



Seal Coat Specification Recommendations

Technical Report 0-6989-P1

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation
<http://tti.tamu.edu/documents/0-6989-P1.pdf>

SEAL COAT SPECIFICATION RECOMMENDATIONS

by

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Product 0-6989-P1
Project 0-6989
Project Title: Update Seal Coat Application Rate Design Method

Performed in cooperation with the
Texas Department of Transportation
and the
Federal Highway Administration

Published: March 2020

TEXAS A&M TRANSPORTATION INSTITUTE
College Station, Texas 77843-3135

DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The engineer in charge of the project was Darlene C. Goehl, P.E. #80195.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

ACKNOWLEDGMENTS

This project was conducted in cooperation with TxDOT and FHWA. The author thanks Ross Taylor, Bryan Wilson, Stephen Sebesta, Darrin Jensen, Wade Odell, Enad Mahmoud, Arash Motamed, Eric Lykins, Jerry Peterson, Jace Lee, James Robbins, Magdy Mikhail, Sergio Cantu, and Shannon Ramos.

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BACKGROUND

An extensive literature review was conducted in this project, including review of Texas Department of Transportation (TxDOT), national, and international specifications. Based on the findings and results from prior tasks, several specification changes are recommended. This report contains the proposed specifications and a summary of the key changes. Along with the specification recommendations, new test procedures are also needed as part of the specification requirements.

This research focused on developing a new design procedure for application rates. It is proposed that the new design procedure be outlined in a TxDOT test procedure format, then that procedure referenced in the specifications.

SPECIFICATIONS

There are four proposed specifications. Due to the reporting and inspection differences associated with an asphalt-rubber binder, it is recommended that the asphalt-rubber binder seal coat be placed in a separate specification. Then, each of these specifications is divided into a method and performance specification for a total of four proposed specifications. The key recommendations for each of these specifications are summarized and include the differences compared to the existing TxDOT specification, Item 316, “Seal Coat” [1]. Appendix A contains a complete version of each specification.

SS XXXX, “SEAL COAT”

The new special specification will replace the existing Item 316, “Seal Coat” [1]. In previous TxDOT specification books, there was a separate specification for seal coats with an asphalt-rubber binder, Item 318, “Hot Asphalt-Rubber Surface Treatments.” Due to the unique reporting requirements and inspection techniques needed for the use of an asphalt-rubber binder, it is recommended to have a standalone item.

The current specification refers to the plan set or as directed for application rates. It is proposed to add a requirement to use the application rate design method to set target application rates. For this specification, the engineer sets the target rates following the new test method. The engineer also makes field adjustments based on the new test method.

There is currently a requirement for a test strip when there are issues with the binder application, but not with aggregate application problems. Therefore, it is recommended that a test strip requirement be added for aggregate application issues.

There are concerns with seal coat bonding to the existing pavement when it is wet [2]. It is recommended to add a pavement moisture check to the surface preparation section, including a reference to a new test method that checks whether the pavement surface is dry or wet. The pavement moisture check was developed based on the wording in TxDOT’s striping specification, Item 666, “Retroreflectorized Pavement Markings” [1].

Since this specification includes placing the seal coat directly on a flexible or stabilized base course, it is recommended to add similar wording in the specification for Item 310, “Prime Coat” [1], to sprinkle base courses with water. This is intended for use when the seal coat is used as a prime seal.

Pay reduction factors for failing binder tests are included and are similar to those found in the Arizona Department of Transportation Specifications [3]. Additionally, the standard deviation of TxDOT binder test results from 2017 to 2018 was used to establish the tolerance ranges for the pay reduction factors. A pay reduction was included for streaked areas when corrective action was not required.

SS XXXX, “HOT ASPHALT-RUBBER SEAL COAT”

The new special specification is intended for seal coats requiring the use of asphalt-rubber binders. To highlight the unique requirements, a separate specification is needed. This item is similar to the proposed SS XXXX, “Seal Coat” except that only asphalt-rubber binders are allowed.

Since the placement of the asphalt-rubber binder requires nozzles that will allow the rubber particles to move through them and the application rate tends to be significantly higher than other seal coats, it is recommended to remove transverse variable rate requirements.

Storage temperatures for asphalt-rubber are not addressed in the specification. Requirements for heating and storage were added, like those found in the Arizona Department of Transportation Specifications [3].

SS XXXX, “SEAL COAT (PERFORMANCE)”

This Special Specification is very similar to the proposed SS XXXX, “Seal Coat,” but it also includes performance criteria. Since this is a performance specification, the contractor sets the target rates following the new test method and the engineer approves the target rates. The contractor with engineer approval also makes field adjustments based on the new test method.

For the performance criteria, it is important to do a site evaluation to document changes in conditions from the PS&E development to construction. TxDOT typically continues to do seal coat preparatory work until close to the new construction time. It is recommended to add a site evaluation that will allow the contractor to develop a list of concerns with meeting the performance criteria.

Since the performance criteria are dependent on the quality of the initial construction, it is important to establish a baseline. It is recommended to add initial construction criteria that includes a visual evaluation of seal coat defects and texture measurements. Defects include loose rock, streaking, flushing, and bleeding. Many of these defects will lead to texture loss.

The existing texture can be measured with Tex-436-A, “Sand Patch Method.” Only three of TxDOT’s current specifications have texture requirements, Item 354, “Planing and Texturing Pavement,” Item 360, “Concrete Pavement,” and Item 422, “Concrete Superstructures.” Please refer to Table 1 for the specification limits. Based on this information and the testing performed

in research project 0-5833, the recommended minimum texture depth of seal coats in Texas should be an average of 0.05 inches with no readings below 0.035 inches. Please refer to Table 2 for the texture measurement results from project 0-5833 [4]. Note that in the table, the tests taken in the wheelpath and outside the wheelpath are referenced with WP and OWP, respectively.

Table 1. Texture Requirements [1].

Item	Texture Depth (in.)	
	Minimum	Correct if texture is less than
354	0.05	
360	0.04	0.03
422	0.035 (avg.)	0.02

Table 2. Project 0-5833 Texture Tests [4].

Roadway	Sand Patch Results Mean Texture Depth		Roadway	Sand Patch Results Mean Texture Depth	
	WP	OWP		WP	OWP
	(in.)	(in.)		(in.)	(in.)
FM 696	0.085	0.098	US 190	0.067	0.093
FM 696	0.037	0.084	US 190	0.082	0.094
FM 908	0.031	0.084	US 190	0.072	0.096
FM 908	0.085	0.127	SH 153	0.040	0.074
FM 819	0.047	0.078	FM 3425	0.042	0.060
FM 819	0.059	0.099	US 283	0.039	0.065
FM 2457	0.031	0.090	US 283	0.041	0.075
FM 2457	0.016	0.056	FM 2134	0.090	0.141
SH 147	0.076	0.115	FM 2134	0.094	0.119
SH 147	0.053	0.055	SH 6	0.050	0.074
SH 147	0.024	0.094	FM 2689	0.053	0.101
SH 147	0.057	0.070	FM 2689	0.137	0.154
SH 103	0.031	0.100	Avg. of all Locations	0.057	0.093
SH 103	0.053	0.111	Min	0.016	0.055
SH 103	0.053	0.110	Max	0.085	0.127
Description				WP (in.)	OWP (in.)
Severe Flushing (Bleeding) of Grade 3 Seal Coat				0.031	0.100
Moderate to Severe Flushing (Bleeding) of Grade 3				0.031	0.090
Moderate Flushing of Grade 3 Seal Coat				0.041	0.074
Mild to Moderate Flushing of Grade 3				0.039	0.074
Mild Flushing of Grade 3 Seal Coat				0.036	0.084
Slight Color Difference in Wheel Path of Grade 4 Seal Coat				0.084	0.126
No Color Difference in Wheel Path of Grade 4 Seal Coat				0.084	0.098

Most issues with the seal coat occur during the first year of seal coat placement. This timeframe allows the seal coat to experience weather extremes. It is recommended to add performance criteria for 10 months after placement that include a visual evaluation of seal coat defects and texture measurements. These are the same defects documented just after initial construction. An average texture depth of 0.05 inches should be maintained with no measurements below a texture depth of 0.035 inches at the end of the performance period.

The New Zealand performance specification has a requirement for counting loose aggregate particles [5]. This information was used as the basis for the recommended specification limits and procedure to check for loose aggregate.

A section for corrective action was added to address the acceptable repairs to various defects. These corrective actions include resealing and preparatory work needed before resealing such as hydroblasting or milling. Some defects may not require a repair, but it is recommended that a pay reduction be assigned to those defects. These may be defects such as streaking caused by clogged nozzles. The pay reduction is based on the area of the streak and the assumption that there will be aggregate loss in the streaked area. The pay reduction reduces the quantity of aggregate resulting in no pay for that volume of aggregate lost over the streaked area.

Areas with an average texture between 0.035 inches and 0.05 inches may be assessed a pay reduction. The recommendation is to reduce the quantity of aggregate and binder resulting in a pay reduction of up to 50 percent.

SS XXXX, “HOT ASPHALT-RUBBER SEAL COAT (PERFORMANCE)”

This Special Specification is new and is very similar to the proposed SS XXXX, “Hot Asphalt-Rubber Seal Coat,” but it also includes performance criteria. The performance criteria are the same as proposed in SS XXXX, “Seal Coat (Performance).”

TEST METHODS

New test methods were developed to supplement the specifications. The literature review provided information that was used in the development of the test methods. This information was used for the following:

- The definition for flushing and bleeding [2].
- The assumptions for the mat thickness, aggregate spread rate, and percent embedment [6].
- Temperature to volume correction procedure for binders [7].
- The time of year correction for the emulsions and cutbacks is the same procedure currently found in the Modified Kearby Method [8].

Appendix B contains the proposed new test procedures.

PROPOSED TEST METHODS

Tex-2XX-F, “TEXAS SEAL COAT DESIGN METHOD,” outlines and steps through the procedure to set the target application rates for a single and multiple seal coat including the use of transverse variable rates. This test method is referenced in all four specifications.

Tex-2XX-F, “SEAL COAT AGGREGATE AVERAGE MAT THICKNESS, provides procedures to calculate the average mat thickness. This test method is referenced in the proposed Tex-2XX-F, “TEXAS SEAL COAT DESIGN METHOD.”

Tex-2XX-F, “PAVEMENT MOISTURE CHECK,” provides a procedure to check whether the pavement is wet or dry. This test method is referenced in all four specifications.

Tex-2XX-F, “SEAL COAT PERFORMANCE TESTS,” provides a procedure to document the pre-seal, initial construction condition and the post-performance period evaluations. It includes recommendations for texture measurements and summarizing visual defects. This test method is referenced in the performance specifications.

SITEMANAGER TEMPLATES

It is recommended to add Sitemanager templates for the following:

- **Seal Coat Rate Design Method.** The proposed template name is TXSCDSN.xlsm. This template will be used to document the calculations for the target application rates.
- **Average Mat Thickness.** The proposed template name is TX2XX.xlsm, where XX would be replaced by the test method number. This template will be used to document the calculations for the average mat thickness.
- **Pavement Moisture Check.** The proposed template name is TX2XX.xlsm, where XX would be replaced by the test method number. This template will be used to document the pavement moisture condition.
- **Seal Coat Performance Tests.** The proposed template name is TX2XXP1.xlsm and TX2XXP2.xlsm, where XX would be replaced by the test method number. This template would include the pre-seal, initial construction, and post-performance period evaluations.
- **Modify Sitemanager template TXARDES.XLSM.** The specification requires the mix properties to be reported at reaction times of 60, 90, 240, 360, and 1,440 min. in accordance with Section 300.2.9., “Asphalt-Rubber Binders.” The current form does not include information about reaction times. The author recommends adding columns for each reaction time. Please refer to Figure 1.



TEXAS DEPARTMENT OF TRANSPORTATION

A ASPHALT-RUBBER BINDER DESIGN
Physical Properties of Asphalt-Rubber Binder

Retest Workbook

File Version: 03/09/15 10:27:41

SAMPLE ID:	SAMPLED DATE:
TEST NUMBER:	LETTING DATE:
SAMPLE STATUS:	CONTROLLING CSJ:
COUNTY:	SPEC YEAR:
SAMPLED BY:	SPEC ITEM:
SAMPLE LOCATION:	SPECIAL PROVISION:
MATERIAL CODE:	GRADE:
MATERIAL NAME:	
PRODUCER:	
AREA ENGINEER:	PROJECT MANAGER:

COURSE/LIFT:	STATION:	DIST. FROM CL:
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Virgin Asphalt Binder:

Crumb Rubber Type:

Rubber Content (%):

Property	Test Procedure	Asphalt-Rubber Binder Property	Specification Limits		
			Type I	Type II	Type III
Apparent Viscosity, 347F, cP	D2196, Method A		1500 - 5000	1500 - 5000	1500 - 5000
Penetration, 77F, 100g, 5 sec	T 49		25 - 75	25 - 75	50-100
Penetration, 39.2F, 200g, 60 sec	T 49		min 10	min 15	min 25
Softening Point, F	T 53		min 135	min 130	min 125
Resilience, 77F, %	D 5329		min 25	min 20	min 10
Flash Point, C.O.C., F	T 48		min 450	min 450	min 450
Tests on Residue from Thin Film Oven Test:	T 179				
Retained Penetration Ratio, 39.2F, 200g, 60 sec., % of original	T 49			min 75	

Insert a Row for reaction times. Add columns to report Asphalt-Rubber Binder Properties at reaction times of 60, 90, 240, 360, and 1440 minutes.

Remarks:

--

Test Method:	Tested By:	Tested Date:
TXARDES		
Test Stamp Code:	Omit Test:	Completed Date: Reviewed By:
Locked By:	TxDOT:	District: Area:
Authorized By:	Authorized Date:	

Figure 1. A-R Binder Design Form.

GUIDE SCHEDULE

The June 28, 2019, “Guide Schedule of Sampling & Testing for Design Bid-Build (DBB) Projects – (DBB Guide Schedule)” contains the seal coat testing requirements in its Table II. Table 3 shows the proposed additions and modifications to the DBB Guide Schedule.

Table 3. DBB Guide Schedule Table II Changes.

Material or product	Test for	Test number	Project tests		Remarks
			Location or time of Sampling	Frequency of Sampling	
Aggregate	Flakiness Index	Tex-224-F	Stockpile	1 per Design	Sample in accordance with Tex-221-F
	Average Mat Thickness	Tex-2XX-F	Stockpile or at Source	1 per Design	Sample in accordance with Tex-221-F
Design	Target Application Rates	Tex-2XX-F		1 for each combination of aggregate and binder (per type, grade, and source of aggregate and per binder source)	
	Gradation	Tex-200-F, Part I	Stockpile (At source or at point of delivery)	1 per Design	Sample in accordance with Tex-221-F.
	Dry Loose Unit Wt.	Tex-404-A	Stockpile	1 per Design	Sample in accordance with Tex-221-F.
	24 hr. Water Absorption	Tex-433-A	Stockpile	1 per Design	Sample in accordance with Tex-221-F.
	Bulk Specific Gravity	Tex-403-A (natural aggregate) Tex-433-A (lightweight aggregates)	Stockpile	1 per Design	Sample in accordance with Tex-221-F.

Material or product	Test for	Test number	Project tests		Remarks
			Location or time of Sampling	Frequency of Sampling	
Pavement	Moisture Check	Tex-2XX-F	Pavement Surface	1 per day per roadway sealed	Testing frequency may be lowered when no rain has occurred since the previous moisture check that indicated a dry pavement
	Pre-Seal Visual Evaluation	Tex-2XX-F	Pavement Surface	At least 2 weeks before scheduled work begins	
	Performance Criteria	Tex-2XX-F Part I	Pavement Surface	Within 1 month of seal coat construction	
	Performance Criteria	Tex-2XX-F Part II	Pavement Surface	10 months but no longer than 12 months after initial seal coat construction	

FUTURE WORK

In order to improve the procedures and specifications:

- Validate the criteria in the specifications.
- Test methods should continue to be improved to remove subjective criteria and replaced with a measurable value.
- The test methods also can be improved to minimize the need for traffic control and to provide more data points. For example, a high-speed, laser-based texture measurement system may be developed for the texture measurements.

REFERENCES

- [1] TxDOT, "Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges," 2014. [Online]. Available: <ftp://ftp.dot.state.tx.us/pub/txdot-info/des/spec-book-1114.pdf>.
- [2] W. D. Lawson, "Maintenance Solutions for Bleeding and Flushed Pavements," TECHMRT: Multidisciplinary Research in Transportation, Lubbock, TX, 2006.
- [3] Arizona Department of Transportation, Standard Specifications for Road and Bridge Construction, Phoenix: Arizona Department of Transportation, 2008.
- [4] P. E. Krugler and C. K. Estakhri, "IMPLEMENTATION OF TRANSVERSE VARIABLE ASPHALT RATE SEAL COAT PRACTICES IN TEXAS," Texas A&M Transportation Institute, College Station, 2010.
- [5] New Zealand Transit Agency, "Performance based specification for reseals," October 2012. [Online]. Available: <https://www.nzta.govt.nz/assets/resources/bituminous-reseals/docs/bituminous-reseals.pdf>. [Accessed 2019].
- [6] S. Patrick, "Guide to Pavement Technology Part 4k selection and Design of Sprayed Seals," Austroads, Sydney, 2018.
- [7] Texas Department of Transportation, "Asphalt Binder Temperature-Volume Corrections," Texas Department of Transportation, Austin, Texas, 2019.
- [8] TxDOT, *Seal Coat and Surface Treatment Manual*, Texas Department of Transportation, 2017.

APPENDIX A. SPECIFICATIONS

Special Specification XXXX Seal Coat



1. DESCRIPTION

Construct a seal coat consisting of one or more applications of a single layer of asphalt material covered with a single layer of aggregate.

2. MATERIALS

Furnish materials of the type and grade shown on the plans in accordance with the following:

2.1. **Asphalt.** Furnish asphalt materials meeting the requirements of Item 300, "Asphalts, Oils, and Emulsions."

2.2. **Aggregate.** Furnish aggregate meeting Item 302, "Aggregates for Surface Treatments."

2.2.1. When the seal coat is the final riding surface, furnish aggregate with the minimum Surface Aggregate Classification shown on the plans. When the Surface Aggregate Classification is not shown on the plans, furnish aggregate with a minimum B Surface Aggregate Classification.

3. EQUIPMENT

3.1. **Distributor.** Furnish a distributor that will apply the asphalt material uniformly at the target rate and with the bar height and nozzles set for a triple overlap pattern.

3.1.1. **Transverse Variable Rate.** When a transverse variable rate is needed based on Tex-2XX-F, use either a multiple spray bar distributor or a single spray bar distributor with variable nozzle sizes. For the single spray bar distributor, ensure that the nozzles outside the wheel paths will output a predetermined percentage more asphalt material by volume than the nozzles over the wheel paths. Use a dual spray bar distributor as desired to provide for a transverse variable rate.

3.1.2. **Calibration.**

3.1.2.1. **Tank Volume.** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, Part I.

Provide documentation of distributor calibration performed not more than 5 yr. before the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, Part II.

3.1.2.2. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.

3.1.2.3. **Transverse Distribution.** Furnish a distributor test report, less than 1 yr. old, when tested in accordance with Tex-922-K, Part III. The Department reserves the right to witness the calibration testing. Notify the Engineer 3 days before calibration testing.

Include the following documentation on the test report:

- the serial number of the distributor,
- a method that identifies the actual nozzle set used in the test, and
- the fan width of the nozzle set aligned for a triple overlap pattern. Refer to the distributor manufacturers recommendations for the bar height.

The Engineer may verify the transverse rate and distribution at any time. If verification does not meet the requirements, correct deficiencies and furnish a new test report.

3.2. **Aggregate Spreader.** Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the target rate. If racked-in aggregate is specified on the plans, furnish a second aggregate spreader for the racked-in aggregate to apply aggregate uniformly at the specified rate.

3.3. **Rollers.** Unless otherwise shown on the plans, furnish light pneumatic-tire rollers in accordance with Item 210, "Rolling."

3.4. **Broom.** Furnish rotary, self-propelled brooms.

3.5. **Asphalt Storage and Handling Equipment.** When the plans or the Engineer allows storage tanks, furnish a thermometer in each tank to indicate the asphalt temperature continuously. Keep equipment clean and free of leaks. Keep asphalt material free of contamination.

3.6. **Aggregate Haul Trucks.** Unless otherwise approved, use trucks of uniform capacity to deliver the aggregate. Provide documentation showing measurements and calculation in cubic yards. Clearly mark the calibrated level. Truck size may be limited when shown on the plans.

3.7. **Digital Distance Measuring Instrument.** Furnish a vehicle with a calibrated digital distance measuring instrument accurate to ± 6 ft per mile.

4. CONSTRUCTION

4.1. **General.** Comply with the seal coat season as shown on the plans. Asphalt and aggregate rates shown on the plans are for estimating purposes only.

4.2. **Application Rates.**

4.2.1. **General.** Furnish the Engineer with representative samples of all materials for the seal coat.

- 4.2.2. **Target Application Rates.** The Engineer will determine the target application rates for both the asphalt material and aggregate in accordance with Tex-2XX-F. The Engineer will furnish the rates including adjustments to the Contractor at least two weeks before the scheduled placement.
- 4.2.2.1. **Transverse Variable Rates.** The Engineer will determine the target variable application rates for the asphalt material in accordance with Tex-2XX-F and the Distributor calibration record for the transverse distribution.
- 4.2.3. **Field Adjustments.** Adjust the target rate during construction based on changing existing conditions in accordance with Tex-2xx-F and as directed.

The Contractor may request target application rate changes at any time during the project. The Contractor shall provide all calculations and testing to support the requested target application rate changes in accordance with Tex-2XX-F. The Engineer will approve all application rate changes before the Contractor can begin placement.

- 4.3. **Temporary Aggregate Stockpiles.** The Engineer will approve the location of temporary aggregate stockpiles on the right of way before delivery. Place stockpiles in a manner that will not:

- obstruct traffic or sight distance,
- interfere with the access from abutting property, or
- interfere with roadway drainage.

Locate stockpiles a minimum of 30 ft from roadway when possible. Sign and barricade as shown on the plans.

- 4.4. **Aggregate Furnished by the Department.** When shown on the plans, the Department will furnish aggregate to the Contractor without cost. Stockpile locations are shown on the plans.

- 4.5. **Adverse Weather Conditions.** Do not place surface treatments when, in the Engineer's opinion, general weather conditions are unsuitable. Meet the requirements for air and surface temperature shown below.

- 4.5.1. **Standard Temperature Limitations.** Apply seal coat when air temperature is above 50°F and rising. Do not apply seal coat when air temperature is 60°F and falling. In all cases, do not apply seal coat when surface temperature is below 60°F.

- 4.5.2. **Polymer-Modified Asphalt Cement Temperature Limitations.** When using materials described in Section 300.2.2., "Polymer Modified Asphalt Cement," apply seal coat when air temperature is above 70°F and rising. Do not apply seal coat when air temperature is 80°F and falling. In all cases, do not apply seal coat when surface temperature is below 70°F.

- 4.5.3. **Cool Weather Night Air Temperature.** The Engineer reserves the right to review the **National Oceanic and Atmospheric Administration (NOAA)** weather forecast and determine if the nightly air temperature is suitable for asphalt placement to prevent aggregate loss.

- 4.5.4. **Cold Weather Application.** When asphalt application is allowed outside of the above temperature restrictions, the Engineer will approve the binder grade and the air and surface temperatures for asphalt material application. Apply seal coat at air and surface temperatures as directed.
- 4.6. **Surface Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges.
- 4.6.1. When placing on an existing seal coat or asphaltic concrete pavement, check the pavement moisture condition in accordance with Tex-2XX-F. If the pavement is wet, wait until it is dry to place the seal coat.
- 4.6.2. When placing on a flexible or stabilized base (without asphaltic material), lightly sprinkle the surface with water before applying bituminous material, when directed, to control dust and ensure absorption.
- 4.7. **Rock Land and Shot.**
- 4.7.1. Definitions.
- A “rock land” is the area covered at the aggregate target rate, with 1 truckload of aggregate.
 - A “shot” is the area covered by 1 distributor load of asphalt material.
- 4.7.2. **Setting Lengths.** Calculate the lengths of both rock land and shot. Adjust shot length to be an even multiple of the rock land. Verify that the distributor has enough asphalt material to complete the entire shot length. Mark shot length before applying asphalt. When directed, mark length of each rock land to verify the aggregate rate.
- 4.8. **Asphalt Placement.**
- 4.8.1. **General.** The maximum shot width is the width of the current transverse distribution test required under Section 316.3.1.3.1., “Transverse Distribution,” or the width of the aggregate spreader box, whichever is less. Adjust the shot width so operations do not encroach on traffic or interfere with the traffic control plan, as directed. Use paper or other approved material at the beginning and end of each shot to construct a straight transverse joint and to prevent overlapping of the asphalt. Unless otherwise approved, match longitudinal joints with the lane lines. The Engineer may require a string line if necessary to keep joints straight with no overlapping. Use sufficient pressure to flare the nozzles fully.
- Select an application temperature, as approved, in accordance with Item 300, “Asphalts, Oils, and Emulsions.” Uniformly apply the asphalt material at the rate directed, within 15°F of the approved temperature, and not above the maximum allowable temperature.
- 4.8.2. **Limitations.** Do not apply asphalt to the roadway until:
- traffic control methods and devices are in place as shown on the plans or as directed,
 - the loaded aggregate spreader is in position and ready to begin,

- haul trucks are loaded with enough aggregate to cover the shot area, and are in place behind the spreader box, and
- rollers are in place behind the haul trucks.

4.8.3. **Test Sections.** The Engineer may stop asphalt application and require construction of test strips at the Contractor’s expense if any of the following occurs:

- nonuniformity of application continues after corrective action;
- on 3 consecutive shots, application rate differs by more than 0.03 gal. per square yard from the target rate; or
- any shot differs by more than 0.05 gal. per square yard from the target rate.

The Engineer will approve the test section location. The Engineer may require additional test sections until seal coat application meets specification requirements.

4.8.4. **Nonuniform Application.** Stop application if not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine the cause of nonuniform application and correct it.

4.8.5. **Sampling and Testing Binder.**

4.8.5.1. **Sample Collection.** Collect all samples in accordance with Tex-500-C, “Sampling Bituminous Materials, Pre-Molded Joint Fillers, and Joint Sealers,” from the distributor and witnessed by the Engineer. Collect a sample from the transport, when directed.

Collect at least one sample of each binder grade and source used on the project for each production day. The Engineer will retain these samples. At least once per project, collect split samples of each binder grade and source used. The Engineer will submit one split sample to MTD for testing and retain the other split sample.

The Engineer will keep all retained samples for one year, for hot-applied binders and cutback asphalts; or for two months, for emulsified asphalts. The Engineer may submit retained samples to MTD for testing as necessary or as requested by MTD.

4.8.5.2. **Material Adjustment Factors.** The Engineer will determine if failing material is suitable to leave in place. Pay reduction factors will be applied to failing materials that are allowed to remain in place.

4.9. **Aggregate Placement.** When using an asphalt cement binder, the aggregate must be surface dry before application. As soon as possible, apply aggregate uniformly at the target rate without causing the rock to roll over.

4.9.1. **Nonuniform Application.** Stop application if it is not uniform in the transverse direction. Verify equipment condition, operating procedures, and transverse application rate. The transverse application rate should be within 1 lb. Determine and correct the cause of nonuniform application.

4.9.2. **Test Sections.** The Engineer may stop aggregate application and require construction of test strips at the Contractor’s expense if any of the following occurs:

- nonuniformity of application continues after corrective action;

- on 3 consecutive rock lands, the length placed by a haul truck differs by more than 25 ft from the rock land length calculated for the target application rate, or
- any rock land length differs by more than 50 feet from the rock land length calculated for the target application rate.

The Engineer will approve the test section location. The Engineer may require additional test sections until seal coat application meets specification requirements.

4.10. **Rolling.** Start rolling operation on each shot as soon as aggregate is applied. Use sufficient rollers to cover the entire mat width in 1 pass (i.e., 1 direction). Roll in a staggered pattern. Unless otherwise shown on the plans, make a minimum of:

- 5 passes; or
- 3 passes when the asphalt material is an emulsion.

If rollers are unable to keep up with the spreader box, stop application until rollers have caught up, or furnish additional rollers. Keep roller tires asphalt-free.

4.11. **Repairs.**

4.11.1. **Patching.** Before rolling, repair spots where coverage is incomplete. Repair can be made by hand spotting or other approved method. When necessary, apply additional asphalt material to embed aggregate.

4.11.2. **Repairs.** The seal coat shall have all defects corrected the same day as initial construction. These defects include locations of blocked spray nozzles, poorly constructed longitudinal or transverse joints, or any other construction defect. The finished seal coat surface when visually inspected shall not have any flushing, significant aggregate loss, or loose aggregate. When the Engineer determines that a defect may be left in place without repairs, a pay reduction will be assessed.

4.12. **Patching.** Before rolling, repair spots where coverage is incomplete. Repair can be made by hand spotting or other approved method. When necessary, apply additional asphalt material to embed aggregate.

4.13. **Racked-in Aggregate.** If specified on the plans, apply racked-in aggregate after patching, uniformly at the rate directed. The racked-in aggregate must be applied before opening the roadway or intersection to traffic.

4.14. **Brooming.** After rolling, sweep as soon as aggregate has sufficiently bonded to remove excess. In areas of racked-in aggregate, sweep as directed.

4.15. **Final Acceptance.** Maintain seal coat until the Engineer accepts the work. Repair any surface failures. Before final project acceptance, remove all temporary stockpiles and restore the area to the original contour and grade.

5. MEASUREMENT

5.1. **Asphalt Material.** Unless otherwise shown on the plans, asphalt material will be measured by one of the following methods:

- 5.1.1. **Volume.** Asphalt material, including all components, will be measured at the applied temperature by strapping the tank before and after road application. The distributor calibrated strap stick will be used for measuring the asphalt level in the distributor asphalt tank. The certified tank chart will be used to determine the beginning gallons and the final gallons in the distributor tank. The quantity to be measured for payment will be the difference between the beginning gallons and the final gallons.
- 5.1.2. **Weight.** Asphalt material will be measured in tons using certified scales meeting the requirements of Item 520, "Weighing and Measuring Equipment," unless otherwise approved. The transporting truck must have a seal attached to the draining device and other openings. Random checking on public scales at the Contractor's expense may be required to verify weight accuracy.
- Upon work completion or temporary suspension, any remaining asphalt material will be weighed by a certified public weigher or measured by volume in a calibrated distributor or tank and the quantity converted to tons at the measured temperature. The quantity to be measured will be the number of tons received minus the number of tons remaining after all directed work is complete and minus the amount used for other items.
- 5.1.3. **Quantity Adjustments.** When shown on the plans, the measured quantity will be adjusted to compensate for variation in required application or residual rates for different types of asphalt.
- 5.2. **Aggregate.** Aggregate will be measured by the cubic yard in the trucks as applied on the road. Strike off the loaded aggregate for accurate measurement when directed.
- 5.3. **Loading, Hauling, and Distributing Aggregate.** When the Department furnishes the aggregate, the loading, hauling, and distributing will be measured by the cubic yard in the trucks as applied on the road.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Asphalt," "Aggregate," and "Loading, Hauling, and Distributing Aggregate" of the types-grades specified on the plans. These prices are full compensation for surface preparation; furnishing, preparing, hauling, and placing materials; removing existing pavement markers and excess aggregate; rolling; cleaning up stockpiles; and equipment, labor, tools, and incidentals.

- 6.1. **Payment Adjustment Factors.** The payment adjustment factor is based on the Engineer's test results. A payment adjustment factor will be determined from Table 1. The adjustment factor will be applied to the bid price for "Asphalt" of the types-grades specified on the plans.

**Table 1
Payment
Adjustment Factors**

Tests on Distillation Residue or Binder:	Test Method	Pay Factor		Contract Limit ²	
		Test Value	Pay Factor ¹	Min	Max
Softening point, °F	T 53	≥ L	1	"L"	
		(L-4) ≤ Result ≤ L	0.85 ³		
		< (L-4)	0.7 ³		
Penetration, 77°F, 100 g, 5 sec.	T 49	L ≤ Result ≤ X	1	"L"	"X"
		Result is in ranges (L-24) ≤ Result ≤ L or X ≤ Result ≤ (X+24)	0.85 ³		
		Result < L or Result > X	0.7 ³		
Residue from distillation, volume %	T59	≥ L	1	"L"	
		(L-4) ≤ Result ≤ L	0.85 ³		
		< (L-4)	0.7 ³		
Elastic recovery, 50°F, %	Tex-539-C	≥ L	1	"L"	
		(L-12) ≤ Result ≤ L	0.85 ³		
		< (L-12)	0.7 ³		
Viscosity, 140°F, poise	T 202	L ≤ Result ≤ X	1	"L"	"X"
		Result is in ranges (L x 0.8) ≤ Result ≤ L or X ≤ Result ≤ (X x 1.2)	0.85 ³		
		Result < L or Result > X	0.7 ³		
All other tests		Meet Requirements	1		
		Does not Meet Requirements	0.9 ³		

1. When the binder does not meet requirements in more than one test and is allowed to remain in place, use the largest reduction based on all tests not meeting requirements.
2. Refer to requirements in Item 300, "Asphalts, Oils, and Emulsions."
3. The pay adjustment applies if the material is allowed to remain in place.

When a single line streak occurs instead of corrective action, the Engineer may assess a payment adjustment for each line of streaking resulting in no pay for the aggregate lost in the streaked area.

6.2. Total Adjusted Pay Calculation. Total adjusted pay will be based on the applicable payment adjustment factors from 6.2.1 and 6.2.2. Apply the pay adjustment factor to the bid price for "Asphalt" and "Aggregate."

6.2.1. **“Asphalt.”** Apply the adjusted pay based on quantity of binder represented by the testing.

$$\text{TAP} = F \times B$$

Where

TAP = Total adjusted pay

F = Binder pay factor, (Table 1)

B = Quantity of binder represented by the test, gal.

6.2.2. **“Aggregate.”** Apply the adjusted pay based on quantity of aggregate placed in the area requiring repairs.

$$\text{TAP} = V - [\text{AR} \times (\text{L} \times \text{W})/9]$$

Where

V = Total volume of aggregate placed in the area with streaks, cy

AR = Aggregate rate applied in streaked location, cy/sy

L = Length of streak, ft.

W = Average width of streak, ft.

Special Specification XXXX

Seal Coat (Performance)



1. DESCRIPTION

Construct a seal coat consisting of one or more applications of a single layer of asphalt material covered with a single layer of aggregate.

2. MATERIALS

Furnish materials of the type and grade shown on the plans in accordance with the following:

2.1. **Asphalt.** Furnish asphalt materials meeting the requirements of Item 300, "Asphalts, Oils, and Emulsions."

2.2. **Aggregate.** Furnish aggregate meeting Item 302, "Aggregates for Surface Treatments."

2.2.1. When the seal coat is the final riding surface, furnish aggregate with the minimum Surface Aggregate Classification shown on the plans. When the Surface Aggregate Classification is not shown on the plans, furnish aggregate with a minimum B Surface Aggregate Classification.

3. EQUIPMENT

3.1. **Distributor.** Furnish a distributor that will apply the asphalt material uniformly at the target rate and with the bar height and nozzles set for a triple overlap pattern.

3.1.1. **Transverse Variable Rate.** When a transverse variable rate is needed based on Tex-2XX-F, use either a multiple spray bar distributor or a single spray bar distributor with variable nozzle sizes. For the single spray bar distributor, ensure that the nozzles outside the wheel paths will output a predetermined percentage more asphalt material by volume than the nozzles over the wheel paths. Use a dual spray bar distributor as desired to provide for a transverse variable rate.

3.1.2. **Calibration.**

3.1.2.1. **Tank Volume.** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, Part I.

Provide documentation of distributor calibration performed not more than 5 yr. before the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, Part II.

3.1.2.2. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.

- 3.1.2.3. **Transverse Distribution.** Furnish a distributor test report, less than 1 yr. old, when tested in accordance with Tex-922-K, Part III. The Department reserves the right to witness the calibration testing. Notify the Engineer 3 days before calibration testing.

Include the following documentation on the test report:

- the serial number of the distributor,
- a method that identifies the actual nozzle set used in the test, and
- the fan width of the nozzle set aligned for a triple overlap pattern. Refer to the distributor manufacturers recommendations for the bar height.

The Engineer may verify the transverse rate and distribution at any time. If verification does not meet the requirements, correct deficiencies and furnish a new test report.

- 3.2. **Aggregate Spreader.** Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the target rate. If racked-in aggregate is specified on the plans, furnish a second aggregate spreader for the racked-in aggregate to apply aggregate uniformly at the specified rate.
- 3.3. **Rollers.** Unless otherwise shown on the plans, furnish light pneumatic-tire rollers in accordance with Item 210, "Rolling."
- 3.4. **Broom.** Furnish rotary, self-propelled brooms.
- 3.5. **Asphalt Storage and Handling Equipment.** When the plans or the Engineer allows storage tanks, furnish a thermometer in each tank to indicate the asphalt temperature continuously. Keep equipment clean and free of leaks. Keep asphalt material free of contamination.
- 3.6. **Aggregate Haul Trucks.** Unless otherwise approved, use trucks of uniform capacity to deliver the aggregate. Provide documentation showing measurements and calculation in cubic yards. Clearly mark the calibrated level. Truck size may be limited when shown on the plans.
- 3.7. **Digital Distance Measuring Instrument.** Furnish a vehicle with a calibrated digital distance measuring instrument accurate to ± 6 ft per mile.

4. SITE EVALUATION

- 4.1. **Site Evaluation.** Inspect each roadway and provide a plan to meet the construction and performance criteria, in accordance with Tex-2XX-F, "Seal Coat Performance Tests." Submit in writing any concerns with the proposed seal coat for each roadway to be sealed.
- 4.1.1. The Engineer and Contractor will review all areas of concern, and if mutually agreed, the areas will not be required to meet the performance criteria; however the application rates in these areas will be agreed upon before placement of the seal coat. Construction defects shall be corrected.

5. CONSTRUCTION

5.1. **General.** Comply with the seal coat season as shown on the plans. Asphalt and aggregate rates shown on the plans are for estimating purposes only. For projects with more than one roadway to be seal coated, each location will have a project reference.

5.2. Application Rates.

5.2.1. **General.** Furnish the Engineer with representative samples of all materials for the seal coat. The Contractor shall provide all calculations and testing to support the target application rates in accordance with Tex-2XX-F. The Engineer will approve all target application rates, including transverse variable rates, before the Contractor can begin placement.

5.2.2. **Target Application Rates.** The Contractor will determine the target application rates for both the asphalt material and aggregate in accordance with Tex-2XX-F. The Contractor will furnish the rates including adjustments to the Engineer for review at least two weeks before the scheduled placement.

5.2.2.1. **Transverse Variable Rates.** The Contractor will determine the target variable application rates for the asphalt material in accordance with Tex-2XX-F and the Distributor calibration record for the transverse distribution.

5.2.3. **Field Adjustments.** Adjust the target rate during construction based on changing existing conditions in accordance with Tex-2xx-F.

The Contractor may request target application rate changes at any time during the project. The Contractor shall provide all calculations and testing to support the requested target application rate changes in accordance with Tex-2XX-F. The Engineer will approve all application rate changes before the Contractor can begin placement.

5.3. **Temporary Aggregate Stockpiles.** The Engineer will approve the location of temporary aggregate stockpiles on the right of way before delivery. Place stockpiles in a manner that will not:

- obstruct traffic or sight distance,
- interfere with the access from abutting property, or
- interfere with roadway drainage.

Locate stockpiles a minimum of 30 ft from roadway when possible. Sign and barricade as shown on the plans.

5.4. **Aggregate Furnished by the Department.** When shown on the plans, the Department will furnish aggregate to the Contractor without cost. Stockpile locations are shown on the plans.

5.5. **Adverse Weather Conditions.** Do not place surface treatments when, in the Engineer's opinion, general weather conditions are unsuitable. Meet the requirements for air and surface temperature shown below.

- 5.5.1. **Standard Temperature Limitations.** Apply seal coat when air temperature is above 50°F and rising. Do not apply seal coat when air temperature is 60°F and falling. In all cases, do not apply seal coat when surface temperature is below 60°F.
- 5.5.2. **Polymer-Modified Asphalt Cement Temperature Limitations.** When using materials described in Section 300.2.2., “Polymer Modified Asphalt Cement,” apply seal coat when air temperature is above 70°F and rising. Do not apply seal coat when air temperature is 80°F and falling. In all cases, do not apply seal coat when surface temperature is below 70°F.
- 5.5.3. **Cool Weather Night Air Temperature.** The Engineer reserves the right to review the **National Oceanic and Atmospheric Administration (NOAA)** weather forecast and determine if the nightly air temperature is suitable for asphalt placement to prevent aggregate loss.
- 5.5.4. **Cold Weather Application.** When asphalt application is allowed outside of the above temperature restrictions, the Engineer will approve the binder grade and the air and surface temperatures for asphalt material application. Apply seal coat at air and surface temperatures as directed.
- 5.6. **Surface Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges.
- 5.6.1. When placing on an existing seal coat or asphaltic concrete pavement, check the pavement moisture condition in accordance with Tex-2XX-F. If the pavement is wet, wait until it is dry to place the seal coat.
- 5.6.2. When placing on a flexible or stabilized base (without asphaltic material), lightly sprinkle the surface with water before applying bituminous material, when directed, to control dust and ensure absorption.
- 5.7. **Rock Land and Shot.**
- 5.7.1. **Definitions.**
- A “rock land” is the area covered at the aggregate target rate, with 1 truckload of aggregate.
 - A “shot” is the area covered by 1 distributor load of asphalt material.
- 5.7.2. **Setting Lengths.** Calculate the lengths of both rock land and shot. Adjust shot length to be an even multiple of the rock land. Verify that the distributor has enough asphalt material to complete the entire shot length. Mark shot length before applying asphalt. When directed, mark length of each rock land to verify the aggregate rate.
- 5.8. **Asphalt Placement.**
- 5.8.1. **General.** The maximum shot width is the width of the current transverse distribution test required under Section 316.3.1.3.1., “Transverse Distribution,” or the width of the aggregate spreader box, whichever is less. Adjust the shot width so operations do not encroach on traffic or interfere with the traffic control plan, as directed. Use paper or other approved material at the beginning and end of each shot to construct a straight

transverse joint and to prevent overlapping of the asphalt. Unless otherwise approved, match longitudinal joints with the lane lines. The Engineer may require a string line if necessary to keep joints straight with no overlapping. Use sufficient pressure to flare the nozzles fully.

Select an application temperature, as approved, in accordance with Item 300, "Asphalts, Oils, and Emulsions." Uniformly apply the asphalt material at the rate directed, within 15°F of the approved temperature, and not above the maximum allowable temperature.

5.8.2. **Limitations.** Do not apply asphalt to the roadway until:

- traffic control methods and devices are in place as shown on the plans or as directed,
- the loaded aggregate spreader is in position and ready to begin,
- haul trucks are loaded with enough aggregate to cover the shot area, and are in place behind the spreader box, and
- rollers are in place behind the haul trucks.

5.8.3. **Test Sections.** The Engineer may stop asphalt application and require construction of test strips at the Contractor's expense if any of the following occurs:

- nonuniformity of application continues after corrective action;
- on 3 consecutive shots, application rate differs by more than 0.03 gal. per square yard from the target rate; or
- any shot differs by more than 0.05 gal. per square yard from the target rate.

The Engineer will approve the test section location. The Engineer may require additional test sections until seal coat application meets specification requirements.

5.8.4. **Nonuniform Application.** Stop application if not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine the cause of nonuniform application and correct it.

5.8.5. **Sampling and Testing Binder.**

5.8.5.1. **Sample Collection.** Collect all samples in accordance with Tex-500-C, "Sampling Bituminous Materials, Pre-Molded Joint Fillers, and Joint Sealers," from the distributor and witnessed by the Engineer. Collect a sample from the transport, when directed.

Collect at least one sample of each binder grade and source used on the project for each production day. The Engineer will retain these samples. At least once per project, collect split samples of each binder grade and source used. The Engineer will submit one split sample to MTD for testing and retain the other split sample.

The Engineer will keep all retained samples for one year, for hot-applied binders and cutback asphalts; or for two months, for emulsified asphalts. The Engineer may submit retained samples to MTD for testing as necessary or as requested by MTD.

5.8.5.2. **Material Adjustment Factors.** The Engineer will determine if failing material is suitable to leave in place. Pay reduction factors will be applied to failing materials that are allowed to remain in place.

- 5.9. **Aggregate Placement.** When using an asphalt cement binder, the aggregate must be surface dry before application. As soon as possible, apply aggregate uniformly at the target rate without causing the rock to roll over.
- 5.9.1. **Nonuniform Application.** Stop application if it is not uniform in the transverse direction. Verify equipment condition, operating procedures, and transverse application rate. The transverse application rate should be within 1 lb. Determine and correct the cause of nonuniform application.
- 5.9.2. **Test Sections.** The Engineer may stop aggregate application and require construction of test strips at the Contractor's expense if any of the following occurs:
- nonuniformity of application continues after corrective action;
 - on 3 consecutive rock lands, the length placed by a haul truck differs by more than 25 ft from the rock land length calculated for the target application rate, or
 - any rock land length differs by more than 50 ft from the rock land length calculated for the target application rate.
- The Engineer will approve the test section location. The Engineer may require additional test sections until seal coat application meets specification requirements.
- 5.10. **Rolling.** Start rolling operation on each shot as soon as aggregate is applied. Use sufficient rollers to cover the entire mat width in 1 pass (i.e., 1 direction). Roll in a staggered pattern. Unless otherwise shown on the plans, make a minimum of:
- 5 passes; or
 - 3 passes when the asphalt material is an emulsion.
- If rollers are unable to keep up with the spreader box, stop application until rollers have caught up, or furnish additional rollers. Keep roller tires asphalt-free.
- 5.11. **Repairs.**
- 5.11.1. **Patching.** Before rolling, repair spots where coverage is incomplete. Repair can be made by hand spotting or other approved method. When necessary, apply additional asphalt material to embed aggregate.
- 5.11.2. Document the seal coat condition in accordance with Tex-2XX-F, "Seal Coat Performance Tests."
- 5.11.3. **Repairs.** The seal coat shall have all defects corrected the same day as initial construction. These defects include locations of blocked spray nozzles, poorly constructed longitudinal or transverse joints, or any other construction defect. The finished seal coat surface when visually inspected shall not have any flushing, significant aggregate loss, or loose aggregate.
- 5.12. **Racked-in Aggregate.** If specified on the plans, apply racked-in aggregate after patching, uniformly at the rate directed. The racked-in aggregate must be applied before opening the roadway or intersection to traffic.
- 5.13. **Brooming.** After rolling, sweep as soon as aggregate has sufficiently bonded to remove excess. In areas of racked-in aggregate, sweep as directed.

- 5.14. **Partial Construction Acceptance.** Repair any surface failures. Remove all temporary stockpiles and restore the area to the original contour and grade within 1 month of completing the seal coat per location and before final project acceptance.

6. PERFORMANCE REQUIREMENTS

- 6.1. The seal coat shall have a uniform single retained layer of aggregate that is uniformly spread both in the transverse and longitudinal direction.
- 6.1.1. **Performance Period.** All seal coats must meet the requirements of this specification for at least 10 months after installation. Document the seal coat condition in accordance with Tex-2XX-F, “Seal Coat Performance Tests.”
- 6.1.2. Based on visual inspection, the seal coat shall not have significant aggregate or texture loss over the performance period.
- Disputes over the visual inspection results will be resolved measuring the texture depth and counting loose aggregate such that no more than 50 loose particles for grade 3 and 4 or 100 loose particles for grade 5 are left in a 2 sq. yd. area. The seal coat shall have a texture depth of at least 0.05 in. after initial construction and maintain an average texture depth of at least 0.05 in. with no locations less than 0.035 in. over the performance period, in accordance with Tex-436-A.
- 6.1.3. Perform aggregate loss and texture measurements in accordance with Tex-2XX-F, “Seal Coat Performance Tests.”
- 6.1.4. **Corrective Action.** Repair areas not meeting the performance requirements.
- 6.1.5. The seal coat shall have all defects corrected. These defects include areas of aggregate or texture loss caused by:
- blocked spray nozzles,
 - poorly constructed longitudinal or transverse joints,
 - material failures,
 - incorrect application rates, or
 - any other construction defect.
- Repair areas with aggregate loss by placing a new seal coat over the area. The Engineer may assess a payment adjustment for a single line streak instead of corrective action.
- Repair areas with a texture depth less than 0.035 in. and when the average texture depth is less than 0.05 in. by restoring the texture through placement of a new seal coat. Additional work may be required before the seal coat is placed, such as hydroblasting or milling to remove excess binder. Repair method to be approved by the Engineer and shall not damage the underlying pavement structure. The Engineer may assess a payment adjustment when the average texture depth is less than 0.05 in. but greater than 0.035 in.
- 6.1.6. Unless otherwise directed, repair all areas that fail to meet requirements at the Contractor’s expense. Maintain the seal coat during the performance period. Repair noncompliant areas within 30 days of notification. All repairs must also meet all requirements of this Item until the end of the performance period. Repairs completed at

the end of the performance period must meet the requirements for 60 days after repairs are completed.

- 6.2. **Referee Testing.** The Contractor may request referee testing if a repair condition is determined based on the Engineer's test results. Make the request within 5 working days after receiving test results from the Engineer. Include Contractor test results with the referee request. Referee tests will be performed only for the particular tests in question. Allow 10 working days from the time the referee request is made for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than 3 referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.
- 6.3. **Acceptance Plan and Payment Adjustments.** The Engineer will evaluate the seal coat performance criteria for determining acceptance, payment adjustment, and corrective action.

7. FINAL ACCEPTANCE

- 7.1. Final Acceptance. Maintain seal coat until the Engineer accepts the work. Repair any surface failures. Before final project acceptance, remove all temporary stockpiles and restore the area to the original contour and grade.

8. MEASUREMENT

- 8.1. **Asphalt Material.** Unless otherwise shown on the plans, asphalt material will be measured by one of the following methods:
- 8.1.1. **Volume.** Asphalt material, including all components, will be measured at the applied temperature by strapping the tank before and after road application. The distributor calibrated strap stick will be used for measuring the asphalt level in the distributor asphalt tank. The certified tank chart will be used to determine the beginning gallons and the final gallons in the distributor tank. The quantity to be measured for payment will be the difference between the beginning gallons and the final gallons.
- 8.1.2. **Weight.** Asphalt material will be measured in tons using certified scales meeting the requirements of Item 520, "Weighing and Measuring Equipment," unless otherwise approved. The transporting truck must have a seal attached to the draining device and other openings. Random checking on public scales at the Contractor's expense may be required to verify weight accuracy.
- Upon work completion or temporary suspension, any remaining asphalt material will be weighed by certified public scales or measured by volume in a calibrated distributor or tank and the quantity converted to tons at the measured temperature. The quantity to be measured will be the number of tons received minus the number of tons remaining after all directed work is complete and minus the amount used for other items.
- 8.1.3. **Quantity Adjustments.** When shown on the plans, the measured quantity will be adjusted to compensate for variation in required application or residual rates for different types of asphalt.

- 8.2. **Aggregate.** Aggregate will be measured by the cubic yard in the trucks as applied on the road. Strike off the loaded aggregate for accurate measurement when directed.
- 8.3. **Loading, Hauling, and Distributing Aggregate.** When the Department furnishes the aggregate, the loading, hauling, and distributing will be measured by the cubic yard in the trucks as applied on the road.

9. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit prices bid for “Asphalt,” “Aggregate,” and “Loading, Hauling, and Distributing Aggregate” of the types-grades specified on the plans. These prices are full compensation for surface preparation; furnishing, preparing, hauling, and placing materials; removing existing pavement markers and excess aggregate; rolling; cleaning up stockpiles; and equipment, labor, tools, maintenance, repairs, and incidentals.

The work performed, materials furnished, certification and recertification, traffic control for all testing, materials and work needed for corrective action, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to this Item. Payment adjustment for defects will be applied at the end of the performance period.

- 9.1. **Partial Payment.** Upon completion of initial construction, 95% payment will be made for “Asphalt,” “Aggregate,” and “Loading, Hauling, and Distributing Aggregate” of the types-grades specified on the plans.
- 9.2. **Final Payment.** Upon final acceptance, the payment will be determined based on the payment adjustment factors. Previous payments under this Item will be deducted from this amount.
- 9.2.1. **Payment Adjustment Factors.** The payment adjustment factor is based on the Engineer’s test results. A payment adjustment factor for binder tests will be determined from Table 1. Pay adjustment for performance criteria can be found in Table 2.

**Table 1
Payment
Adjustment Factors**

Tests on distillation residue or Binder:	Test Method	Pay Factor		Contract Limit ²	
		Test Value	Pay Factor ¹	Min	Max
Softening point, °F	T 53	≥ L	1	"L"	
		(L-4) ≤ Result ≤ L	0.85		
		<(L-4)	0.7 ³		
Penetration, 77°F, 100 g, 5 sec.	T 49	L ≤ Result ≤ X	1	"L"	"X"
		Result is in ranges (L-24) ≤ Result ≤ L or X ≤ Result ≤ (X+24)	0.85		
		Result < L or Result > X	0.7 ³		
Residue from distillation, volume %	T59	≥ L	1	"L"	
		(L-4) ≤ Result ≤ L	0.85		
		<(L-4)	0.7 ³		
Elastic recovery, 50°F, %	Tex-539-C	≥ L	1	"L"	
		(L-12) ≤ Result ≤ L	0.85		
		<(L-12)	0.7 ³		
Viscosity, 140°F, poise	T 202	L ≤ Result ≤ X	1	"L"	"X"
		Result is in ranges (L x 0.8) ≤ Result ≤ L or X ≤ Result ≤ (X x 1.2)	0.85		
		Result < L or Result > X	0.7 ³		
All other tests		Meets requirements	1		
		Does not meet requirements	0.9		

1. When the binder does not meet requirements in more than one test and is allowed to remain in place, use the largest reduction based on all tests not meeting requirements.
2. Refer to requirements in Item 300, "Asphalts, Oils, and Emulsions."
3. The pay adjustment applies if the material is allowed to remain in place.

**Table 2
Performance
Payment
Adjustment Factors**

Performance Criteria	Test Method	Pay Adjustments	
		Test Value	Pay Factor
Texture	Tex-436-A	≥ 0.05 in	1
		0.05 ≤ Result ≤ .040	0.75
		0.40 ≤ Result ≤ .035	0.5
		<0.035	Corrective Action

When a single line steak occurs instead of corrective action, the Engineer may assess a payment adjustment for each line of streaking resulting in no pay for the aggregate lost in the streaked area.

9.2.2. **Total Adjusted Pay Calculation.** Total adjusted pay will be based on the applicable payment adjustment factors from Table 1, Table 2 and 9.1.1. Apply the pay adjustment factor to the bid price for “Asphalt” and “Aggregate.”

9.2.2.1. **“Asphalt.”** Apply the adjusted pay based on quantity of binder represented by the testing.

$$\text{TAP} = F \times B + A \times \text{BR} \times T$$

Where

TAP = Total adjusted pay

F = Binder Pay factor, (Table 1)

B = quantity of binder represented by the test, gal.

A = Area represented by texture test, sy

BR = Average Binder rate applied to the area represented by texture test, gal/sy

T = Texture Pay Factor (Table 2)

9.2.2.2. **“Aggregate.”** Apply the adjusted pay based on quantity of aggregate placed in the area requiring repairs and testing.

$$\text{TAP} = A \times \text{AR} \times T + V - [(L \times W)/9 \times \text{AR}]$$

Where

A = Area represented by texture test, sy

AR = Aggregate rate applied in streaked location, cy/sy

T = Texture Pay Factor (Table 2)

V = Total volume of aggregate placed in the streaked area, cy

L = Length of streak, ft.

W = Average width of streak, ft.

Special Specification XXXX

Hot Asphalt-Rubber Seal Coat



1. DESCRIPTION

Construct a seal coat consisting of one or more applications of a single layer of hot asphalt-rubber (A-R) binder covered with a single layer of aggregate.

2. MATERIALS

Furnish materials of the type and grade shown on the plans in accordance with the following:

2.1. **Binder.** Furnish Type II or Type III A-R binder in accordance with Section 300.2.9., "Asphalt-Rubber Binders."

2.1.1. Furnish a blend design for approval, at least 2 weeks prior to use. Include in the design, at a minimum, the following:

- manufacturer and grade of asphalt cement;
- manufacturer and grade of crumb rubber;
- manufacturer, type, and percentage of extender oil, if used;
- test report on crumb rubber gradation in accordance with Tex-200-F, Part I;
- design percentage of crumb rubber versus asphalt content;
- blending temperature; and
- test results on the properties at reaction times of 60, 90, 240, 360, and 1,440 min. in accordance with Section 300.2.9., "Asphalt-Rubber Binders."

2.1.2. Furnish a new asphalt-rubber blend design if the grade or source for any of the components changes.

2.1.3. If a tack coat is specified when using asphalt-rubber, unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a performance grade (PG) binder with a minimum high temperature grade of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use. If required, verify that emulsified asphalt proposed for use meets the minimum residual asphalt percentage specified in Item 300, "Asphalts, Oils, and Emulsions."

2.2. **Aggregate.** Furnish precoated aggregate meeting Item 302, "Aggregates for Surface Treatments."

2.2.1. When the seal coat is the final riding surface, furnish aggregate with the minimum Surface Aggregate Classification shown on the plans. When the Surface Aggregate Classification is not shown on the plans, furnish aggregate with a minimum B Surface Aggregate Classification.

3. EQUIPMENT

- 3.1. **Distributor.** Furnish a distributor that will apply the asphalt material uniformly at the target rate and with the bar height and nozzles set for a triple overlap pattern.
- 3.1.1. **Agitation for Asphalt-Rubber.** Furnish a distributor capable of keeping the rubber in uniform suspension and adequately mixing the asphalt, rubber, and any additional additives. If equipped with an onboard scale system or micro-motion meters for proportioning or payment, they must weigh or measure the load within a 0.4 percent accuracy in accordance with Item 520, “Weighing and Measuring Equipment.”
- 3.1.2. **Calibration.**
- 3.1.2.1. **Tank Volume.** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, Part I.
- Provide documentation of distributor calibration performed not more than 5 yr. before the date first used on the project. The Engineer may verify calibration accuracy in accordance with [Tex-922-K](#), Part II.
- 3.1.2.2. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.
- 3.2. **Aggregate Spreader.** Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the target rate. If racked-in aggregate is specified on the plans, furnish a second aggregate spreader for the racked-in aggregate to apply aggregate uniformly at the specified rate.
- 3.3. **Rollers.** Unless otherwise shown on the plans, furnish light pneumatic-tire rollers in accordance with Item 210, “Rolling.”
- 3.4. **Broom.** Furnish rotary, self-propelled brooms.
- 3.5. **Hot Asphalt-Rubber Blending and Storage Equipment.** Provide a mechanical blender for proper proportioning and thorough mixing of the asphalt and rubber. Keep A-R binder free of contamination. Use proportioning, weighing, and measuring devices meeting the requirements of Item 520, “Weighing and Measuring Equipment.” If an A-R binder storage tank is used, equip it with:
- a heating system to maintain the proper temperature of the binder,
 - recording thermometer in each tank to indicate the asphalt-rubber binder temperature continuously,
 - an internal mixing unit capable of maintaining a homogeneous mixture of asphalt and rubber, and
 - a sampling port.
- 3.6. **Aggregate Haul Trucks.** Unless otherwise approved, use trucks of uniform capacity to deliver the aggregate. Provide documentation showing measurements and calculation in cubic yards. Clearly mark the calibrated level. Truck size may be limited when shown on the plans.

- 3.7. **Digital Distance Measuring Instrument.** Furnish a vehicle with a calibrated digital distance measuring instrument accurate to ± 6 ft per mile.
- 3.8. **Truck Scales.** Provide standard platform scales in accordance with Item 520, "Weighing and Measuring Equipment." Truck scales will not be required if the distributor has an adequate calibrated scale system.
- 3.9. **Aggregate Heating System.** If required, furnish a heating system that will:
- heat aggregate to the specified temperature,
 - not damage aggregate,
 - not leave fuel residue on heated aggregate, and
 - provide a continuous recording thermometer to indicate aggregate temperature as it leaves the system.

4. **CONSTRUCTION**

- 4.1. **General.** Comply with the seal coat season as shown on the plans. Asphalt and aggregate rates shown on the plans are for estimating purposes only.
- 4.2. **Application Rates.**
- 4.2.1. **General.** Furnish the Engineer with representative samples of all materials for the seal coat at least 3 weeks before the scheduled placement.
- 4.2.2. **Target Application Rates.** The Engineer will determine the target application rates for both the asphalt material and aggregate in accordance with Tex-2XX-F. The Engineer will furnish the rates including adjustments to the Contractor at least two weeks before the scheduled placement.
- 4.2.3. **Field Adjustments.** Adjust the target rate during construction based on changing existing conditions in accordance with Tex-2xx-F and as directed.
- The Contractor may request target application rate changes at any time during the project. The Contractor shall provide all calculations and testing to support the requested target application rate changes in accordance with Tex-2XX-F. The Engineer will approve all application rate changes before the Contractor can begin placement.
- 4.3. **Temporary Aggregate Stockpiles.** The Engineer will approve the location of temporary aggregate stockpiles on the right of way before delivery. Place stockpiles in a manner that will not:
- obstruct traffic or sight distance,
 - interfere with the access from abutting property, or
 - interfere with roadway drainage.

Locate stockpiles a minimum of 30 ft from roadway when possible. Sign and barricade as shown on the plans.

- 4.4. **Aggregate Furnished by the Department.** When shown on the plans, the Department will furnish aggregate to the Contractor without cost. Stockpile locations are shown on the plans.
- 4.5. **Adverse Weather Conditions.** Do not place surface treatments when, in the Engineer's opinion, general weather conditions are unsuitable. Apply seal coat when the air temperature is 80°F and above, or above 70°F and rising. In all cases, do not apply seal coat when surface temperature is below 70°F.
- 4.5.1. **Cool Weather Night Air Temperature.** The Engineer reserves the right to review the **National Oceanic and Atmospheric Administration (NOAA)** weather forecast and determine if the nightly air temperature is suitable for asphalt placement to prevent aggregate loss.
- 4.5.2. **Cold Weather Application.** When asphalt application is allowed outside of the above temperature restrictions, the Engineer will the air and surface temperatures for asphalt material application. Apply seal coat at air and surface temperatures as directed.
- 4.5.3. **Mixing Hot A-R Binder.** Mix in accordance with the approved blend design required in Section XXXX.2.1., "Asphalt."

Wait a minimum of 1 hour after addition of the rubber before use. During this time, ensure the rubber and asphalt cement are thoroughly and continuously mixed at a temperature between 325°F and 400°F. Insufficient mixing is determined when the crumb rubber particles are in clumps or are floating on the surface.

4.6. **Handling and Storage of A-R Binder.**

After mixing, keep the A-R binder thoroughly and continuously mixed at a temperature between 325°F and 400°F. Do not store for longer than 10 hours at temperatures above 325°F and not exceeding 400°F. After 10 hours, allow A-R to cool then gradually reheat before use. Reheating will only be allowed once. Do not store above 250°F for more than four days.

At the end of each shift, provide the Engineer with production documentation, which includes the following:

- amount and temperature of asphalt cement before addition of rubber,
- temperature immediately after addition of rubber,
- application temperature,
- amount of rubber and any extender added,
- viscosity of each hot A-R batch just before roadway placement in accordance with ASTM D6114 and modified ASTM D2196, and
- time of the rubber additions and viscosity tests.

- 4.7. **Surface Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges. When directed, apply a tack coat before applying the hot asphalt-rubber treatment on an existing wearing surface in accordance with Section 340.2.5., "Tack Coat."

4.7.1. Check the pavement moisture condition in accordance with Tex-2XX-F. If the pavement is wet, wait until it is dry to place the seal coat.

4.8. **Rock Land and Shot.**

4.8.1. **Definitions.**

- A “rock land” is the area covered at the aggregate target rate with 1 truckload of aggregate.
- A “shot” is the area covered by 1 distributor load of asphalt material.

4.8.2. **Setting Lengths.** Calculate the lengths of both rock land and shot. Adjust shot length to be an even multiple of the rock land. Verify that the distributor has enough asphalt material to complete the entire shot length. Mark shot length before applying hot A-R. When directed, mark length of each rock land to verify the aggregate rate.

4.9. **Hot A-R Binder Placement.**

4.9.1. **General.** Adjust the application temperature, not exceeding 425°F, to obtain the proper application characteristics. Uniformly apply at the target rate.

The maximum shot width is 13 ft. Adjust the shot width as directed so operations do not encroach on traffic or interfere with the traffic control plan. Use paper or other approved material at the beginning and end of each shot to construct a straight transverse joint and to prevent overlapping of the asphalt. Unless otherwise approved, longitudinal joints must match lane lines.

Test the viscosity of the asphalt-rubber prior to use, in accordance with ASTM D6114 and modified ASTM D2196.

4.9.2. **Limitations.** Do not apply asphalt to the roadway until:

- traffic control methods and devices are in place as shown on the plans or as directed,
- the loaded aggregate spreader is in position and ready to begin,
- haul trucks are loaded with enough aggregate to cover the shot area, and are in place behind the spreader box, and
- rollers are in place behind the haul trucks.

4.9.3. **Test Sections.** Place a test section at an approved location to demonstrate that equipment is capable of uniformly mixing and placing the A-R binder. The Engineer may stop work at any time and require additional test sections to be shot if:

- nonuniformity of application continues after corrective action;
- on 3 consecutive shots, application rate differs by more than 0.03 gal. per square yard from the target rate; or
- any shot differs by more than 0.05 gal. per square yard from the target rate.

The Engineer will approve the test section location. The Engineer may require additional test sections until surface treatment application meets specification requirements.

4.9.4. **Nonuniform Application.** Stop application if not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Verify equipment condition, operating

procedures, application temperature, and material properties. Determine the cause of nonuniform application and correct it.

4.9.5. **Sampling and Testing Binder.**

4.9.5.1. **Sample Collection.** Collect all samples in accordance with Tex-500-C, “Sampling Bituminous Materials, Pre-Molded Joint Fillers, and Joint Sealers,” from the distributor and witnessed by the Engineer. Collect a sample from the transport, when directed.

Collect at least one sample of each binder grade and source used on the project for each production day. The Engineer will retain these samples. At least once per project, collect split samples of each binder grade and source used. The Engineer will submit one split sample to MTD for testing and retain the other split sample.

The Engineer will keep all retained samples for one year, for hot-applied binders and cutback asphalts; or for two months, for emulsified asphalts. The Engineer may submit retained samples to MTD for testing as necessary or as requested by MTD.

4.9.5.2. **Material Adjustment Factors.** The Engineer will determine if failing material is suitable to leave in place. Pay reduction factors will be applied to failing materials that are allowed to remain in place.

4.10. **Aggregate Placement.** The aggregate must be surface dry before application. When shown on the plans, preheat aggregate to between 250°F and 350°F. Cover each load with tarping material to minimize the temperature drop of the preheated aggregate. Immediately after the distributor has started spraying the hot asphalt-rubber, uniformly apply the aggregate at the rate specified by the Engineer.

4.10.1. **Nonuniform Application.** Stop application if it is not uniform in the transverse direction. Verify equipment condition, operating procedures, and transverse application rate. The transverse application rate should be within 1 lb. Determine and correct the cause of nonuniform application.

4.10.2. **Test Sections.** The Engineer may stop aggregate application and require construction of test strips at the Contractor’s expense if any of the following occurs:

- nonuniformity of application continues after corrective action;
- on 3 consecutive rock lands, the length placed by a haul truck differs by more than 25 ft from the rock land length calculated for the target application rate; or
- any rock land length differs by more than 50 ft from the rock land length calculated for the target application rate.

The Engineer will approve the test section location. The Engineer may require additional test sections until seal coat application meets specification requirements.

4.10.3. **Rolling.** Start the rolling operation on each shot as soon as aggregate is applied. Use sufficient rollers to cover entire mat width in 1 pass (1 direction). Roll in a staggered pattern. Unless otherwise shown on the plans, make at least 5 passes.

If rollers are unable to keep up with spreader box, stop application until rollers have caught up, or furnish additional rollers. Keep roller tires free of asphalt.

- 4.11. **Repairs.**
- 4.11.1. **Patching.** Before rolling, repair spots where coverage is incomplete. Repair can be made by hand spotting or other approved method. When necessary, apply additional hot A-R binder to embed aggregate.
- 4.11.2. **Repairs.** The seal coat shall have all defects corrected the same day as initial construction. These defects include locations of blocked spray nozzles, poorly constructed longitudinal or transverse joints, or any other construction defect. The finished seal coat surface when visually inspected shall not have any flushing, significant aggregate loss, or loose aggregate. When the Engineer determines that a defect may be left in place without corrective action, a pay reduction will be assessed.
- 4.12. **Racked-in Aggregate.** If specified on the plans, apply racked-in aggregate after patching, uniformly at the rate directed. The racked-in aggregate must be applied before opening the roadway or intersection to traffic.
- 4.13. **Brooming.** After rolling, sweep as soon as aggregate has sufficiently bonded to remove excess. In areas of racked-in aggregate, sweep as directed.
- 4.14. **Final Acceptance.** Maintain seal coat until the Engineer accepts the work. Repair any surface failures. Before final project acceptance, remove all temporary stockpiles and restore the area to the original contour and grade.

5. MEASUREMENT

- 5.1. **A-R Binder.** Unless otherwise shown on the plans, A-R Binder will be measured by one of the following methods:
- 5.1.1. **Volume.** A-R Binder, including all components, will be measured at the applied temperature by strapping the tank before and after road application. The distributor calibrated strap stick will be used for measuring the asphalt level in the distributor asphalt tank. The certified tank chart will be used to determine the beginning gallons and the final gallons in the distributor tank. The quantity to be measured for payment will be the difference between the beginning gallons and the final gallons.
- 5.1.2. **Weight.** A-R binder, including all components, will be measured in tons just before delivery to the point of application.
- 5.2. **Aggregate.** Aggregate will be measured by the cubic yard in the trucks as applied on the road. Strike off the loaded aggregate for accurate measurement when directed.
- 5.3. **Loading, Hauling, and Distributing Aggregate.** When the Department furnishes the aggregate, the loading, hauling, and distributing will be measured by the cubic yard in the trucks as applied on the road.

6. PAYMENT

These prices are full compensation for surface preparation, tack coat, heating and mixing, hauling and placing all materials, rolling and removing excess aggregate, cleaning up stockpiles, test sections, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit prices bid for “A-R Binder,” of the type specified “Aggregate,” and “Loading, Hauling, and Distributing Aggregate” of the types-grades specified on the plans.

6.1. **Payment Adjustment Factors.** The payment adjustment factor is based on the Engineer’s test results. A payment adjustment factor will be determined from Table 1 for binder samples. The adjustment factor will be applied to the bid price for “A-R Binder” of the types-grades specified on the plans.

**Table 1
Binder Payment
Adjustment Factors**

Description	Test Procedure	Binder Type							
		A-R Type II				A-R Type III			
		Pay Adjustment		Contract Limits		Pay Adjustment		Contract Limits	
		Test Value	Pay Factor ¹	Min	Max	Test Value	Pay Factor ¹	Min	Max
Apparent viscosity, 347°F, cP	D2196	1,500 ≤ Result ≥ 5,000	1	1,500	5,000	1,500 ≤ Result ≥ 5,000	1	1,500	5,000
	Method A	Result < 1,500 or Result > 5,000	Reject in Field			Result < 1,500 or Result > 5,000	Reject in Field		
Penetration, 39.2°F, 200 g, 60 sec.	T 49	≥ 15	1	15	–	≥ 25	1	25	–
		13-14	0.85			23-24	0.85		
		< 13	0.7 ²			< 23	0.7 ²		
Softening point, °F	T 53	≥ 130	1	130	–	≥ 125	1	125	–
		125-129	0.85			122-125	0.85		
		< 125	0.7 ²			< 122	0.7 ²		
Resilience, 77°F, %	D5329	≥ 20	1	20	–	≥ 10	1	10	–
		15-19	0.85			10-14	0.85		
		10-14	0.7			6-9	0.7		
		< 10	0.5 ²			< 6	0.5 ²		
All other tests	Meet Requirements	1							
	Does not Meet Requirements	0.9							

1. When the binder does not meet requirements in more than one test and is allowed to remain in place, use the largest reduction based on all tests not meeting requirements.
2. The pay adjustment applies if the material is allowed to remain in place.

6.2. **Total Adjusted Pay Calculation.** Total adjusted pay will be based on the applicable payment adjustment factors from Table 1. Apply the pay adjustment factor to the bid price for “A-R Binder” and “Aggregate.”

6.2.1. **“A-R Binder.”** Apply the adjusted pay based on quantity of binder represented by the testing.

$$\text{TAP} = F \times B$$

Where

TAP = Total adjusted pay

F = Binder pay factor, (Table 1)

B = Quantity of binder represented by the test, gal.

6.2.2. **“Aggregate.”** Apply the adjusted pay based on quantity of aggregate placed in the area requiring repairs.

$$\text{TAP} = V - [\text{AR} \times (\text{L} \times \text{W})/9]$$

Where

V = Total volume of aggregate placed in the area with streaks, cy

AR = Aggregate rate applied in streaked location, cy/sy

L = Length of streak, ft.

W = Average width of streak, ft.

Special Specification XXXX

Hot Asphalt-Rubber Seal Coat (Performance)



1. DESCRIPTION

Construct a seal coat consisting of one or more applications of a single layer of hot asphalt-rubber (A-R) binder covered with a single layer of aggregate.

2. MATERIALS

Furnish materials of the type and grade shown on the plans in accordance with the following:

2.1. **Binder.** Furnish Type II or Type III A-R binder in accordance with Section 300.2.9., "Asphalt-Rubber Binders."

2.1.1. Furnish a blend design for approval at least 2 weeks prior to use. Include in the design, at a minimum, the following:

- manufacturer and grade of asphalt cement;
- manufacturer and grade of crumb rubber;
- manufacturer, type, and percentage of extender oil, if used;
- test report on crumb rubber gradation in accordance with Tex-200-F, Part I;
- design percentage of crumb rubber versus asphalt content;
- blending temperature; and
- test results on the properties at reaction times of 60, 90, 240, 360, and 1,440 min. in accordance with Section 300.2.9., "Asphalt-Rubber Binders."

2.1.2. Furnish a new asphalt-rubber blend design if the grade or source for any of the components changes.

2.1.3. If a tack coat is specified when using asphalt-rubber, unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a performance grade (PG) binder with a minimum high temperature grade of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use. If required, verify that emulsified asphalt proposed for use meets the minimum residual asphalt percentage specified in Item 300, "Asphalts, Oils, and Emulsions."

2.2. **Aggregate.** Furnish precoated aggregate meeting Item 302, "Aggregates for Surface Treatments."

2.2.1. When the seal coat is the final riding surface, furnish aggregate with the minimum Surface Aggregate Classification shown on the plans. When the Surface Aggregate Classification is not shown on the plans, furnish aggregate with a minimum B Surface Aggregate Classification.

3. EQUIPMENT

- 3.1. **Distributor.** Furnish a distributor that will apply the asphalt material uniformly at the target rate and with the bar height and nozzles set for a triple overlap pattern.
- 3.1.1. **Agitation for Asphalt-Rubber.** Furnish a distributor capable of keeping the rubber in uniform suspension and adequately mixing the asphalt, rubber, and any additional additives. If equipped with an onboard scale system or micro-motion meters for proportioning or payment, they must weigh or measure the load within a 0.4 percent accuracy in accordance with Item 520, “Weighing and Measuring Equipment.”
- 3.1.2. **Calibration.**
- 3.1.2.1. **Tank Volume.** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, Part I.
- Provide documentation of distributor calibration performed not more than 5 yr. before the date first used on the project. The Engineer may verify calibration accuracy in accordance with [Tex-922-K](#), Part II.
- 3.1.2.2. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.
- 3.2. **Aggregate Spreader.** Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the target rate. If racked-in aggregate is specified on the plans, furnish a second aggregate spreader for the racked-in aggregate to apply aggregate uniformly at the specified rate.
- 3.3. **Rollers.** Unless otherwise shown on the plans, furnish light pneumatic-tire rollers in accordance with Item 210, “Rolling.”
- 3.4. **Broom.** Furnish rotary, self-propelled brooms.
- 3.5. **Hot Asphalt-Rubber Blending and Storage Equipment.** Provide a mechanical blender for proper proportioning and thorough mixing of the asphalt and rubber. Keep A-R binder free of contamination. Use proportioning, weighing, and measuring devices meeting the requirements of Item 520, “Weighing and Measuring Equipment.” If an A-R binder storage tank is used, equip it with:
- a heating system to maintain the proper temperature of the binder,
 - recording thermometer in each tank to indicate the asphalt-rubber binder temperature continuously,
 - an internal mixing unit capable of maintaining a homogeneous mixture of asphalt and rubber, and
 - a sampling port.
- 3.6. **Aggregate Haul Trucks.** Unless otherwise approved, use trucks of uniform capacity to deliver the aggregate. Provide documentation showing measurements and calculation in cubic yards. Clearly mark the calibrated level. Truck size may be limited when shown on the plans.

- 3.7. **Digital Distance Measuring Instrument.** Furnish a vehicle with a calibrated digital distance measuring instrument accurate to ± 6 ft per mile.
- 3.8. **Truck Scales.** Provide standard platform scales in accordance with Item 520, "Weighing and Measuring Equipment." Truck scales will not be required if the distributor has an adequate calibrated scale system.
- 3.9. **Aggregate Heating System.** If required, furnish a heating system that will:
- heat aggregate to the specified temperature,
 - not damage aggregate,
 - not leave fuel residue on heated aggregate, and
 - provide a continuous recording thermometer to indicate aggregate temperature as it leaves the system.

4. **SITE EVALUATION**

- 4.1. **Site Evaluation.** Inspect each roadway and provide a plan to meet the construction and performance criteria. Submit in writing any concerns with the proposed seal coat for each roadway to be sealed.
- 4.1.1. The Engineer and Contractor will review all areas of concern, and if mutually agreed, the areas will not be required to meet the performance criteria; however the application rates in these areas will be agreed upon before placement of the seal coat. Construction defects shall be corrected.

5. **CONSTRUCTION**

- 5.1. **General.** Comply with the seal coat season as shown on the plans. Asphalt and aggregate rates shown on the plans are for estimating purposes only. Adjust the rates for existing conditions as directed. For projects with more than one roadway to be seal coated, each location will have a project reference.
- 5.2. **Application Rates.**
- 5.2.1. **General.** Furnish the Engineer with representative samples of all materials for the seal coat. The Contractor shall provide all calculations and testing to support the target application rates in accordance with Tex-2XX-F. The Engineer will approve all target application rates before the Contractor can begin placement.
- 5.2.2. **Target Application Rates.** The Contractor will determine the target application rates for both the asphalt material and aggregate in accordance with Tex-2XX-F. The Contractor will furnish the rates including adjustments to the Engineer, for review, at least two weeks before the scheduled placement.
- 5.2.3. **Field Adjustments.** Adjust the target rate during construction based on changing existing conditions in accordance with Tex-2XX-F.

The Contractor may request target application rate changes at any time during the project. The Contractor shall provide all calculations and testing to support the requested target

application rate changes in accordance with Tex-2XX-F. The Engineer will approve all application rate changes before the Contractor can begin placement.

5.3. **Temporary Aggregate Stockpiles.** The Engineer will approve the location of temporary aggregate stockpiles on the right of way before delivery. Place stockpiles in a manner that will not:

- obstruct traffic or sight distance,
- interfere with the access from abutting property, or
- interfere with roadway drainage.

Locate stockpiles a minimum of 30 ft from roadway when possible. Sign and barricade as shown on the plans.

5.4. **Aggregate Furnished by the Department.** When shown on the plans, the Department will furnish aggregate to the Contractor without cost. Stockpile locations are shown on the plans.

5.5. **Adverse Weather Conditions.** Do not place surface treatments when, in the Engineer's opinion, general weather conditions are unsuitable. Apply seal coat when the air temperature is 80°F and above, or above 70°F and rising. In all cases, do not apply seal coat when surface temperature is below 70°F.

5.5.1. **Cool Weather Night Air Temperature.** The Engineer reserves the right to review the **National Oceanic and Atmospheric Administration (NOAA)** weather forecast and determine if the nightly air temperature is suitable for asphalt placement to prevent aggregate loss.

5.5.2. **Cold Weather Application.** When asphalt application is allowed outside of the above temperature restrictions, the Engineer will the air and surface temperatures for asphalt material application. Apply seal coat at air and surface temperatures as directed.

5.5.3. **Mixing Hot A-R Binder.** Mix in accordance with the approved blend design required in Section XXXX.2.1., "Asphalt."

Wait a minimum of 1 hour after addition of the rubber before use. During this time, ensure the rubber and asphalt cement are thoroughly and continuously mixed at a temperature between 325°F and 375°F. Insufficient mixing is determined when the crumb rubber particles are in clumps or are floating on the surface.

5.6. **Handling and Storage of A-R Binder.**

After mixing, keep the A-R binder thoroughly and continuously mixed at a temperature between 325°F and 400°F. Do not store for longer than 10 hours at temperatures above 325°F or exceeding 400°F. After 10 hours, allow A-R to cool then gradually reheat before use. Reheating will only be allowed once. Do not store above 250°F for more than four days.

At the end of each shift, provide the Engineer with production documentation, which includes the following:

- amount and temperature of asphalt cement before addition of rubber,

- temperature immediately after addition of rubber,
- application temperature,
- amount of rubber and any extender added,
- viscosity of each hot A-R batch just before roadway placement, in accordance with ASTM D6114 and modified ASTM D2196, and
- time of the rubber additions and viscosity tests.

5.7. **Surface Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges. When directed, apply a tack coat before applying the hot asphalt-rubber treatment on an existing wearing surface in accordance with Section 340.2.5., “Tack Coat.”

5.7.1. Check the pavement moisture condition in accordance with Tex-2XX-F. If the pavement is wet, wait until it is dry to place the seal coat.

5.8. **Rock Land and Shot.**

5.8.1. **Definitions.**

- A “rock land” is the area covered at the aggregate target rate with 1 truckload of aggregate.
- A “shot” is the area covered by 1 distributor load of asphalt material.

5.8.2. **Setting Lengths.** Calculate the lengths of both rock land and shot. Adjust shot length to be an even multiple of the rock land. Verify that the distributor has enough asphalt material to complete the entire shot length. Mark shot length before applying hot A-R. When directed, mark length of each rock land to verify the aggregate rate.

5.9. **A-R Binder Placement.**

5.9.1. **General.** Adjust the application temperature, not exceeding 425°F, to obtain the proper application characteristics. Uniformly apply at the target rate.

The maximum shot width is 13 ft. Adjust the shot width as directed so operations do not encroach on traffic or interfere with the traffic control plan. Use paper or other approved material at the beginning and end of each shot to construct a straight transverse joint and to prevent overlapping of the asphalt. Unless otherwise approved, longitudinal joints must match lane lines.

Test the viscosity of the asphalt-rubber prior to use, in accordance with ASTM D6114 and modified ASTM D2196.

5.9.2. **Limitations.** Do not apply asphalt to the roadway until:

- traffic control methods and devices are in place as shown on the plans or as directed,
- the loaded aggregate spreader is in position and ready to begin,
- haul trucks are loaded with enough aggregate to cover the shot area, and are in place behind the spreader box, and
- rollers are in place behind the haul trucks.

5.9.3. **Test Sections.** Place a test section at an approved location to demonstrate that equipment is capable of uniformly mixing and placing the A-R binder. The Engineer may stop work at any time and require additional test sections to be shot if:

- nonuniformity of application continues after corrective action;
- on 3 consecutive shots, application rate differs by more than 0.03 gal. per square yard from the target rate; or
- any shot differs by more than 0.05 gal. per square yard from the target rate.

The Engineer will approve the test section location. The Engineer may require additional test sections until surface treatment application meets specification requirements.

5.9.4. **Nonuniform Application.** Stop application if not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine the cause of nonuniform application and correct it.

5.9.5. **Sampling and Testing Binder.**

5.9.5.1. **Sample Collection.** Collect all samples in accordance with Tex-500-C, “Sampling Bituminous Materials, Pre-Molded Joint Fillers, and Joint Sealers,” from the distributor and witnessed by the Engineer. Collect a sample from the transport, when directed.

Collect at least one sample of each binder grade and source used on the project for each production day. The Engineer will retain these samples. At least once per project, collect split samples of each binder grade and source used. The Engineer will submit one split sample to MTD for testing and retain the other split sample.

The Engineer will keep all retained samples for one year, for hot-applied binders and cutback asphalts; or for two months, for emulsified asphalts. The Engineer may submit retained samples to MTD for testing as necessary or as requested by MTD.

5.9.5.2. **Material Adjustment Factors.** The Engineer will determine if failing material is suitable to leave in place. Pay reduction factors will be applied to failing materials that are allowed to remain in place.

5.10. **Aggregate Placement.** The aggregate must be surface dry before application. When shown on the plans, preheat aggregate to between 250°F and 350°F. Cover each load with tarping material to minimize the temperature drop of the preheated aggregate. Immediately after the distributor has started spraying the hot asphalt-rubber, uniformly apply the aggregate at the rate specified by the Engineer.

5.10.1. **Nonuniform Application.** Stop application if it is not uniform in the transverse direction. Verify equipment condition, operating procedures, and transverse application rate. The transverse application rate should be within 1 lb. Determine and correct the cause of nonuniform application.

5.10.2. **Test Sections.** The Engineer may stop aggregate application and require construction of test strips at the Contractor’s expense if any of the following occurs:

- nonuniformity of application continues after corrective action;

- on 3 consecutive rock lands, the length placed by a haul truck differs by more than 25 ft from the rock land length calculated for the target application rate, or
- any rock land length differs by more than 50 ft from the rock land length calculated for the target application rate.

The Engineer will approve the test section location. The Engineer may require additional test sections until seal coat application meets specification requirements.

- 5.10.3. **Rolling.** Start the rolling operation on each shot as soon as aggregate is applied. Use sufficient rollers to cover entire mat width in 1 pass (1 direction). Roll in a staggered pattern. Unless otherwise shown on the plans, make at least 5 passes.

If rollers are unable to keep up with spreader box, stop application until rollers have caught up, or furnish additional rollers. Keep roller tires free of asphalt.

- 5.11. **Repairs.**

- 5.11.1. **Patching.** Before rolling, repair spots where coverage is incomplete. Repair can be made by hand spotting or other approved method. When necessary, apply additional hot A-R binder to embed aggregate.

- 5.11.2. **Repairs.** The seal coat shall have all defects corrected the same day as initial construction. These defects include locations of blocked spray nozzles, poorly constructed longitudinal or transverse joints, or any other construction defect. The finished seal coat surface when visually inspected shall not have any flushing, significant aggregate loss, or loose aggregate.

- 5.12. **Racked-in Aggregate.** If specified on the plans, apply racked-in aggregate after patching, uniformly at the rate directed. The racked-in aggregate must be applied before opening the roadway or intersection to traffic.

- 5.13. **Brooming.** After rolling, sweep as soon as aggregate has sufficiently bonded to remove excess. In areas of racked-in aggregate, sweep as directed.

- 5.14. **Partial Construction Acceptance.** Repair any surface failures. Remove all temporary stockpiles and restore the area to the original contour and grade within 1 month of completing the seal coat per location and before final project acceptance.

6. PERFORMANCE REQUIREMENTS

- 6.1. The seal coat shall have a uniform single retained layer of aggregate that is uniformly spread both in the transverse and longitudinal direction.

- 6.1.1. **Performance Period.** All seal coats must meet the requirements of this specification for at least 10 months after installation. Document the seal coat condition in accordance with Tex-2XX-F, "Seal Coat Performance Tests."

- 6.1.2. Based on visual inspection, the seal coat shall not have significant aggregate or texture loss over the performance period.

Disputes over the visual inspection results will be resolved measuring the texture depth and counting loose aggregate such that no more than 50 loose particles for grade 3 and 4 or 100 loose particles for grade 5 are left in a 2 sq. yd. area. The seal coat shall have a texture depth of at least 0.05 in. after initial construction and maintain an average texture depth of at least 0.05 in. with no locations less than 0.035 in. over the performance period, in accordance with Tex-436-A.

6.1.3. Perform aggregate loss and texture measurements in accordance with Tex-2XX-F, "Seal Coat Performance Tests."

6.1.4. **Corrective Action.** Repair areas not meeting the performance requirements.

6.1.5. The seal coat shall have all defects corrected. These defects include areas of aggregate or texture loss caused by

- blocked spray nozzles,
- poorly constructed longitudinal or transverse joints,
- material failures,
- incorrect application rates, or
- any other construction defect.

Repair areas with aggregate loss by placing a new seal coat over the area. The Engineer may assess a payment adjustment for a single line streak instead of corrective action.

Repair areas with a texture depth less than 0.035 in. and when the average texture depth is less than 0.05 in. by restoring the texture through placement of a new seal coat. Additional work may be required before the seal coat is placed, such as hydroblasting or milling to remove excess binder. Repair method to be approved by the Engineer and shall not damage the underlying pavement structure. The Engineer may assess a payment adjustment when the average texture depth is less than 0.05 in. but greater than 0.035 in.

Unless otherwise directed, repair all areas that fail to meet requirements at the Contractor's expense. Maintain the seal coat during the performance period. Repair noncompliant areas within 30 days of notification. All repairs must also meet all requirements of this Item until the end of the performance period. Repairs completed at the end of the performance period must meet the requirements for 60 days after repairs are completed.

6.2. **Referee Testing.** The Contractor may request referee testing if a repair condition is determined based on the Engineer's test results. Make the request within 5 working days after receiving test results from the Engineer. Include Contractor test results with the referee request. Referee tests will be performed only for the particular tests in question. Allow 10 working days from the time the referee request is made for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than 3 referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

6.3. **Acceptance Plan and Payment Adjustments.** The Engineer will evaluate the seal coat performance criteria for determining acceptance, payment adjustment, and corrective action.

7. FINAL ACCEPTANCE

- 7.1. Final Acceptance. Maintain seal coat until the Engineer accepts the work. Repair any surface failures. Before final project acceptance, remove all temporary stockpiles and restore the area to the original contour and grade.

8. MEASUREMENT

- 8.1. **A-R Binder.** Unless otherwise shown on the plans, A-R Binder will be measured by one of the following methods:
- 8.1.1. **Volume.** A-R Binder, including all components, will be measured at the applied temperature by strapping the tank before and after road application. The distributor calibrated strap stick will be used for measuring the asphalt level in the distributor asphalt tank. The certified tank chart will be used to determine the beginning gallons and the final gallons in the distributor tank. The quantity to be measured for payment will be the difference between the beginning gallons and the final gallons.
- 8.1.2. **Weight.** A-R binder, including all components, will be measured in tons just before delivery to the point of application.
- 8.2. **Aggregate.** Aggregate will be measured by the cubic yard in the trucks as applied on the road. Strike off the loaded aggregate for accurate measurement when directed.
- 8.3. **Loading, Hauling, and Distributing Aggregate.** When the Department furnishes the aggregate, the loading, hauling, and distributing will be measured by the cubic yard in the trucks as applied on the road.

9. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for "A-R Binder," of the type specified "Aggregate," and "Loading, Hauling, and Distributing Aggregate" of the types-grades specified on the plans. These prices are full compensation for surface preparation, tack coat, heating and mixing, hauling and placing all materials, rolling and removing excess aggregate, cleaning up stockpiles, test sections, equipment, labor, tools, maintenance, repairs, and incidentals.

- 9.1. **Partial Payment.** Upon completion of initial construction, 95% payment will be made for "Asphalt," "Aggregate," and "Loading, Hauling, and Distributing Aggregate" of the types-grades specified on the plans.
- 9.2. **Final Payment.** Upon final acceptance, the payment will be determined based on the payment adjustment factors. Previous payments under this Item will be deducted from this amount.
- 9.2.1. **Payment Adjustment Factors.** The payment adjustment factor is based on the Engineer's test results. A payment adjustment factor for binder tests will be determined from Table 1. A payment adjustment factor for performance requirements will be determined from Table 2.

**Table 1
Binder Payment
Adjustment Factors**

Description	Test Procedure	Binder Type							
		A-R Type II				A-R Type III			
		Pay Adjustment		Contract Limits		Pay Adjustment		Contract Limits	
		Test Value	Pay Factor ¹ , "F"	Min	Max	Test Value	Pay Factor ¹ , "F"	Min	Max
Apparent viscosity, 347°F, cP	D2196	1,500 ≤ Result ≤ 5,000	1	1,500	5,000	1,500 ≤ Result ≤ 5,000	1	1,500	5,000
	Method A	Result < 1,500 or Result > 5,000	Reject in Field			Result < 1,500 or Result > 5,000	Reject in Field		
Penetration, 39.2°F, 200 g, 60 sec.	T 49	≥ 15	1	15	-	≥ 25	1	25	-
		13-14	0.85			23-24	0.85		
		< 13	0.7 ²			< 23	0.7 ²		
Softening point, °F	T 53	≥ 130	1	130	-	≥ 125	1	125	-
		125-129	0.85			122-125	0.85		
		< 125	0.7 ²			< 122	0.7 ²		
Resilience, 77°F, %	D5329	≥ 20	1	20	-	≥ 10	1	10	-
		15-19	0.85			10-14	0.85		
		10-14	0.7			6-9	0.7		
		< 10	0.5 ²			< 6	0.5 ²		
All other tests		Meet Requirements	1						
		Does not Meet Requirements	0.9						

1. When the binder does not meet requirements in more than one test and is allowed to remain in place, use the largest reduction based on all tests not meeting requirements.
2. The pay adjustment applies if the material is allowed to remain in place.

**Table 2
Performance
Payment
Adjustment Factors**

Performance Criteria	Test Method	Pay Adjustments	
		Test Value	Pay Factor
Texture	Tex-436-A	≥ 0.05 in	1
		0.05 ≤ Result ≤ .040	0.75
		0.40 ≤ Result ≤ .035	0.5
		< 0.035	Corrective Action

When a single line streak occurs instead of corrective action, the Engineer may assess a payment adjustment for each line of streaking resulting in no pay for the aggregate lost in the streaked area.

9.2.2. **Total Adjusted Pay Calculation.** Total adjusted pay will be based on the applicable payment adjustment factors from 9.1.1 and 9.1.2. Apply the pay adjustment factor to the bid price for “A-R Binder” and “Aggregate.”

9.2.2.1. **“A-R Binder.”** Apply the adjusted pay based on quantity of binder represented by the testing.

$$\text{TAP} = \text{F} \times \text{B} + \text{A} \times \text{BR} \times \text{T}$$

Where

TAP = Total adjusted pay

F = Binder pay factor, (Table 1)

B = Quantity of binder represented by the test, gal.

A = Area represented by texture test, sy

BR = Average binder rate applied to the area, gal/sy

T = Texture pay factor (Table 2)

9.2.2.2. **“Aggregate.”** Apply the adjusted pay based on quantity of aggregate placed in the area requiring repairs and testing.

$$\text{TAP} = \text{A} \times \text{AR} \times \text{T} + \text{V} - [(\text{L} \times \text{W})/9 \times \text{AR}]$$

Where

A = Area represented by texture test, sy

AR = Aggregate rate applied in streaked location, cy/sy

T = Texture pay factor (Table 2)

V = Total volume of aggregate placed in the streaked area, cy

L = Length of streak, ft.

W = Average width of streak, ft.

APPENDIX B. TEST METHODS**Test Procedure for****TEXAS SEAL COAT DESIGN METHOD
TxDOT Designation: Tex-2xx-F****Effective Date:****1. SCOPE**

- 1.1. Use this test method to determine the target application rate for seal coat binder and aggregate. This test method includes four parts.
- 1.1.1. Use Part 1, to determine the target aggregate spread rate in sq. yd. per cu. yd.
- 1.1.2. Use Part 2, (Group A) to determine the target binder application rate in gal. per sq. yd. for asphalt cement (AC), Asphalt Rubber (A-R), and residual binder of emulsions and cutbacks.
- 1.1.3. Use Part 2, (Group B) to determine the target binder application rate in gal. per sq. yd. for emulsions and cutback asphalts.
- 1.1.4. Use Part 3, to determine the target application rates for multiple layer applications.
- 1.1.5. Use Part 4, to determine transverse variable rates.
- 1.2. The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.
- 1.3. The target application rate is determined based on the aggregate size, void space, and conditions of the roadway. The target application rate is adjusted as the conditions change.

2. DEFINITIONS

- 2.1. *Mat Thickness*—the average seal coat mat thickness determined from a representative sample of the aggregate. The aggregate is oriented to its flattest side to establish the length, width, and thickness portions of the particle.
- 2.1.1. *Flattest Side* – The aggregate particles oriented to simulate the effects of rolling the aggregate during construction. The length and width comprise the flattest side.
- 2.1.1.1. *Length (L)*—maximum dimension of the particle.
- 2.1.1.2. *Width (W)*—maximum dimension in the plane perpendicular to the length.
- 2.1.1.3. *Thickness (T)*—maximum dimension perpendicular to the length and width.

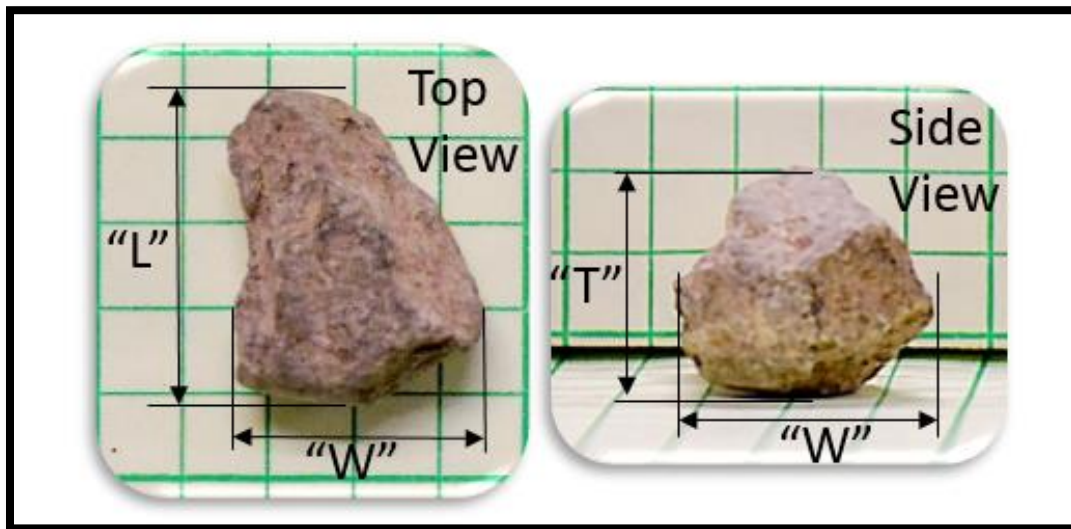


Figure 1: Aggregate Dimensions

- 2.2. *Volume of Seal Coat*—the space on the pavement surface that the seal coat occupies and is comprised of the aggregate, binder, and air.
- 2.3. *Void Space*—the space on the pavement that is comprised of the volume of roadway available for the binder. It is the volume of seal coat minus the volume of aggregate.
- 2.4. *Percent Embedment*—the amount of the aggregate that is embedded into the binder.
- 2.5. *Aggregate Spread Rate*—the quantity of aggregate needed to cover a known area, one particle in depth with the particles not touching and oriented to their flattest side, expressed in sq. yd. per cu. yd.
- 2.6. *Binder Application Rate*—the quantity of binder needed to cover a known area, expressed in gal. per sq. yd.
- 2.7. *Dry loose unit weight*—the loose mass of the aggregate, in accordance with Tex-404-A.
- 2.8. *Specific gravity*—the bulk volume of the aggregate that displaces a volume of water, in accordance with either Tex-403-A (natural aggregate) or Tex-433-A (lightweight aggregate).
- 2.9. *Absorption*—the moisture content of the aggregate at saturated surface-dry condition, in accordance with either Tex-403-A (natural aggregate) or Tex-433-A (lightweight aggregate).
- 2.10. *Flakiness index (FI)*—the percentage of aggregate particles that have a thickness of less than one-half of the nominal size, in accordance with Tex-224-F.
- 2.11. *Multiple layer*—seal coats are layers placed immediately after one and other (placed the same day or within the minimum cure days of each layer).

2.12. *Variable rates*—transverse rates that vary across the pavement width being sealed and are generally designed for in the wheelpath and outside the wheelpath on pavement with an existing seal coat surface that is flushed or bleeding.

2.12.1. *Single Bar Distributor*—asphalt distributor that uses small and large nozzles placed over the lane to apply transverse variable rates. Figure 2 shows the typical wheelpaths. Figure 3 shows an example of the nozzle layout for a 12 ft lane.

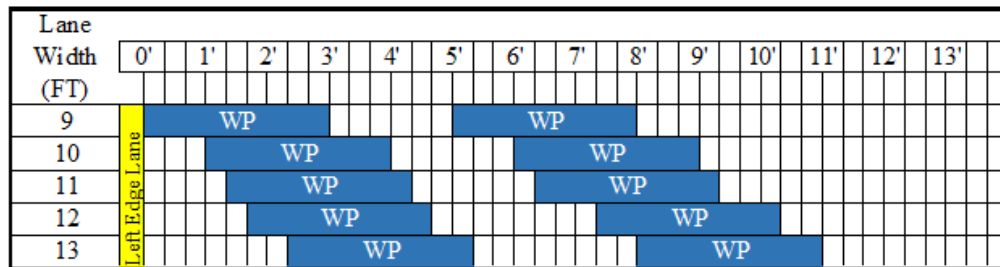


Figure 2: Wheelpath Locations

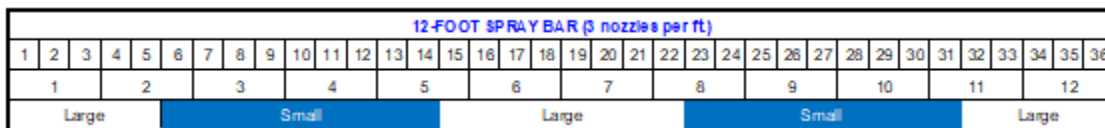


Figure 3: Variable Transverse Rates

2.13. *Flushing and Bleeding*—the upward movement of asphalt resulting in the formation of a film of asphalt on the roadway surface [2].

2.13.1. Flushing has a pavement texture less than 0.05 inches and greater than or equal to 0.035 inches, measured in accordance with Tex-436-A.

2.13.2. Bleeding has a pavement texture less than 0.035 inches, measured in accordance with Tex-436-A.

2.14. *Pavement Conditions* vary depending on the existing surface being sealed. Refer to Figure 4 through Figure 9 for examples of pavement conditions and their corresponding descriptions.

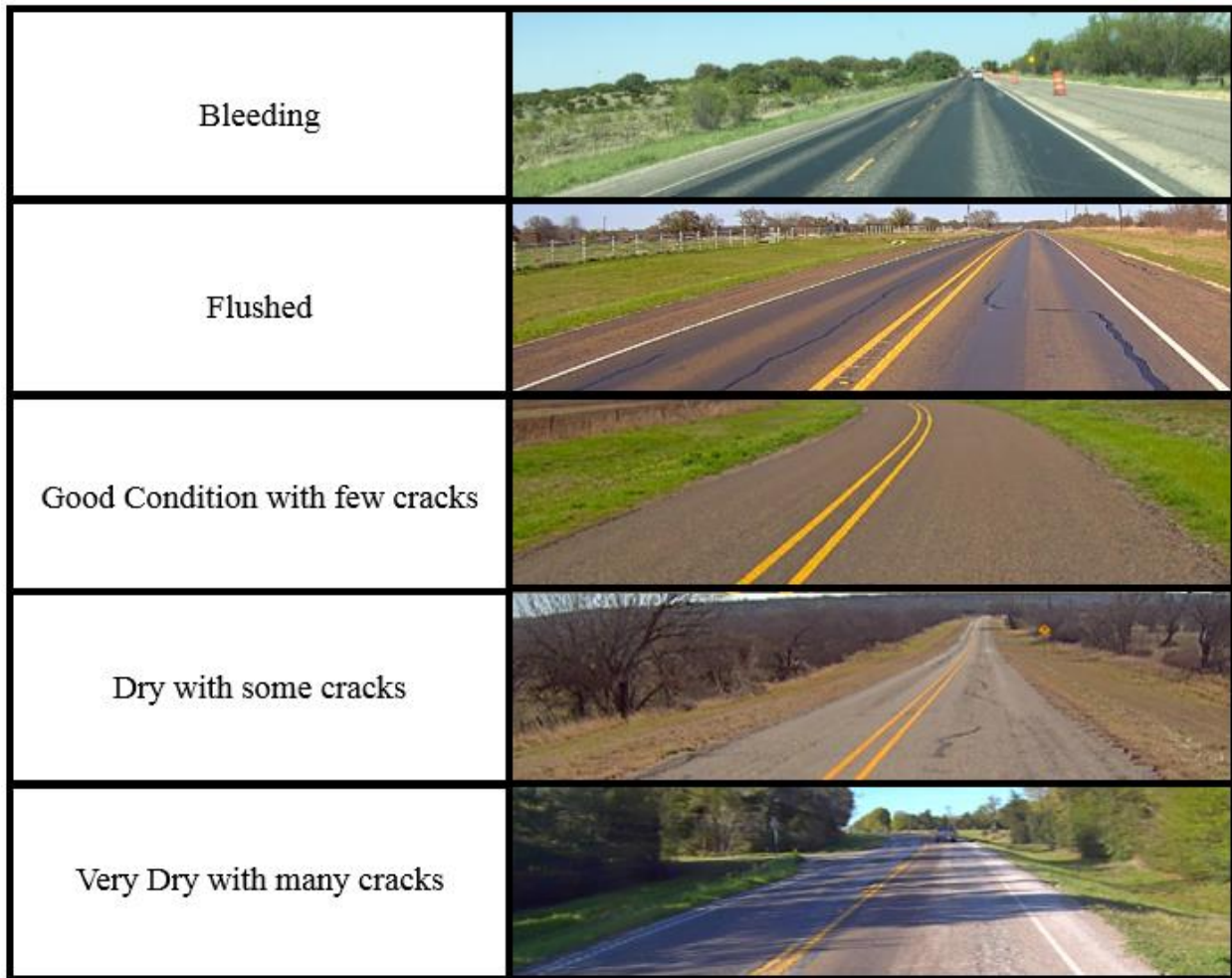


Figure 4: Pavement Condition—Existing Seal Coat Surface



Figure 5: Pavement Condition—Concrete Pavement





<p>Good Condition with few cracks</p>	
<p>Dry with some cracks</p>	
<p>Very Dry with many Cracks</p>	
<p>Bleeding from Underseal</p>	

Figure 6: Pavement Condition—Existing Asphaltic Concrete Surface

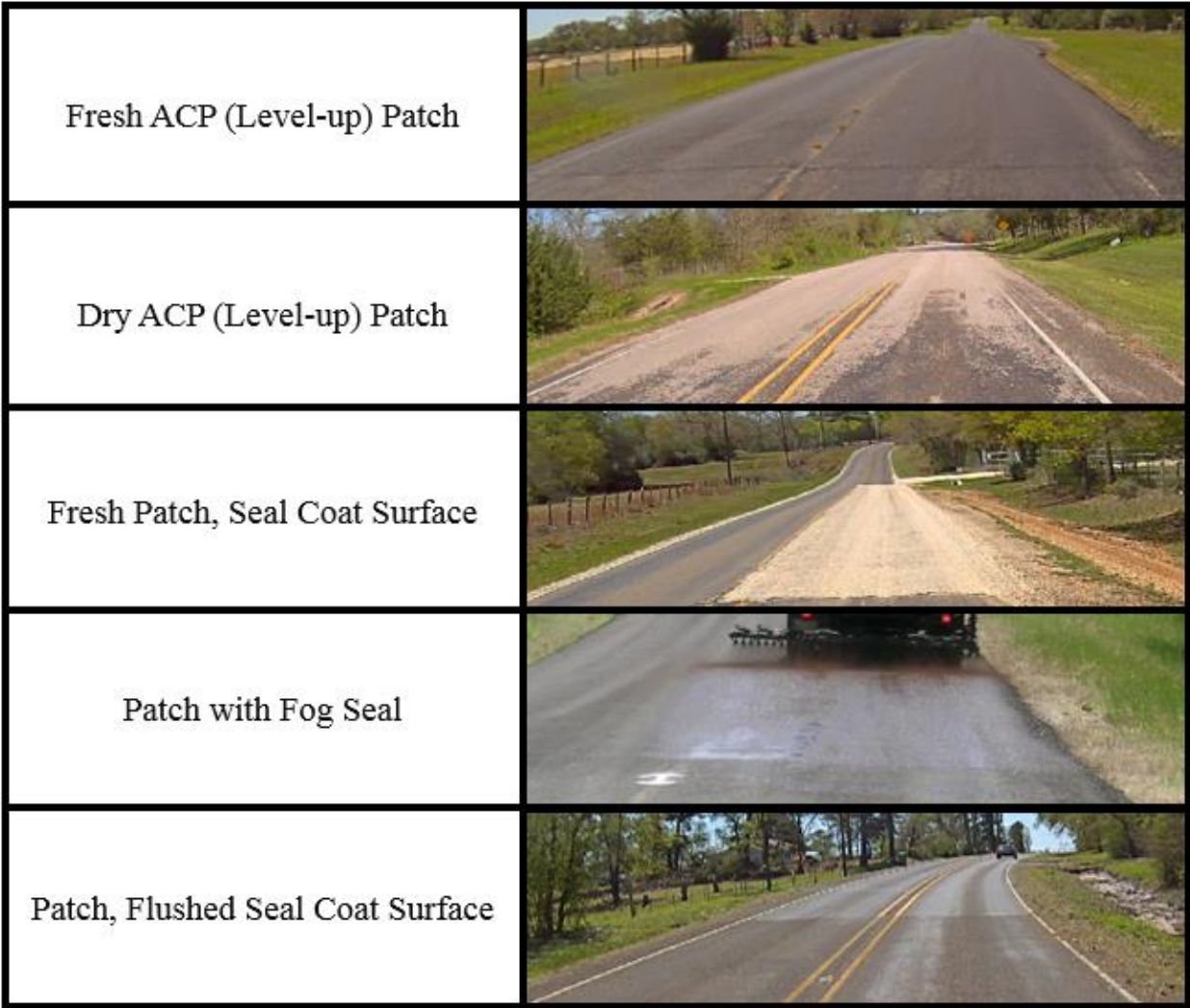


Figure 7: Pavement Condition: Patch

<p>Flexible Base</p>	
<p>Stabilized Base</p>	
<p>Prime Seal w/GR 5, Bleeding</p>	
<p>Prime Seal w/GR5 Good</p>	
<p>Prime: Dry Lightly Primed</p>	
<p>Prime: Waxy & wet, not well penetrated</p>	
<p>Good Prime Rate, well penetrated</p>	

Figure 8: Pavement Condition Prime and Base

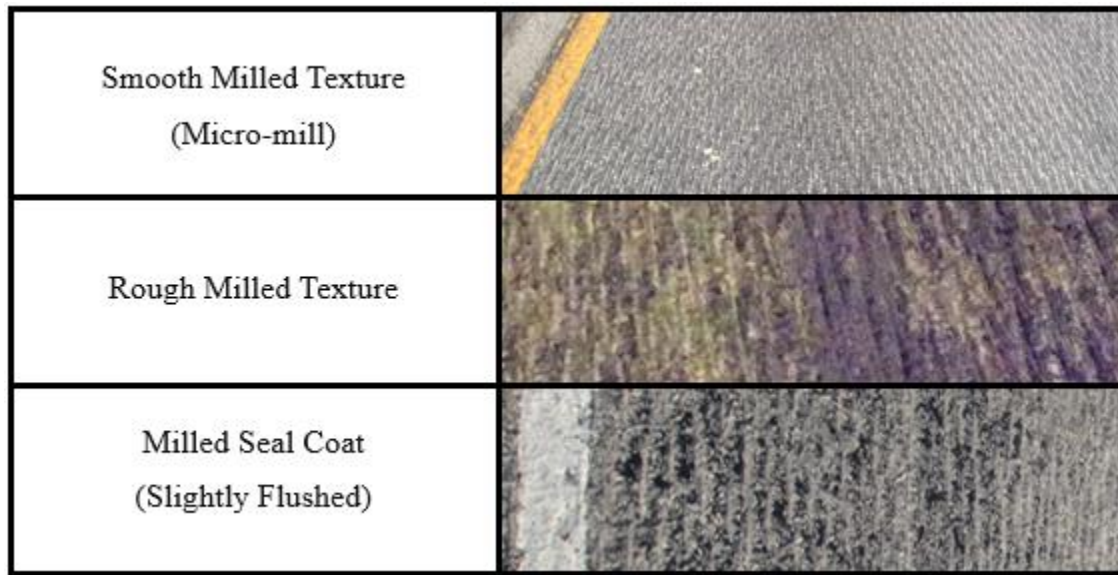


Figure 9: Milled Surfaces

2.15. **ASSUMPTIONS**

- 2.15.1. Aggregate is spread in a uniform layer of one particle thickness, with the least dimension near vertical and the particles have no or minimal contact with each other.
- 2.15.2. Average mat thickness of the aggregate must be representative of the aggregate being used.
- 2.15.3. Aggregate spread rate determines the void space in the seal coat layer. The void space has a direct impact on the amount of binder required, therefore a failure to achieve, within practical limits, the design aggregate spread rate will result in the design binder application rate being incorrect [6].
- 2.15.4. The percent embedment should be varied to optimize requirements such as final surface texture and maximum seal life. Factors to adjust the design embedment are included in the design method.
- 2.15.5. The adjustment factors in the design were developed to account for the conditions that would ultimately affect the embedment depth. The factors are based on the following:
 - Aggregate size and shape.
 - Existing pavement texture.
 - Hardness of existing pavement.
 - Absorptive properties of existing pavement.
 - Traffic volume.
 - Percent trucks.
 - Time of year.
- 2.15.5.1. The temperature adjustment factor tables are based on the assumption that the specific gravity was greater than 0.967. Other binders may be used with lower specific gravity,

but the temperature to volume conversion will need to be adjusted for that material using TxDOT's "Asphalt Binder Temperature-Volume Corrections" [7].

2.15.6. The following material information was used:

- Unit weight of water is 62.4 lb per cu. ft.
- Asphalt at 60°F with a specific gravity of 1.02 is:
 - 63.648 lb per cu. ft.
 - 8.508 lb per gal.
 - 7.48 gal. per cu. ft.
 - 5.61 gal.-in. per sq. yd.

3. APPARATUS

- 3.1. Balance, Class G2 in accordance with Tex-901-K, minimum capacity of 33 lb (15 kg).
- 3.2. Board, test area made of wood or other sturdy material with a minimum of size of 0.25 sq. yd.
- 3.3. Sample splitter, quartering machine, or quartering cloth.
- 3.4. Standard U.S. sieves, meeting the requirements of Tex-907-K.
- 3.5. Mechanical sieve shaker.
- 3.6. Pans.
- 3.7. Brass wire brush.
- 3.8. Bristle brush.
- 3.9. Scoop.
- 3.10. Drying oven, capable of attaining a temperature of at least $230 \pm 9^\circ\text{F}$ ($110 \pm 5^\circ\text{C}$).

4. REPORTING AND DOCUMENTATION

- 4.1. Report all test data and pertinent information using the SiteManager form TXSCDSN.xlsm.

PART I— DETERMINING THE TARGET AGGREGATE RATE

5. PROCEDURES

- 5.1. *Preparing Sample*
- 5.1.1. Obtain a representative aggregate sample in accordance with Tex-221-F. Sample a minimum of 55 lb of aggregate.

- 5.1.2. Place a representative sample in oven and dry to constant weight, at a temperature of $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$). Dry the limestone rock asphalt or precoated aggregate to constant weight at a temperature of $140 \pm 5^{\circ}\text{F}$ ($60 \pm 3^{\circ}\text{C}$). Cool to room temperature.
- 5.2. *Spread Rate Visual Analysis*
- 5.2.1. Determine the dry loose unit weight in lb per cu. ft in accordance with Tex-404-A.
- 5.2.2. Determine the average mat thickness in accordance with Tex-2XX-F, "Average Mat Thickness."
- 5.2.3. Calculate the theoretical aggregate spread rate in sq. yd. per cu. yd., using equation 9.1.
- 5.2.4. Place the representative sample at the theoretical spread rate on a board of known area using Equation 9.2 to calculate the weight of material.
- 5.2.5. Visually evaluate whether or not the theoretical spread rate is acceptable. An acceptable spread rate should be one particle thick on the flattest side covering the full area of the board.
- 5.2.6. Remove or add material until the acceptable visual spread rate is achieved.
- 5.2.7. Weigh the material on the board.
- 5.2.8. Determine the target spread rate using equation 9.3 if the visual spread rate was adjusted, otherwise use the theoretical spread rate from equation 9.1
- 5.3. *Field Adjustments*
- 5.3.1. Randomly verify the spread rate by sampling and testing the aggregate stockpiles following 5.2.1 through 5.2.8.
- 5.3.2. When problems occur during construction, adjust the rate until visually acceptable and repeat steps 5.2.1 through 5.2.8 to determine what caused the need for adjustment and monitor those changes.
- 5.3.3. If a significant change in aggregate size and or shape occurs, follow steps 5.2.1 through 5.2.8 to establish a new spread rate.

PART II— DETERMINING THE TARGET BINDER RATE

6. PROCEDURE

- 6.1. Obtain the most recent binder test report from Materials and Test Division for each of the specified binders being used on the project.
- 6.2. Group A- Asphalt Cement (AC) and Asphalt-Rubber (A-R) binders.
- 6.2.1. Obtain the quantity of crumb rubber in percent from the A-R binder design.

- 6.2.2. Determine the average mat thickness in accordance with Tex-2XX-F, “Average Mat Thickness.”
- 6.2.3. Determine the dry loose unit weight in lb per cu. ft in accordance with Tex-404-A.
- 6.2.4. Determine the specific gravity and absorption in accordance with either Tex-403-A (natural aggregate) or Tex-433-A (lightweight aggregate).
- 6.2.5. Determine the flakiness index (FI) of the aggregate in accordance with Tex-224-F.
- 6.2.6. Determine the available voids on the pavement using Equation 9.4.
- 6.2.7. Determining the design embedment.
 - 6.2.7.1. Obtain current traffic counts in vehicles per lane per day.

Note: When there is a significant change in the traffic, develop rates based on the various traffic conditions. For example, the rate on a wide shoulder will be higher than the rate in the lane.

- 6.2.7.2. Determine the design embedment percentage using Table 1 for all binders except A-R binders. Use Table 2 for A-R binders. Values shown in the tables are shown as a percentage.

Table 1: Design Embedment

	AC, Modified AC, Emulsion and Cutback					
FI	≤8%	≤8%	≤8%	>8%	>8%	>8%
Aggregate Grade	Gr 3	Gr 4	Gr 5	Gr 3	Gr 4	Gr 5
Traffic (v/d/l)	De (%)	De (%)	De (%)	De (%)	De (%)	De (%)
0–50 SHLD	41	40.5	40.5	37	36.5	36
51–100	40	39.5	39.5	36	35.5	35
101–250	39.5	39	39	35.5	35	34.5
251–400	39	38.5	38.5	35	34.5	34
401–600	38	37.5	37.5	34	33.5	33
601–800	37.5	37	37	33.5	33	32.5
801–1000	37	36.5	36.5	33	32.5	32
1001–1500	36.5	36	36	32.5	32	31.5
1501–2000	36	35.5	35.5	32	31.5	31
2001–3000	35.5	35	35	31.5	31	30.5
>3000	35	34.5	34.5	31	30.5	30

Table 2: Design Embedment, A-R Binders

	A-R Binders					
FI	≤8%	≤8%	≤8%	>8%	>8%	>8%
Aggregate Grade	Gr 3	Gr 4	Gr 5	Gr 3	Gr 4	Gr 5
Traffic (v/d/l)	De (%)	De (%)	De (%)	De (%)	De (%)	De (%)
0–50 SHLD	52.5	51.5	51.5	47	46.5	46
51–100	52	51	51	46.5	46	45.5
101–250	51.5	50.5	50.5	46	45.5	45
251–400	50.5	49.5	49.5	45	44.5	44
401–600	49.5	48.5	48.5	44	43.5	43
601–800	49	48	48	43.5	43	42.5
801–1000	48	47	47	42.5	42	41.5
1001–1500	47.5	46.5	46.5	42	41.5	41
1501–2000	47	46	46	41.5	41	40.5
2001–3000	46	45	45	40.5	40	39.5
>3000	45.5	44.5	44.5	40	39.5	39

6.2.8. Determine the Residual binder based on the aggregate size and shape at 60°F using Equation 9.5.

6.2.9. Adjust the binder rate based on the application with Equation 9.6. Use the volume correction factors from TxDOT internal excel worksheet, “Asphalt Binder Temperature-Volume Corrections” [9]. The Factors for the typical application rates of binders with an assumed asphalt specific gravity of 1.02 at 60°F can be found in Table 3 through Table 5.

Note: If the application temperature is unknown, for estimating purposes use 375°F for AC and A-R binders and 150°F for Emulsions and Cutback binders.

**Table 3: Application Temperature
Volume Correction Factors for Emulsion
Binders**

App. Temp.	Vol. Correction Factor to	App. Temp.	Vol. Correction Factor to
[°F]	[60°F]	[°F]	[60°F]
120	0.98500	150	0.97750
120	0.98500	141	0.97975
121	0.98475	142	0.97950
122	0.98450	143	0.97925
123	0.98425	144	0.97900
124	0.98400	145	0.97875
125	0.98375	146	0.97850
126	0.98350	147	0.97825
127	0.98325	148	0.97800
128	0.98300	149	0.97775
129	0.98275	150	0.97750
130	0.98250	151	0.97725
131	0.98225	152	0.97700
132	0.98200	153	0.97675
133	0.98175	154	0.97650
134	0.98150	155	0.97625
135	0.98125	156	0.97600
136	0.98100	157	0.97575
137	0.98075	158	0.97550
138	0.98050	159	0.97525
139	0.98025	160	0.97500
140	0.98000		

**Table 4: Application Temperature Volume
Correction Factors for Cutback Binders**

App. Temp.	Vol. Correction Factor to	App. Temp.	Vol. Correction Factor to
[°F]	[60°F]	[°F]	[60°F]
125	0.97747	151	0.96857
126	0.97713	152	0.96823
127	0.97679	153	0.96789
128	0.97644	154	0.96755
129	0.97610	155	0.96720
130	0.97576	156	0.96686
131	0.97541	157	0.96652
132	0.97507	158	0.96618
133	0.97473	159	0.96584
134	0.97438	160	0.96550
135	0.97404	161	0.96516
136	0.97370	162	0.96482
137	0.97336	163	0.96448
138	0.97301	164	0.96414
139	0.97267	165	0.96380
140	0.97233	166	0.96346
141	0.97199	167	0.96312
142	0.97164	168	0.96278
143	0.97130	169	0.96244
144	0.97096	170	0.96210
145	0.97062	171	0.96176
141	0.97199	172	0.96142
142	0.97164	173	0.96108
143	0.97130	174	0.96074
144	0.97096	175	0.96040
145	0.97062	176	0.96006
146	0.97028	177	0.95972
147	0.96993	178	0.95939
148	0.96959	179	0.95905
149	0.96925	180	0.95871
150	0.96891		

Table 5: Application Temperature Volume Correction Factors for Hot Applied Binders

App. Temp.	Vol. Correction Factor to	App. Temp.	Vol. Correction Factor to	App. Temp.	Vol. Correction Factor to	App. Temp.	Vol. Correction Factor to
[°F]	[60°F]	[°F]	[60°F]	[°F]	[60°F]	[°F]	[60°F]
300	0.91871	332	0.90826	364	0.89791	396	0.88765
301	0.91838	333	0.90794	365	0.89759	397	0.88733
302	0.91806	334	0.90762	366	0.89727	398	0.88701
303	0.91773	335	0.90729	367	0.89694	399	0.88669
304	0.91740	336	0.90697	368	0.89662	400	0.88637
305	0.91707	337	0.90664	369	0.89630	401	0.88605
306	0.91675	338	0.90632	370	0.89598	402	0.88573
307	0.91642	339	0.90599	371	0.89566	403	0.88541
308	0.91609	340	0.90567	372	0.89534	404	0.88510
309	0.91576	341	0.90534	373	0.89501	405	0.88478
310	0.91544	342	0.90502	374	0.89469	406	0.88446
311	0.91511	343	0.90470	375	0.89437	407	0.88414
312	0.91478	344	0.90437	376	0.89405	408	0.88382
313	0.91446	345	0.90405	377	0.89373	409	0.88350
314	0.91413	346	0.90372	378	0.89341	410	0.88319
315	0.91380	347	0.90340	379	0.89309	411	0.88287
316	0.91348	348	0.90308	380	0.89277	412	0.88255
317	0.91315	349	0.90275	381	0.89245	413	0.88223
318	0.91282	350	0.90243	382	0.89213	414	0.88192
319	0.91250	351	0.90211	383	0.89181	415	0.88160
320	0.91217	352	0.90178	384	0.89149	416	0.88128
321	0.91185	353	0.90146	385	0.89116	417	0.88096
322	0.91152	354	0.90114	386	0.89084	418	0.88065
323	0.91119	355	0.90081	387	0.89052	419	0.88033
324	0.91087	356	0.90049	388	0.89020	420	0.88001
325	0.91054	357	0.90017	389	0.88988	421	0.87969
326	0.91022	358	0.89984	390	0.88956	422	0.87938
327	0.90989	359	0.89952	391	0.88925	423	0.87906
328	0.90957	360	0.89920	392	0.88893	424	0.87874
329	0.90924	361	0.89888	393	0.88861	425	0.87843
330	0.90892	362	0.89855	394	0.88829		
331	0.90859	363	0.89823	395	0.88797		

6.2.10. Adjust the binder rate based on the pavement surface condition, traffic volume, and aggregate grade using equation 9.7.

Note: When there is a significant change in the pavement condition, develop rates based on the various conditions. For example, the rate on a fresh patch will be higher than the rate a section with flushed wheel paths.

6.2.10.1. Compare the rates to a usual maximum and minimum rate based on the aggregate size, percent voids, and embedment to ensure the rate is in a reasonable range. Extreme conditions may require the rate to be outside the ranges; however caution should be used when outside the limits. The upper and lower limits can be found by using equation 9.8 and equation 9.9.

Table 6: Pavement Surface Condition Adjustments

Binder Rate Adjustment Factors for Pavement Surface Condition (existing or new pavement-wheel path conditions)				
Surface Type	Surface Condition	Aggregate Grade		
		Gr 3	Gr 4	Gr 5
		gal./sq. yd.	gal./sq. yd.	gal./sq. yd.
Asphaltic Concrete Pavement (ACP)	Very dry ACP with many cracks	0.08	0.06	0.05
	Dry ACP with some cracks	0.05	0.04	0.03
	Good condition ACP with few cracks	0.02	0.02	0.01
Seal	Very dry with many cracks	0.06	0.06	0.04
	Very Coarse Texture and Dry with few cracks	0.04	0.04	0.03
	Dry seal with few cracks	0.03	0.03	0.02
	Good seal with few cracks	0.00	0.00	0.00
	Flushed seal	-0.02	-0.02	-0.01
	Bleeding seal	-0.04	-0.04	-0.02
Patches	Dry or fresh patch	0.03	0.03	0.02
	Fogged patch	0.00	0.00	0.00
	Flushed patch	-0.03	-0.03	-0.03
Prime	Dry surface, light rate	0.02	0.02	0.02
	Penetrated well, good rate	0.00	0.00	0.00
	Waxy and wet, not penetrated well	-0.03	-0.03	-0.02
Base	Flex Base	0.04	0.03	0.02
	Stabilized Base	0.02	0.01	0
	Asphalt Stabilized Base	0.01	0	-0.01
Multiple Layer	1st Course Good Condition	-0.02	-0.02	-0.01
	1st Course Flushed	-0.04	-0.03	-0.02
	1st Course Bleeding	-0.05	-0.04	-0.03
Milled Surface	Smooth (micro-mill texture)	0.03	0.03	0.02
	Rough milled texture	0.08	0.06	0.05
	Milled Seal Coat, slightly flushed	0.03	0.03	0.02

Table 7: Traffic Volume Adjustments

Binder Rate Adjustment Factors for Traffic Volume			
	Aggregate Grade		
Current Traffic	Gr 3	Gr 4	Gr 5
Veh/Day/Lane	gal./sq. yd.	gal./sq. yd.	gal./sq. yd.
0–50 (SHLD)	0.05	0.05	0.02
50–100	0.05	0.05	0.02
101–250	0.04	0.04	0.01
251–400	0.03	0.03	0.00
401–500	0.02	0.02	0.00
501–650	0.01	0.01	0.00
651–900	0.00	0.00	0.00
901–1500	-0.01	-0.01	-0.01
1501–2000	-0.02	-0.02	-0.01
> 2000	-0.03	-0.03	-0.01

Table 8: Heavy Truck Traffic Adjustments

Binder Rate Adjustment Factors for Truck Traffic			
	Aggregate Grade		
Current Traffic	Gr 3	Gr 4	Gr 5
% Trucks	gal./sq. yd.	gal./sq. yd.	gal./sq. yd.
≤ 15%	0.00	0.00	0.00
15.1%–30%	-0.01	-0.01	0.00
> 30%	-0.02	-0.02	0.00

- 6.3. Group B - Emulsion or Cutback Binder application rate.
 - 6.3.1. Obtain the residual binder rate, “B” from equation 9.7.
 - 6.3.2. Adjust the rate based on time of year and percent residual binder for Emulsions and Cutbacks. Application rates for emulsions and cutbacks are determined from equation 9.10 and the seasonal adjustment factors from Table 9 [8].

Table 9: Seasonal Adjustment Factors

Construction Time	Seasonal Adjustment Factor (K)	
	Emulsion	Cutback
Spring	0.60	0.70
Summer	0.40	0.60
Fall	0.70	0.80
Winter	0.90	0.90

- 6.3.3. Compare the rates to a usual maximum and minimum rate based on the aggregate size, percent voids, and embedment to ensure the rate is in a reasonable range. Extreme conditions may require the rate to be outside the ranges, but caution should be used when outside the limits. The upper and lower limits can be found by using Equation 9.11 and Equation 9.12.

PART III—APPLICATION RATES FOR MULTIPLE LAYER SEAL COATS

7. PROCEDURE

- 7.1. Determine the application rates for each individual layer based on the procedures in section 5 and section 6. Note: The adjustment values for each layer depends on the previous layer placed or the existing pavement for the first layer.

PART IV— VARIABLE APPLICATION RATES

8. PROCEDURES

- 8.1. Evaluate the existing condition of the pavement both inside and outside the wheelpaths.
- 8.2. Visual Evaluation.
- 8.2.1. Evaluate the texture in the wheelpaths and outside the wheelpaths. When the wheelpaths are visually flushing or bleeding, consider the use of transverse variable rates.
- 8.3. Texture Measurement.
- 8.3.1. Use Tex 436-A to measure the texture in and outside the wheelpaths.
- 8.3.2. Consider the use of variable nozzles when the difference in the Sand Patch Average diameter is greater than 0.79 in. (20 mm).
- 8.4. Determine the wheelpath rate and outside the wheelpath rates following the procedure in section 6.
- Note: Use the traffic range 0–50 SHLD for outside the wheelpath instead of the vehicles per day per lane.
- 8.5. Single Bar Distributor with variable nozzles.
- 8.5.1. Obtain the calibration records for the distributor from the Contractor showing the percent change in and outside the wheelpaths.
- 8.5.2. Use equation 9.13 to determine the average rate for the distributor computer and comparison to the strap of the tank.
- 8.5.3. Use equation 9.14 to determine the rate outside the wheelpath.
- 8.5.4. Compare the rate outside the wheelpath to the rate determined from Equation 9.8 or Equation 9.11. When the rate exceeds the rate from Equation 9.8 or Equation 9.11, consider not using the variable application since the rate may be too high and lead to other performance issues.
- 8.6. Multiple Bar distributors.

- 8.7. Use the rates determined in section 8.4.

9. CALCULATIONS

9.1.
$$S = \frac{36}{T_m}$$

Where:

S = Theoretical Spread Rate, sq. yd. per cu. yd.

T_m = Average Mat Thickness (Determined in Tex-2XX-F), in.

9.2.
$$W_B = \frac{27 \times U_w \times B_t}{S}$$

Where:

W_B = Weight of Aggregate, lb per sq. yd.

U_w = Dry Loose Unit Weight of aggregate, in lb. per cu. ft.

B_t = Area of the board in sq. yd.

9.3.
$$S_t = \frac{27 \times U_w}{\frac{W_a}{B_t}}$$

Where:

S_t = Target Spread Rate, sq. yd. per cu. yd.

9.4.
$$V = 1 - \frac{U_w}{(62.4 \times G)}$$

Where:

V = Volume of Voids, percent (expressed as a decimal).

G = Dry Bulk Specific Gravity of the Aggregate.

Note: Use formula results when a Heavy spread rate is anticipated and for a usual spread rate, use V=0.55 (55%).

9.5.
$$R = 5.61 \times V \times D_e \times T_m \times (1 + C_r)$$

Where:

R = Residual Binder at 60°F in gal. per sq. yd.

V = Volume of Voids, percent (expressed as a decimal).

D_e = Design Embedment, percent (expressed as a decimal).

C_r = Crumb Rubber content, percent (expressed as a decimal).

9.6.
$$A = \frac{R}{F_t}$$

Where:

A = the Binder application rate adjusted for application temperature, gal. per sq. yd.

F_t = the temperature correction factor from in Table 3, Table 4, and Table 5 or TxDOT's "Asphalt Binder Temperature-Volume Corrections."

9.7. $B = A + P + T_V + T_H$

Where:

B = Adjusted Residual Binder, gal. per sq. yd.

P = Pavement adjustment factor, gal. per sq. yd., Refer to **Table 5**.

T_V = Traffic adjustment factor, gal. per sq. yd., Refer to **Table 6**.

T_H = Heavy Traffic adjustment factor, gal. per sq. yd., Refer to **Table 7**.

9.8. $U_L = \frac{5.61 \times E_{max} \times 0.55 \times T_m}{F_t}$

Where:

U_L = Residual Binder at the upper limit, gal. per sq. yd.

0.55 = 55% Voids, percent (expressed as a decimal).

E_{max}, = 0.50 for A-R (50% Embedment) or = 0.40 all other Binders (40% Embedment).

9.9. $L_L = \frac{5.61 \times E_{min} \times V \times T_m}{F_t}$

Where:

L_L = Residual Binder at the lower limit, gal. per sq. yd.

V = Volume of Voids, percent (expressed as a decimal), from equation 10.4.

E_{min} = 0.40 for A-R (40% Embedment) or = 0.30 for all other Binders (30% Embedment).

9.10. $B_{ec} = B + K \times \left(\frac{B}{R_a} - B \right)$

Where:

B_{ec} = the recommended application rate of either the emulsion or cutback, gal. per sq. yd.

K = the seasonal adjustment factor from **Table 8**.

R_a = the percent residual asphalt in the emulsion or cutback expressed as a decimal.

9.11. $U_{ec} = L_L + K \times \left(\frac{L_L}{R_a} - L_L \right)$

Where:

U_{ec} = Emulsion/Cutback rate at the Upper limit, gal. per sq. yd.

9.12. $U_{ec} = U_L + K \times \left(\frac{U_L}{R_a} - U_L \right)$

Where:

L_{ec} = Emulsion/Cutback rate at the Lower limit, gal. per sq. yd.

9.13. $D = \left(\left(\frac{N}{N_t} \right) \times I \times R_T \right) + R_T$

Where:

D = the average application rate, gal. per sq. yd.

N = Number of larger nozzles.

N_t = Total number of nozzles.

I = % increase in asphalt rate selected for outside of the wheel paths, expressed as a decimal.

R_T = design rate of asphalt application for the wheel paths (B or B_{ec}) from Part 2, gal. per sq. yd.

9.14. $O_{wp} = R_T \times (1 + I)$

Where:

O_{wp} = the application rate outside the wheelpath, gal. per sq. yd.

10. TEST REPORT

10.1. Report the theoretical and target aggregate spread rate in square yard per cubic yard to the nearest whole number.

10.2. Report the binder application rate in gal. per sq. yd. to the nearest hundredth.

10.2.1. When transverse variable binder application rates are used, report the wheelpath, outside the wheelpath and distributor rates in gal. per sq. yd. to the nearest hundredth.

Note: When conditions change, report the limits of the changes and the associated rates.

Test Procedure for

SEAL COAT AGGREGATE AVERAGE MAT THICKNESS TxDOT Designation: Tex-2XX-F



Effective Date:

1. SCOPE

- 1.1. Use this test method to determine the average mat thickness for seal coat aggregate. There are three measurement methods for determining average mat thickness, by:
- Line Laser
 - Caliper
 - Estimation based on sieve size
- 1.2. The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.
-

2. DEFINITIONS

- 2.1. *Mat Thickness*—the average seal coat mat thickness determined from a representative sample of the aggregate. The aggregate is oriented to its flattest side to establish the length, width, and thickness portions of the particle.
- 2.1.1. *Flattest Side* – The aggregate particles oriented to simulate the effects of rolling the aggregate during construction. The length and width comprise the flattest side.
- 2.1.1.1. *Length (L)*—maximum dimension of the particle.
- 2.1.1.2. *Width (W)*—maximum dimension in the plane perpendicular to the length.
- 2.1.1.3. *Thickness (T)*—maximum dimension perpendicular to the length and width.

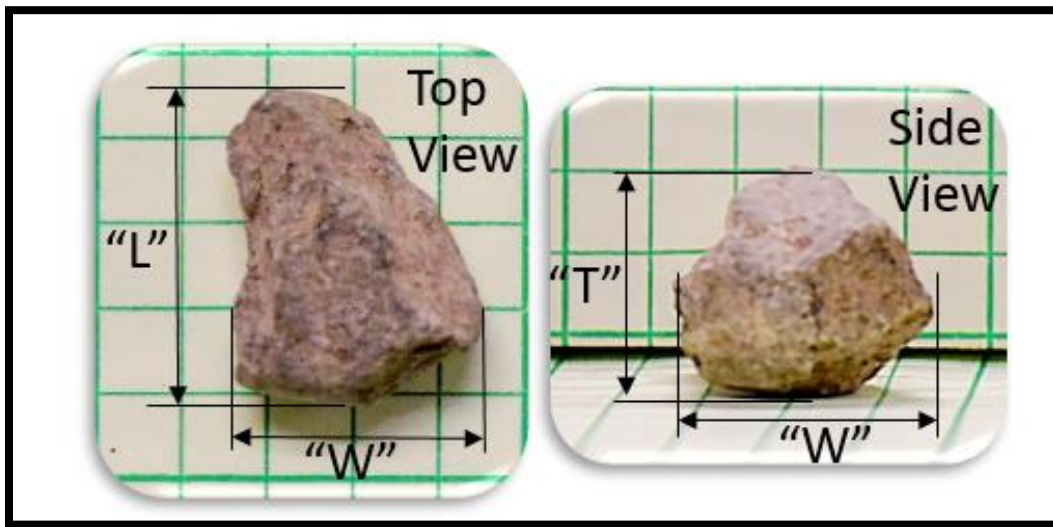


Figure 1 – Aggregate Dimensions

3. APPARATUS

- 3.1. *Balance*, Class G2 in accordance with Tex-901-K, minimum capacity of 33 lb (15 kg).
- 3.2. *Sample splitter, quartering machine, or quartering cloth.*
- 3.3. *Standard U.S. sieves, meeting the requirements of Tex-907-K.*
- 3.4. Mechanical sieve shaker.
- 3.5. *Pans.*
- 3.6. Brass wire brush.
- 3.7. Bristle brush.
- 3.8. Scoop.
- 3.9. *Drying oven*, capable of attaining a temperature of at least $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$).
- 3.10. *Caliper*, capable of measuring to 0.0005 in.
- 3.11. *Line Laser Test Grid*, test area with a 4 in. by 1 in. (100 mm by 25 mm) grid, a minimum of 48 in. (1200 mm) in length. The test area can be placed on a portable board made of wood or other sturdy material with a dull (non-reflective) finish.
- 3.12. *Line Laser*, capable of measuring a minimum of 4 in. (100 mm) wide at a minimum spacing of 0.004 in. (0.1115 mm) (Laser equivalent to a Keyence LJ-V7200)

4. REPORTING AND DOCUMENTATION

- 4.1. Report all test data and pertinent information using the SiteManager forms TX2xxL.xlsm for Line Laser Method, TX2XXC.xlsm for Caliper Method, and TX2XXE.xlsm for the estimated method.

5. PROCEDURES

5.1. *Preparing Sample*

- 5.1.1. Obtain a representative aggregate sample in accordance with Tex-221-F. Sample a minimum of 10 lb of aggregate.
- 5.1.2. Place a representative sample in oven and dry to constant weight, at a temperature of $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$). Dry the limestone rock asphalt or precoated aggregate to constant weight at a temperature of $140 \pm 5^{\circ}\text{F}$ ($60 \pm 3^{\circ}\text{C}$).
- 5.1.3. Sieve the sample in accordance with Tex-200-F, Part I, using a 7/8 in., 3/4 in., 5/8 in., 1/2 in., 3/8 in., 1/4 in. No. 4, and a No. 8 sieve.
- 5.1.4. Reduce each size fraction with 10 percent or more retained by quartering in accordance with Tex-200-F, until obtaining a minimum of 200 particles.
- 5.1.5. Test each of the particles in each size fraction by one of the following methods.
- 5.2. Determine the Mat Thickness – Line Laser Method.
- 5.2.1. Place each particle, oriented on its flattest side, on the Laser grid.
- Note 1** – Record the location on the test grid that the size fraction changes to summarize results by sieve size.
- Note 2** – Place the first particle on the second line of the grid until a maximum of 45 particles are placed in the grid area.
- 5.2.2. Align the laser on the first line of the grid.
- 5.2.3. Operate laser for a distance of 46 in. (1175 mm).
- 5.2.4. Measure the aggregate with the line laser and obtain 2 scans (for repeatability verification).
- 5.2.5. Repeat steps 5.2.1 to 5.2.4 until all aggregate particles have been measured.
- 5.2.6. Import the data files into TX2xxL.xlsm to summarize the height of each particle.
- 5.2.7. Using TX2xxL.xlsm, calculate the average thickness per sieve size and calculate the average thickness of all particles tested.
- 5.2.8. Report the overall average as the mat thickness.

- 5.2.8.1. For information purposes only, report the average thickness per retained sieve size. (Note: this will be used to improve Part III of this procedure)
- 5.3. *Determine the Mat Thickness – Caliper Method.*
- 5.3.1. Use a caliper to measure the thickness of each particle.
- 5.3.2. Record each measurement and calculate the average thickness of all particles tested and summarize by average thickness per sieve size and overall average thickness.
- 5.3.3. Report the overall average as the mat thickness.
- 5.3.3.1. For information purposes only, report the average thickness per retained sieve size. (Note: this will be used to improve Part III of this procedure).
- 5.4. *Estimate the Mat Thickness – Gradation.*
- 5.5. Sieve the sample in accordance with Tex-200-F, Part I, using a 7/8 in., 3/4 in, 5/8 in., 1/2 in., 3/8 in., 1/4 in., No. 4, and a No. 8 sieve.
- 5.6. Determine the median particle thickness from the sieve analysis, using Equation 6.1.
- 5.6.1. Find the first sieve that the cumulative percent retained is less than and greater than 50 percent. Record the cumulative percent retained and sieve size.
- 5.7. Estimate the mat thickness using Equation 6.2.

6. CALCULATION

6.1.
$$M = S_1 + \left\{ \frac{[(R_1 - 0.5) \times (S_1 - S_2)]}{R_1 - R_2} \right\}$$

Where:

M = Median Particle Size from the sieve analysis, inches.

0.5 = 50 percent cumulative retained.

S₁ = first sieve with less than 50 percent cumulative retained, sieve size to nearest thousandth of an inch.

S₂ = first sieve with more than 50 percent cumulative retained, sieve size to nearest thousandth of an inch.

R₁ = percentage retained on the first sieve with less than 50 percent cumulative retained, expressed as a decimal.

R₂ = percentage retained on the first sieve with more than 50 percent cumulative retained, expressed as a decimal.

6.2.
$$T = 0.4447 \times M + 0.1147$$

Where:

T = Average Mat Thickness, in.

M = Median Particle Size from the sieve analysis, in.

6.3. Example Calculation:

Sieve	Cumulative Percent Retained	Comments
1	0.0%	
7/8	0.0%	
3/4	0.0%	
5/8	0.0%	
1/2	1.9%	
3/8	47.4%	First Sieve with <50% Retained (R1, S1)
1/4	93.8%	First Sieve with >50% Retained (R2, S2)
No. 4	97.8%	
No. 8	99.0%	
Pass #8	100.0%	

$$M = 0.375 + \left\{ \frac{[(0.474 - 0.5) \times (0.375 - 0.250)]}{0.938 - 0.474} \right\} = 0.368 \text{ inches}$$

$$T = (0.4447 \times 0.368) + 0.1147 = 0.278 \text{ inches}$$

7. TEST REPORT

- 7.1. Report the average thickness per sieve.
- 7.2. Report the average mat thickness to the nearest thousandth of an inch.

Test Procedure for**PAVEMENT MOISTURE CHECK
TxDOT Designation: Tex-2XX-F****Effective Date:**

1. SCOPE

- 1.1. Use this method to visually estimate the moisture condition of a pavement surface. This method is intended to be used for Seal Coat applications placed on an existing paved surface.
- 1.2. The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. APPARATUS

- 2.1. 1 sq. ft piece of tarpaper.
- 2.2. 1 sq. ft piece of clear plastic, at least .002 in. (2 mil) thick.
- 2.3. Small weights capable of holding the tarpaper or plastic flush against the pavement surface.
- 2.4. Stopwatch or other timing device that is capable of timing a minimum of 15 min.

3. PROCEDURE

- 3.1. Select a location in an unshaded and shaded area, if a shaded area is present.
- 3.2. For seal coat binder placed at a temperature greater than 212°F:
 - 3.2.1. Place a piece of tarpaper on the pavement surface.
 - 3.2.2. Weigh down the edges of the tarpaper, so that it is flush against the pavement surface.
 - 3.2.3. Place a sample of binder at the application temperature on the tarpaper.
 - 3.2.4. Allow the material to cool to ambient temperature, then inspect the underside of the tarpaper.
 - 3.2.5. Pavement will be considered dry if there is no condensation on the tarpaper. Pavement will be considered wet if there is condensation.
- 3.3. For seal coat binder placed at a temperature less than 212°F:
 - 3.3.1. Place the clear plastic on the pavement surface.

PAVEMENT MOISTURE CHECK

TxDOT Designation: Tex-
2XX-F

- 3.3.2. Weigh down the edges of the plastic, so that it is flush against the pavement surface.
- 3.3.3. Wait 15 minutes.
- 3.3.4. Inspect the underside of the plastic.
- 3.3.5. Pavement will be considered dry if there is no condensation on the underside of the plastic. Pavement will be considered wet if there is condensation.

4. TEST REPORT

- 4.1. Report the pavement condition, Dry or Wet.

Test Procedure for**SEAL COAT PERFORMANCE TESTS****TxDOT Designation: Tex-2xx-F****Effective Date:**

1. SCOPE

- 1.1. Use this test method to document the seal coat condition after initial construction and after the performance period. The seal coat condition will be documented through a visual observation and texture measurements.
 - 1.1.1. Use Part I to document the pre-construction conditions.
 - 1.1.2. Use Part II to document post construction and performance period conditions.
- 1.2. The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. DEFINITIONS

- 2.1. *Flushing and Bleeding* is the upward movement of asphalt resulting in the formation of a film of asphalt on the roadway surface [2].
 - 2.1.1. Flushing has a pavement texture less than 0.05 in. and greater than or equal to 0.035 in., measured in accordance with Tex-436-A.
 - 2.1.2. Bleeding has a pavement texture less than 0.035 in., measured in accordance with Tex-436-A.
- 2.2. *Pavement Conditions* vary depending on the existing surface being sealed. Refer to Figure 1 through Figure 6 for examples of pavement conditions.

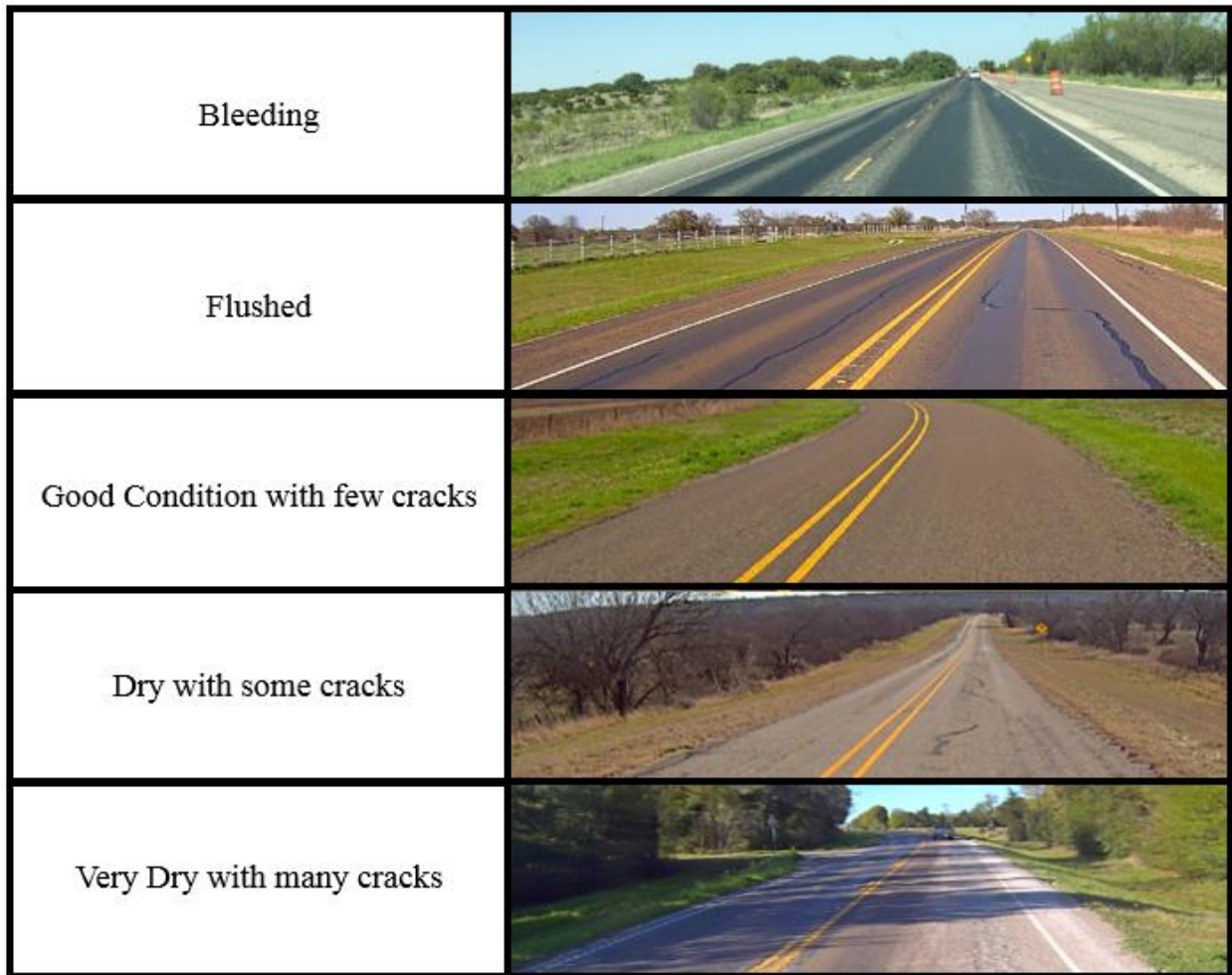


Figure 1: Pavement Condition—Existing Seal Coat Surface



Figure 2: Pavement Condition—Concrete Pavement





<p>Good Condition with few cracks</p>	
<p>Dry with some cracks</p>	
<p>Very Dry with many Cracks</p>	
<p>Bleeding from Underseal</p>	

Figure 3: Pavement Condition—Existing Asphaltic Concrete Surface






<p>Fresh ACP (Level-up) Patch</p>	 A photograph showing a road with a fresh, dark asphalt patch in the center. The patch is smooth and level with the surrounding pavement.
<p>Dry ACP (Level-up) Patch</p>	 A photograph showing a road with a dry, light-colored asphalt patch in the center. The patch appears slightly textured and is surrounded by a darker asphalt surface.
<p>Fresh Patch, Seal Coat Surface</p>	 A photograph showing a road with a fresh, light-colored patch in the center. The patch is surrounded by a dark asphalt surface that has been treated with a seal coat, giving it a slightly glossy appearance.
<p>Patch with Fog Seal</p>	 A photograph showing a road with a patch in the center. The patch is surrounded by a dark asphalt surface that has been treated with a fog seal, giving it a slightly glossy appearance.
<p>Patch, Flushed Seal Coat Surface</p>	 A photograph showing a road with a patch in the center. The patch is surrounded by a dark asphalt surface that has been treated with a seal coat, giving it a slightly glossy appearance.

Figure 4: Pavement Condition: Patch

<p>Flexible Base</p>	
<p>Stabilized Base</p>	
<p>Prime Seal w/GR 5, Bleeding</p>	
<p>Prime Seal w/GR5 Good</p>	
<p>Prime: Dry Lightly Primed</p>	
<p>Prime: Waxy & wet, not well penetrated</p>	
<p>Good Prime Rate, well penetrated</p>	

Figure 5: Pavement Condition Prime and Base



<p>Smooth Milled Texture (Micro-mill)</p>	
<p>Rough Milled Texture</p>	
<p>Milled Seal Coat (Slightly Flushed)</p>	

Figure 6: Pavement Condition Milled Surfaces

2.3. *Seal coat defects* that can occur due to improper application rates, construction equipment problems, or material problems are rock loss, flushing, and bleeding. Refer to Figure 7 through Figure 8 for examples of defects.

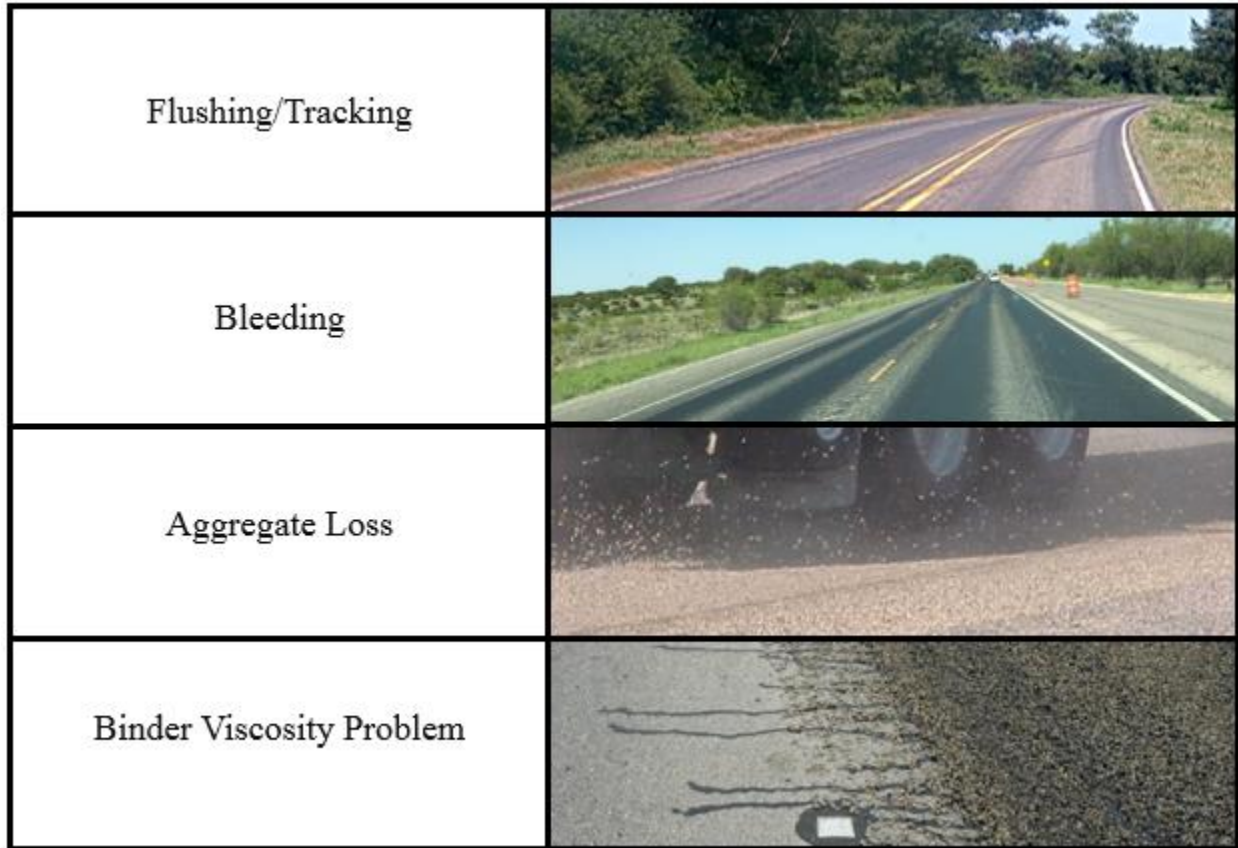


Figure 6: Seal Coat Defects, Initial Construction

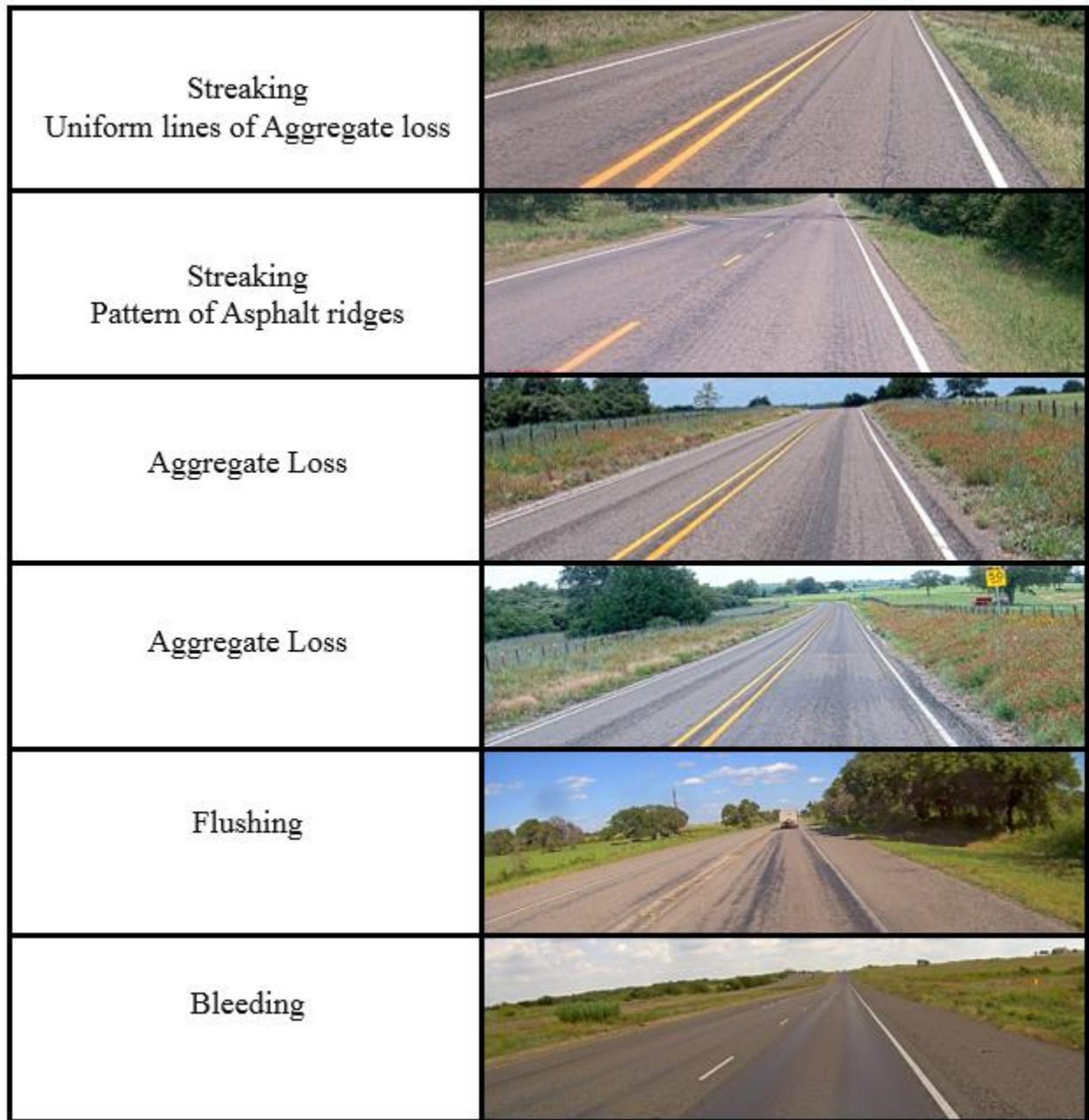


Figure 8: Seal Coat Defects, During Performance Period

3. APPARATUS

- 3.1. *Distance Measuring Instrument (DMI)*, vehicle mounted distance measuring instrument capable of accuracy of plus or minus 1 ft and a resolution of 1 ft.
- 3.2. *Measuring tape*, minimum measuring distance of 15 ft.
- 3.3. *Push Broom* – with a minimum 36 in. sweep face and 3 in. trim length comprised of medium or stiffer bristles.

- 3.4. *High definition video logging system* – capable of capturing high definition images of the pavement along with location information such as latitude and longitude.
- 3.5. *Paint* – temporary marking spray paint.

PART I—PRE-CONSTRUCTION CONDITION

4. PROCEDURE

4.1. Visual Conditions

- 4.2. Use a high-definition system video logging system to document the pavement condition.
- 4.3. Document the limits and types of pavement conditions. Use descriptions from Figure 1 through Figure 5.

PART II—POST-CONSTRUCTION AND PERFORMANCE PERIOD CONDITION

5. PROCEDURE

5.1. Visual Conditions

- 5.1.1. Use a high-definition system video logging system to document the pavement condition.
- 5.1.2. Document the limits and types of pavement conditions. Use descriptions from Figure 1 through Figure 8.
- 5.2. Perform the aggregate loss check before taking the texture measurements.
- 5.2.1. Determine the testing locations for the aggregate loss and texture measurements.
- 5.2.1.1. Select 15 random numbers for each roadway sealed. Note: Random numbers must be a decimal unit between 0.001 through 0.999.
- 5.2.1.2. Multiply the total length of each travel lane by the random number and convert to the equivalent station.
- 5.2.1.3. Perform the aggregate loss check and texture measurements at each station. Refer to Figure 9 for typical locations of wheelpaths and example test areas.

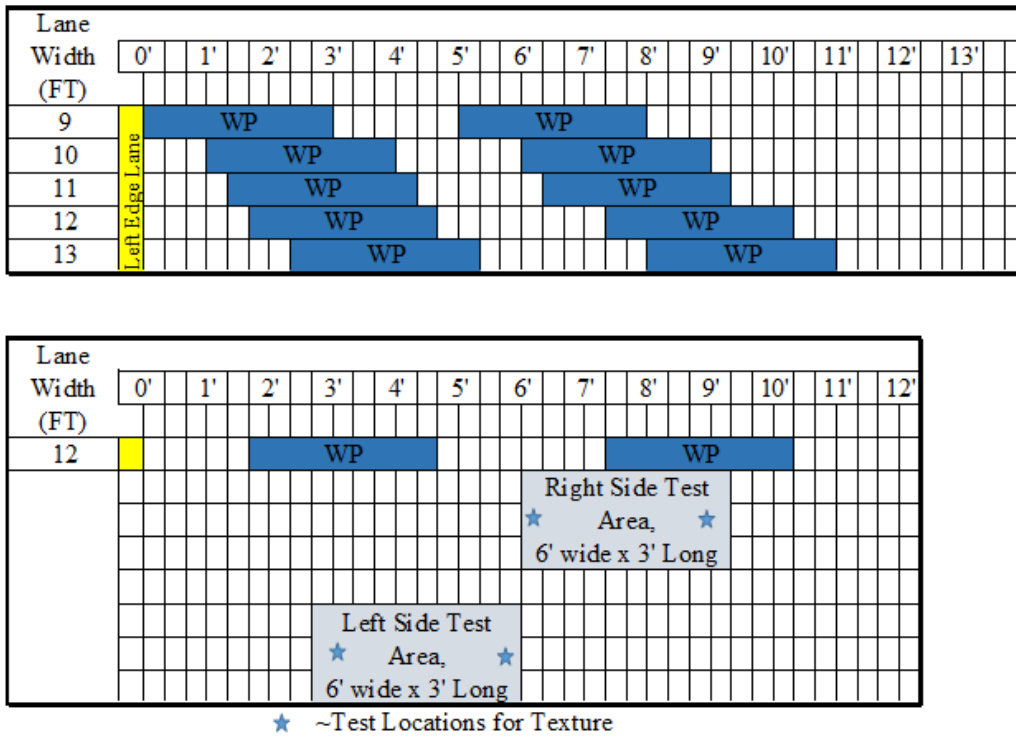


Figure 9: Testing Layout

5.2.2. Aggregate Loss Check.

- 5.2.2.1. Designate a 6 ft wide by 3 ft long (2 square yard) area starting in the center of the lane measuring 6 ft to the right at the first location and 6 ft to the left at the second location and alternating for each location thereafter. Use paint to mark the limits.
- 5.2.2.2. Use a broom to sweep the area.
- 5.2.2.3. Count the loose aggregate in the designated area.
- 5.2.2.4. Record the number of loose particles.
- 5.2.2.5. There should be less than 50 loose particles for Grade 3 or 4 aggregate and less than 100 loose particles for Grade 5 aggregate.

Record as Fail if the number of loose particles exceeds the limits and as Pass if the number of loose particles is below than the limits.

5.2.3. Texture Measurements.

- 5.2.3.1. Perform texture measurements in accordance with Tex-436-A, between the wheel paths (plus or minus 1 ft from center of lane) and one in the wheel path (plus or minus 1 ft from center of wheel path). Alternate between testing the right and left wheelpaths at each station, beginning with the right wheel path.
- 5.2.3.2. Record the texture measurements to the nearest thousandth of an inch.

- 5.2.3.3. The average of all measurements should be greater than or equal to 0.05 in. with no reading being less than 0.035 in.

6. TEST REPORT

- 6.1. Report the visual condition, including limits of pavement conditions for existing roadway, initial construction, and post-performance periods.
- 6.2. Report the Aggregate loss as Pass or Fail.
- Report the pavement texture to the nearest thousandth of an inch.
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