

SECTION 02700

SLURRY SEAL

PART 1 - GENERAL

1.1 Scope

The intent of this guideline is to aid in the design, testing methods, quality control, measurement and payment procedures for the application of Emulsified Asphalt Slurry Seal Surfacing.

1.2 Description

The slurry seal shall consist of a mixture of an approved emulsified asphalt, mineral aggregate, water and specified additives, proportioned, mixed and uniformly spread over a properly prepared surface as directed by the OWNER. The completed slurry seal shall leave a homogeneous mat, adhere firmly to the prepared surface, and have a friction resistant surface texture throughout its service life.

1.3 Reference Test Standards and Specifications

It is not normally required to run all tests on every project. Some tests are expensive and take a substantial time to conduct. If the materials to be used on the project have a past record of good performance, the requirements for testing may be decreased. Paving authorities are often familiar with local materials and should be able to furnish information which would minimize the amount of testing required.

AGENCIES AND TEST METHODS

AASHTO		American Association of State Highway and Transportation Officials
ASTM		American Society for Testing and Materials
ISSA		International Slurry Surfacing Association
AASHTO T2	ASTM D75	Sampling Mineral Aggregates

AASHTO T27 AASHTO T11	ASTM C136 ASTM C117	Sieve Analysis of Aggregates Materials Finer than No. 200 in Mineral Aggregate
AASHTO T76	ASTM D2419	Sand Equivalent Value of Soils and Fine Aggregate
AASHTO T84	ASTM C128	Specific Gravity and Absorption of Fine Aggregate
AASHTO T19	ASTM C29	Unit Weight of Aggregate
AASHTO T96	ASTM C131	Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine. (This test should be performed on the parent rock that is used for crushing the finer gradation slurry seal material).
AASHTO T37	ASTM D546	Sieve Analysis of Mineral Filler
AASHTO T104	ASTM C88 ASTM D242	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulphate Mineral Filler for Bituminous Paving Mixtures
AASHTO T127	ASTM C183	Sampling Hydraulic Cement
AASHTO T40	ASTM D140	Sampling Bituminous Materials
AASHTO T59	ASTM D244	Testing Emulsified Asphalt
AASHTO M140	ASTM D977	Specification for Emulsified Asphalt
AASHTO M208	ASTM D2397	Specification for Cationic Emulsified Asphalt
	ISSA T102	Mixing, Setting and Water Resistance Test to Identify "Quick-Set" Emulsified Asphalt

AASHTO T59	ASTM D244	Residue by Evaporation
AASHTO T49	ASTM D2397	Penetration 100 gm at 5 sec. 77°F (25°C)
	ISSA T101	Guide for Sampling Slurry Mix for Extraction Test
	ISSA T106	Measurement of Slurry Seal Consistency
	ISSA T109	Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester
	ISSA T111	Outline Guide Design Procedure for Slurry Seal
	ISSA T112	Method of Estimate Slurry Seal Spread Rates and to Measure Pavement Macrotecture
	ISSA T114	Wet Stripping Test for Cured Slurry Seal Mixes
	ISSA T115	Determination of Slurry Seal Compatibility
	ISSA T139	Method of Classified Emulsified Asphalt, Aggregate Mixtures by Modified Cohesion Test Measurement of Set and Cure Characteristics
	ASTM D3910	Design, Testing and Construction of Slurry Seal
	ASTM D217	Quantitative Extraction of Bitumen for Bituminous Paving Mixtures

1.4 Submittals

A. General

The **CONTRACTOR** shall submit a certified mix design as described in Section 2700 of the Technical Specifications covering the specific materials to be used on the project. This design will be performed by a laboratory who has experience in designing Emulsified Asphalt Slurry Seal Surfacing. Twenty (20) working days must be allowed for **OWNER** to review the submittal. The submittal will be clearly marked with the **OWNERS'** acceptance or rejection.

After the mix design has been approved, no substitution will be permitted, unless approved by the **OWNER**.

ISSA can provide a list of laboratories experienced in testing of slurry seal materials for mix designs.

B. Mix Design

The **CONTRACTOR** shall submit to the **OWNER** for approval a complete mix design prepared and certified by the laboratory a minimum of twenty (20) working days prior to the scheduled use of the material on the site, and no later than (15) working days after the Notice to Proceed has been issued. Compatibility of the aggregate, emulsion, mineral filler, and other additives shall be verified by the mix design. The aggregate gradation for the mix design shall be made from the same source and material as the **CONTRACTOR** will provide on the project. Recommended tests and values are as follows:

TEST	DESCRIPTION	SPEC
ISSA T106	Slurry Seal Consistency	
ISSA TB-139 (For quick traffic systems)	Wet Cohesion 30 minutes min. (set) 60 minutes min.	12 kg-cm min. 20 kg-cm min.
ISSA TB-109 (For heavy traffic areas only)	Excess Asphalt By LWT Sand Adhesion	50 g/ft ² max. (538 g/m ² max)
ISSA TB-114	Wet Stripping	Pass (90% min)
ISSA TB-100	Wet Track Abrasion Loss One Hour Soak	75 g/ft ² max. (807 g/m ²)
ISSA TB-113	*Mix Time	Controllable to 180 sec min.

*The mixing test and set time test should be done at the highest temperatures expected during the construction, 105° Fahrenheit.

The wet track abrasion test is used to determine the minimum asphalt content.

The mixing test is used to predict how long the material can be mixed in the machine before it begins to break. It is more for information to be used by the **CONTRACTOR** than for the quality of the end product. It is however, a good field test to check for consistent sources of material, both emulsified asphalt and aggregate.

The laboratory shall also report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect). The report must clearly show the proportions of aggregate, mineral filler (min. and max.), water (min. and max.) additives(s) (usage), and asphalt emulsion based on the dry weight of the aggregate.

All the component materials used in the mix design shall be representative of the materials proposed by the **CONTRACTOR** to be used on the project.

The percentages of each individual material required shall be shown in the laboratory report. Adjustments may be required during the construction, based on the field conditions. The **OWNER** will give final approval for all such adjustments.

The **OWNER** shall approve the mix design and all slurry seal materials and methods prior to use. The component materials shall be within the following limits:

RESIDUAL ASPHALT	TYPE I - 10% - 16%
	TYPE II - 7.5% - 13.5%
	TYPE III - 6.5% - 12%
	Based on dry weight of aggregate.
MINERAL FILLER	0.5% - 2.0%
	Based on dry weight of aggregate.
ADDITIVES	As needed.
WATER	As needed to achieve proper mix consistency. (Total mix liquids should not exceed the loose aggregate voids. ISSA T106 should be used to check optimum liquids.)

C. Rate of Application

The slurry seal mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition. The average application rate, as measured by the **OWNER**, shall be in accordance with the following table:

<u>SUGGESTED APPLICATION RATE</u>		
TYPE I	Parking Areas, Urban and Residential Streets, Airport Runways	8-12#/SY (3.63-5.44 kgs/m ²)
TYPE II	Urban and Residential Streets Airport Runways	12-20#/SY (5.44-9.07 kgs/m ²)
TYPE III	Primary and Interstate Routes	18-30#/SY (8.16-13.6 kgs/m ²)

Application rates are affected by the unit weight of the aggregate, the gradation of the aggregate and the demand of the surface to which the slurry seal is being applied. ISSA Technical Bulletin 112 gives a method to determine expected application rates.

D. Tolerances

Tolerances for individual materials as well as the slurry seal mixture are as follows:

1. After the designed residual asphalt content is determined, a plus or minus one percentage point variation will be permitted.
2. The percentage of aggregate passing each sieve shall be within stockpile tolerance range as stated.
3. The percentage of aggregate passing shall not go from the high end to the low end of the specified range of any two successive sieves.
4. The slurry consistency shall not vary more than ± 0.5 cm from the job mix formula after field adjustments.
5. The rate of application once determined by the **OWNER** shall not vary more than $\pm 2\#/SY$, while remaining within the design application rate.

PART 2 - MATERIALS

2.1 Emulsified Asphalt

The emulsified asphalt shall conform to grade specified in the mix design, Qsh, CQS-1h, Quick Set Mixing Grade) and shall meet the requirements of the approved tests (ASTM D977, D2397, AASHTO M140 and M208). The cement mixing test is waived.

A. Quality Tests

<u>TEST</u>	<u>QUALITY</u>	<u>SPEC</u>
AASHTO T59	Residue after Distillation	60% min
	<u>TEST ON RESIDUE</u>	
AASHTO T49 ASTM 2397	Penetration at 77° F (25°C)	^w 40-70

^wClimate conditions should be considered when establishing this band.

Each load of emulsified asphalt shall be accompanied with a certificate of analysis/compliance to assure that is the same as that used in the mix design.

2.2 Aggregate

A. General

The mineral aggregate used shall be the type and grade specified for the particular use of the slurry seal. The aggregate shall be manufactured crushed stone such as granite, slag, limestone, chat, or other high quality aggregate, or combination thereof. To assure the material is totally crushed, 100% of the parent aggregate will be larger than the largest stone in the gradation to be used.

B. Quality Tests

When tested according to the following tests, the aggregate will meet these requirements.

TEST**	QUALITY	SPEC
AASHTO T176 ASTM D2419	Sand Equivalent	45 min
AASHTO T104	Soundness	15% max using NA ₂ , SO ₄ or 25% max using MgSO ₄ .
AASHTO T96 ASTM C131	Abrasion Resistance	35% max

The abrasion test is to be run on the aggregate before it is crushed.
The aggregate should meet approved polishing values.

C. Grading

When tested in accordance to AASHTO T27 (ASTM C136) and AASHTO T11 (ASTM C117), the target (mix design) aggregate gradation (including the mineral filter) shall be within one of the following bands:

ISSA

	TYPE I	TYPE II	TYPE III	
Sieve Size	Percent Passing	Percent Passing	Percent Passing	Stockpile Tolerance
Ø (9.5 mm)	100	100	100	
#4 (4.75 mm)	100	90-100	70-90	+ or - 5%
#8 (2.36 mm)	90-100	65-90	45-70	+ or - 5%
#16 (1.16 mm)	65-90	45-70	28-50	+ or - 5%
#30 (600 µm)	40-65	30-50	19-34	+ or - 5%
#50 (330 µm)	25-42	18-30	12-25	+ or - 4%
#100 (150 µm)	15-30	10-21	7-18	+ or - 3%
#200 (75 µm)	10-20	5-15	5-15	+ or - 2%

The job mix (target) gradation shall be within the gradation band for the desired type. After the target gradation has been submitted (this should be the gradation that the mix design is based on) then the percent passing each sieve shall not vary by more than the stockpile tolerance and still remain within the gradation band.

The aggregate will be accepted at the job location or stockpile. The stockpile shall be accepted based on five gradation tests according to AASHTO T2 (ASTM D75). If the average of the five tests is within the gradation tolerances, then the materials will be accepted. If the tests show the material to be out, the **CONTRACTOR** will be given the choice to either remove the material or blend other aggregates with the stockpiles material to bring it into specifications. Materials used in blending must meet the quality test before blending and must be blended in a manner to produce a consistent gradation. This may require a new mix design.

Screening shall be required at the stockpile if there are any problems created by having oversize materials in the mix.

2.3 Mineral Filler

Portland Cement, hydrated lime, limestone dust, flyash or other approved filler meeting the requirements of ASTM D242 shall be used if required by the mix design. They shall be considered as part of the dry aggregate.

2.4 Water

The water shall be free of harmful salts and contaminants.

2.5 Additives

Additives may be used to accelerate or retard the break-set of the slurry seal, or improve the resulting finished surface. The use of additives in the slurry mix (or individual materials) shall be made initially in quantities predetermined by the mix design with field adjustments if required, after approval by the OWNER.

PART 3 - EQUIPMENT

3.1 General

All equipment, tools, and machines used in performance of this work shall be maintained in satisfactory working condition at all times to ensure a high quality product.

3.2 Mixing Equipment

The machine shall be specifically designed and manufactured to lay slurry seal. The material shall be mixed by a self-propelled slurry seal mixing machine of either truck-mounted or continuous-run design. Continuous-run machines are those that are equipped to self-load materials while continuing to lay slurry seal. Either type machine shall be able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive and water to maintain an adequate supply to the proportioning controls.

The CONTRACTOR must decide which type of equipment best suits their specific project, and if that type of equipment is readily available and utilized in their area. Generally truck-mounted machines or continuous-run machines may be used on similar projects. In some cases, truck-mounted machines may be more suited, i.e. cul-de-sacs, small narrow roadways, parking lots, etc. On major highways, interstates, etc., continuous-run equipment may be the desired choice due to the continuity of mix and the reduction of start-up joints.

If continuous-run equipment is used, the machine shall be equipped to allow the operator to have full control of the forward and reverse speed during application of the slurry seal. It shall be equipped with a self-loading device, opposite-side driver stations, and forward and reverse

speed controls.

3.3 Proportioning Devices

Individual volume or weight controls for proportioning each material to be added to the mix (i.e. aggregate, mineral filler, emulsified asphalt and additive) shall be provided and properly marked.

The proportioning devices are usually revolution counters or similar devices and are used in material calibration and determining the material output at any time.

3.4 Spreading Equipment

The mixture shall be spread uniformly by means of a conventional surfacing spreader box attached to the mixer and equipped to agitate and spread the material evenly throughout the box. A front seal shall be provided to ensure no loss of the mixture at the road contact point. The rear seal shall act as final strike-off and shall be adjustable. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry. A burlap drag or other approved screed may be attached to the rear of the spreader box to provide a uniform, highly textured mat.

3.5 Auxiliary Equipment

Suitable surface preparation equipment, traffic control equipment, hand tools, and any other support equipment shall be provided as necessary to perform the work.

PART 4 - EXECUTION

4.1 Calibration

Each mixing unit to be used in performance of the work shall be calibrated in the presence of the **OWNER** prior to construction and meet with his approval. Previous calibration documentation covering the exact materials to be used may be acceptable, provided they were made during the calendar year. The documentation shall include an individual calibration of each material at various settings, which can be related to the machine's metering devices. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

4.2 Verification

Test strips will be made by each machine after calibration and prior to construction. Test strips shall be a portion of the project. Samples of the slurry seal will be taken and verification made as to mix consistency and proportioning. Verification of rate of application will also be made. Upon failure of any of these tests, additional test strips, at no cost to the buyer, will be required until each unit is authorized to work. Any unit failing to pass the tests after the third trial will not be permitted to work on the project. Test strips must be accepted or rejected within 24 hours after application.

4.3 Weather Limitations

Slurry seal shall be applied only when the atmospheric temperature is 65°F and rising and does not exceed 105°F. Slurry seal shall not be placed when the temperature is expected to drop below 60°F during working hours. The mixture shall not be applied when weather conditions prolong opening to traffic beyond a reasonable time. At any time that the **OWNER** determines that weather is effecting application, work may be stopped.

4.4 Notification

The **CONTRACTOR** shall issue a news release once a week for the duration of the project. The release will be published in Sunday's newspaper and shall indicate the area in which the **CONTRACTOR** will be performing work for that week.

Written notice of the approximate schedule and explanation of work shall be given to each resident, home **OWNER**, business or school at least (5) days prior to commencement of work in the area. Verbal door-to-door communication shall be made at least twenty-four (24) hours prior to construction to remind all affected parties of the construction to take place.

The **OWNER** shall receive a copy of all notifications to residents. In the event of complaints by residents, the **OWNER** may require the **CONTRACTOR** to provide documentation (ie., check list) showing the date and time of verbal door-to-door communication.

Business must be notified forty-eight (48) hours prior to any restrictions on normal parking areas used by their employees or patrons.

4.5 Traffic Control

The **CONTRACTOR** shall submit for approval a traffic control and barricade plan within ten (10) days of receipt of Notification of Award of Contract. There shall be no deviations from the approved barricade plan unless a revised barricade plan is submitted and approved.

The **CONTRACTOR** shall provide and station competent flaggers whose sole purpose shall be to direct the movement of public traffic through or around the work. Proper advanced warning signs shall be in place when flaggers are working and removed when work requiring flaggers is completed. Flaggers must assist trucks for safe ingress and egress whenever truck movements may interfere with safe passage through the work zone.

All traffic control devices that are not in use or will not be used for a period greater than 72 hours or that are determined by the **OWNER** to be unnecessary, confusing, or causing an unsafe condition, shall be removed by the **CONTRACTOR** from the public right-of-way immediately upon notification by the **OWNER**.

Every attempt shall be made to provide public safety during the construction of the project. Traffic control shall be performed in accordance with Section 2650, Traffic Control, of the Technical Specification.

Suitable methods shall be used by the **CONTRACTOR** to protect the slurry seal from all types of vehicular traffic without damage. Opening to traffic does not constitute acceptance of the work. The **OWNER** shall be notified of the methods to be used.

In areas which are subject to an increased rate of sharp turning vehicles, additional time may be required for a more complete cure of the slurry seal mat to prevent damage. Blotter material shall also be used as a means of minimizing traffic turning damage. Blotter material and equipment used to apply it will be considered incidental to the work. The exact rate to be applied will be based on the characteristics of surface. Slight tire marks may be evident in these areas after opening but will diminish over time with rolling traffic. If these areas are not severely rutted, they should be considered as normal characteristics of a slurry seal and should be accepted.

4.6 Surface Preparation

Immediately prior to applying the slurry seal the surface shall be cleared of all loose material, and other objectionable material. Any standard cleaning method will be acceptable. If water is used, cracks shall be allowed to dry thoroughly before slurry surfacing. The **OWNER** shall approve the surface preparation prior to surfacing

Manholes, valve boxes, drop inlets and other service entrances shall be protected from the slurry seal by placing Fibreen Grade 208-SD-10 reinforced, waterproof, all-purpose paper as manufactured by Fortifiber Corporation, or other suitable material, approved by the **OWNER**. The paper shall be held in place with spray glue and removed within twenty-four (24) hours after the slurry has cured. The **OWNER** shall approve the surface preparation prior to surfacing.

4.7 Tack Coat

Normally tack coat is not required unless the surface to be covered is extremely dry and raveled or is concrete or brick. If required, the tack coat should consist of one part emulsified asphalt and three parts water. The emulsified asphalt should be the same as used in the mix. The distributor shall be capable of applying the dilution evenly at a rate of .05 to .10 gallons per square yard (0.15 to 0.35 liters per square meter). The tack coat shall be allowed to cure before application of the slurry seal.

4.8 Application

When required by local conditions, the surface shall be pre-wetted by fogging ahead of the spreader box.

The rate of application of the fog spray shall be adjusted by the **CONTRACTOR** during the day to suit temperatures, surface texture, humidity, and dryness of the pavement.

The slurry seal shall be of the desired consistency upon leaving the mixer. A sufficient amount of material shall be carried in all parts of the spreader at all times so that a complete coverage is obtained. Overloading to of the spreader shall be avoided.

No lumping, balling, or unmixed aggregate shall be permitted. No streaks, such as those caused by oversized aggregate shall be left in the finished surface. If excess oversize develops, the job will be stopped

until the **CONTRACTOR** proves to the **OWNER** that the situation has been corrected. Some situations may require screening the aggregate just prior to loading it into the units going from the stockpile area to the laydown operation.

4.9 Joints

No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. The **CONTRACTOR** shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. Half passes and odd width passes will be used only in minimum amounts. If half passes are used, they shall not be the last pass of any paved area. A maximum of six inches (6") (152 mm) shall be allowed for overlap of longitudinal lane line joints.

4.10 Mix Stability

The slurry seal shall possess sufficient stability so that premature breaking of the material in the spreader box does not occur. The mixture shall be homogeneous during and following mixing and spreading. It shall be free of excess water and emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate. Spraying of additional water into the spreader box will not be permitted.

4.11 Hand Work

Areas which cannot be reached with slurry seal machines shall be surfaced using hand squeegees to provide complete and uniform coverage. The area to be handworked shall be lightly dampened prior to mix placement and the slurry worked immediately. Care shall be exercised to leave no unsightly appearance from handwork. The same type finish as applied by the spreader box shall be required. Handwork shall be completed during the machine applying process.

4.12 Lines

Care shall be taken to ensure straight lines along curbs and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide good appearance.

4.13 Rolling

Rolling is usually not necessary for slurry seal surfacing on roadways. Airports and parking areas should be rolled by a self-propelled 10-ton pneumatic roller with a tire pressure of 50 PSI (3.4 ATMS) and equipped with a water spray system. The surfaced areas shall be subjected to a minimum of two (2) full coverage passes by the roller. Rolling should not commence until the slurry has cured enough so that it will not pick upon the tires of the roller.

4.14 Street Sanding

In areas which are subject to an increase rate of sharp turning vehicles, blotter material be used as a means of minimizing traffic turning damage. A sand material conforming to Type I slurry gradation may be used. The material to be used must be submitted and approved by the engineer. Sand shall be spread by a truck mounted mechanical sanding spreading device such as a Whirlybird, or an approved equal. The blotter material, application and clean-up shall be considered as incidental to the project.

4.15 Clean-Up

All areas such as, concrete gutters, decorative crosswalks and intersections shall have the slurry seal removed as specified by the **OWNER**. The **CONTRACTOR** shall remove any debris associated with the performance of the work on a daily basis.

PART 5 - QUALITY CONTROL

5.1 Inspection

The **OWNER** intends to provide a resident inspector for the project. The resident inspector will be available a forty (40) hour period during the week from Monday through Friday, eight (8) hours per day during the Contract.

5.2 Materials

The **CONTRACTOR** will provide samples of the aggregate and asphalt emulsion used in the project at the engineers discretion. Gradation and sand equivalent tests may be run on the aggregate and residual asphalt content tests on the emulsion. Test results will be compared to

specifications. Tests will be run at the expense of the **OWNER**.

The **OWNER** must notify the **CONTRACTOR** immediately if any test fails to meet the specifications.

5.3 Slurry Seal

Samples of the slurry seal will be taken directly from the slurry unit(s) at a minimum rate of one sample per mixing unit per each day's use. Consistency and residual asphalt content tests may be made on the samples and compared to the specifications. Tests will be run at the expense of the **OWNER**. The **OWNER** must notify the **CONTRACTOR** immediately if any test fails to meet specifications.

The **OWNER** may use the recorders and measuring facilities of the slurry seal unit to determine application rates, asphalt emulsion content, mineral filler and additive(s) content for an individual load.

It is the responsibility of the **CONTRACTOR** to check stockpile moisture content and to set the machine accordingly to account for aggregate bulking.

5.4 Non-Compliance

If any two successive tests fail on the stockpile material, the job shall be stopped. It is the responsibility of the **CONTRACTOR**, at his own expense, to prove to the **OWNER** that the conditions have been corrected. If any two successive tests on the mix from the same machine fail, the use of the machine shall be suspended. It will be the responsibility of the **CONTRACTOR**, at his own expense, to prove to the **OWNER** that the problems have been corrected and that the machine is working properly.

PART 6 - MEASUREMENT AND PAYMENT

6.1 General

The slurry seal shall be measured and paid for by the weight of aggregate and weight of emulsion used on the work completed and accepted by the **OWNER**. The **CONTRACTOR** shall submit to the **OWNER** a certified affidavit and delivery tickets which show quantities of each material delivered to the job site and used on the project.

The price shall be full compensation for furnishing all materials and for preparation, mixing, and applying these materials, and for all labor, equipment, tools, blotter material, test design, clean-up and incidentals

necessary to complete and warrant the job as specified herein.

See Section 00310 Bid Schedule for Bid Item.

****END OF SECTION****