single seals	square metre (m ²)
C10.1.18.2	Multiple stone seals	square metre (m ²)
C10.1.18.3	Cape seals with one layer of slurry	square metre (m ²)
C10.1.18.4	Cape seals with two layers of slurry	square metre (m ²)
C10.1.18.5	Graded aggregate seals	square metre (m ²)
C10.1.18.6	Sand and Grit seals	square metre (m ²)
C10.1.18.7	Conventional slurry	square metre (m ²)
C10.1.18.8	Microsurfacing	square metre (m ²)
C10.1.18.9	Adding Grit or slurry to single seals on areas subjected to traffic turning and breaking actions or localised cold areas:	
	(a) Application of diluted emulsion (State type, % bitumen and dilution)	litre (ℓ)
	(b) Applying Grit	cubic metre (m ³)
	(c) Applying Texture slurry	cubic metre (m ³)

The tendered rate shall include full compensation for all additional costs to execute the work in areas inaccessible to mechanical equipment.

Payment will not distinguish between the various types of binders or various sizes or grades of aggregate.

Item	Description	Unit
C10.1.19	Supply and application of geosynthetic membrane:	
C10.1.19.1	Supply and application of geosynthetic membrane (state type)	square metre (m ²)

Item	Description	Unit
C10.1.20	Slurry and microsurfacing:	
C10.1.20.1	Conventional slurry (indicate type and grade of binder and grade of aggregate)	cubic metre (m ³)
C10.1.20.2	Microsurfacing (indicate type and grade of binder and grade of aggregate)	cubic metre (m ³)

The unit of measurement for slurry and microsurfacing shall be the cubic metre of saturated fine aggregate as determined according to the method described in Clause A20.1.5.13 of Chapter 20.

The nominal rates for slurry and microsurfacing as per Clause A10.1.3.14 shall apply.

The tendered rates shall include full compensation, for furnishing all materials, demarcating the working area, mixing and applying the slurry, rolling 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	Description	Unit
C10.1.21	Bituminous single seal and slurry, including a cover spray if specified:	
C10.1.21.1	Bituminous single seal with 20 mm aggregate and first slurry (indicate type of tack coat and cover spray binder and grade of aggregate)	square metre (m ²)
C10.1.21.2	Bituminous single seal with 14 mm aggregate and slurry (indicate type of tack coat and cover spray binder, grade of aggregate and grade of slurry)	square metre (m ²)
C10.1.21.3	Bituminous single seal with 10 mm aggregate and slurry (indicate type of tack coat and cover spray binder, grade of aggregate and grade of slurry)	square metre (m ²)
C10.1.21.4	Extra over C10.1.21.1 for application of second slurry (State grade of slurry)	square metre (m ²)

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

The nominal rates for single seals and slurry as per Clause A10.1.3.14 shall apply.

The tendered rates shall include full compensation, for furnishing all materials, demarcating the working area, spraying the binders, spreading the aggregates, 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.

The cost of providing the slurry seal over the final primed width shall be included in the rate for providing the seal with slurry over the bituminous surfaced width

Item	Description	Unit
C10.1.22	Slurry-bound macadam seal:	
C10.1.22.1	Slurry-bound macadam seal with 14 mm aggregate and slurry (indicate thickness and grade of aggregate)	square metre (m ²)
C10.1.22.2	Slurry-bound macadam seal with 20 mm aggregate and slurry (indicate thickness and grade of aggregate)	square metre (m ²)
C10.1.22.3	Slurry-bound macadam seal with 28 mm aggregate and slurry (indicate thickness and grade of aggregate)	square metre (m ²)

The unit of measurement for the complete slurry-bound macadam seal with aggregate and slurry shall be the square metre. The nominal rates for slurry-bound macadam seals as per Clause A10.1.3.14 shall apply.

The tendered rates shall include full compensation, for furnishing all materials, demarcating the working area, spraying the binders, spreading the aggregates, 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	Description	Unit
C10.1.23	Variation in the rate of application of the slurry:	
C10.1.23.1	Fine slurry, Fine grade	cubic metre (m ³)
C10.1.23.1	Fine slurry, Medium grade	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 C1.1.4 of Chapter 1.

Item	Description	Unit
C10.1.24	Variation in active filler content (specify active filler)	ton (t)

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

Payment for variations shall be made as specified in C1.1.4 of Chapter 1.

Item	Description	Unit
C10.1.25	Trial sections for all seal types specified	
C10.1.24.1	(specify seal type)	Lump sum

The tendered rates shall include full compensation, for furnishing all materials, demarcating the working area, constructing the seal, and all other incidentals necessary for completing the work as specified.

Item	Description	Unit
C10.1.26	Provision of Performance Guarantee in respect of the Surfacing:	Lump sum

The tendered rate shall include the provision of a bank guarantee in respect of the Surfacing, for an amount equal to 10 % of the contract value, valid for a period of two (2) years from Completion. The terms and conditions applicable to the release of the guarantee shall be as described under Clause D10.1.7. The guarantee shall be valid for two years, after the issuing of the Completion Certificate.

The performance guarantee as required shall be delivered to the Employer by the successful Contractor before signing of the contract with the applicable date of commencement of validity of the guarantee stated to be from the Completion Certificate and its estimated date.

The guarantee shall be prepared to the format provided in the Contract Documentation. The terms of the conditions applicable to the release of the performance guarantee shall be as described under Clause D10.1.3.

The tendered lump sum shall not be subject to Contract Price Adjustment and shall become payable once the Contractor has submitted and the Employer has accepted the guarantee.

Item	Description	Unit
C10.1.27	Surfacing (State type and binders)	square metre (m²)

The unit of measurement shall be the square metre of surfacing constructed within specifications.

The tendered rate shall include full compensation for materials and construction as well as for process-control testing, and for protecting and maintaining the work, all as specified.

D10.1 GENERAL REQUIREMENTS FOR SURFACE TREATMENTS

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

CONTENTS

PART D: GUARANTEES AND COMPLIANCE CERTIFICATES

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D10.1.10	REMEDIAL WORK

D10.1.1 SCOPE

This Section covers the specifications and work related to the functional and structural condition of the bituminous surface treatment (surfacing seal) in terms of a performance guarantee to be provided by the Contractor, valid for the specific period from the issue of a Completion Certificate for the whole of the Works. It includes performance parameters, field measurements, acceptance criteria and remedial work methodologies.

D10.1.2 GENERAL

This specification supplements Clause A10.1.4.

D10.1.3 PERFORMANCE GUARANTEE REQUIREMENTS

The surfacing shall be constructed in terms of a performance guarantee. The performance guarantee, in the form of a financial guarantee, shall be limited to the performance of the surfacing, only. With the exception of de-bonding between the surfacing and the substrate, the Contractor shall not be held liable for any failures of the surfacing that might occur as a result of failure within the underlying layers. During the Performance Period, the Contractor shall also not be held liable for any damage to the surfacing resulting from "outside" sources, including, but not limited to:

- Traffic accidents
- Spillage of fuel, oils, hazardous materials, etc.
- Materials falling off vehicles
- Travelling of construction/tracked plant (other than his own) after completion of the Works.

Prior to the issuing of the Completion Certificate, the Contractor shall provide a guarantee, valued at 10 % of the cost of the surfacing as measured under item C10.1.25 for the performance of the surfacing layer. The guarantee shall be issued by a bank or other institution approved by the Employer and shall become effective on issue of the Completion Certificate. It shall remain valid until released in terms of Table D10.1.3-1.

The programme for the release of the guarantees shall be as follows:

Table D10.1.3-1: Program for release of guarantees

Time	Activity
Completion of Works and issue of the Taking-Over Certificate	Provision of one guarantees (10 %) Payment of 50 % of retention (as per sub-clause 14.9 of GCC)
Acceptable performance of Works one year after issuing of the Completion Certificate	Payment of balance of retention to be released upon issuing of Performance Certificate (as per sub-clause 14.9 of GCC)
Acceptable performance of the surfacing two years after issuing of the Completion Certificate	Release of guarantee (10 %)

D10.1.4 FUNCTIONAL PERFORMANCE ASSESSMENTS

The monitoring of the functional performance of the Surfacing seal shall be by the visual assessment of functional performance parameters and instrumental assessment of macro texture immediately after completion (prior to the issue of the Completion Certificate), and then by the visual and instrumental assessments of the relevant parameters at the ends of years 1 and 2 after the issuing of the Completion Certificate.

The Employer may, at his sole discretion, omit the assessment programme for the end of year 2 if, in his opinion, there is no evidence of any non-conformance to the specified criteria. The functional performance parameters to be assessed are listed in Table D10.1.4-1 for both visually - as well as instrumentally - assessed parameters.

Table D10.1.4-1: Functional performance parameters for surfacing seals

Visually-assessed parameters	Instrumentally-assessed parameters
1. Surface failure (de-bonding)	1. Surface macro-texture
2. Surface cracking	
3. Surface ravelling (aggregate loss)	
4. Bleeding	

The functional performance assessments undertaken in years 1 and 2 after the issuing of the Completion Certificate shall, as far as practicably possible, coincide with the Employer's regular road-assessment programme within those years. The roughness and surface macro-texture surveys will be commissioned, and the costs thereof will be borne, by the Employer.

D10.1.5 VISUALLY ASSESSED PROPERTIES

D10.1.5.1 Definition

The detailed description and definition for the visually-assessed parameters and the degree of a visually-assessed parameters, as specified in TMH 9 Manual for Visual Assessment of Road Pavements PART A and PART B: issued by the Committee of Transport Officials (COLTO), May 2016. Assessment methodology, shall apply

The visual assessments of the pavement surfacing during the Performance Period shall be undertaken by means of a Visual-Assessment Panel comprising the following representatives:

- Employer: 1 representative
- Contractor: 1 representative
- Engineer or suitably qualified external assessor: 1 representative

All site investigations or inspections shall be undertaken by the panel of representatives. The arrangements, responsibilities and costs for such inspections shall vest with the Contractor, but he shall not be responsible for the travel, accommodation and personnel costs of the Employer and Engineer during the panel inspections. The visual assessments shall be carried out during daylight hours in off-peak periods.

D10.1.5.2 Assessment specification

A detailed visual-assessment (walk over) by the assessment panel will quantify each occurrence of the visually-assessed parameters by rating the degree of distress according to the TMH 9 definitions and the extent as the linear length (in metres) affected in the direction of travel. The minimum linear length to be recorded for any single occurrence of any of the visually-assessed parameters shall be 0,5 metres. Visual assessments must be done in accordance with the specification presented in Table D10.1.5-1.

Table D10.1.5-1: Specification for visual assessment

Item	Specification
Frequency of assessment	Immediately after completion, and then in years 1, 2 and 3 after the issuing of the Taking-Over Certificate and coinciding with the Employer's regular road-assessment programme.
Position of assessment	Each lane and shoulder shall be individually assessed.
Segment lengths	1,0 km
Degree	As defined in TMH 9.
Extent	The actual length affected, with a minimum recorded linear length per single occurrence of 0,5 metres.

D10.1.5.3 Data processing and reports

For each of the visually-assessed parameters the Combined Index Value will be calculated for every 1,0 km segment of each lane and shoulder. The Combined Index Value (CIV) for each visually-assessed parameter will be processed as follows:

$$Combined\ Index\ Value\ (CIV) = \sum_{Degree=1}^5 Degree \times \frac{(Length_{Degree})}{10}$$

$$\left(1 \times \frac{Length_1}{10}\right) + \left(2 \times \frac{Length_2}{10}\right) + \left(3 \times \frac{Length_3}{10}\right) + \left(4 \times \frac{Length_4}{10}\right) + \left(5 \times \frac{Length_5}{10}\right)$$

Where Length₁ = Total linear length (in metres) of degree 1 distress over the 1 km segment, etc.

The processed results shall be used to produce results in the format specified in Table D10.1.5-2.

Table D10.1.5-2: Specification for output of visual assessments

Item	Specification
Unit	Combined Index Value (CIV)
Segment lengths	1,0 km
Statistical summary	Produce Combined Index Value (CIV) for each lane and shoulder

Reporting, which shall be the responsibility of the Contractor, shall consist of the following:

- Completion and copying of report forms according to Employer's format.
- Compiling of report on findings as well as remedial measures required.

The abovementioned requirements shall be completed and delivered in triplicate to the office of the Employer within one calendar month of the inspection date.

D10.1.5.4 Acceptance criteria

The visually-assessed parameters as well as the calculated Combined Index Value shall meet the Acceptance Criteria listed in Table D10.1.5-3 for the applicable year of survey.

Table D10.1.5-3: Acceptance criteria for visually-assessed distress on surfacing seals

Type of Distress	Time ¹ (Years)	Maximum Allowable	
		Degree ²	CIV ³
Surface failure (de-bonding)	1	1	0.0
	2	2	0.1
	3	2	0.2
Surface cracking	1	1	1.0
	2	2	2.0
	3	2	3.0
Surface ravelling	1	1	0.0
	2	2	1.0
	3	3	3.0
Bleeding	1	1	0.0
	2	2	1.0
	3	2	3.0

Notes:

1. Time in years after the issuing of the Taking-Over Certificate.
2. The degree of a visually-assessed parameter as specified in TMH 9 Manual for Visual Assessment of Road Pavements PART A and PART B: issued by the Committee of Transport Officials (COLTO), May 2016.
3. Combined Index Value (CIV) per one kilometre length of lane or shoulder.

D10.1.6 INSTRUMENTALLY ASSESSED PROPERTIES

D10.1.6.1 Surface macro-texture

a) Definition

Macro-texture is the deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of 0,5 – 50 mm.

b) Equipment and accuracy

The macro-texture in terms of Mean Profile Depth (MPD) shall be measured in accordance with the procedure described in Chapter 20.

c) Validation and operation

Validation and operation of the non-contact laser spot sensor must be carried out in accordance with the manufacturer's requirements, and it must have successfully completed the validation trials of the Employer not more than six months before the measurements are taken in accordance with these specifications.

d) Measurement specification

Macro-texture measurements must be taken in accordance with the specification presented in Table D10.1.6-1.

Table D10.1.6-1: Specification for measurement of surface macrotexture

Item	Specification
Frequency of measurement	Between 7 and 14 days after opening to traffic, and then after year 1 and 2 of the performance period, coinciding with the Employer's regular road-assessment programme.
Position of measurement	Both wheel paths and in-between wheel paths of all trafficked lanes.
Testing intervals	Record data over 10m intervals.

e) Data Processing and Reports

Surface macro-texture data must be processed so as to produce results in the format specified in Table D10.1.6-2.

Table D10.1.6-2: Specification for output of surface macro-texture

Item	Specification
Unit	Mean Profile Depth (ISO 13473-1) calculated for each 10 metres.
Segment lengths	1 km
Statistical summary	Produce cumulative distribution graph for each segment

f) Acceptance criteria

Using the cumulative distribution graph for each segment, the measured surface macro-texture must meet the acceptance criteria presented in Table D10.1.6-3.

Table D10.1.6-3: Acceptance criteria (Minimum) for initial surface macro-texture

Seal Type	10 mm	14 mm	14/7	20/10	20/7/7	20/7	20 Cape	14 Cape
5 th Percentile MPD	1.8	1.95	1.5	1.8	1.55	1.7	NA	NA

Notes:

The average MPD value per km lot becomes the reference MPD for performance measurement

The volumetric texture depth as determined by SANS 3001-BT11 = 1.35 times the Mean Profile Depth

Table D10.1.6-4: Acceptance criteria for surface macro-texture performance – double seals

Time	Percentage retention of initial Mean profile depth (%) ²	Maximum (%) of 1 km segment with surface macro-texture retention worse than limit value
Year 1 ¹	85.0	20 %
	80.0	5 %
	75.0	0 %
Year 2 ¹	80.0	20 %
	75.0	5 %
	70.0	0 %

Notes:

1. Time in years after the issuing of the Performance Certificate.
2. Mean Profile Depth value over 10 m.

Table D10.1.6-5: Acceptance criteria for surface macro-texture performance –single seals

Time	Percentage retention of initial Mean profile depth (%) ²	Maximum (%) of 1,0 km segment with surface macro-texture retention worse than limit value
Year 1 ¹	70.0	20%
	60.0	5%
	55.0	0%
Year 2 ¹	60.0	20%
	55.0	5%
	45.0	0%

Notes:

1. Time in years after completion.
2. Mean Profile Depth value over 10 m.

D10.1.7 EVALUATION FOR ACCEPTANCE

The following procedures shall be followed by the Engineer to determine the acceptance of the surfacing or to determine whether remedial work is required on it. These procedures shall be followed as appropriate after each of the assessments.

D10.1.7.1 Assessment on completion of the works

An assessment shall be done on completion of the Works and the Contractor shall repair all defects recorded.

The first 50% of the Retention Money will be released subject to the further requirements of sub-clause 14.9 of the FIDIC Conditions of Contract.

D10.1.7.2 Assessment one year after completion in performance period

Should all parameters meet the full Acceptance Criteria at the end of the Defects Notification Period, the Engineer shall issue a report to the Employer and notify the Contractor accordingly. The balance of the Retention Money will be released.

Should the full Acceptance Criteria not be met, the Engineer shall advise the Contractor of such defects as may be evident and may, in consultation with the Employer, either:

- a) Instruct the Contractor to undertake immediate remedial work.
- b) Grant a concession to allow the remedial work to be held in abeyance until further notices are issued by the Engineer.
- c) Notwithstanding the concessions that may be granted under b) above, the Contractor may elect to attend to and defects immediately.

D10.1.7.3 Assessment two (2) years after completion in performance period

Should all parameters meet the full Acceptance Criteria two years after completion, the Engineer shall issue a report to the Employer and notify the Contractor accordingly and the Performance Guarantee shall be released to the Contractor. The Contract shall then be complete and the Contractor shall then have no further liability for the performance of the works, except for unfulfilled obligations as provided for under clause 11.10 of the FIDIC Conditions of Contract.

Should the full Acceptance Criteria not be met, the Engineer shall advise the Contractor of such defects as may be evident and may, in consultation with the Employer, either:

- a) Instruct the Contractor to undertake remedial work in accordance with Clauses D10.1.8, D10.1.9 and D10.1.10.
- b) Establish a fair valuation of the costs or damages that may be incurred due to the defective work and request payment of such amounts from the Contractor. Once such payments have been received the Performance Guarantee shall be released to the Contractor.
- c) The Contractor may elect to undertake all outstanding remedial work, which shall be undertaken in accordance with Clauses D10.1.8, D10.1.9 and D10.1.10. Upon satisfactory completion of such remedial work and acceptance by the Engineer and the Employer, the Performance Guarantee shall be released to the Contractor

Once the conditions stated under either a), b) or c) above have been met, the Contract shall be complete and the Contractor shall then have no further liability for the performance of the Works.

D10.1.7.4 Assessment at any time during the Performance Period

The Employer or the Engineer shall be entitled to carry out an assessment of the work at any time during the Performance Period. Should any parameter/s fall into the remedial-work-required category, the Employer or his agent shall inform the Contractor who shall immediately propose a solution to rectify the problem/s and obtain the Employer's or his agent's approval and rectify the problem/s in accordance with Clauses D10.1.8, D10.1.9 and D10.1.10.

D10.1.8 ADDITIONAL PROCEDURES TO BE ADOPTED IN THE EVENT OF FAILURE

In addition to procedures described in Clause D10.1.7 the following shall apply:

- a) The Engineer's approval shall be obtained prior to the Contractor's carrying out any remedial work. Notwithstanding the approval by the Engineer of the remedial work, the Contractor shall remain fully liable for the performance of his proposed remedial action/s measured in terms of the specified

performance parameters.

- b) Lane rental shall be applicable when repair work is undertaken by the Contractor during the Performance Period at the rates specified in the Contract Documentation.
- c) In the event of the Contractor's failing to undertake the required steps to rectify/reinstate any defects to conform with the specified requirements, the Employer reserves the right to withhold payment of any monies which are payable to the Contractor or which may become payable to him under the Contract.

D10.1.9 NOTIFICATION OF REMEDIAL WORK

The Employer or his agent shall notify the Contractor in writing of any remedial work or repairs required to the surfacing in terms of this section of the specifications. Such notification shall take place at any time during the Performance Period, but at least after each year of the Performance Period.

The Contractor shall search and find the cause and mechanism of failure and propose appropriate remedial actions within fourteen (14) days of the date of such notification.

Following acceptance by the Employer, a programme of work must be submitted for approval to the Employer or his agent within fourteen (14) days of the date of such acceptance.

The Contractor shall commence with the remedial work within thirty (30) days from the date on which the site is handed to him by an order in writing from the Engineer.

D10.1.10 REMEDIAL WORK

All remedial work or repairs to the surfacing shall comply with the following requirements:

- a) The Contractor shall, at his own cost, supply, erect and maintain the necessary temporary traffic-control signs in accordance with the requirements in the Contract Documentation and the latest version of the South African Road Traffic Signs Manual,
- b) The Contractor shall, also at his own cost, repair/reinstate such items as road studs, road marking, etc., should these be damaged or influenced by the required remedial work.
- c) The various types of remedial work contained in Table D10.1.10-1, depending on the degree of distress, shall be undertaken by the Contractor, at his own cost, to reinstate/rectify specified defects in the pavement surfacing during the specified Performance Period.

Final acceptance shall only be given upon completion of all remedial works to the satisfaction of the Employer and the Engineer.

Table D10.1.10-1: Remedial work for surfacing seals

Type of Distress	Acceptance Criteria	Minimum Remedial Measures
Surface Failure	Requirements in Table D10.1.5-3 not met	Mill out full depth of defective surfacing and replace with suitable asphalt surfacing
Surface Cracking	Requirements in Table D10.1.5-3 not met	Investigation
Surface Ravelling	Requirements in Table D10.1.5-3 not met	Application of a fog spray and slurry texture treatment
Bleeding	Requirements in Table D10.1.5-3 not met	Water cutting of surfacing
Surface Macrotecture	Requirements in Table D10.1.6-4 and Table D10.1.6-5 not met	Water cutting of surfacing