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Recommended Performance Guideline For Chip Seal

A165

NOTICE

It is not intended or recommended that this guideline be used as a verbatim specification. It should be used as an outline, helping user agencies establish their particular project specification. Users should understand that almost all geographical areas vary as to the availability of materials. An effort should be made to determine what materials are reasonably available, keeping in mind system compatibility and specific job requirements. Contact the ISSA for answers to questions and for a list of ISSA member contractors and companies.

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RECOMMENDED PERFORMANCE GUIDELINE FOR CHIP SEAL

1. SCOPE

The intent of this guideline is to aid in the design, testing, quality control, measurement and payment procedures for the application of a Chip Seal Surface.

2. DESCRIPTION

Chip seal shall consist of a uniform spray application of an asphalt binder followed by a uniform application of a graded cover coat aggregate which is then rolled with pneumatic tire rollers over a properly prepared surface. Excess aggregate is removed and an optional application of fog seal (emulsified asphalt) may be applied.

3. SPECIFICATIONS

It is not normally required to run all tests on every project. A compilation of results from the listed tests should be indicative of system performance. Failure to meet the specification for an individual test does not necessarily disqualify the system. If, for example, the system to be used on the project has a record of good performance, individual requirements for testing may be waived. The testing methods are listed in Appendix A and form a part of this guideline.

4. MATERIALS

4.1 ASPHALT BINDER

4.1.1 EMULSIFIED ASPHALT BINDER

The emulsified asphalt shall contain asphalt, water, emulsifier, and may contain polymer. When polymer is used, it is typically recommended that the emulsified asphalt contain three percent (3%) polymer solids based on asphalt weight. It shall be pumpable and suitable for application through a distributor truck. Examples of emulsified asphalt classifications may include RS-2, RS-2h, HFRS-2, CHFRS-2P, CRS-2, CRS-2h, CRS-2P (SBS), CRS-2L (LM). Emulsified asphalt shall meet the requirements listed in Section 5.2.1.

4.1.2 HOT ASPHALT BINDER

The asphalt may be modified or non-modified. The asphalt shall be heated to a point where it is pumpable and suitable for application through a distributor truck. Examples of asphalt classifications are: PG 52 -28, PG 58 -28, PG 64 -22.

4.2 COVER COAT AGGREGATE

4.2.1 GENERAL

The cover coat aggregate used shall be the type specified for the particular application requirements of the chip seal. The cover coat aggregate shall be clean, durable stone such as granite, slag, limestone or other high-quality aggregate.

The shape and quality of the cover coat material is important to the successful application and performance of a chip seal. A hard, crushed, single size aggregate with 100% fractured faces is recommended. Aggregate meeting requirement locks together and provides better long-term retention and stability.

4.2.2 GRADATION

When tested in accordance with AASHTO T 27 (ASTM C 136) and AASHTO T 11 (ASTM C 117), the aggregate gradation shall be within one of the following bands (or one recognized by the local authority).

SIEVE SIZE	TYPE I 1/4" (6.4 mm) Percent Passing	TYPE II 3/8" (9.5 mm) Percent Passing	TYPE III 1/2" (12.5 mm) Percent Passing
3/4" (19 mm)	100	100	100
1/2" (12.5 mm)	100	100	95-100
3/8" (9.5 mm)	100	95-100	0-15
1/4" (6.4 mm)	95-100	0-35	0-10
#8 (2.36 mm)	0-3.0	0-3.0	0-3.0
#200 (75 µm)	0-1.0	0-1.0	0-1.0

4.2.3 QUALITY TESTS

The cover coat aggregate should meet the values specified by the Buyer's Authorized Representative (B.A.R.). See Section 5.2.3.

5. LABORATORY EVALUATION

5.1 GENERAL

Before work begins, the Contractor shall submit the signed certificate(s) of analysis covering the specific materials to be used on the project. System component quality tests will be performed by a laboratory which has experience in designing asphalt chip seals. Once the design has been approved, no material substitution will be permitted unless approved by the B.A.R.

The method of mix design shall be specified by the B.A.R. The mix design shall specify target application rates for both the aggregate and binder as well as permissible operating tolerances so that adjustments may be made due to varying field conditions.

5.2 QUALITY TESTS

5.2.1 EMULSIFIED ASPHALT

The emulsified asphalt and emulsified asphalt residue shall meet the requirements of ASTM D 977, AASHTO M 140, ASTM D 2397, and AASHTO M 208 for emulsion. Recommended tests and values are as follows:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Tests on Emulsified Asphalt			
Residue (Oven Evaporation), %	T 59	D 6934	65 Minimum
Residue (Distillation), %	T 59	D 6997	
Viscosity, Saybolt Furol, 122°F (50°C), sfs	T 59	D 7496	100 – 400
Storage Stability, 24 Hr, %	T 59	D 6930	1.0 Maximum
Sieve, %	T 59	D 6933	0.1 Maximum
Demulsibility (RS-2, HFRS-2, RS-2P, CRS-2P)	T 59	D 6936	40% Minimum
Demulsibility (CRS-2, CRS-2h, CHFRS-2P)			60% Minimum
Tests on Emulsified Asphalt Residue			
Ductility, 77°F (25°C), 5 cm/min, cm	T 51	D 113	40 Minimum
Penetration in dmm, 77°F (25°C), 100g, 5s	T 49	D 5	(Area Specific)
Elastic Recovery, 5 cm/min, % (other test parameters are area specific)	T 301	D 6084	(Area Specific)

Each load of emulsified asphalt shall be accompanied with a Certificate of Analysis (COA) or Certificate of Compliance (COC) to insure it meets the above specifications.

5.2.2 ASPHALT

The asphalt shall meet the requirement of AASHTO M 320 (Performance-Graded Asphalt Binder), AASHTO M 226 (Viscosity-Graded Asphalt Cement), or AASHTO M 20 (Penetration-Graded Asphalt Cement) specification. Examples of commonly used asphalt types:

Performance-Graded Asphalt	Viscosity-Graded Asphalt	Penetration-Graded Asphalt [dmm, 77°F (25°C), 100g, 5 sec]
	AC - 2.5	
PG 52 -28	AC - 5	150 - 250
PG 58 -28	AC - 10	100 - 150
PG 64 -22	AC - 20	60 - 80

5.2.3 COVER COAT AGGREGATE

The cover coat aggregate should meet values specified by the B.A.R. and these minimum requirements:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Flat and elongated particles in cover coat aggregate		D 4791	Ratio of 3:1 <12%
Fractured Face	T 335	D 5821	100%
Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine	T 96	C 131	25% Maximum

6. EQUIPMENT

6.1 GENERAL

All equipment, tools, and machines used in the application of chip seal shall be maintained in satisfactory working conditions at all times.

6.1.1 ASPHALT DISTRIBUTOR

The distributor shall be self-powered and capable of providing a uniform application rate of asphalt binder varying from .05-1.00 gal/yd^2 (0.23-4.5 liters/m^2) over a variable width up to twenty feet (six meters) in a single pass. The uniformity of the distributor shall not vary by more than 0.02 gal/yd^2 (0.09 l/m^2). It shall be equipped with a variable power unit for the pump and full circulation spray bars, which are adjustable laterally and vertically. The nozzle angle and bar height shall be set to provide 100 percent of double coverage in a single pass. Where multiple passes will be required to complete the full width, the four inches (ten centimeters) adjacent to the second pass may be left with 50 percent coverage so that the next pass will complete the full application rate specified. The distributor shall be self-powered and include computerized application controls, a tachometer, pressure gauges, accurate volume devices, calibrated tank, and a thermometer for measuring temperatures of the emulsified asphalt in the tank.

6.1.2 CHIP SPREADER

The machine shall be specifically designed and manufactured to apply various types of aggregate. It shall be self-propelled and supported by at least four tires on two axles capable of providing a uniform application rate of aggregate from 5-50 lbs/yd^2 (2.7-27 kg/m^2) over a variable width. It shall be designed to convey aggregate materials from a rear receiving hopper to a front spread hopper. The front spread hopper will be fixed width or variable width. The machine shall apply this aggregate in a uniform pattern across the entire width of the spread hopper regardless of spreading widths. The application rates will remain consistent regardless of the speed of the machine or changing spread widths. This shall be done with computer controls that monitor the ground speed and adjust the spread hopper rate in relationship to ground speed. Application rates will be preset in lbs/yd^2 (kg/m^2).

6.1.3 PNEUMATIC ROLLERS

A minimum of two self-propelled pneumatic tired rollers shall be used on the project unless otherwise requested by the Project Manager. The rubber tired rollers shall have a gross load adjustable to apply 200-250 psi (1379-1724 kPa) of rolling width. Tire pressure shall be specified for the pneumatic tire rollers and shall not vary more than plus or minus 5.0 psi (34.5 kPa). Depending on the speed of the chip seal operation and the width of coverage, additional rollers may be required. It is recommended that the rollers travel no more than 10 miles per hour.

6.1.4 SWEEPERS

Self-propelled four wheeled rotary mechanical brooms and or vacuum brooms capable of operating in both forward and reverse is recommended. Brooms should be checked to ensure they are in good condition and meet applicable environmental standards.

7. CALIBRATION

The distributor and chip spreaders shall be calibrated to assure the proper amount of binder and aggregate are applied. The calibration shall consist of assuring mechanical and electronic components are set correctly and in good operation order. Distributors should be checked for proper nozzle size. Manufacturers of the equipment can provide detailed instructions for calibration procedures.

8. WEATHER LIMITATIONS

The chip seal shall not be applied when the pavement is moist, or when the weather is, or may be, detrimental. Detrimental weather is defined as rain showers, cool temperatures, moist pavements, threat of rain showers, or other environmental factors which could affect the performance of the chip seal construction. No chip seal shall be applied if either the pavement or air temperature is below 60°F (15.5°C) and falling, but may be applied when both pavement and air temperatures are above 60°F (15.5°C) and rising. Temperatures ranges should be adjusted for regional climates.

9. NOTIFICATION AND TRAFFIC CONTROL

9.1 NOTIFICATION

Homeowners and businesses affected by the construction shall be notified at least one day in advance of the surfacing. Should work not occur on the specified day, a new notification will be distributed. The notification shall be in the form of a written posting, stating the time and date that the surfacing will take place. If necessary, signage alerting traffic to the intended project should be posted.

9.2 TRAFFIC CONTROL

A traffic control plan approved by the B.A.R. will be required before any work begins. Temporary raised pavement markers will be installed as needed, at a minimum of 40 foot (12 meter) spacing. The cost of signage, markers and traffic control necessary to complete this project shall be included in the unit price of the chip seal. Traffic control devices shall be in accordance with agency requirements and, if necessary, conform to the requirements of the Manual on Uniform Traffic Control Devices.

10. SURFACE PREPARATION

10.1 GENERAL

Immediately prior to applying chip seal, the surface shall be cleared of all loose material, silt spots, vegetation, and other objectionable material. Any standard cleaning method will be acceptable. If water is used, cracks shall be allowed to dry thoroughly before applying chip seal. Manholes, valve boxes, drop inlets and other service entrances shall be protected from the chip seal by a suitable method. The B.A.R. shall approve the surface preparation prior to surfacing.

10.2 CRACKS

It is recommended to treat cracks wider than 0.25 in (0.64 cm) in the pavement surface with an approved crack sealer prior to application of the chip seal.

10.3 PATCHING

Prior to the chip sealing operation all failed pavement sections should be removed and patched. The perimeter of excavated areas should be milled or saw cut to form a neat vertical face. Unstable areas of sub-grade should be back filled with well graded and compacted aggregate. Asphalt concrete should then be placed, leveled and compacted to form a smooth and bump free surface.

11. APPLICATIONS

11.1 APPLICATION OF ASPHALT BINDER

Asphalt binder shall be applied by means of a pressure distributor. Application shall be a uniform continuous, full coverage spread, and under such pressure as to thoroughly coat the surface at the specified rate. The forward speed of the distributor truck shall be synchronized with the application of the cover coat aggregate. Asphalt binder shall not be applied on a wet surface or when weather conditions would prevent the proper construction of the chip seal.

11.2 APPLICATION OF COVER COAT MATERIAL

The cover coat material should be applied immediately following the asphalt binder application. The quantity of cover coat aggregate per yd^2 (m^2) shall be specified and agreed upon with the B .A.R. The Contractor, prior to start of work, shall calibrate the aggregate spreader to achieve the design application rate of the cover coat aggregate. Spreading shall be accomplished in such a manner that the tires of the trucks and aggregate spreader never contact the newly applied asphalt binder. The width of the aggregate spreader shall be equal to the width of the asphalt binder coverage, except where additional passes are required. Areas which are deficient in aggregate shall be covered immediately with additional cover coat aggregate.

11.3 ROLLING

Initial rolling shall begin immediately after the application of the cover coat aggregate. Rollers shall work in tandem and complete a minimum of three passes with a sufficient overlap. Should the rolling operation be delayed, the aggregate and asphalt binder application shall be halted until the operation regains proper sequencing and timing. The maximum speed of the rolling operations shall be 10 mph (16 kph).

11.4 SWEEPING

Within 24 hours of curing, excess aggregate shall be swept or picked up from the roadway and adjacent areas. Excess aggregate that is clean may be stockpiled and re-used in subsequent locations at the discretion of the B.A.R.

11.5 FOG SEAL

After the initial sweeping an optional application of fog seal may be applied to all areas chip sealed. The polymer modified fog seal or approved equal emulsion shall be diluted 40 percent with water. The application rate shall vary between 0.08-0.12 gal/yd^2 (0.04-.065 l/m^2) as deemed necessary by the Contractor and B.A.R.

11.6 APPLICATION RATES

The specific asphalt binder, cover aggregate and fog seal application rate shall be determined using factors such as surface temperature, traffic volume, existing road condition and time of year. The Contractor may alter the application rate at any time during the course of the construction upon approval by the B.A.R.

Material	Type I Chip Seal	Type II Chip Seal	Type III Chip Seal
Asphalt	0.20-0.24 gal/yd^2 (0.9-.1.1 l/m^2)	0.24-0.28 gal/yd^2 (1.1-1.27 l/m^2)	0.26-0.32 gal/yd^2 (1.18-1.45 l/m^2)
Emulsified Asphalt	0.28-0.34 gal/yd^2 (1.27-1.54 l/m^2)	0.34-0.40 gal/yd^2 (1.54-1.81 l/m^2)	0.38-0.46 gal/yd^2 (1.72-2.08 l/m^2)
Fog Seal (Emulsified Asphalt)	0.08 gal/yd^2 (0.36 l/m^2) Minimum	0.11 gal/yd^2 (0.49 l/m^2) Minimum	0.12 gal/yd^2 (0.54 l/m^2) Minimum
Cover Coat Aggregate	18 lbs/yd^2 (9.8 kg/m^2) Minimum	22 lbs/yd^2 (11.9 kg/m^2) Minimum	25 lbs/yd^2 (13.6 kg/m^2) Minimum

12. QUALITY CONTROL

12.1 INSPECTION

Inspectors assigned to projects must be familiar with the materials, equipment and the application process of chip seals. Local conditions and specific project requirements should be considered when determining the parameters of field inspection.

Points of emphasis for inspectors on chip seal projects should be: field environmental conditions conducive to application, application rate of asphalt product and aggregate, proper rolling, calibration of equipment, weather conditions, and traffic control.

12.2 MATERIALS

At the B.A.R.'s discretion, material testing may be run on representative samples of the cover coat aggregate and the asphalt binder. Tests will be run at the expense of the Buyer. The B.A.R. must notify the Contractor immediately if any test fails to meet the specifications.

12.3 CHIP SEAL

If required, the B.A.R. may request application rate verification from equipment metering devices taken directly from the asphalt distributor and cover coat aggregate spreader.

12.4 NON-COMPLIANCE

If any two successive tests performed on the stockpile aggregate fail to meet specifications, the job shall be stopped. If any two successive tests of application rate are outside the design parameters, the use of the machine shall be suspended. It will be the responsibility of the Contractor, at his expense, to prove to the B.A.R. that the problems have been corrected.

13. METHOD OF MEASUREMENT

The method of measurement shall be for the total quantity of asphalt binder applied either in gallons, liters, or tons. The surface treatment application shall be measured by the square yard or square meter of surface area treated.

14. PAYMENT

Payment for asphalt binder can be made per gallon, liter or ton of the total quantity applied through approved distributors.

Payment for the cover coat aggregate can be made per ton of total quantity applied through the chip spreader by weigh tickets of material delivered.

Payment for the complete chip seal application can be by the area treated in square yards or square meters.

APPENDIX A

AGENCIES

AASHTO: **American Association of State Highway and Transportation Officials**

ASTM: **American Society for Testing and Materials**

TEST METHODS

EMULSIFIED ASPHALT

AASHTO TEST NO.	ASTM TEST NO.	TEST
T 59	D 6930	Settlement and Storage Stability of Emulsified Asphalts
T 59	D 6933	Oversized Particles in Emulsified Asphalts (Sieve Test)
T 59	D 6934	Residue by Evaporation of Emulsified Asphalt
T 59	D 6936	Determining Demulsibility of Emulsified Asphalt
T 59	D 6997	Distillation of Emulsified Asphalt
T 59	D 7496	Viscosity of Emulsified Asphalt by Saybolt Furol Viscometer
T 200	E 70	pH of Aqueous Solutions with the Glass Electrode
Tests on Emulsion Residue		
T 49	D 5	Penetration of Bituminous Materials
T 50	D 139	Float Test for Bituminous Materials
T 51	D 113	Ductility of Bituminous Materials
T 301	D 6084	Elastic Recovery of Bituminous Materials by Ductilometer

ASPHALT

AASHTO SPEC. NO.	ASTM SPEC. NO.	SPECIFICATION
M 20	D 946 / D 946M	Penetration-Graded Asphalt Cement
M 226	D 3381 / D 3381M	Viscosity-Graded Asphalt Cement
M 320	D6373	Performance-Graded Asphalt Binder