



SECTION 8 CAPE SEALS USING ASPHALT EMULSIONS

8.1 Scope

This performance guide covers materials, equipment and construction procedures for the Cape Seal surface treatment for pavements. It is written as a guide for assistance in preparing specifications and placing Cape Seals.

8.2 Description

Definition — A Cape Seal is a multiple surface treatment that consists of the application of an asphalt emulsion chip seal followed by the application of asphalt emulsion slurry seal.

This pavement treatment method was originally developed in South Africa in the late 1950's by the Cape of Good Hope Provincial Administration for which it was named.

Function-Cape Seals are designed to provide:

1. An economical initial asphalt bound pavement layer over granular bases where stage construction is planned.
2. An economical surface course over new asphalt emulsion sand or dense-graded bases or cold recycled surfaces.
3. To seal existing pavements to retard the entrance of air and moisture and to prevent raveling.
4. Provide a skid resistant driving surface when appropriate aggregate is used.
5. Provide a highly durable surface treatment. The slurry bonds the chips to prevent loss and the chips prevent undue traffic abrasion and erosion of the slurry.

8.3 Applicable Documents

The following standards form a part of this performance guide and reference should be made to them.

- **AEMA — Asphalt Emulsion Manufacturers Association**
- **ASTM — American Society for Testing and Materials**
- **ISSA — International Slurry Surfacing Association**

8.3.1 ASTM Standards

- *C29 Test Method for Unit Weight and Voids in Aggregate*
- *C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate*
- *C117 Test Method for Materials finer than 75 mm (No. 200) in Mineral Aggregates by Washing*
- *C127 Test Method for Specific Gravity and Absorption of Coarse Aggregate*



- C128 *Test Method for Specific Gravity and Absorption of fine Aggregate*
- C131 *Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine*
- C136 *Method for Sieve Analysis of fine and Coarse Aggregates*
- C183 *Practice for Sampling Hydraulic Cement*
- D2419 *Test Method for Sand Equivalent Values of Soils and fine Aggregate*
- D5 *Test Method for Penetration of Bituminous Materials*
- D75 *Practice for Sampling Aggregates*
- D113 *Test Method for Ductility of Bituminous Materials*
- D140 *Practice for Sampling Bituminous Materials*
- D242 *Specification for Mineral filler for Bituminous Paving*
- D244 *Test Methods for Emulsified Asphalts*
- D448 *Classification for Sizes of Aggregate for Road and Bridge Construction*
- D546 *Test Method for Sieve Analysis of Mineral filler for Road and Paving Materials*
- D977 *Specification for Emulsified Asphalt*
- D1139 *Specification for Aggregate for Single or Multiple Bituminous Surface Treatments*
- D2172 *Test for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures*
- D2397 *Specification for Cationic Emulsified Asphalt*
- D2995 *Practice for Determining Application Rate of Bituminous Distributors*
- D3910 *Practices for Design, Testing, and Construction of Slurry Seal*

8.3.2 ISSA Documents

- A105 *Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal Surfaces*
- TB101 *Guide for Sampling of the Slurry Mix for Extraction Test*
- TB 102 *Mixing, Setting and Water Resistance Test to Identify “Quick-Set” Emulsified Asphalts*
- TB 116 *Specifications for Quick-Set Emulsified Asphalt Slurry Seal*
- TB117 *Specifications for Slow-Set Emulsified Asphalt Slurry Seal Systems*
- TB140 *Specifications for Quick-Traffic Emulsified Asphalt Slurry Seal Systems*

8.3.3 AEMA Documents

- *Recommended Performance Guideline for Single and Multiple Chip Seals Using Asphalt Emulsions*
- *Recommended Performance Guideline for Asphalt Emulsion Prime (AEP)*
- *Recommended Performance Guideline for Tack Coat and Fog Seal Using Asphalt Emulsions*

8.4 Asphalt Emulsions

Asphalt emulsions should conform to the requirements of ASTM D977 or ASTM D2397.

The type of asphalt emulsion for the chip seal should be RS-2, HFRS-2, or CRS-2.

The type of asphalt emulsion for the tack coat should be SS-1, SS-1h, CSS-1, or CSS-1h

The type of asphalt emulsion for the slurry seal should be SS-1, SS-1h, CSS-1, CSS-1h, or Quick Setting QS-1h or CQS-1h.



8.5 Aggregate

8.5.1 Cover Aggregate for the Chip Seal

Cover aggregate for the chip seal should conform to the requirements of ASTM D448 and D1139 and may consist of most hard aggregates such as crushed stone, crushed slag or crushed gravel. [Table 8-1 Cover Aggregate for Chip Seal](#) shows the aggregate sizes recommended for the chip seal portion of the Cape Seal.

8.5.2 Aggregate for the Slurry Seal Mixes

Aggregate for the slurry seal mixes should conform to the requirements of ASTM D3910, Type 1 or 2, and may consist of most hard crushed aggregates such as granite, limestone, traprock, slag and expanded clays and shale. [Table 8-2 Aggregate for Slurry Seal](#) shows the aggregate sizes recommended for the slurry seal portion of the Cape Seal.

NOTE

The Type 1 gradation is preferred where it is desired to have the chips remaining uncovered, i.e., producing a knobby surface texture for skid resistance.

Table 8-1 Cover Aggregate for Chip Seal

ASTM Size D448	Nominal Size Square Openings	Cape Seal Application
8	9.5 to 2.36 mm (3/8 in. to No. 8)	City Streets & Urban County Roads
7	12.5 to 4.75 mm (1/2 in. to No. 4)	State Highways & Rural County Roads
6	19.0 to 9.5 mm (3/4 to 3/8 in.)	Untreated Granular Base Courses

Table 8-2 Aggregate for Slurry Seal

ASTM Size D448	Nominal Size Square Openings	Cape Seal Application
8	9.5 to 2.36 mm (3/8 in. to No. 8)	Type 1 or 2
7	12.5 to 4.75 mm (1/2 in. to No. 4)	Type 1 or 2
6	19.0 to 9.5 mm (3/4 to 3/8 in.)	Type 1 or 2



8.6 Other Materials

8.6.1 Mineral Filler

Mineral filler for slurry seal mixes should conform to the requirements of ASTM 0242 and should be used if indicated required by the mix design. Mineral fillers may include materials such as portland cement, hydrated lime, limestone dust and fly ash.

8.6.2 Water

All water used should be potable and compatible with the slurry mix.

8.6.3 Additives

Chemical additives may be used to accelerate or retard the break or set of the slurry mix. The contractor should indicate the type of additive to be used and the initial quantity as predetermined by the mix design.

8.7 Cape Seal Design

8.7.1 Chip Seal

Before work commences, the Contractor should submit a seal coat design covering the specific materials to be used on the project. The compatibility or affinity between the proposed asphalt emulsion and cover aggregate (chips) should have been checked with coating and resistance to stripping determined. The selection of asphalt emulsion quantity or application rate, L/m^2 (gal/yd²), should be based on the suggested design procedures contained in **SECTION 4 SINGLE AND MULTIPLE CHIP SEALS USING ASPHALT EMULSIONS**.

8.7.2 Slurry Seal

Before work commences, the Contractor should submit a mix design covering the specific materials to be used on the project. The design laboratory test report should include evidence that all materials are individually acceptable and are collectively compatible when mixed together to produce the slurry seal. The mix design procedures should be in accordance with those contained in ASTM 03910 and **SECTION 7 RECOMMENDED PERFORMANCE GUIDELINES FOR EMULSIFIED ASPHALT SLURRY SEAL**.

8.8 Equipment

The basic equipment required for the construction of a Cape Seal should include the following:

- Emulsion distributor.
- Cover aggregate spreader, preferably mechanical self-propelled type.
- Roller, preferably pneumatic tired.
- Rotary power broom, vacuum assisted.
- Truck or trailer mounted slurry mixing/spreading machine, continuous flow mixing type.

- Trucks for hauling cover and slurry aggregates.
- Front end loader for filling trucks or slurry machine.
- Auxiliary equipment such as hand tools and barricades.



8.8.1 Asphalt Emulsion Distributor

The distributor used for applying asphalt emulsion for prime coat, tack coat and chip seal should consist of a fully insulated tank mounted on a truck or trailer propelled by a power unit capable of accurately maintaining the speed required for proper application rates. The distributor should have the following minimum capabilities.

An adequate heating system so as to heat asphalt emulsion uniformly to a temperature up to 85° C (185° F). An approved tachometer-odometer to accurately register speed and distances traveled when spraying.

A pump capable of developing uniform pressures or volumes for asphalt emulsion.

A rear mounted spraybar capable of vertical and transverse adjustment to provide proper asphalt emulsion application.

8.8.2 Cover Aggregate Spreader

Cover aggregate spreaders may be of the tailgate type but preferred are the mechanical self-propelled type to obtain a more continuous and uniform rate of cover aggregate application.

8.8.3 Rollers

All rollers should be of the self-propelled type with pneumatic tired preferred, particularly when the surface is uneven or the cover aggregate is soft. A minimum of three rollers is preferred with two rollers staying immediately behind the chip spreader and the third for back rolling.

8.8.4 Rotary Broom

The broom should be a powered rotary type, preferably vacuum assisted unit, which shall be capable of thoroughly cleaning the existing surface prior to chip sealing and removing excess, loose chips before slurry application.

8.8.5 Slurry Mixing Equipment

The slurry mixing equipment should be of the continuous flow type with suitable means of accurately metering each individual material fed into the mixer. The unit should be equipped with approved devices so that the mixer can be accurately calibrated. The mixer should thoroughly blend all materials to produce a homogenous material before leaving the mixer.

8.8.6 Spreading Equipment

The spreading equipment should be a mechanical squeegee type equipped with flexible material in contact with the surface to prevent loss of slurry from the distributing

box. There should be a flexible rear strike-off which is adjustable in width and capable of producing a uniform surface its full width.



For quick-setting type slurry systems, the distributing box may need hydraulic powered augers to prevent premature slurry setting and allow uniform spreading.

8.9 Preparation of Existing Surface

When an untreated base course, the surface should be prepared as outlined in **SECTION 10 ASPHALT EMULSION PRIME (AEP)** which would include the following:

1. Grading to insure the surface is free of local high or low spots and potholes and that the base material is evenly distributed and not segregated.
2. Watering to obtain better penetration of the asphalt emulsion priming materials (done some period in advance of priming so surface is damp but not saturated).
3. Application of asphalt emulsion prime using diluted (normally 1 + 1) SS-1 and SS-1h conforming to ASTM D997, CSS-1 and CSS-1h conforming to ASTM D2397 or other asphalt emulsion grades which have exhibited priming capabilities. Typical application rates of diluted emulsion are 2.3 to 4.5 L/m² (0.5 to 1.0 gal/yd²).
4. Compaction to consolidate loosened base material.
5. The light application, if necessary, of 2.2 to 3.3 kg/m² (4 to 6lb/yd²) of a clean sand to allow for some interim use of the base until placement of the chip seal.
6. For a Cape Seal being placed on an already asphalted surface, the surface should be thoroughly cleaned with loose material, dust, mud and vegetation removed and potholes and other failed areas repaired and wider cracks sealed.

Table 8-3 Application Rates for Chip Seal

ASTM Size D448	Emulsion L/m ² (gal/yd ²)	Aggregate kg/m ² (lb/yd ²)
8 0.	9 to 1.4 (0.20 to 0.30)	8 to 11 (15 to 20)
7	1.1 to1.6 (0.25 to 0.35)	11 to14 (20 to 25)
6	1.6 to 2.0 (0.35 to 0.45)	20 to 25 (35 to45)

8.10 Chip Sealing

The recommended quantities of asphalt emulsion and cover aggregate for the chipping portion of the Cape Seal are given in **Table 8-3 Application Rates for Chip Seal**.

NOTE

The quantities of asphalt emulsion cover the normal range of conditions that include primed aggregate base, cold recycled mat, and old pavement. The application rates will vary within the ranges indicated dependent on cover aggregate gradations and the existing surface condition. The weight of aggregate shown is based upon a material with a specific gravity of 2.65 and on obtaining a single layer of cover stone (attempt to have none to very few extra chips).



8.10.1 Tack Coat

The tack coat should consist of a mixture of equal parts (1 +1) of asphalt emulsion and water applied at a rate of 0.5 to 0.9 L/m² (0.10 to 0.20 gal/yd²).

8.10.2 Temperature and Weather Requirements

The temperature of the surface on which the chip seal or tack coat is to be applied should not be less than 10° C (50° F) and rising. In addition, no rain should be expected for a minimum period of 24 hours.

8.10.3 General Construction Procedures

Normal good practices should be followed for the seal coat construction as outlined in **SECTION 4 SINGLE AND MULTIPLE CHIP SEALS USING ASPHALT EMULSIONS**.

Some of the more important or unique construction procedures required are:

1. Calibration of the asphalt distributor with the use of proper nozzle size and angle and spraybar height above the surface.
2. Immediately after the asphalt emulsion has been applied, it should be covered with chips (spread as close as possible to a single layer).
3. Rolling should begin as soon as possible after the cover aggregate has been applied with pneumatic tired units preferred. The rolling should consist of a minimum of 3 coverages.

NOTE

After the initial rolling has been completed with pneumatic tired units, further rolling may be carried out with a 4.5 to 7.3 tonne (5 to 8 ton) steel wheeled unit (optional). To avoid excessive chip crushing, only one complete coverage should be made.

4. The surface should be clean with the surface broomed prior to the tack coat if needed to remove any excess chips, dirt, and other objectionable matter. Not less than 24 hours after application and the asphalt emulsion for the chip seal has completely broken, the tack coat may be applied.

NOTE

The tack coat may be eliminated if the cover aggregate is clean and not dusty.



8.11 Slurry Sealing

8.11.1 Materials Quantities

The quantities of aggregate and residual asphalt in the slurry mix are given in [Table 8-4 Application Rates for Slurry Seal](#).

Table 8-4 Application Rates for Slurry Seal

ASTM Size D448	Emulsion % Dry wt. of Aggregate	Aggregate kg/m ² (lb/yd ²)
8	16 to 22	Type 1-5.5 to 8.0 (10 to 15)
	14 to 18	Type 2-7.5 to 10.0 (14to18)
7	16 to 22	Type 1-6.5 to 8.5 (12 to 16)
	14 to 18	Type 2-7.5 to 11.0 (14 to 20)
6	14to18	Type 1-8.0 to 11.0 (15 to 20)
	12 to 16	Type 2-10.0 to 13.5 (18 to 25)

NOTE

The aggregate quantities actually used will be dependent on the graduation of the chips and the type of surface texture desired (lesser amount for knobby appearance or increased for greater smoothness).

8.11.2 Temperature and Weather Requirements

The slurry seal should not be applied if the surface temperature is 12° C (54° F) and falling but may be applied if the temperature is above 7° C (45° F) and is rising. No slurry seal shall be applied if there is the possibility that the slurry could freeze within 24 hours after placement. In addition, no rain should be expected for a minimum period of 24 hours.

8.11.3 General Construction Procedures



Normal good practices should be followed for the slurry seal construction as outlined in ISSA's **SECTION 7 RECOMMENDED PERFORMANCE GUIDELINES FOR EMULSIFIED ASPHALT SLURRY SEAL**. Some of the more important or unique construction procedures required are:

1. Each slurry unit to be used should be calibrated or have been calibrated with the exact materials to be used. Test strips should be placed prior to construction to determine the desired quantity of slurry to be spread and to provide samples of slurry for verification of mix consistency and materials proportioning.
2. Immediately prior to placement of the slurry seal, the surface should be cleaned by power brooming and, if needed, flushed with a water truck to remove all loose material, dirt, vegetation and other objectionable matter.
3. Not less than seven days nor more than four weeks after the final emulsion spray, the slurry seal should be applied.
4. As the slurry is applied, the surface should be lightly sprayed with water (damp but no free water puddles).
5. In areas where traffic is to be very light, the slurry may need to be rolled by a self-propelled 9.1 tonne (10 ton) pneumatic tired roller with a water spray system (rolling optional). The slurry should be given a minimum of five coverages. The rolling should not begin until there will be no pickup of the slurry by the tires of the roller but not later than on the first working day following the layer placement.
6. The Cape Seal should not be opened to traffic until the slurry has cured sufficiently so as to not exhibit pickup by the tires of regular traffic (asphalt emulsion broken and turned from brown to black color).

Table 8-5 Cover Aggregate Grading Requirements

Sieve Size square opening mm	Sieve Size square opening in.	Weight, Percent Passing		
		ASTM Size No.6	ASTM Size No.7	ASTM Size No. 8
25.0	1.0	100		
19.0	3/4	90 to 100	100	
12.5	1/2	20 to 55	90 to 100	100
9.5	3/8	0 to15	40 to 70	85 to 100
4.75	No. 4	0 to5	0 to15	10 to30
2.36	No. 8		0 to 5	0 to 10
1.18	No. 16			0 to 5

Table 8-6 Slurry Aggregate Grading Requirements



Sieve Size square opening mm	Sieve Size square opening in.	Weight, Percent Passing		
		ISSA Type 1	ISSA Type 2	ISSA Type 3
9.5	3/8	100	100	100
4.75	No. 4	100	90 to 100	70 to 90
2.36	No. 89	0 to 10	0 65 to 9	0 45 to 70
1.18	No.16	65 to 90	45 to 75	28 to 50
0.60	No.30	40 to 65	30 to 50	19 to 34
0.30	No.50	25 to 42	18 to 30	12 to 25
0.150	No.100	15 to 30	10 to 21	7 to 18
0.075	No. 200	10 to 20	5 to 15	5 to 15