INTERNATIONAL SLURRY SURFACING ASSOCIATION

No. 111

TECHNICAL BULLETIN

800 Roosevelt Road, Building C-312, Glen Ellyn, IL 60137

Issued 1977
1st Revision 1990
2nd Revision 2005

Outline Guide Design Procedure for Slurry Seal

The following guide is presented to aid designers of Slurry Mixes and contains excerpts from papers presented by Huffman, Benedict, Gordillo and others at the ISSA World Congress in Madrid and at the AEMA convention in Phoenix, February 1977. Tests to be used may be selected by the check list provided. Limits or values to each test must be established by the designer or engineer.

Part 1
Preliminary Design Considerations

1. Describe the Pavement to be treated
   a. Surface condition– macrotexture, absorbivity, surface and structural cracks, surface contamination, longitudinal and transverse geometry, rutting, vegetation.
   b. Climate and weather conditions - temperature, rainfall, shade, wind
   c. Average Daily Traffic (ADT), speed limits
2. State Objectives of the Treatment
   a. Skid numbers required, surface macrotexture
   b. Sealing, raveling correction, crack filling, wedging, rut correction, preparation for overlay, slipperiness correction, etc.
   c. Life expectancy requirements
3. Evaluate and Select Materials
   a. Evaluation of proposed Aggregate
      1. Field Durability record
      2. Skid Resistance Level (SRL), polish susceptibility
      3. Gradation, void content, quality of fines, sand equivalent, particle shape microtexture
      4. Mechanical properties resistance to mechanical abrasion, L.A. Rattler Shaker loss, British Wheel abrasion, hardness, crush resistance, freeze-thaw, friability
      5. Chemical properties acid insolubity, sodium sulfate soundness, water solubility
      6. Mineralogy/petrology, geology
      7. Economics-location, availability, transportation, cost
   b. Select Aggregate and Gradation to Meet Objectives
   c. Evaluation of proposed Emulsion
      1. Field Durability record
      2. Base asphalt source and type-oxidation/hardening resistance
      3. Emulsion particle size-stability, shear sensitivity, sieve
      4. Climate/penetration- viscosity requirements
      5. Weather-shade, sun, wind, ice, salt, traffic time required
      6. Quick-set/slow-set requirements
      7. Compatibility/adhesion characteristics of the aggregate-filler-retard-accelerator system, re-emulsification
      8. Economics– location, availability, transportation, cost
   d. Select Emulsion to Meet Objectives

Part 2

Job Mix Formula Procedures

1. Estimate the Theoretical Pure Asphalt Requirements (PAR) or Bitumen Requirement (BR) by Surface Area Method for an 8µm coating
   a. Aggregate Sand Equivalent
   b. Aggregate Apparent Specific Gravity
   c. Aggregate Gradation (dry sieving)
   d. Aggregate Centrifuge Kerosene Equivalent
   e. Calculate Total Surface Area
   f. Emulsion percent asphalt residue
   g. Calculate the theoretical PAR/BR for an 8µm thickness coating of the calculated surface area and record as:
      1. Percent asphalt added to dry weight of aggregate
      2. Percent emulsion added to dry weight of aggregate @ % asphalt residue
      3. Percent asphalt of total dry solids
2. System Compatibility Determination
   a. Estimate filler/additive requirements
      1. Run 100-gram trial cup mixes using 100% PAR to estimate optimum water content, filler requirement and mix-set-traffic/cure time characteristics (ISSA TB #102)
      2. Adjust PAR for added filler if required
   b. Cone Consistency Test run to obtain 2.5 centimeter consistency, ISSA TB #106
      1. Determine optimum mix-water content for three levels of emulsion content, e.g., 100%, 85%, 70% PAR for 2.5cm consistency
      2. Adjust filler content, mix-water content and PAR for changes in mix-set-traffic time if required
      3. Construct 3-point consistency/mix-water curve for consistency ranges of 2-3 cm., 4.-5 cm., and 6–7 cm. ranges for each of the three PAR levels selected. Air dry at ambient and save each specimen.
   c. Compatibly Test
      1. Examine cross-sections of centrally split consistency specimens for evidence asphalt or aggre gate migration or existence of excessively sticky surfaces.

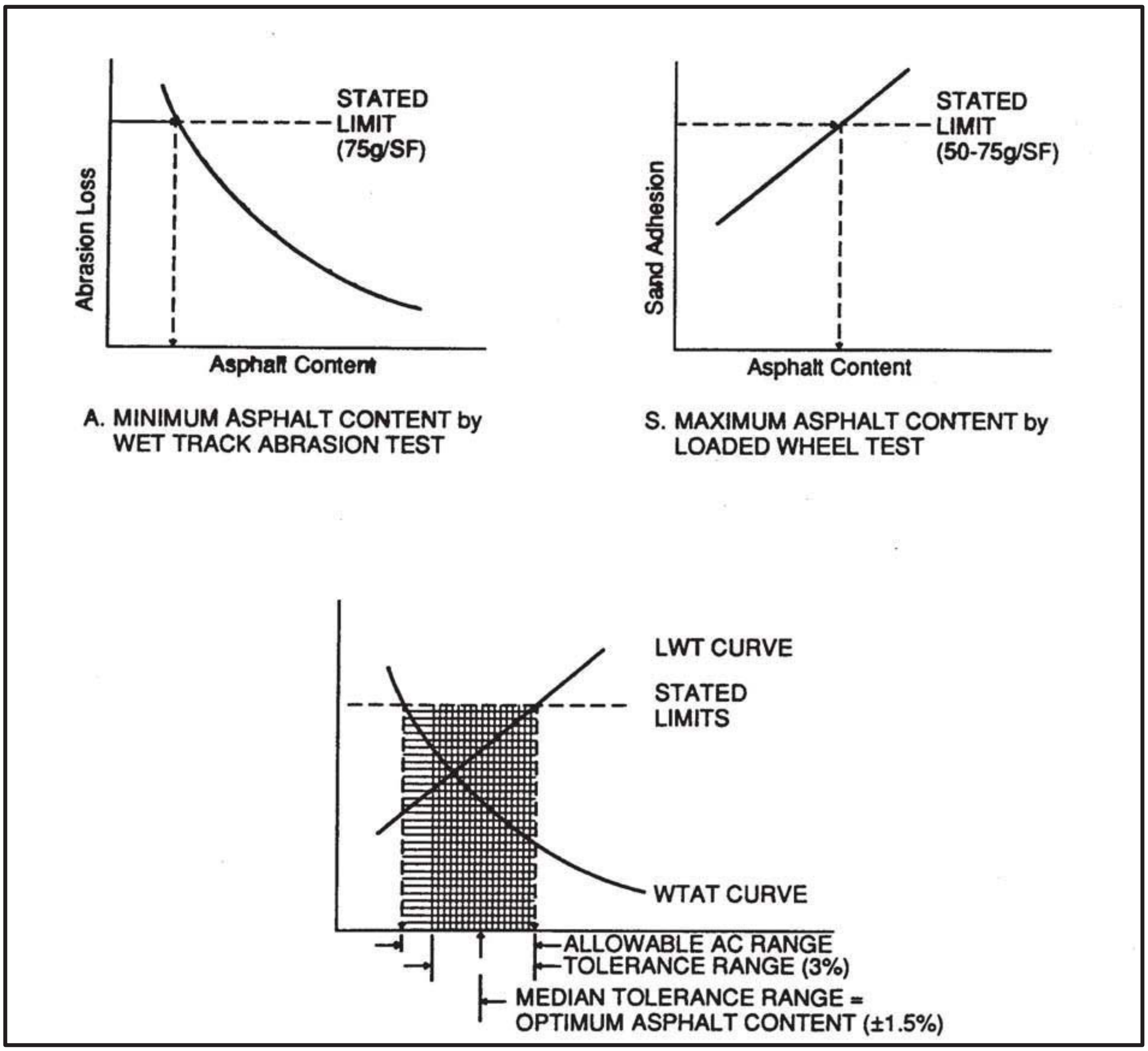
2. If suspicious disuniformity is observed, run Cup Compatibility Test
    a. Mix 100 grams of each formulation in a small, plastic-lined drinking cup, cure in the cup for 12 hours. Separate into upper and lower halves, dry, run asphalt extraction by reflux and split median gradation of extracted aggre gate. Substantial variation (10 to 15%) from top and bottom halves indicates and incom-patible system.
3. Wet Stripping Test-10 grams cured slurry in 400 ml. Moderately boiling water for 3 minutes. De cant and place on absorbent paper towel. Low asphalt retention can indicate lack of adhesion, low film coalescence, poor emulsion formulation, re-emulsification or possible false slurry.

3. Traffic/Cure Time by Slurry Cohesion tester
    a. Mix and set time by ISSA TB #102 at job temperature conditions
    b. Traffic Time by Slurry Cohesiometer at job tempera-tures, e.g. 50°(10°), 80°(26.7°), and 110°F(43.3°C) or 60°(15.6°), 80°(26.7°), 100°F(37.8°C). (Proposed ASTM D04.24)

4. Physical Tests on Cured Slurry
    a. Wet Track Abrasion Test (WTAT)- measurement of resistance to mechanical abrasion, kick-out, internal mat adhesion
    b. Loaded Wheel Test (LWT)- traffic simulation, meas-urement of resistance to flushing under heavy traffic loads

5. Selection of Optimum Design
    a. State Maximum limits to WTAT = minimum asphalt content (75g/ft²?) (807.3g/m² ?)
    b. State Maximum limits to LWT = maximum asphalt content or State Maximum LWT limits for Traffic Counts
    Light = 0 to 500 ADT (70g/ft²?)(753.5 g/m² ?) sand adhesion, 1000 Ø @ 125 lbs. (56.7 kg)
    Medium = 250 to 1500 ADT (60 g/ft²?)(645.8 g/m² ?)
    Heavy = 1500 to 3000 + (50 g/ft² ?)(538.2 g/m² ?)
    c. State Job Tolerance Limits (Contractor Proficiency)
    d. Draw graphs of the physical test data and superim pose the stated limits and read optimum asphalt content.

Graphical Determination of Optimum Asphalt Content



After the optimum design suggested is established, it is necessary to translate this design into field control quantities. One suggested method is described in ISSA TB #107, “A Method for Unit Field Control of Slurry Seal Quantities.” The objective of this method is to aid operators and inspectors to control the field material quantities and application rates so that design results are obtained. The method is essentially to translate laboratory design into field units of gallons, tons and bags and to measure these during application.

The following is an example of the laboratory design translation into the essential field control quantities:

Laboratory Design for Field Control

- Example -

Optimum Lab Design Control Quantities			Tolerances
a) Aggregate	100.0%		
b) Filler* Type PC-11	1.0%	2 bags/ 10 tons	± 1/2 bag
c) Mix Water*	12.0%	29 gals./ton (121 l/t)	± 1%
d) Cone Flow Consistency	2.5cm.		± 0.75 cm
e) AC Target Extraction	10.5%		± 1.5%
f) Emulsion* @ 61.0% Res. AC	17.2%*	41.0 gals./ton (171 l/t)	± 1.7%
g) Design Width	20.0 ft.(6.6 m)	2 lanes x 10 ft.(3.05 m)	± 0.5’ (.152 m) OA
h) Spread Rate	15.0 lbs./SY (8.14 kg/m²)	133 SY/ton(123 m²/t)	± 2.0 lbs./SY (1 kg/m²)

i) Lineal Ft./ton @ Lane Width 120 LF/ton (40.3 m/t)

j) Aggregate Specific Weight vs. Moisture Content:

Moisture Content	Moist Lbs./ft³ Loose	Dry Lbs./ft³ of Moist Ag.	% Dry/Wet	Machine Gate Setting at Design
0%	96.4 (1544.1 kg/m³)	96.4 (1544.1 kg/m³)	100.0	________
1	95.4 (1528.1 kg/m³)	94.5 (1513.7 kg/m³	98.0	________
2	83.6(1339.1 kg/m³)	81.9 (1311.9 kg/m³)	84.9	________
3	79.7 (1276.6 kg/m³)	77.3 (1238.2 kg/m³)	80.1	________
4	79.0 (1265.4 kg/m³)	75.8 (1214.2 kg/m³)	78.6	________
5	78.0 (1249.4 kg/m³)	74.1 (1186.9 kg/m³)	76.8	________
6	77.9 (1247.8 kg/m³)	73.2 (1172.5 kg/m³)	75.9	________

Note: % Dry/Wet = Dry weight of the aggregate at 0% moisture content / Dry weight of the aggregate at the different moisture contents

* Percent added to the dry weight of the aggregate Note: Unit (t) = metric ton

Slurry Seal and Microasphalt Design Test Checklist

Materials Analysis

Aggregate, Primary Design Tests:

Gradation (Dry) ASTM C136
Gradation (Wet) ASTM C136, C117
Sand Equivalent ASTM D 2419

Aggreagate; Auxillary Tests:

Specific Gravity (Dry) - ASTM C128
Apparent Specific Gravity, Sat. Surf. Dry-ASTM C128
Absorption– ASTM C128
Centrifuge Kerosene Equivalent– CALTRANS 303
Surface Area ISSA– TB #145
Methylene Blue Absorption– ISSA TB #145
Methylene Blue Factor– Prop., ISSA Tb #145
Lhorty Coefficient of Activity– Prop.
pH 10:1 Initial/Delayed– Prop.
Unit Weight, Loose, ISSA-TB #126
Unit Weight, Compacted– ASTM C29, Prop.
Voids, Loose & Compacted (Total Liquids Capacity)
Unit Weight at 2, 4, 6% Moisture, Loose & Compacted
Soundness, Sodium or Magnesium Sulfate– ASTM C88
Durability, Los Angeles Rattler– ASTM C131, C535
Durability Index-ASTM D3744
Shaker Wear Test Traffic Count Gradation– ISSA TB #123
Polished Stone Value (PSV)(SRL) - ASTM D3319
Acid Solubility– ASTM D3042, PROP.
Mineralogy & Petrology– ASTM C294, C295

Asphalt Emulsion Primary Design Tests:

Residue, % (by Evaporation) - ASTM D244
Sieve– ASTM D244
Stability– Subjective Settlement– ASTM D244

Asphalt Emulsion Auxiliary Tests

pH Prop.
Particle Charge– ASTM D244
Viscosity– ASTM D88
Penetration of Residue– ASTM D5
Ductility of Residue– ASTM D113
Specific Gravity– ASTM D70, D3289
Ring & Ball Softening Point– ASTM D36, AASHTO T-53
Plastic Interval– Prop.
Specifications for Emulsified Asphalt– ASTM D977, D3497
Specifications for Slow Set Systems-ISSA TB #117
Specifications for Quick Set Systems-ISSA TB#116
Specifications for Quick Traffic Systems-ISSA TB#140

Chemical Filler, Primary Tests

Portland Cement– ASTM C150, AASHTO M85
Hydrated Lime– ASSHTO M216

Mineral Filler

Specifications for Mineral Filler– ASTM D242
Filler Sieve Analysis– ASTM D546

Water

Chemical, Biological and Physical Analysis of Water– AASHTO T263

Mix Design Tests

Trial Mixes for Mix Characteristics and Compatibility

Mix, Time, Clear Water Set Time-ISSA TB #102, #113
Set & Traffic Time Additive by 30' & 60' Wet Cohesion-ISSA TB #139
Optimum filler content by 30' & 60' Wet Cohesion
Subjective Appearance, Toughness, Wet Adhesion, Substrate Adhesion-Prop.
Boiling Water Adhesion-ISSA TB #114, #149
High Temperature, 140°F(60°C) Cured Cohesion Classification– Prop, TB #139
Consistency, Total Liquids Content-ISSA TB #106
Compatibility-ISSA TB #115, #149
Compatibility Classification by Schulze-Breuer-ISSA TB#144

Field Simulation Tests at 3 Emulsion Contents

Wet Track Abrasion Test One-hour Soak (Duplicates)-ISSA TB #100
Wet Track Abrasion Test 6-day Soak (Single)-ISSA TB #100
Monolayer Loaded Wheel Sand Adhesion– Un compacted (Single)-ISSA TB #109
Multilayer Loaded Wheel Displacement-ISSA TB #147A
Low Temperature Flexural Tension Cracking Resistance Test-ISSA TB #146
High Temperature Wheel Tracking Test, Rate of Compaction, Compacted Density-ISSA TB #147B
Voids Analysis– Prop. ISSA Tb #150
Surface Area Analysis-ISSA TB #118
Graphical Selection of Optimum Job Mix Formula-ISSA TB #111
Spreadrate-ISSA TB #112

Report

Discussion, Tabulation & Graphs of Test Results
Job Mix Formula Recommendation with Field Control Units