NTPEP

PROJECT WORK PLAN FOR FIELD AND LABORATORY EVALUATION OF PORTLAND CEMENT CONCRETE (PCC) PAVEMENT JOINT SEALANT MATERIALS

1.0 Purpose

1.1 The purpose of this work plan is to define the laboratory, and field procedures used to evaluate pavement joint sealant materials. The current evaluation procedures include hot poured sealants and cold applied chemically curing sealants such as silicone materials. Additional types of joint sealant materials may be included in this evaluation process at a later date.

1.2 The laboratory, procedures consist primarily of ASTM test procedures and the field evaluation procedures are based on procedures described in the Strategic Highway Research Program (SHRP) "Materials and Procedures for the Repair of Joint Seals in Concrete Pavements - Manual of Practice."

1.3 The evaluation procedures are divided into the following sections:

a) Laboratory Evaluation Procedures
- Standard Laboratory Conditions
- Hot Poured Sealants
- Cold Applied. Chemically Curing, Sealants
- Recertification

b) Field Evaluation Procedures
- Site Selection and Required Quantities
- Sealer Installation
- Evaluation
  - Water Infiltration
  - Debris Retention

c) Reporting of Results

2.0 Referenced Documents

ASTM C679 Tack-Free Time of Elastomeric Sealants
ASTM C793 Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants
ASTM D5167 Melting of Hot-Applied Joint and Crack Sealant and Filler for Evaluation
ASTM D5329 Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements
ASTM D5893 Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM D6690 Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

3.0 Laboratory Evaluation Procedures

3.1 Standard Laboratory Conditions - Standard laboratory conditions are defined as a temperature of 24°C ± 4°C (77°F ±7°F) and a relative humidity of 50 ± 10%.

3.2 Hot Pour Sealants
The manufacturer shall supply two 11.4 kg (25 pound) blocks of sealant material from the same lot or batch number of material used for the field evaluation. One of the 11.4 kg (25 pound) blocks will be used to conduct the laboratory evaluation and the second 11.4 kg (25 pound) block of material will be retained for 1 month after the manufacturer has been notified of the laboratory, evaluation results for potential verification testing. The laboratory evaluation will consist of two sample evaluations (i.e., the preparation and testing of two approximately 2,200 gram (4.9 pound) samples of material) using the following procedures. The laboratory results that are reported will be the average of the individual tests at each heating condition. The report forms for the hot pour sealants are provided in Tables 1 and 2 of the Report section.

3.2.1 Sample Preparation - The joint sealant samples be prepared in accordance with ASTM D 5167 using a sample size of approximately 2,200 grams (4.9 pounds). The specimens
will be prepared:
- Immediately after reaching the recommended pouring temperature (ASTM D 1190):
- Immediately after reaching the recommended safe heating temperature (ASTM D3405):
- After maintaining the sealant at the manufacturer's recommended safe heating temperature for 6 hours ± 15 minutes, after which the initial set of test specimens for bond to concrete, flow, resilience, and penetration will be prepared. The sealant material remaining in the melter will be allowed to cool 17 ± 2 hours and then reheated to the manufacturer's recommended safe heating temperature for an additional 6 hours ±15 minutes, after which a second set of test specimens for bond to concrete, flow, resilience, and penetration will be prepared (as selected by the manufacturer).

3.2.2 Sealant Evaluation - The sealant shall be evaluated in accordance with the methods described below and ASTM D6690.

3.2.3 Bond to Concrete - Eighteen bond specimens will be prepared and tested in accordance with ASTM D5329, section 9 using a sealant width of 12.5 mm (0.5 inches) and the blocks will be prepared in accordance with ASTM D 6690, section 6.4 . Three of the bond specimens will be tested in accordance with ASTM D 6690 (this is 50 % extension at -18°C ± 1°C (0°F ± 2°F) for 5 cycles). Three additional bond specimens will be conditioned in water for 96 hours ± 4 hours and then test in accordance with ASTM D 6690, section 6.4). Three non-immersed and three water-immersed bond specimens, prepared as described above, will be tested at -29°C ± 1°C (-20°F ± 2°F) for 3 cycles of 200% extension and recompression. The

remaining six bond specimens (three non-immersed and three water immersed prepared as described above) will be tested at -18°C ± 1°C (0°F ±2°F) for 5 cycles of 100% extension and recompression. The result of each extension cycle for each specimen will be reported as the amount of adhesion and/or cohesion failure in square centimeters (square inches).

3.2.4 Flow - The flow specimens will be prepared in accordance with ASTM D5329, section 8 and tested at 60°C (140°F) for five hours. The flow results will be reported as the total amount of flow exhibited.

3.2.5 Resilience - The resilience specimens will be prepared and in accordance with ASTM D5329, section 12 and tested at 25°C (77°F). The resilience results will be reported as the percent recovery.

3.2.6 Penetration - Two penetration specimens will be prepared in accordance with ASTM D5329, section 6. One penetration specimen will be tested in accordance with ASTM D5329, section 6. The second specimen will be tested in accordance with ASTM D5329. section 6 with the following exceptions; the specimen will be allowed to cool to standard laboratory conditions for 17 ± 2 hours, the specimen will then be placed in a freezer at -18°C ± 1°C (0°F ± 2°F) for 4 hours ±15 minutes prior to testing. One hour before testing, the penetrometer cone attachment will also be placed in the freezer at -18°C ±1°C (0°F ±2°F). At the end of the 4 hour specimen conditioning period, remove the test specimen and cone from the freezer, place the cone in the penetrometer and immediately conduct the test. After making the measurement, clean the cone attachment and place the specimen and cone back in the freezer for 10 ±2 minutes before making two successive measurements for a total of three measurements. The penetration results will be averaged and the average value reported.

3.3 Cold Applied, Chemically Curing Sealants

The manufacturer shall supply six quart size tubes, or equivalent, of sealant material for laboratory, evaluation from the same lot or batch number of the material used for the field evaluation. Three of the tubes, or equivalent, will be used to conduct the laboratory evaluation and the remaining, three tubes of material, or equivalent, will be retained for 1 month after the manufacturer has been notified of the laboratory evaluation results for potential verification testing. The laboratory evaluation will consist of two sample evaluations. The report forms for the cold applied sealants are provided in Tables 3 and 4 of the Report Section.

All specimens shall be cured at standard laboratory conditions. The preparation and testing of samples is described below. The preparation and testing is to be performed in accordance with ASTM D5893 as selected by the manufacturer.

3.3.1 Tack Free Time - The tack free time specimens will be prepared and tested in accordance with ASTM C679.

3.3.2 Weight Loss - Test specimens will be prepared and tested in accordance with

ASTM C792. The weight loss will be reported as percent weight loss.

3.3.3 Bond to Concrete -Twelve test specimens will be prepared and tested in accordance with ASTM D5893, section 8.8 with the following exceptions. Six (three non-immersed and three water-immersed) of the bond specimens will be tested at -29°C + 1°C (-20°F + 2°F) for three cycles of 200% extension and recompression. The remaining six (three non-immersed and three water-immersed) bond specimens will be tested at - 18°C + 1°C (0°F + 2°F) for 5 cycles of 100% extension and recompression. The result of each extension cycle for each specimen will be reported as the amount of adhesion and/or cohesion failure in square centimeters (square inches).

3.3.4 Ultimate Elongation and Tensile Stress at 150% Elongation - Test specimens will be prepared and tested in accordance with ASTM D5893, section 8.11. The tensile stress at 150% elongation and the ultimate percent elongation will be reported.

3.3.5 Accelerated Aging - Test specimens will be prepared and tested in accordance with ASTM
C793 except that the specimens will aged for 2000 hours. The visual condition of the specimens will be reported.

4.0 Field Evaluation Procedures

4.1 Site Selection and Quantities
The member department will select a field evaluation site consisting of at least two replicates of five consecutive Joints for each sealant material.

4.2 Sealant Installation
The manufacturer will supply all materials for the evaluation of their material. The equipment and labor to prepare the joints and install the joint sealant material will be mutually agreed upon by the manufacturer and the test state (i.e., the manufacturer will supply all labor and equipment required or the test state will provide a single contractor for all manufacturers at the manufacturers' expense). Traffic control, installation scheduling, and installation location will be provided by the test state. The manufacturer should have a technical representative present at the installation of the sealant to certify that the material is installed in accordance with their recommended procedures. If the representative believes that the installation is not in accordance with the recommended procedures (including shape factor, etc.), they will inform the designated representative of the member department of this fact in writing within one week of the installation of the material. If this occurs, the member department may eliminate that manufacturer's installation from further evaluation without a refund of fees. If no letter is received within this first week, the installation will be accepted and included in the field evaluation.

During the installation, a drawing will be prepared to show the location of each sealant, provide the slope of the pavement, the joint spacing, the joint width, any special condition of the joints (i.e., chamfered or not, if the joint was cut using Soft cut

technology, the amount of spalling, etc.). The average daily traffic, the closest Strategic Highway Research Program (SHRP) weather data station will also be reported. The manufacturer will supply with the application for evaluation the recommended shape factor and performance characteristics such as the amount of joint movement the sealant is capable of withstanding or the sealant working range, the maximum and minimum joint width for satisfactory performance of the sealant, the recommended joint preparation and sealant installation procedures, and when the area can be reopened to traffic.

The joint preparation and sealant installation techniques used during the installation will be recorded. Any deviation from the manufacturer's recommendations will be noted. Additionally, the manufacturer's representative will be allowed to provide comments on the joint preparation and sealant installation. If the manufacturer's representative does provide such comments, they will be included with the installation report. The weather conditions during the installation will also be recorded.

4.3 Field Evaluation Observations

4.3.1 A "Sealant Condition Number" (SCN) will be assigned to the sealant once a year for three years. The SCN will be based upon two distress types: water infiltration and debris retention. Each distress type will be rated as having no distress, or low, medium, or high severity distress (described below). The results of the two distress ratings will be inserted into the following equation to provide the SCN.

$$SCN = 1(L) + 2(M) + 3(H)$$

where:

SCN = Sealant Condition Number
L = The number of low severity sealant conditions
M = The number of medium severity sealant conditions
H = The number of high severity sealant conditions

If the sealant material has no defects, then the SCN is defined as 0, the best possible rating.
A SCN of 6, the worst possible rating, is obtained when both the debris retention and water infiltration are rated as high severity.

4.3.2 Water Infiltration
Water infiltration will be measured as the percentage of the overall Joint length where water can bypass the sealant and enter the Joint either through complete adhesion or cohesion failure. Adhesion and cohesion failures will be determined through visual inspection or by the use of a vacuum tester. The percentage of joints that allow water infiltration will be determined by the equation:

$$\%L = (Lf/Ltot)* 100$$

where:

%'L = Percent length of the joint allowing water infiltration

Lf = Total length of the joint sealant field evaluation section allowing the Infiltration of water (inches)

Ltot = Total length of the joint sealant field evaluation section (inches)

No Water Infiltration: %L = 0% < %L < 1%
Low Severity Water Infiltration: 1% < %L < 10%
Medium Severity Water Infiltration: 10% < %L < 30%
High Severity Water lnfiltration: %L > 30%

4.3.3 Visual Inspection of Joint Sealants

One hundred percent of the joints shall be inspected to determine the percent allowing water infiltration. Any visual cracks, splits or openings in the sealant or between the sealant and concrete shall be examined to determine the depth of the opening. Instruments such as a dull knife may be used to assist in the evaluation.

4.3.4 Vacuum Tester Inspection of Joint Sealants

One hundred percent of the joints shall be inspected to determine the water tightness of the joint. A soap and water solution shall be applied to the joint and the vacuum box shall be placed on the joint. A minimum vacuum of -5.07×10^4 Pa (15 inches) of mercury (gauge) shall be applied to the box and the results noted. Inability to obtain the minimum vacuum or bubbles that exceed 12.4 mm (0.5 in) shall be considered allowing water infiltration and the length of failure will be estimated. It is expected that the vacuum tester inspection will indicate a higher percentage of water infiltration than the visual inspection.

4.3.5Debris or Stone Retention

Stone or debris retention will be rated as follows:
No Debris Retention: No stones or debris are stuck to the top of the sealant or embedded on the surface of the sealant/ I channel interface.
Low Severity: Occasional stones and/or debris are stuck to the top of the sealant, or debris embedded on the surface of the sealant/channel interface.
Medium Severity: Stones or debris is stuck to the sealant and some debris is deeply embedded in the sealant or material embedded between the sealant and the joint face but not entering the Joint below the sealant.
High Severity: A large amount of stones and debris is stuck to and deeply embedded in the sealant or filling the joint, or a considerable amount of debris is embedded between the sealant and the joint face and entering the joint below the sealant.

4.3.6 Photographs of the joints shall be taken and provided with the report. These photographs will be used to standardize the stone debris retention rating once significant data has been collected. Previous ratings may be adjusted once the standardization has been completed.

4.3.7 Additional information such as the pavement condition, environmental conditions, and traffic conditions will also be recorded. Specific items that are to be recorded are provided in Table 3 in the Report section.

4.3.8 Example SCN Calculation
Assume that a 153 m (500 ft) joint sealant installation was inspected and it was noted that there were occasional stones and/or debris stuck to the top of the sealant and that approximately 31 m (100 ft) exhibited adhesion or cohesion failure that would allow water infiltration through the joints. From this information, one would calculate the total percentage of water infiltration from %L = (Lf/Ltot)* 100 or %L = (31/153)* 100 = 20%. Therefore the sealant would have a low severity debris or stone retention rating and a medium severity water infiltration rating. The number of low severity ratings would equal 1, the number of medium severity ratings would equal 1, and the number of high severity ratings would equal 0. The SCN would be calculated by SCN = 1 (L) + 2(M) + 3(H) = 1 * 1 + 2* 1 + 3*0 = 3. The SCN = 3.

5.0 Reporting of the Results

The results of the sealant evaluations will consist of the appropriate laboratory evaluation form and the field evaluation form.

Table 1 ASTM D6690 Laboratory Evaluation

Joint Sealant Test	Results from 1st Heating[1]	Results from 2nd Heating
Heating Method Selected		
Safe Heating Temperature, °C (°F)		
Pour Point, °C (°F)		
Cone Penetration at 25°C (77°F)		
Flow		
Nonimmersed Bond -18°C (0°F), 3 cycles, 50% extension		
Resilience at 25°C (77°F)		
Asphalt Compatibility		

[1]When testing in accordance with ASTM D1190 heating procedures, only the results from the first heating will be reported. When the alternate heating is selected with the six hour reheat, then the second column will be used.

Table 2. Hot Pour Sealant Laboratory Evaluation.

Joint Sealant Test	Results from 1st Heating	Results from 2nd Heating
Bond To Concrete -29°C (-20°F), 3 cycles, 200% extension		
Bond To Concrete - 18°C(0°F), 5 cycles, 100% extension		
Flow		
Resilience		
Penetration at 25°C (77°F)		
Penetration at -18°C (0°F)		

Table 3. ASTM D5893 Laboratory Evaluation.

Joint Sealant Test	Test Results
Type Sealant	
Cure Evaluation	
Extrusion Rate	
Tack Free Time	
Effects of Heat Aging	
Nonimmersed Bond To Concrete -29°C (-20°F), 5 cycles, 100% extension	
Water-Immersed Bond To Concrete -29°C (-20°F), 5 cycles, 100% extension	
Oven- Aged Bond To Concrete -29°C (-20°F), 5 cycles, 100% extension	
Hardness	
Flow	
Ultimate Elongation	
Tensile Stress at 150% Elongation	
Accelerated Weathering	
Resilience	

Table 4. Cold Applied Sealant Laboratory Evaluation.

Joint Sealant Test	Test Results
Tack Free Time	
Cure Through Test	
Non- Volatile Content	
Bond To Concrete -20°F, 3 cycles, 200% extension	
Bond To Concrete 0°F, 5 cycles, 100% extension	
Compression Set	
Elongation	
Accelerated Aging	

Table 5. Field Evaluation Form.

SEALANT CONDITION					Pavement Condition	
	N	L	M	H	Expected Pavement Life	
% Length Water Entering	0-1	1-<10	10-30	>30	Avg. Faulting (in) (mm)	
Note percentage of adhesion and cohesion failures					Corner Breaks, % slabs	
Stone Intrusion	None	Low	Med	High	Pumping, % joints	
Sealant Condition Number					Spalls > 1 in (25.4mm), % slabs	
Environmental Condition					Current Joint Design	
Avg. Annual Percip. (in) (mm)					Sealer Age, months	
Days < 32°F (0°C)					Avg Sealer Depth, in (mm)	
High/Low Temperature[1]					Avg Joint Width, in (mm)	
Traffic Conditions					Avg Joint Depth, in (mm)	
ADT (vpd): % Truck					Max Joint Spacing, ft (m)	

[1]The high and low temperature data used for this entry should be the data provided in the Strategic Highway Research Program database for the location of the evaluation site.

6.0 Recertification

6.1 Joint sealant samples shall be taken from the laboratory evaluation material and from the field evaluation for Fourier Infrared Spectroscopy (FTIR) analysis using Attenuated Total Internal Reflectance (ATR) technique. Three specimens will be prepared from the laboratory material and three specimens will be prepared from the field material by pouring the sealant into a mold as described in ASTM D5893, section 8.11. 1. The sealant shall be allowed to cure in accordance with the manufacturer's recommendations. Once cured, the specimens shall be cut into three equal portions and individually placed on a germanium crystal and analyzed using an FTIR. The specimens (18 total) will be used as the baseline for future recertification of sealant materials.

6.2 The manufacturer shall submit samples on an annual basis of materials that have undergone laboratory and field evaluations for recertification. The results of the recertification analysis will be reported as statistically the same material or statistically different material. Failure to submit samples for recertification will be noted in the annual report.