CRACK SEALING AND FILLING TREATMENTS FOR ASPHALT CONCRETE PAVEMENTS

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Presentation Topics

• Cracking and Effects in AC Pavements
• Review of Research Findings
• Crack Sealing Process Design
• Sustainability
• Use in Pavement Preservation
Cracks In AC Pavements

- Cracks Happen
- Cracks Move
- Cracks Grow
- Cracks Get Worse
- Cracks Accelerate Pavement Deterioration
Cracks Formation and Types

- Cracks occur as the AC mix ages and can no longer resist stress and strain from temperature changes and traffic loadings.

- Crack Types
  - Transverse
  - Longitudinal
  - Fatigue
  - Block
  - Construction
  - Reflective
Transverse Thermal Crack
Longitudinal Crack
Fatigue Cracks
Crack Movements

Horizontal – temperature changes
- up to 1 inch +

Vertical – Traffic loadings
- greater deflection after cracking
Crack Growth

• Cracks widen as they age
• Crack face deterioration, raveling
• AC mixture shrinkage
• Incompressible intrusion
• Widening of approx 10% of annual movement per year
Pavement Deterioration From Cracking

- Water intrusion weakens subgrade
  - 2% w/c increase, 100% strength reduction
- AC mix damage, 50% thickness reduction
  - Damage approx 1m each side of crack
- Increased deflections from traffic
  - Potholes, secondary cracking
Pavement Condition Curve

PCI Points Lost per Year
Model for Pavement Life of 30 years

- Excellent: Loss of 2-4 PCI Points per Year
- Very Good: Loss of 8-12 PCI Points per Year
- Good: Loss of 1-6 PCI Points per Year

Years
Multnomah County, Oregon
DBCS/Transportation Division

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Crack Treatment Functions

- Reduce water penetration
- Preserve base strength near the crack
- Reduce incompressible entrance
- Reduce crack growth
- Seal crack surfaces
- Reduce crack raveling
Crack Treatment Effects on Pavement Condition

- Slows pavement deterioration
- Slows roughness increases
- Reduces pothole and depression formation
- Slows crack spalling
- Extends pavement life, up to 5 years
Slows Pavement Deterioration

Performance Curves: control vs Treated -- Highway 11 (Ontario)

Pavement Condition Index

Years of Service

Minimal acceptable level

Predicted
Crack Sealing Research

• Research dates back to 1950’s
• Agency projects – late 70’s through 90’s
• SHRP H-106 – 1990’s
• 2000 on - Consortium, NTPEP
Agency Projects

• Over 20 projects performed
• Typical Objectives
  – What product
  – How to install
  – Does it work
  – Is it cost effective
Agency Projects

• Oklahoma, Utah, Ontario, Pennsylvania, Kansas, Minnesota, Manitoba, Montreal, Alberta, Montana, Indiana, Michigan, North Dakota, Ohio, Illinois, Wisconsin, Nevada, Arizona, Texas, others
Agency Research Findings

- **Sealants** -- Different sealants perform different and properties must be matched to climate and crack movements
- **Installation** -- Cracks must be clean and dry, reservoirs for moving cracks
- **Effectiveness** -- Crack sealing can improve pavement life and is cost effective
Agency Research Findings

• Agencies that have done field research projects and adapted the crack treatment process (sealant properties and installation geometry) to local conditions (pavement condition, climate, traffic) have achieved improved performance.
SHRP H-106 Project

• SHRP -1993, LTPP through 1999
• 5 test sites in different climates, 15 materials, 8 installation configurations
• Monitored for 7 years
• Determined service life and cost comparisons
SHRP H-106 Findings

• Different treatments are required for high and low movement cracks
  – **Crack Seal** >3mm movement, transverse cracks in cooler climates—softer, high extensibility sealants in reservoirs
  – **Crack Fill** < 3mm movement, longitudinal or close spaced transverse—stiffer materials, overband installation
SHRP H-106 Best Performance

• **Crack Seal** -- High Movement Cracks
  – Rubberized asphalts installed in reservoirs with cap, 5-7 year life

• **Crack Fill** -- Low Movement Cracks
  – Rubberized asphalt installed in overband, 5-7 year life
SHRP H-106 Findings

- Differences at sites influenced results - climate, crack type, spacing, traffic
- High elongation, low strength materials had best performance in working cracks
- Reservoir installations provided longest life in working cracks
SHRP H-106 Findings

• With appropriate project design-- sealant, installation geometry, installation procedures, and quality control, service lives of at least 7 years can be achieved with both crack seal and crack fill processes
Crack Sealing Treatments Need to Resist

- Temperature extremes
- Traffic loadings
- Horizontal and Vertical Movements
- Aging
- Water
- Abrasion

WITHOUT

- Debonding, Cracking, or Tracking
Crack Treatment Design Process

- Pavement Evaluation
- Process Selection
- Temperature Ranges
- Sealant Selection
- Installation Geometry
- Installation
Pavement Evaluation

• Intact, defined crack faces
• Maximum crack width of 1.5 inch
• Not significant base damage
• PCI range 40-90
• Pavement condition can be too bad for crack sealing or filling
Process Selection

• Determine crack type and movements

• **Working** - >1/8 inch movement,  
  – Typically transverse at over 15-20 ft.  
  – **Use Crack Seal Process**

• **Non-Working** - < 1/8 inch movement,  
  – Typically longitudinal, transverse or other at less than 15-20 ft.  
  – **Use Crack Fill Process**
Crack Seal Process

• Extensible sealants that can withstand annual temperature extremes and crack movements
• Installed in widened reservoirs, designed for the expected movement
  – Widened reservoirs reduce sealant extension percentages as the crack widens from summer to winter
Crack Fill Process

- Stiffer sealants that can withstand annual temperature extremes and remain flexible
- Installed in cleaned existing cracks, or in routed reservoirs for improved life
- Typically installed in a fill with overband configuration
Temperature Ranges

• Determine temperature extremes
• LTPPBIND, at surface level
• Ranges from 76-10 to 64-40
• FHWA Application Note- RD-03-080

Using LTPPBIND V2.1 to Improve Crack Sealing in Asphalt Concrete Pavements
Sealant Selection

- Sealant material performance is controlled by low temperature, high temperature, adhesive and elastic properties over the entire range of temperatures and strains experienced.
Sealant Selection

• Low Temperature
  – **Crack Seal** -- Pass bond extension test at the determined low temperature – 50-200% extension
  – **Crack Fill** -- pass a mandrel bend test at the determined low temperature -10% extension

Experience
Sealant Selection

• High Temperature
  – **Crack Seal** -- Meet D6690 Softening Point requirements - 80 C minimum
  – **Crack Fill** -- Minimum D36 Softening Point of 25C above determined high temperature Experience
General Specification
Applicability

- -34,-40 areas  D6690 Type IV
- -22,-28 areas  D6690 Type II,III
- -16 areas  D6690 Type I
- -10 areas  State, local specs
Installation Geometry

• Crack Seal
  – Widened reservoir to accommodate expected annual crack movement
  – Recess, flush or overband cap

• Crack Fill
  – Existing crack, flush or overband cap
  – Routed Reservoir- improved life.
Reservoir Size- Crack Seal

Width based on temperature range and crack spacing to limit extension

<table>
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<th>Temp Range</th>
<th>Width</th>
<th>Depth</th>
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</thead>
<tbody>
<tr>
<td>&lt;80C</td>
<td>½ in</td>
<td>¾ in</td>
</tr>
<tr>
<td>86C</td>
<td>¾ in</td>
<td>¾ in</td>
</tr>
<tr>
<td>92C</td>
<td>1 1/8 in</td>
<td>½ in</td>
</tr>
<tr>
<td>96C+</td>
<td>1 ½ in</td>
<td>½ in</td>
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For spacing over 50 ft, consider wider size
Reservoir Configurations

- **Configuration A**: Standard Reservoir-and-Flush
- **Configuration B**: Standard Recessed Band-Aid
- **Configuration C**: Shallow Recessed Band-Aid
Installation Configuration- Non Working Cracks

• Fill existing cleaned crack, and/or
• Use overband, 1/16 in max by 4 in wide, or
• Can also use reservoir for longer life, typically 1/2 in by ¾ in.
Recommended Overband
Not Recommended
Installation

- Weather Conditions – Dry, 40F +
- Sealant Preparation - Proper heating
- Reservoir Cutting - Centered, dimensions
- Crack Cleaning - intact, dry, clean
  - Compressed Air
  - Heat Lance
  - Vacuum
Clean Cracks
Failure Modes & Causes

- **Adhesion Loss** - cleaning, moisture, cold weather, install temperatures, weak mix, sealant properties, geometry
- **Cohesive Fracture** - sealant properties, overheating, geometry
- **Pullouts/Tracking** - sealant properties, cleaning, moisture, excess application, early traffic
Sustainability

• Recycled Content
• Packaging
• Energy/GHG
Recycled Content

• Recycled Tire Rubber
  – Post Consumer
  – Used in many sealant types
  – Up to 25% content
  – Provides beneficial properties
  – Used alone, or with other modifiers
  – Millions of tires per year
Packaging

- Pallets
- Pallet Wrapping
- Containers
Pallets

- Wood pallets from renewable resources
- Recycled Pallets used
- Pallets can be reused or recycled
Pallet Wrap

• Stretch wrap and other plastic weatherproofing can be recycled
Containers

- **Cardboard Boxes**
  - Made from renewable resources
  - Have recycle content
  - Can be recycled
- **Meltable/Consumable Containers**
  - Available from multiple suppliers
  - Reduce jobsite labor
  - Reduce disposal or recycling
Energy and GHG Emissions

• Energy Use Considerations
  – Raw Materials - obtain, transport, processing
  – Production, Mixing, Heating
  – Jobsite Transportation
  – Jobsite Installation
Total Energy and GHG

• Crack Seal 1 lf/sy
  – 870 btu/sy and 0.14 lb CO2/sy

• Crack Fill 2 lf/sy
  – 1860 btu/sy and 0.25 lb CO2/sy

• 4 Inch AC Overlay 420 lb/sy
  – 112,800 btu/sy and 24.1 lb CO2/sy
Annualized Energy and GHG

• **Crack Seal**  1-3 yr life extension
  – 290-870 btu/sy/yr
  – 0.05-0.14 lb CO2/sy/yr

• **Crack Fill**  1-2 yr life extension
  – 930-1860 btu/sy/yr
  – 0.13-0.25 lb CO2/sy/yr

• **4 Inch AC Overlay**  15 yr life
  – 7500 btu/sy/yr
  – 1.3 lb CO2/sy/yr
Crack Treatments in Pavement Preservation

- Crack Sealing and Filling are standard pavement preservation treatments
- Commonly used in conjunction with other preservation processes as a pretreatment
Pretreatment for Pavement Preservation Processes

• Used for larger and moving cracks, that exceed sealing and movement capabilities of surfacing process
• Prior to Seal Coats, Slurry Seals, Chip Seals, Microsurfacing, and thin overlays
• Improves crack resistance of the surfacing
Pavement Management

- Crack treatments incorporated in PCI determinations by reducing severity ratings for sealed cracks
- Sealed crack - rated as low severity
- Unsealed crack - moderate, high severity
- Slow pavement roughness increases
Summary

Crack Seal and Fill Treatments

- Slow pavement deterioration rate
- Must use correct materials and installation
- Need to be designed for pavement and climate conditions
- Are cost effective
- Are energy efficient
- Extend Pavement Life