National Transportation Product Evaluation Program (NTPEP)
PCC Joint Sealant/HMA Crack Sealer Data Usage Guide

Review of Evaluations and Significance of Data Generated

The referenced standards provide details regarding the testing cycles and standard testing that is used for evaluation of these sealant systems. The following discussion and suggested parameters for acceptance of products is intended only as a guide. It is recognized that individual agencies may elect to utilize variations of these parameters.

Laboratory Tests

1) Hot-Poured Crack and Joint Sealants ASTM-5329

Cone Penetration - The cone penetration is a measure of consistency or hardness. Higher values indicate a softer consistency. Cone Penetration values vary with temperature. Cone penetration is tested at 25°C (77°F) and -18°C (0°F). Sealant must be formulated so it won’t flow and track at high pavement temperatures and remains soft at lower pavement temperatures.

Bond to Concrete – Adhesive and cohesive bond to concrete at low pavement temperatures is necessary for a sealant to maintain proper field performance. Proper bond to concrete will prevent water infiltration and debris intrusion into pavements. Water immersion can have deleterious effects on the bond to concrete. Only ASTM D-6690 Type III sealants are tested for water-immersed bond to concrete.

Resilience - This test method measures the ability of a sealant to recover after a steel ball has been forced into the surface of the sealant. The ability of a sealant to reject incompressible objects from its surface is important to the functioning of a sealant. It is also important for a sealant to be able to recover from cyclic tensile stresses encountered under different seasonal temperature fluctuations.

Asphalt Incompatibility - Asphalt to sealant incompatibilities can lead to oily exudates, which will lead to early field failures. Sealant is placed in a routed HMA gyratory specimen. At warm test temperatures (60 °C), sealant compatibility is evaluated by attempting to pull sealant from the rout. Resistance to removal of sealant indicates good asphalt to sealant compatibility.

Softening Point - Softening point temperatures give an indication of the temperature at which the sealant will flow. If this temperature exceeds high pavement temperatures, the sealant is not expected to become too soft and track on the pavement.

Rotational Viscosity - Proper viscosities at manufacturers’ safe heating temperatures ensure that the sealant will flow into cracks and help promote good adhesion properties. If the sealant is excessively heated, it will flow out of the crack. If the sealant is not heated enough, it will not flow into the crack and voids can result in poor adhesion performance.
2) Cold-Applied, Chemically-Curing Silicone Sealants ASTM D-5893

Cure Evaluation (Tack-Free Time) - The tack-free time is a measure of the surface cure time and may generally be correlated to a variety of useful parameters such as the time interval before the sealant (1) resists damage by touch or light surface contact, (2) resists job-site or airborne dirt pick-up, (3) resists impinging rainfall.

Effect of Heat Aging- This test method measures weight loss. It can be used in combination with knowledge of sealant density to estimate shrinkage. In addition, when compared to sealant theoretical weight solids, it provides an estimate of the extent to which functional sealant components can be volatilized when exposed to high service temperatures. Substantial losses of this type may help predict early failures in durability. Also, development of cracks or chalking, or both, lessens sealant service life.

Bond to Concrete-This test evaluates adhesive and cohesive bond performance. This test method provides a way to determine bond and movement capability. Poor bond test results may result in water, stone and debris entering a joint causing early pavement failure.

Hardness- The results obtained from this test method is simply a measure of the indentation into the sealant material of the indenter under load at low temperatures. Harder sealants typically have lower elongations and are less flexible.

Ultimate Elongation- This test determines the ability of the silicone sealant to stretch and release tensile stresses as a result of PCC pavement contraction at cold temperatures. Typical PCC silicone sealants have elongations greater than 600%.

Tensile Stress at 150% Elongation- Sealants with lower tensile strengths have lower stresses pulling on the adhesion face. High tensile stresses at the prescribed elongation will cause the sealant to pull away from the joint wall creating adhesion failure.

Accelerated Weathering- A sealant must be able to withstand weathering (aging) to perform in its intended use. This test method is a laboratory evaluation of the resistance to weathering. The weathered sealant shall not flow; show tackiness, form surface blisters, form internal voids, or have surface crazing, chalking, cracking or hardening. Additionally the sealant shall not show cracking or crazing when tested by the mandrel bend test.

Resilience- This test method describes the cure and testing procedure for the sealant and its ability to reject incompressible objects. This test method evaluates the ability of the sealant to rebound when curing. Rejection of incompressibles is an important function of a sealant.

Joint and Crack Sealant Field Evaluation

Sealant test sections, each with ten cracks or joints per test section, are treated with different sealants supplied by manufacturers. There are several types of modes that signify sealant failure. These modes include water infiltration (adhesion loss and cohesion loss), stone/debris retention, spalling, tracking, pull-out of material, and secondary cracks.

1) Water Infiltration

Water infiltration will be measured as the percentage of the overall crack or joint length where water can bypass the sealant and enter the crack or joint either through complete adhesion or cohesion failure. Adhesion and cohesion failures will be determined through the visual inspection method. All cracks or 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 the pavement shall be examined to determine the depth of the opening.
The percentage of cracks/joints that allow water infiltration will be determined by the equation:

\[ %L = \left( \frac{Lf}{L_{tot}} \right) \times 100 \]

where:

- \( %L \) = Percent length of the crack allowing water infiltration
- \( L_f \) = Total length of the crack sealant field evaluation section allowing the infiltration of water (inches)
- \( L_{tot} \) = Total length of the crack sealant field evaluation section (inches)

Water Infiltration Severity Ratings:

- No Water Infiltration: \( %L \) is between 0 and 1%
- Low Severity Water Infiltration: \( %L \) is greater than 1% but less than 10%
- Medium Severity Water Infiltration: \( %L \) is greater than 10% but less than 30%
- High Severity Water infiltration: \( %L \) is greater than 30%
2) Stone/Debris Retention Severity Rating

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/pavement 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/pavement interface.

Medium Severity: Stones or debris are stuck to the sealant and some debris is deeply embedded in the sealant or material embedded between the sealant and the crack/joint face but not entering the crack/joint below the sealant.

High Severity: A large amount of stones and debris are stuck to and deeply embedded in the sealant or filling the crack/joint, or a considerable amount of debris is embedded between the sealant and the crack face and entering the crack below the sealant.

In general evaluators have seen very little to no stone/debris retention in the CS/JS Evaluations.

3) Seal Condition Number

Determine the sealant rating by calculating the seal condition number (SCN). This number can be computed using the following equation:

\[ SCN = 1(L) + 2(M) + 3(H) \]

where:

\( SCN \) = Seal Condition Number.

\( L \) = The number of low-severity seal conditions for both water infiltration and stone/debris retention

\( M \) = The number of medium-severity seal conditions for both water infiltration and stone/debris retention.

\( H \) = The number of high-severity seal conditions for both water infiltration and stone/debris retention.

Use the SCN and the following rating to determine whether the existing joint seal is in good, fair, or poor condition.

Seal Rating (SCN)

Good 0 – 1

Fair 2 - 3

Poor 4 - 6

Data from past evaluations for the most part have shown very little stone/debris retention. The SCN calculation uses severity rating for Water Infiltration and Stone/Debris retention and weights these measurements equally. Consequently, users should consider utilizing water infiltration percentages rather than the severity rating to evaluate field performance of sealants.

4) Other Field Observations

Spalling

Spalling is the length of any cracking, breaking, chipping or fraying of the crack or joint edge. The length
and severity of spalling shall be measured along each crack.

Crack /Joint Movement

Longitudinal and transverse crack or joint movements shall be measured on both sides of three transverse and longitudinal cracks or joints. Vertical movements at the cracks or routs shall be measured by the Georgia Faultmeter or a straightedge, wedge and caliper. Both joint movement measurements shall be an average of three measurements per crack.

Crack /Joint Spacing

The average crack or joint spacing shall be reported. This information is acquired from the crack/joint map created prior to installation of products.

Photo Log

Photographs of the cracks shall be taken and included in the report.

Tracking

Tracking of sealant by traffic will be measured as the linear distance in inches that the sealant tracks from the sealed crack in the direction of traffic. The distance of tracking and photographs may be used to determine levels of severity.

Literature Search for Acceptance Criteria

In performing a literature search for agencies that have set criteria for crack sealant acceptance, it is evident that most use Water Infiltration or adhesion/cohesion sealant failure. There is no AASHTO or ASTM specification limits for acceptance of sealants based on field evaluation of crack or joint sealants. The following discussion examines similar studies performed in the past and the standards set in place by the agency/institution responsible for the study.

1) According to the 2004-2006 Joint and Crack Sealant Evaluation conducted by Manitoba Transportation and Government Services (MTGS) failure percentages were limited to 7% for the first year and 10% for the second year. It should be noted that few sealants in the evaluation met these requirements.

2) In a March 2003 study performed by the National Research Council of Canada (NRC) a few ranges are set forth showing the performance of hot pour sealants. Table 1 show the range of failure levels in the three locations where the studies were performed.

<table>
<thead>
<tr>
<th>Location</th>
<th>Vancouver</th>
<th>Montreal</th>
<th>Ottawa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-year failure level</td>
<td>0% to 5%</td>
<td>6% to 11%</td>
<td>7% to 55%</td>
</tr>
<tr>
<td>4-year failure level</td>
<td>20% to 23%</td>
<td>16% to 28%</td>
<td>not determined</td>
</tr>
</tbody>
</table>

The service life of a sealant is said by the NRC to be extended by at least two years when the product shows less than 10 percent failure after three winters.

3) A 6.5 year study of crack sealant products was conducted by the Federal Highway Administration (FHWA). The typical modes of failure were used to determine effectiveness of the treatments. In the FHWA study the sealant performance was defined in terms of service life which would be the time to reach 75% effectiveness (25% failure).
Table 2 shows the rating used in this study to rate the effectiveness level of the crack sealant products.

**Table 2: Scale used to rate effectiveness of sealant treatments in FHWA study**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Effectiveness Level (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>90-100</td>
</tr>
<tr>
<td>Good</td>
<td>80-89</td>
</tr>
<tr>
<td>Fair</td>
<td>65-79</td>
</tr>
<tr>
<td>Poor</td>
<td>50-64</td>
</tr>
<tr>
<td>Very poor (failed)</td>
<td>&lt; 50</td>
</tr>
</tbody>
</table>

4) The National Research Council of Canada did a study on crack sealants in cold urban conditions and used a weighted performance index (PI) to rank the sealants that were studied. The index put more weight on the pull out of material than the debonding modes of failure. The index was determined by the following equation:

$$PI = 100 - (D + nP)$$

where $D$ is the percent debonded length, $P$ is the percent pull-out length, and $n$ is a weighting factor which relates the effect of the pull-out mode over the debonding modes of failure. In the study a weighting factor of $n = 4$ was used to rank the sealants. It should be noted that after 5 yrs the crack sealants installed on the 2005 NTPEP Crack Sealant Evaluation in Minnesota showed no pull-outs.

The National Research Council of Canada determined that a 2 to 3 years evaluation should be used for product approval. Field performance after 3 years can be variable and failure may increase exponentially.

**References**


