Ministry of Transportation

MTO Perspectives on Performance Testing

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Ontario

Outline

- Development of MTO Specifications
- Equipment Procurement
- Performance Testing of Asphalt Mixtures
- Performance Testing Findings
- Performance Testing Implementation

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Development of MTO Specifications

1997 – Adoption of SHRP Performance Graded Asphalt Cement (PG) system

2000 – Premature cracking identified on provincial highways

2001-2010 – Series of field trials conducted to investigate and develop new asphalt cement tests

2004-2006 – Poor asphalt cement quality identified as one primary cause of premature cracking

2007-2009 – New asphalt cement tests validated to predict premature cracking

2010 – Asphalt Cement Specification limits the use of Recycled Engine Oil Bottoms (REOB) through Ash Content Testing

2011 – Asphalt Cement Initiatives (33 Contracts selected to include the newly developed tests)

Development of MTO Specifications

2012-2014

MSCR and DENT tests implemented

Performance Evaluation of 33 contracts

2015-2016

Ministry's Path Forward presented to industry. ExBBR test piloted on select contracts

2016

AG Report on Road Infrastructure Construction Contract Awarding and Oversight contained seven recommendations

2017

MTO Action Plan for Highway Construction Contracts and Oversight included actions for 2017 construction season and long term actions for 2018 and beyond

Modified ERS with higher benchmarks; suspended incentives. RAS not allowed. The use of RAP was suspended in surface mixes. ExBBR test fully implemented along with MSCR, DENT, Ash

2018-20+

PGAC specification includes Cross-Over Temperature($T\delta45$) and Low Temperature Critical Spread(ΔTc) on 20 hr PAV and 40hr PAV for information

Recovered Asphalt Cement acceptance as interim measure. Phasing-in mix performance testing for acceptance.

Equipment Procurement

- Participant in FHWA Transportation Pooled Fund Program TPF-5 “Implementation of the AMPT for Superpave Validation” since late 2000’s
- NHI AMPT training course at NCAT (May 2-5, 2011)
- National Workshop (Sept11-12, 2012)
- In 2012, MTO acquired an Asphalt Mixture Performance Tester (AMPT)
- Tests conducted on AMPT:
  - Dynamic Modulus
  - Flow Number
  - Stress Sweep Rutting (SSR) Test
  - Cyclic Fatigue (large and small specimens)

Equipment Procurement

- 30 kN Dynamic Testing System (DTS-30) Purchased in 2017
- Servo-hydraulic testing machine applying loads in tension or compression dynamic loading modes
- Environmental controlled chamber -40°C to 80°C
- Complete with various testing jigs, strain gauges, and linear variable differential transducers (LVDTs)

Equipment Procurement

Tests that can be conducted on DTS-30:

- Disk-Shaped Compact Tension (DCT)
- Semi-circular Bend (SCB)
- Cyclic Fatigue
- Dynamic Modulus
- Flow Number
- Texas Overlay
- Indirect Tensile Creep Compliance
- Resilient Modulus
- Four Point Bending
- TSRST (Thermal Stress Restrained Specimen Test)

Equipment Procurement

Hamburg Wheel Tracking (HWT) procured in 2016 with the following features:

- Accommodates both dry and wet testing conditions
- Used to evaluate rutting potential and moisture susceptibility
- Applies a wheel load of 705± 4.5 N on each wheel
- Adjustable speed of 40 to 60 wheel passes per minute across the specimen
- Controls the temperature over a range of 25.0^{o}C to 70.0^{o}C to an accuracy of ± 0.5^{o}C

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Performance Testing of Asphalt Mixtures

- Initiated in mid 2017 to develop acceptance criteria for post-production mixes
- Asphalt mix designs are becoming more complex due to the increased use of various materials and technologies (i.e. recycled materials, binder additives/modifiers, warm mix asphalt technologies, etc.). All of these could impact mixture performance
- Mix volumetrics are insufficient for predicting behaviour of post-production asphalt mixtures
- There is an urgent need to establish reliable performance tests that can help produce durable asphalt pavements, while creating a balance between resistance to cracking and rutting

Performance Testing of Asphalt Mixtures

- In addition to well established tests used to predict rutting, MTO reviewed various cracking tests listed in NCHRP 9-57 report
- Also interested in properties of in-situ asphalt cement
- The most promising tests selected for evaluation were:
  - Semi Circular Bend – SCB IFIT (fatigue cracking)
  - Disk Shaped Compact Tension - DCT (low temperature cracking)
  - Dynamic Modulus and Cyclic Fatigue Test (fatigue cracking)
  - Hamburg Wheel Tracking (rutting and moisture damage)
  - PG grading of asphalt cement recovered from production mix (impact of RAP, etc.)

Performance Testing of Asphalt Mixtures

A work plan was developed to explore the use of performance tests to predict pavement rutting and cracking resistance, and to develop acceptance criteria based on the selected tests

Approach:

- Evaluate a number of performance tests that address various modes of cracking by testing either loose production asphalt mix or pavement cores
- Select appropriate performance tests for use as acceptance (QA) tests to assess resistance of placed asphalt mixtures to cracking, rutting, and moisture damage
- Conduct testing on the recovered AC from the same production asphalt mixtures and evaluate for acceptance
- Develop acceptance criteria for mix performance tests and recovered AC
- Establish new specifications based on findings

Performance Testing of Asphalt Mixtures

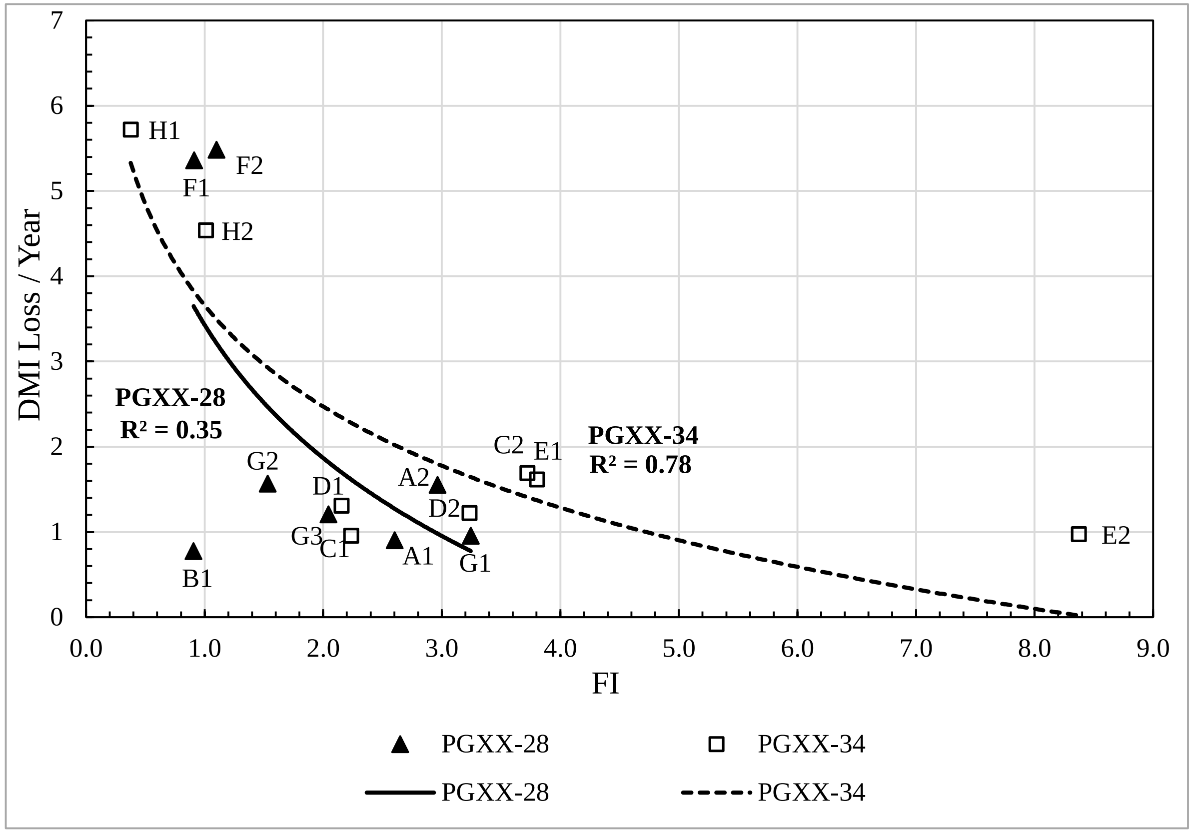
- Loose asphalt mix samples were collected from regional contracts and sent to QA labs for sample preparation
- Loose mix samples were sent to QA labs for extraction and recovery of asphalt cement
- Field core samples were collected and sent to MTO Bituminous laboratory
- Two contracts were chosen for each of the below mix/PGAC combinations for sampling:
  - SMA (70-28)
  - SP12.5 FC2 (70-28)
  - SP12.5 FC2 (64-34)
  - SP12.5 FC1 (58-28)
  - SP12.5 FC1 (64-28)
  - SP12.5 (58-34)
  - SP12.5 (52-34)
  - SP19 (64-28)
  - SP19 (58-28)

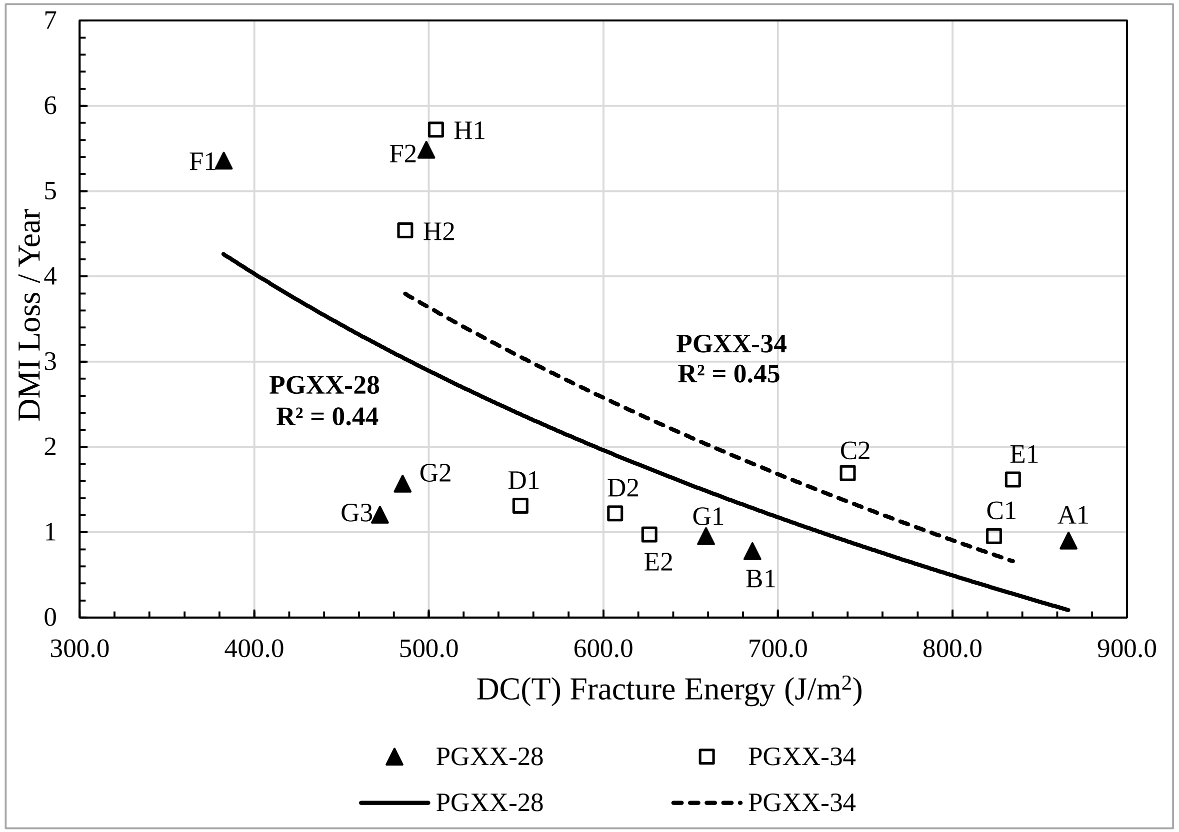
Performance Testing on Aged Pavement Cores

- In a recent study, a number of good performing and poor performing asphalt pavements were selected
- The pavements were constructed between 2005 and 2013
- Pavement cores were taken and tested by SCB and DCT tests
- Pavement condition expressed in terms of DMI loss per year
- RAP was present in two good performing contracts, indicating that RAP could be used responsibly in the asphalt mix
- Fair to good correlation between pavement distress and both FI and DCT fracture energy
- Good performing pavements had FI > 3 and DCT fracture energy > 550 J/m2

Performance Testing on Aged Pavement Cores

- These fracture energy-based tests are able to produce reasonable results even when conducted on the aged pavement cores





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Mix Performance Testing

Based on evaluation of various performance tests, MTO is currently focussing on the following tests to predict cracking and rutting resistance for acceptance

- Flexibility Index (FI) test using Semi-Circular Bend (SCB) Geometry (intermediate temperature crack resistance)
- Disk-Shaped Compact Tension (DC(T)) test (low-temperature crack resistance)
- Hamburg Wheel Tracking (HWT) test (rutting resistance and moisture damage)

Types of Cracking and Fracture Based Cracking Tests

DTS-30kN

FIT test using SCB geometry

DC(T) Test

Flexibility Index Test: Semi-Circular Bend (SCB) Geometry

SCB Test Setup

According to AASHTO TP124

Test Temperature: 25°C

Specimen Thickness: 50 mm

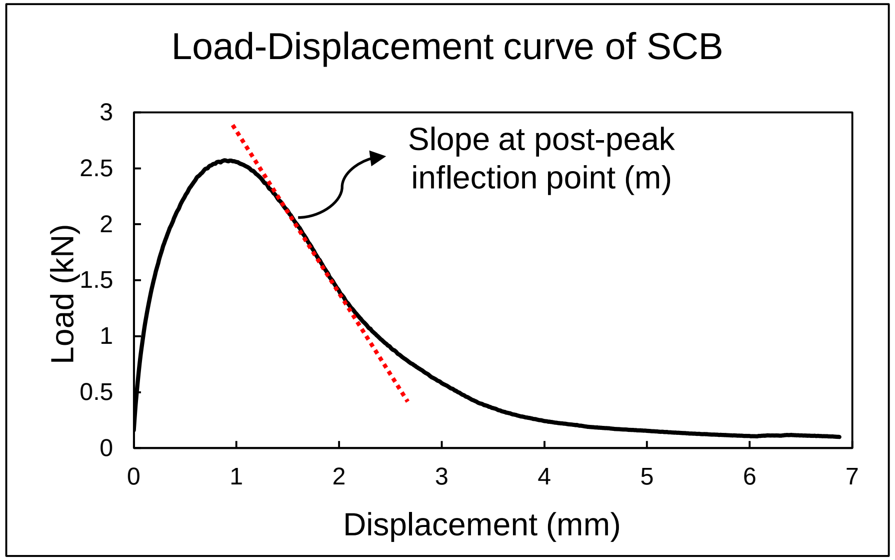
Notch Depth: 15 mm

Monotonic loading: 50 mm/min

Outcome:

Fracture Energy (J/m²)

Flexibility Index (FI)



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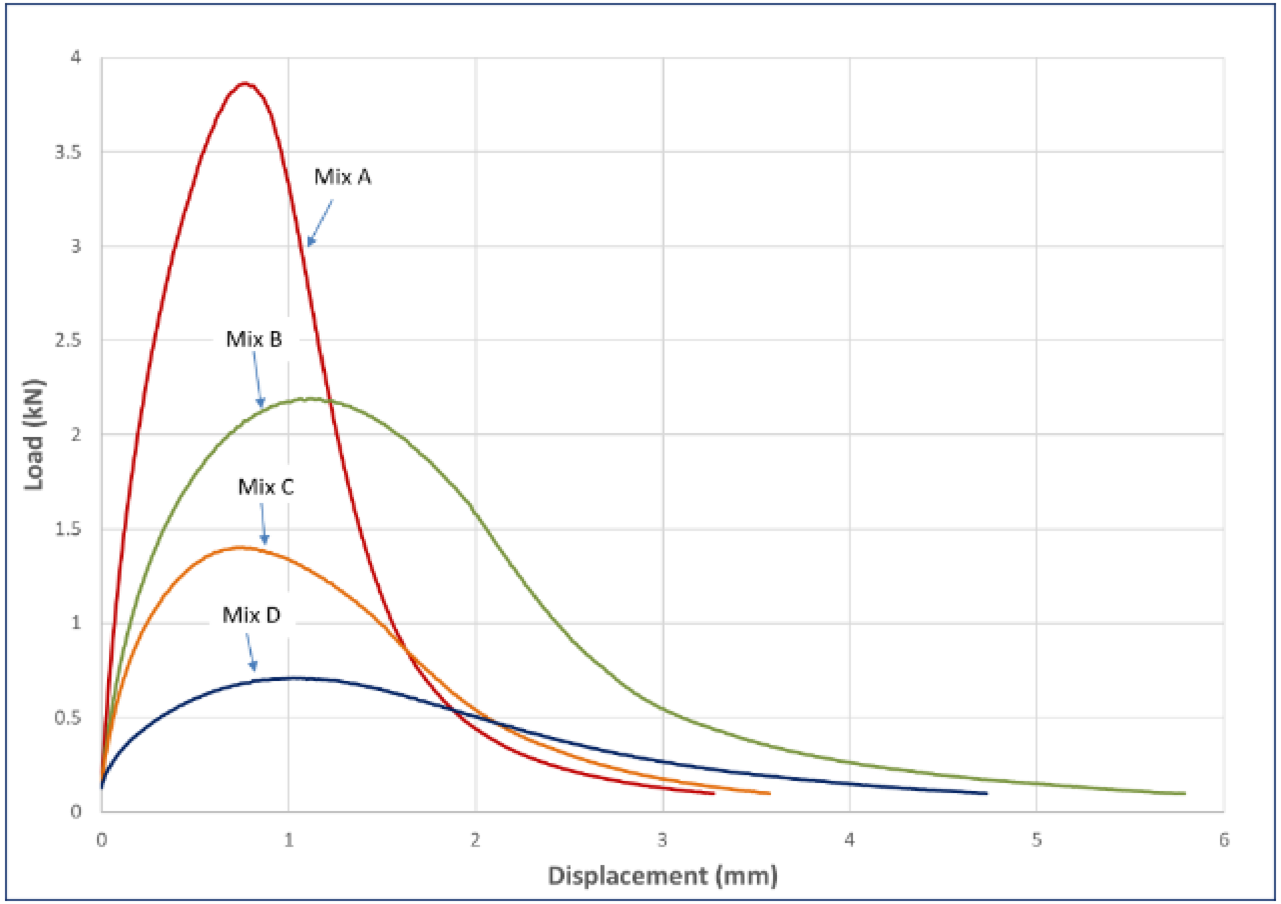
SCB Specimen Preparation

1. Cutting into discs

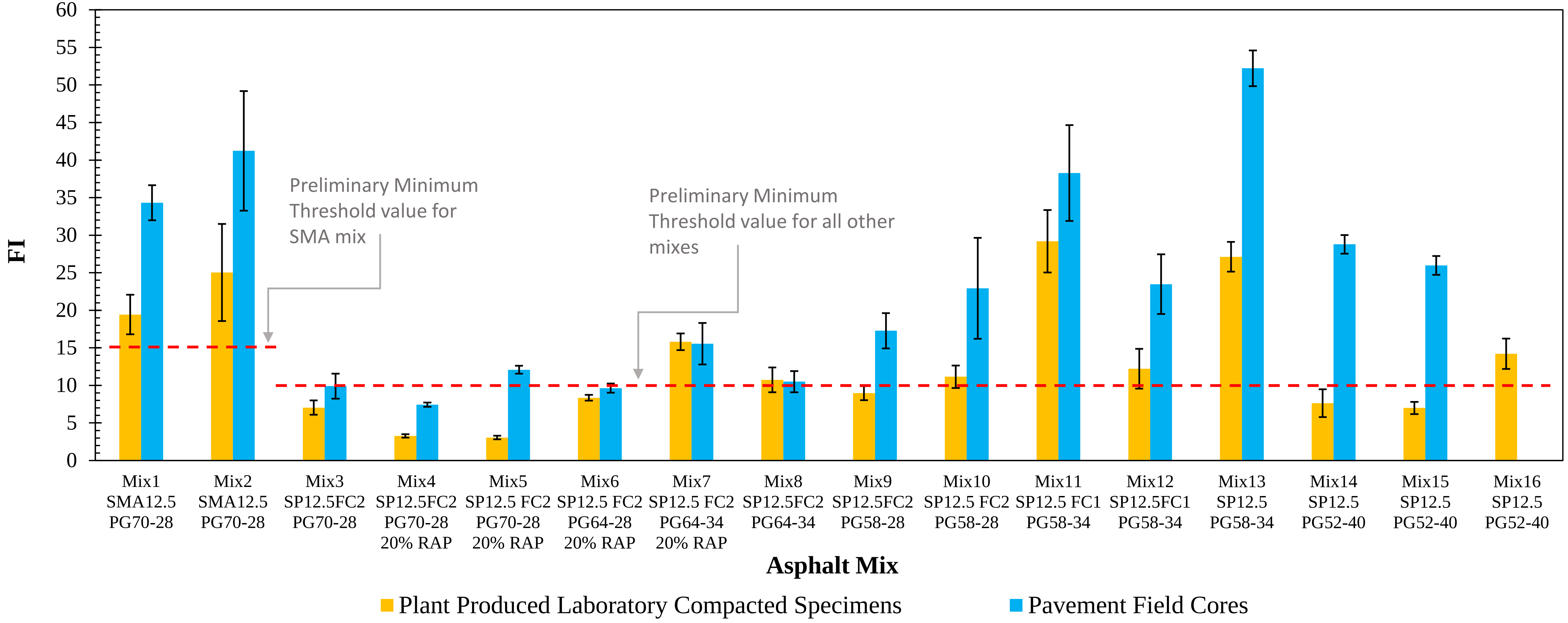
2. Cutting discs in half

3. Cutting the notch

Mix Performance Testing: FI Test



Mix Performance Testing: FIT Test Results



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Disk-Shaped Compact Tension (DC(T)) Test

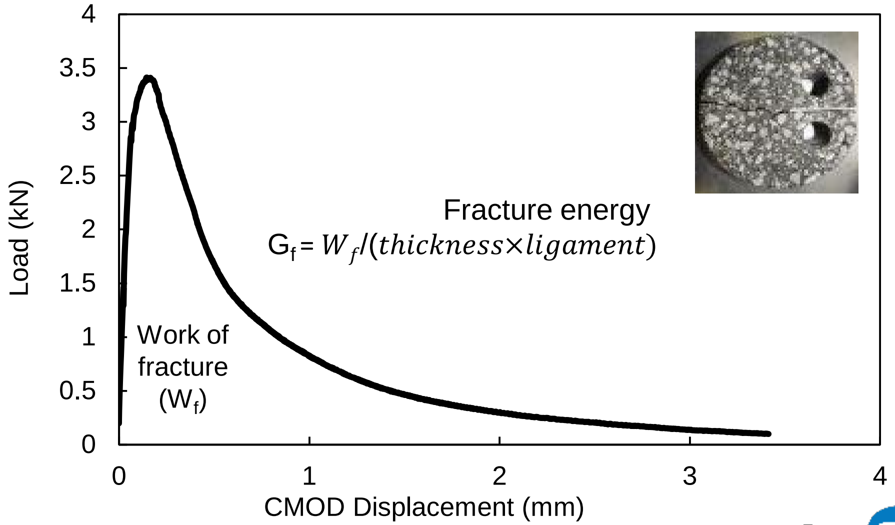
According to ASTM D7313

Test Temperature: 10^{o} C higher than low PG grade

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

Outcome:

Fracture Energy (J/m^2)



Saw Cutting Equipment

Automatic Pave Saw

Tile Saw for precise cutting

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DC(T) Specimen Preparation

1. Cutting into discs

2. Cutting the edge of discs

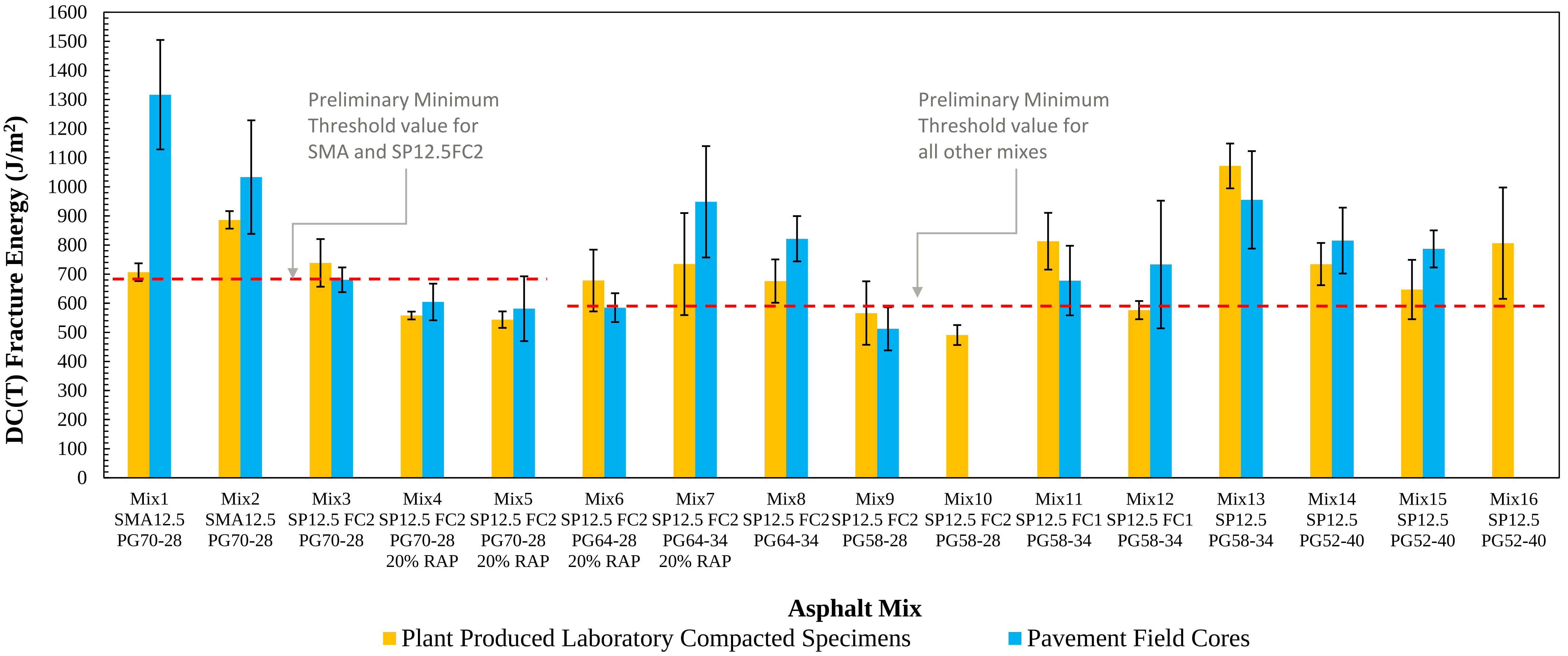
3. Marking the holding holes

4. Coring the holding holes

5. Cutting the notch

6. Gluing the knife edges

Mix Performance Testing: DC(T) Test Results



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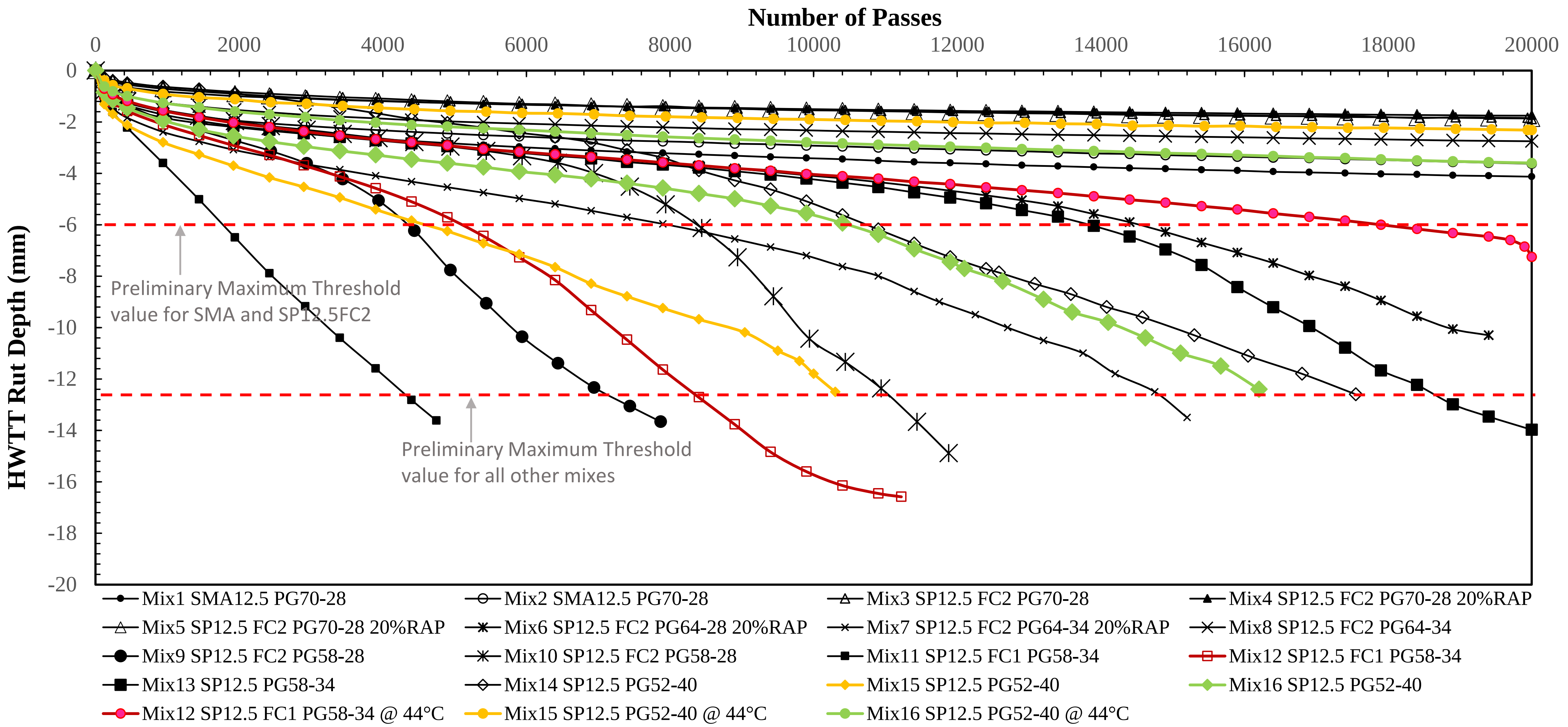
Hamburg Wheel Tracking Test

According to AASHTO T324 →

- Samples submerged in water
- Test Temperature: 50ºC, 44ºC
- Max. number of wheel passes: 20,000

→ Outcome → Rut depth vs. # of load passes

Mix Performance Testing: HWT Test Results



HWT Thresholds under Consideration

PGAC Grade	Test Temperature (°C)	Thresholds
70-XX	50	Max. 6.0 mm Rut Depth @20000 Passes
64-XX	50	Max. 12.5 mm Rut Depth @20000 Passes
58-XX and 52-XX	44	Max. 12.5 mm Rut Depth @20000 Passes

Mix Performance Testing - Implementation

Phased-In approach starting 2020:
Collecting post-production samples from select contracts
Testing for information purposes by QA Labs

SCB Flexibility Index Testing
Hamburg Wheel-Track Testing
DCT testing

SCB correlation ongoing

Contractors are encouraged to use balanced mix design

2 CTAA papers underway

Mix Performance Tests: Long Term Plan

Long-Term Plan:

- Testing carried out by equipped and capable laboratories (QC/QA/Referee)
- Phase in performance testing on post-production mix
- Conduct long-term aging on mixes, analyze effects, and establish mix performance acceptance criteria in relation to in-service pavement performance
- Implement mix performance specifications to improve quality of asphalt mixes used on Ontario's highways

Questions?

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