Reflective Cracking Studies at Virginia’s Accelerated Loading Facility

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Outline

• Interest in reflective crack mitigation
• Recent research experience
• Overview of Virginia’s APT
  – Why APT?
  – Instrumentation
• Trial asphalt mixes
• Expected outcomes
The problem

- Reflective cracking over jointed concrete is a major problem in VA
- Many major thoroughfares = no reconstruction
- Overlays often 1.5 - 4 in thick
- In some cases cracks propagate after only 1 year
VTRC / VDOT’s Approach

• Ideal solution will:
  – Be applicable in many situations
  – Can be specified without sole source procurement
  – Limit changes to construction practice
  – Fall within normal QC/QA practices

• What forms may this come in?
  – Modified binders
  – Mix additives
  – Interlayers
Recent Research Experience
Recent Research Experience

- Use of highly modified (HP) binders (~7.5% SBS)
- HP Phase II project – Overlay Jointed Concrete
  - Comparing different HP mix types
    - SM-9.0 – NOVA District (I-95)
    - SMA-9.5 – NOVA District (I-95)
      Richmond District (I-95)
    - SM-12.5 – NOVA District (I-95, I-495)
  - Many lessons learned
    - Material is performing very well
- What mix type is most effective?
Overlay Test

- Higher = better
Semi-Circular Bend (I-FIT)

- Higher = better
What does it mean?

- Crack tests correspond
- HP outperforms control in most cases
- HP SMA general performs better than dense graded mix
- Will this hold true in the field?
SM-12.5

- I-95 MM 148.09-151.94
- Two winters, some cracks appearing
SMA-9.5

- I-95 SB MM 159.2-161.34
- Most issues relate to need for HP-SMA best practices
- Fewer cracks
Other ongoing studies

• Examining paving fabrics
  – Trial sections placed in York County over jointed concrete with existing asphalt overlay

• Fiber interlayers
  – Project in planning phase
Accelerated Pavement Testing
Accelerated Pavement Testing

- A means to study pavement performance
  - Under controlled conditions, more rapidly
  - Less risk to traveling public/agency
  - Simulate loading and temperature
Testing Relationship

Confidence

Time to test

\[ SN = a_1D_1 + a_2D_2 + \ldots + a_nD_n \]

Empirical

Mechanical Tests

Chemical Tests

Field Trials

APT

Long-term Performance
Dynatest HVS, Mark VI
With 6m extension beam
HVS, Mark VI

• Test length (constant wheel speed)
  – 25 feet to 45 feet (with extension) – run in “short mode”
• Loads applied
  – Up to 22.5 kips
  – Usually we use 9, 12, and maybe 15 kips
• Passes per day
  – 6,000 unidirectional per day is typical (up to 7,000+)
• Investment
  – About $3 million for the machine
### Lanes 1 & 2
- Different overlays on CCPR base
### Lanes 3 & 4
- Study of mix design parameters (gyration levels)
### Lanes 5 & 6
- Reflective cracking study
Instrumentation
Asphalt layer 1
Asphalt layer 2
Aggregate Base
Subgrade

- Pressure Cell
- Horizontal Asphalt Strain Gauge
- Rut profiler
- Temperature Probe
- Multi-Depth Deflectometer
Rut profile
The graph shows the average rut depth (mm) plotted against ESALs. Three curves are present:
- L3CB
- L4CB
- L4CA

Key points:
- 9,000 lbs: 65 gyration
- 12,000 lbs: 50 gyration
- 15,000 lbs: unspecified, but likely a peak or significant change in the graph's trend.
Hardened asphalt binder with a soil nail
Reflective Cracking Study
Concrete Slabs

• Specifications
  – 8 in. thick
  – 10 ft wide
  – 300 ft long
  – 10 ft saw cut joints

• Placed on top of ~1 in of SM-9.5
Slab layout

- Series of 10x10-ft slabs
- Overlay with experimental mix
Section 1

- Place instrumentation
- Pave with control or experimental mixture
Section 1

- Loaded wheel influences ~6 joints
- Joints are considered replicates
Section 2

Load induced cracking

- After lane cracks, move to the next lane
• After total sections both lanes crack, compare!
How will we control cracking?

• Environmental effects
  – Temperature control (~40F with a/c and heating)
  – When not being tested, will be covered with concrete blanket to reduce UV and slab movement

• Vertical slab movement
  – Loading will be ramped up
  – 4.5-kip, 9-kip, 12-kip, etc.
How will we instrument?

- Strain gauges will be used to monitor slab movement
- Cracks will be tracked using high definition camera
- Crack maps will be generated and tracked with paint
- Falling weight deflectometer used before and after testing to measure slab deflections
Test

- 3” SMA-12.5 with PG64E-22 binder (control)
- 3” SMA-12.5 (control) + fiber reinforcing additive
- 3” SMA-12.5 + High Polymer
- 1” Interlayer + 3” SMA-12.5 (control)
- **Future…**
  - Cold Central Plant Recycled (CCPR) mix + SMA?
  - Saw-and-seal?
  - Your idea?
Expected outcomes

• Identify the most promising reflective crack mitigation treatments
• Establish APT method for testing future innovations in reflective crack mitigation
• Provide implementable results and recommendations to VDOT
Thank you!

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