Post-Production Mix Performance Testing
MTO’s Experience

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Mix Expert Task Group
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Outline

- Background
- HMA Performance Tests and Results
  - Semi-Circular Bend
  - Disk-Shaped Compact Tension
  - Hamburg Wheel Tracking
- Results & Findings
- Next Steps
Background

- Superpave mix design covers material properties and mix volumetrics, but does not test for performance
- MTO is committed to evaluate suitable performance tests and develop acceptance criteria for post-production asphalt mix that provide a balance between both resistance to cracking and rutting and correlate with pavement performance
- Work in this area started in 2017 and is ongoing
MTO reviewed various performance tests available to predict cracking and rutting.

The following tests are believed to have the highest potential for post-production acceptance criteria:

- Semi-Circular Bend (SCB) test (intermediate temperature crack resistance)
- Disk-shaped Compact Tension (DCT) test (low-temperature crack resistance)
- Hamburg Wheel Tracking test (rutting and moisture damage)
- Cyclic Fatigue test (fatigue crack resistance)
- Texas Overlay-Future Testing (reflective crack resistance)
Materials Tested

- We received loose mix for 13 of 16 contracts selected in 2017.
- Tested both:
  - lab prepared Superpave gyratory specimens and
  - pavement cores obtained during construction
- For SCB test, four specimens tested to determine the average flexibility index.
- For DCT test, three specimens tested to determine the average fracture energy.
- For Hamburg Wheel Track test, four specimens in two separate moulds were tested.
Semi-Circular Bend (SCB) Test

According to AASHTO TP124

Test Temperature: 25°C
Specimen Thickness: 50 mm
Notch Depth: 15 mm
Monotonic load of: 50 mm/min

Outcome:
Flexibility Index (FI)
Fracture Energy (J/m²)

SCB Test Setup

Load-Displacement curve of SCB
Slope at post-peak inflection point (m)
SCB Test Specimen Preparation

1. Cutting into discs

2. Cutting discs in half
   • Requires tile saw for precision cutting to 1.0 mm precision
When the pavement’s core diameter < 150mm, the technician must adjust specimen’s position so the notch is correctly centered.
SCB Test Results

![Bar chart showing SCB test results for different asphalt mix samples. The chart compares Plant Mix Lab Compacted Specimens and Pavement Cores Specimens. Each sample is labeled with a code such as PGXX-28R, PGXX-28, etc. The y-axis represents the Flexibility Index (FI) ranging from 0 to 70. The chart shows a variety of Flexibility Index values for each sample, with some samples having higher or lower values compared to others.](image-url)

Materials Engineering and Research Office
SCB Test Results

- Results for gyratory lab compacted specimens vs recovered AC content for each mix

![Graph showing correlation between AC Content (%) and Flexibility Index (FI)]
SCB Observations

- Appears AC content may impact FI
- Has anyone seen a correlation with effective AC or with film thickness?
- Is SCB a RAP Test?
Disk-Shaped Compact Tension (DCT) Test

According to ASTM D7313

Test Temperature: 10° C higher than low PG grade

Crack Mouth Opening Displacement (CMOD) Rate: 1 mm/min

Outcome:

Fracture Energy (J/m²)

Outcome:

\[ G_f = \frac{W_f}{(\text{thickness} \times \text{ligament})} \]

Load (kN) vs. CMOD Displacement (mm) graph

Work of fracture (\( W_f \))
DCT Test Specimen Preparation

1. Cutting into discs
2. Cutting the edge of discs
3. Marking the holding holes
4. Coring the holding holes
5. Cutting the notch
6. Gluing the knife edges
MTO’s V-Shape Jig Attachment for DCT
V-Shape Jig Attachment for DCT
DCT Test Specimen Preparation

- For pavement cores check diameter: +/- 150mm
  - Adjust specimen in the saw to ensure precision of flat edges and notch

=150 mm diameter core:
When reclined on frame’s right wall, the notch in the middle

<150 mm diameter core:
Notch is misaligned when core is placed against the right wall of the frame - care required
DCT Test Specimen Conditioning & Testing Challenges

- Long preconditioning time
  - According to ASTM D7313: 8 to 16 hour preconditioning time required at test temperature

- Testing at -24°C and -30°C test temperature
  - As soon as you open the chamber to mount the specimen, testing is delayed ~ 30 to 45 minutes, to get the temperature of chamber and dummy specimen back to testing temperature
DCT Test Results

Fracture Energy (J/m²)

Asphalt Mix Samples

- Plant Mix Lab Compacted Specimens
- Pavement Cores Specimens
DCT and SCB Observations

- Sometimes crack propagation in some specimens deviates from notch alignment
- Should we be concerned?
Hamburg Wheel Tracking Test

According to AASHTO T324

Samples submerged in water

Test Temperature: 50º C

Number of cycles: 10000 cycles

Outcome:

Rut depth vs. # of load cycles
Hamburg Wheel Tracking Test Results

![Bar chart showing different asphalt mix samples with their corresponding rut depths. The samples include PG52-YY, PG58-YY, PG64-YY, PG64-RAP, PG64-YY, PG70-YY, PG70-YY, and PG70-YY RAP. The rut depths range from 0 to 14 mm. The chart indicates that PG58-YY has the highest rut depth, followed by PG64-YY and PG52-YY.]
Results: SCB & HWT
Results: DCT & HWT

![Graph showing the relationship between DCT Fracture Energy (J/m²) and Hamburg Rut Depth (mm) for various materials labeled PGXX-28, PGXX-34, and PGXX-40. The graph displays data points for each material, illustrating the variation in fracture energy across different rut depths.](image-url)
Results: Fracture Energy DCT & SCB

SCB-DCT Fracture Energy (Field Cores)

DCT Fracture Energy (J/m²)

SCB Fracture Energy (J/m²)
Findings to-Date

- FI (SCB) was more variable for SMA mix (lab and pavement cores)
- DCT lab and pavement core test values were closer, than the SCB lab and pavement cores test values for the same production mix
- Appears there is a trend for between FI and AC content
- RAP mixes have lower FI (SCB) and Fracture Energy (DCT) results
Next Steps

- Run remaining mixture tests
- Drop test temperature for SCB test to environmental intermediate test temperature for softer grades
- Carry out Hamburg Wheel Track Testing at 44°C for PG 52-XX instead of 50°C
- Investigate impact of changing SCB test with the SCB jig for QA/QC lab using:
  - TSR loading frame
  - Alternate conditioning methods
Questions

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Appendix

- Additional Slides
Big Saw for Cutting Slices
Tile Saw by MK Diamond Products
Findings: SCB, DCT and HWT

More Crack and Rut Resistant