ITEM 25

CHIP SEAL

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25.1 DESCRIPTION

This work shall consist of placing an application of asphalt emulsion and a single size of aggregate to an existing pavement to seal the surface. A uniform surface with acceptable skid resistance should be produced. A fog seal shall be applied if specified by the **AGENCY** or if the **CONTRACTOR** elects to apply one.

The **CONTRACTOR** shall furnish all labor, equipment, materials, supplies, mobilization, traffic control, environmental protection, raised markers, demobilization, and incidentals necessary to provide the chip seal. Traffic control will not be paid separately but shall be included in the bid prices. All workmanship and materials shall conform to the specifications contained herein.

25.2 MATERIALS

A. Non-Polymer Modified Asphalt Emulsion (Fog Seal)

Non-polymer modified asphalt emulsions for the fog seal shall conform to the requirements of AASHTO M 140 (all grades) or AASHTO M 208 (Cationic) as applicable for the designated grades.

When grade CSS-1h or SS-1h emulsified asphalt is used as a fog seal, the residue penetration test values shall be 40 to 120 dmm@ 77°F(ASTM D 5).

B. Polymer Modified Asphalt Emulsion Binder

Polymer modified asphalt emulsions shall conform to the requirements listed in Table 25.2B-1. All test procedures will comply with those in AASHTO T59 except where noted using CDOT CP-L procedures. The asphalt cement shall be polymer modified before emulsification using either a Styrene-Butadiene Rubber or Styrene-Butadiene-Styrene block copolymer and shall contain at least 3 percent polymer by weight of asphalt cement. The emulsion shall be pumpable and suitable for application through a distributor. The mixture shall contain polymer modified asphalt, water and emulsifiers and meet the requirements of CCRS-2R or CRS-2P as listed in Table 25.2B-1.

TABLE 25.2B-1
Emulsified Asphalt Specifications

TEST	CRS-2R	CRS-2P
Viscosity @ 122°F (AASHTO T 59)	50 to 450	50 to 450
Storage Stability (24 hrs) (AASHTO T 59)	1 % Max	1 % Max
Particle Charge Test (AASHTO T 59)	Positive	Positive
Sieve Test (AASHTO T 59)	0.10 % Max	0.10% Max
Oil Distillate-Volume (AASHTO T 59)	3% Max	3% Max
Residue by Evaporation (CP-L 2212)	65% Min	65% Min
Solubility in TCE (AASHTO T44)	97.5% Min.[1]	97.5% Min[1]
Penetration @ 77°F (AASHTO T 49)	70 to 150'	70 to 150'
Coatability (AASHTO T 59)	Good	Good
Demulsibility (AASHTO T 59)	40 Min	40 Min
Toughness 2 77°F (CPL 2210)	Min. 90 in-lb	Min. 70 in-lb
Tenacity @ 77°F (CPL 2210)	Min. 60 in-lb	Min. 45 in-lb
Ductility @ 39.2°F (AASHTO T 51)	40 cm Min	

[1] Denotes tests run on residue from evaporation

Emulsion shall be on the CDOT Approved Products List (APL). The APL identifies emulsion products and emulsion suppliers whose products and quality plans have been vetted to help ensure successful chip seal applications in the field.

Should a manufacturer's emulsion not be on the APL, the supplier of the emulsion shall submit to the **AGENCY** a one quart sample of the final emulsion along with a test report indicating full compliance with the required material properties. The supplier shall provide to the **AGENCY** a copy of their Quality Plan, production, storage, and handling guidelines, material information, and any other information relevant to the quality and successful field construction. The **AGENCY** may reject the emulsion, at it's discretion, based upon failing tests, aggregate incompatibility, or lack of the ability or past history to follow the QC plan. Rejection shall not be cause to delay or increase the cost of a project. The **CONTRACTOR** shall submit sample at least 14 days before construction.

25.3 AGGREGATES

Aggregates shall be hard, durable, clean, and be free of any coatings or deleterious material. The aggregates shall have 100% fractured faces. The aggregate shall have a maximum loss of 25 percent when tested using the LA Abrasion procedure as defined by AASHTO T 96. Only one type of aggregate shall be used and substitutions shall not be allowed. When tested using AASHTO T 182, the aggregate shall retain at least 95 percent of the emulsion. When tested by the boiling water stripping test method ASTM

D 3625, the aggregate shall retain at least 80 percent emulsion. The aggregate shall conform to the gradation shown in Table 25.3-1.

TABLE 25.3-1
Aggregate Gradation

Sieve Size	Type I Chip Seal	Type II Chip Seal	Type III Chip Seal
3/4" (19 mm)	100	100	100
1/2" (12.5 mm)	100	100	90 – 100
3/8" (9.5 mm)	100	90 – 100	5 – 30
#4 (4.75 mm)	90 – 100	5 – 30	0 – 10
#8 (2.38 mm)	5 – 30	0 – 3.0	0 – 3.0
#200 (75 micrometer)	0 – 1.0	0 – 1.0	0 – 1.0

Aggregates shall be kept moist while in the stockpile. Aggregates shall be uniformly moist when delivered to the job site and shall and have a moisture content less than 2.0 percent by weight. Aggregates shall be from a single source. The quarry source shall not change during the course of construction.

25.4 MIX DESIGN

Before work begins, the **CONTRACTOR** shall submit the signed certificate(s) of analysis covering the specific materials to be used on the project. All Aggregate and Emulsion quality tests listed in Sections 25.2 and 25.3 will be performed by a laboratory which has experience in designing chip seals. The design shall be done using the aggregates and emulsion that will be provided for the project. Should the emulsion or aggregate be rejected due to incompatibility this shall not constitute justification for delay or increase the cost of the project. Should materials change during construction a new mix design may be required. The emulsion supplier shall supply the certificate of analysis indicating the materials are compatible. The mix design shall indicate the quantity of emulsion in gal / square yard to be applied using the aggregate supplied for the work.

25.5 EQUIPMENT

Equipment shall include at least one sweeper, one distributor, one aggregate spreader, two pneumatic tire rollers as well as other incidental equipment necessary to complete construction in a timely and efficient manner. This group of equipment shall be denoted as a unit spread and shall be the minimum equipment required. The size and condition of all equipment shall be acceptable to the **AGENCY**. All equipment and machinery shall be kept in good working order, free of leaks and properly muffled. All taxes, licenses and fees shall have been paid and proper licenses and permits shall be posted as required by law.

Should equipment be unsatisfactory for whatever cause, the **CONTRACTOR** shall remove and replace the equipment without delay or cost to the **AGENCY**. Equipment shall conform to the minimum requirements listed in the following sections.

A. Sweeper

A power broom shall be used until the surface is free from dirt or other foreign matter. Hand push brooms shall be used to clean areas not accessible to the power broom. When necessary other equipment including high pressure water and wet brooms shall be provided to thoroughly clean the roadway prior to the application of asphalt emulsion.

B. Distributor

The distributor shall be computer controlled and capable of providing a uniform application rate varying from 0.10 to 1.0 gallons per square yard of emulsion uniformly over a variable width up to 12 feet in a single pass. The uniformity of the distributor shall not vary by more than 0.02 gallons per square yard. The **CONTRACTOR** shall provide verification of the uniformity. The distributor shall be equipped with a variable power unit for the pump and full circulation spray bars which are adjustable laterally and vertically. The distributor spray bar shall contain nipples and valves so constructed that the nipples will not become partially plugged with congealing asphalt material. 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 4 inches adjacent to the second pass may be left with 50 percent coverage so that the next pass completes the full application rate listed in Table 25.6I-1. The distributor shall also contain calibrated and working heater, tachometer, pressure gauges, volume measuring devices, and a thermometer to measure the tank temperature. Calibration records and/or independent testing reports shall be provided prior to use of the distributor.

C. Aggregate Spreader

The aggregate spreader shall be computer controlled, self-propelled and shall be capable of applying aggregates at rates of 5 to 50 pounds per square yard in a uniform manner across variable widths. The variability of the aggregate spreader shall be less than or equal to 1 pound per square yard. Tests shall be run on the aggregate spreader to determine the variability using the specified aggregate gradation for this project. The test shall be run by the **CONTRACTOR** and witnessed by a representative of the **AGENCY**.

D. Rollers

Individual tires on the pneumatic tire rollers shall be similar in nature and identical in loaded stress applied to the friction course. The rollers shall be self-propelled and equipped with smooth tread tires. Care shall be taken that the pneumatic rollers do not break the rock. The tire pressures shall be within 5 psi and shall be

checked daily by the **CONTRACTOR** and reported to the **AGENCY**. Depending upon the speed of the distributor and the aggregate spreader additional rollers may be required.

25.6 CONSTRUCTION

Traffic control shall be provided and shall be in accordance with the *Manual on Uniform Traffic Control Devices*, latest edition. A traffic control plan shall be submitted at least 10 days before any work is performed. The **AGENCY** will review the plan and may require adjustments during construction to accommodate local conditions.

A. Limitations

Chip seal shall not be applied when air temperature is below 60°F and falling, but may be applied when air temperature is 60°F and rising. No construction shall take place when the pavement surface temperature falls below 60°F, when the pavement is moist or dirty, or weather is or may become detrimental in the opinion of the **AGENCY**. Detrimental weather is defined as rain showers, cool temperatures, moist pavement or other factors which could affect the performance of the construction. Construction shall occur only during daylight hours and prior to October 1st.

B. Surface Preparation

Sweeping shall be performed the same day as the application of emulsion. The **CONTRACTOR** shall be responsible for all measures required to provide a thoroughly clean and dry pavement surface including sweeping and washing. The **CONTRACTOR** shall determine the work necessary to provide a clean, dry pavement for construction and shall include the work necessary. No separate measurement and payment for surface preparation shall be made.

If removal of worn or excessively built up paint or thermoplastic pavement markings is included in the project, the **CONTRACTOR** is responsible for complete removal and cleanup of the pavement marking materials to satisfaction of the project manager. In general, pavement marking removal methods shall not exceed 1/8” depth into the underlying pavement surface.

Manholes, valve boxes and other features within the construction zone which are not to be treated with the friction course shall be protected. The manner of protection shall be the **CONTRACTOR’S** responsibility and the **CONTRACTOR** shall be responsible for cleaning all materials from utilities within 48 hours. Clean up shall be done before completing an area including sand blasting of any overspray.

C. Emulsion Application

The application of the emulsion shall be performed by the distributor in a manner to achieve a uniform, continuous spread of emulsion over the section treated. The temperature of the emulsion at the time of application shall be 160°F to 195°F or as recommended by the manufacturer. The quantity of emulsion to be applied shall be in accordance with the final design using the aggregate supplied for the work. The
AGENCY may alter the application rate by up to 50 percent at any time during the course of construction if in the opinion of the **AGENCY** the porosity of the pavement surface is excessive.

If at any time a nozzle becomes clogged or not spraying a proper pattern, the operation shall be immediately halted until repairs are made. At no time shall water or solvents of any kind be used to fix a clog or repair the chip seal equipment. The area covered by any one spread of asphalt emulsion shall not exceed 100 feet and be no more than can be covered with aggregate within 1 minute from the time of the application upon any part of the spread. If field conditions warrant, this time may be increased by the **AGENCY**. The width of the spread shall be no greater than the width shown on the plans or the width of the aggregate spreader, whichever is less. Where additional passes are required, the emulsion may be extended 4 inches beyond the aggregate spread at a 50 percent application rate. At no time shall the emulsion be allowed to pre-maturely break, chill, setup, harden or otherwise impair the aggregate retention. After completion of the spread, during repairs or normal work stoppages, the distributor shall be parked off the roadway and the spray bar shall be protected from spillage on public or private property.

D. Aggregate Application

Aggregate shall be applied immediately following the emulsion application, by the acceptable aggregate spreader at the application rate listed in Table 25.6I-1. The aggregate spreader shall be calibrated by the **CONTRACTOR** to achieve the design application rate beginning at the start of work in an area. The results shall be transmitted at the completion of each test on the **CONTRACTOR'S** daily report.

The spreader shall be positioned such that the tires of the unit never contact the emulsion. The spreader shall be positioned such that the emulsion does not have time to break, cure, chill, or harden before the aggregate is placed. The width of the aggregate spread shall be equal to the width of the emulsion spread, except where additional passes are required for an adjacent lane. The aggregate spreader shall not cover the outside 4 inches of the emulsion which has been applied at a 50 percent application when planning for an adjacent pass.

The **AGENCY** may alter the application rate at any time during the construction operations to ensure that the chips are approximately 50% embedded in the

emulsion. The application rates in Table 25.6I-1 must be met for the final accepted surface.

E. Clean Up Operation

Areas which are deficient in aggregate or emulsion shall be immediately covered with additional material to the satisfaction of the **AGENCY**.

F. Rolling

Initial rolling shall start immediately after the aggregate is spread. A minimum of two pneumatic tire rollers shall be used. Rollers shall work in tandem and shall overlap 50 percent. Rolling shall be completed within 40 minutes after the application of the aggregate and before the emulsion breaks, cures, chills or hardens. Should the rolling operation be delayed, the aggregate and emulsion spreading shall be halted until the operation regains proper sequencing and timing. The maximum speed of the rolling operation shall be 5 miles per hour. A minimum of four passes of the roller shall be required. Roller must be able to keep up with the distributor and chip spreader and provide enough passes to embed the chips. If the rollers travel too fast, embedment will not be achieved. This is because the rollers need to 'linger' over an area of chip seal to obtain the desired chip embedment.

G. Finishing

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 **AGENCY**. **CONTRACTOR** shall be held responsible for any windshield or vehicle damage that may occur.

H. Opening to Traffic

Traffic may be allowed on the chip seal after rolling is completed; however, traffic speed should be limited to about 20 miles/hour for about 2 hours after placement.

I. Fog Seal

After the initial sweeping an optional application of fog seal may be applied to all areas chip sealed or shall be applied if specified by the **AGENCY**. The polymer modified fog seal or approved equal emulsion shall be diluted 50 percent with water. The application rate shall vary between 0.08-0.12 gal per square yard as per Table 25.6I-1 or as deemed necessary by the **CONTRACTOR** and the **AGENCY**.

TABLE 25.6I-1
Application Rates

Material	Type I Chip Seal	Type II Chip Seal	Type III Chip Seal
Emulsified Asphalt (Chip process)	0.28 – 0.34 gal per square yd	0.34 – 0.40 gal per square yd	0.38 – 0.46 gal per square yd
Fog Seal (Emulsified Asphalt)	.08 gal per square yd minimum	.11 gal per square yd minimum	.12 gal per square yd minimum
Chip Seal Aggregate	18 lbs per square yd minimum	22 lbs per square yd minimum	25 lbs per square yd minimum

25.7 QUALITY CONTROL

The **CONTRACTOR** shall be responsible for Quality Control. The **AGENCY** shall determine if the quality of materials and work are acceptable. The **AGENCY** may take samples of the aggregate and/or the emulsion at any time and the **CONTRACTOR** shall assist in obtaining these samples. Should the testing indicate any variance from these specifications, the **CONTRACTOR** shall stop work until testing indicates the emulsion or aggregate is within the specifications. Should the **CONTRACTOR** fail to meet these specifications, the **AGENCY** shall not be liable for any payment to the **CONTRACTOR** for the portion of work deemed unsatisfactory due to workmanship or material deficiencies.

Daily inspection will include the following:

- The finished surface shall have no more than four tears or untreated areas greater than 1 inch wide and 4 inches long in any 120 square yard area.
- Joints are neat and uniform. There is no buildup, uncovered areas, or other unsightly appearance.
- Longitudinal joints have less than a 2 inch overlap.
- Transverse joints have no more than ¼ inch difference in elevation as measured across the joint using a 6 foot straightedge.
- The edge of the chip seal does not vary more than 2 inches in any 100 feet along a shoulder or edge.
- Typical stone embedment is 2/3 of a typical chip.

25.8 PROJECT ACCEPTANCE

Deficiencies in chip seal construction often do not show up until the surface has been under traffic for a period of time. The Engineer and **CONTRACTOR** will review the completed chip seal in 25 to 35 days after placement. Surface patterns that show streaking or ridging, bleeding/flushing, and loss of cover aggregate are to be specifically evaluated. The **CONTRACTOR** is required to perform corrective work when any one defect exceeds 20% of any 120 square yard area. The following is a description of these defects and likely causes:

Streaking is caused by a faulty distributor adjustment or operation resulting in the asphalt being placed in ridges. Contrary to popular belief, these ridges will not flow together, particularly when the cover aggregate is applied immediately after the

application of asphalt material as required by the specifications. Streaking results in insufficient asphalt material between the ridges to hold the aggregate in place. This aggregate is loose and will be kicked up by traffic. This leaves only the aggregate that was embedded in the ridged asphalt producing a streaked appearance.

25.9 MEASUREMENT

Measurement shall be by the acceptable square yard of surface covered.

25.10 PAYMENT

Payment shall be made at the unit rate listed in the bid schedule in $/yd^2.

Item	Description	Payment
25.10	Chip Seal	$ / yd^2