Asphalt Mix Performance Checklist for Municipalities

Sina Varamini, Ph.D., P.Eng.
Director, Pavements and Materials Group

UNTAPPED
Re-engineering & Realizing Opportunities To Meet Future Demands
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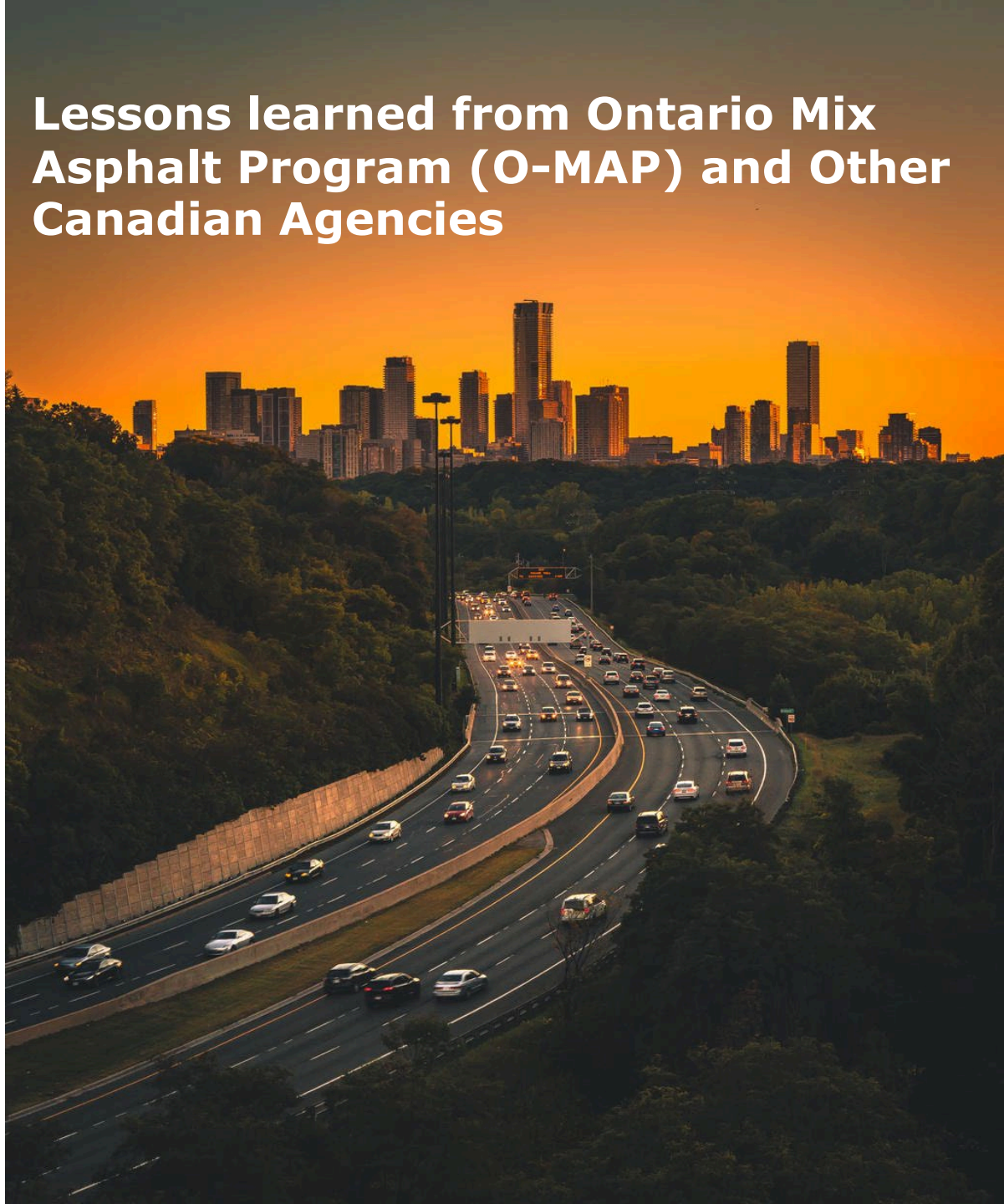
Lessons learned from Ontario Mix Asphalt Program (O-MAP) and Other Canadian Agencies



OUTLINE

Asphalt Mixture

What properties required?

Past, current & trending mix design approaches

Volumetrics versus Performance-Based

Level of readiness to adopt performance testing

What is next!

Picture Retrieved Via LINK

ASPHALT MIXTURE

Mixture of **aggregate** and **binder** agent

Provide a **hard-top**, while being **waterproof** to a level to prevent the support layers from becoming saturated and loosing support

Stiffness and Behaviour at different in-service temperatures controlled by aggregate skeleton and/or binder properties.

ASPHALT MIXTURE

Desired Mix Design = Optimized **Ratio of A/B** Based on **Cost Durability**

%BW= 4 to 6%
$/MT = 40 to 55%

%BW= 94 to 96%
$/MT = 5 to 50%

PRODUCTION

ENERGY
$/MT = 10 to 20%

RECYCLED ASPHALT PAVEMENT (RAP) (Aggregate/Binder)

ASPHALT MIXTURE

Mix Design Historical Trends

1890 — Barber Asphalt Paving Company
Mix of AC with Sand and Pulverized carbonite Lime

1905 — Clifford Richardson, New York Testing Company
Surface Sand Mix
Asphalt mix for lower layers
VMA terminology used

1920s — Hubbard-Field Method
Sand asphalt design
30 blow, 6" diameter with compression test

1927 — Francis Hveem (Caltrans)
Surface Area factors to determine binder content (Hveem stabilometer and cohesionmeter)

Air voids not used initially, mixes generally drier relative to others

Issues with fatigue cracking

1943 — Bruce Marshall (Mississippi DOT)
Refined Hubbard Field Method – standardization of compaction energy with drop hammer
Used only air voids (3 to 5%)
VFA and VMA added in 1962
Stability and flow utilized

1993 — Superpave
- Level 1 (volumetric-based approach) using 4% air voids, VFA, VMA, DP
- Introduction of gyratory compactor
- Level 2 (performance-based approach) – **Never implemented**

First Canadian trials in mid1990s

NOW?

Timeline prepared by Sina.V after reviewing "History of asphalt mix design in North America" published by Asphalt Magazine, Asphalt Institute Link: http://asphaltmagazine.com/history-of-asphalt-mix-design-in-north-america-part-1/

ASPHALT MIXTURE

The Bigger Issue – ***"Asphalt Mix Iceberg™"*** *as we think of..*

Navigating using ***PAST EXPERIENCE*** *by seeing*

Asphalt Binder Physical & Chemical Properties

Aggregate Properties

AGG-Binder Volumetrics (ABV) Relationship

NO MIX PERFORMANCE *under laboratory conditions*

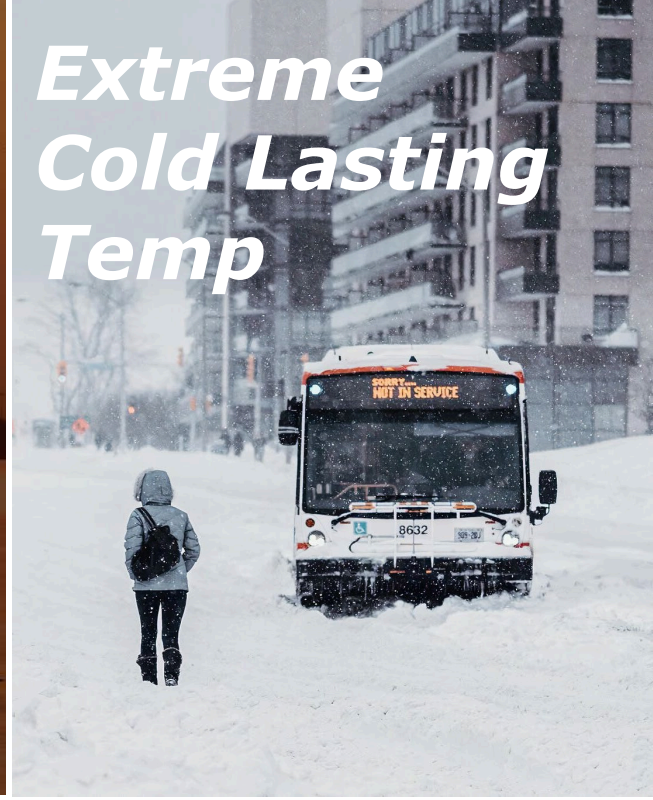
=

HIGH RISK *in Extreme Events & Complex Projects*

REDUCED *Structural* ***RESILIENCY***


Increasing
Heavy Traffic
LINE 1 SHUTTLE BUS
SOUTHBOUND


Extreme
Heat Waves


Extreme
Cold Lasting
Temp
SORRY
NOT IN SERVICE

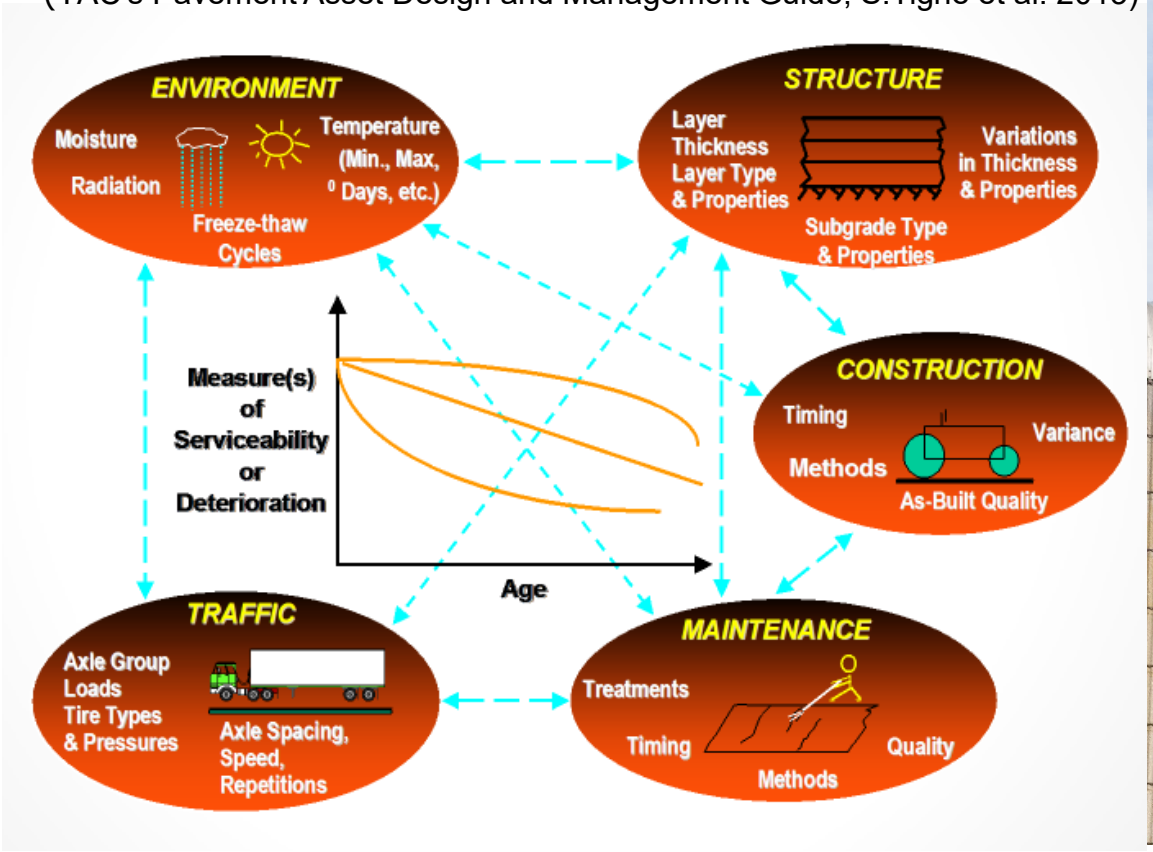

Changes
in material supply
Binders, additives, aggregates, etc.


Extreme
Flooding

HOW RESILIENT-READY ARE WE?

Factors Affecting Roadway Performance

(TAC's Pavement Asset Design and Management Guide, S.Tighe et al. 2013)



ASPHALT MIXTURE

Considering Performance in Mixture Design

1 Recipe & Volumetric Selection

2 Performance-Verified Volumetric Design

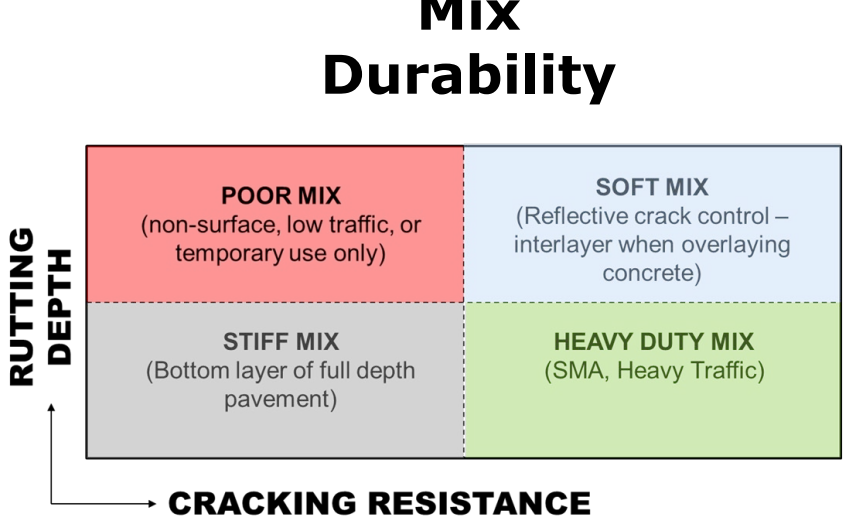
Verification of resistant to a specific distress
Example: Asphalt Cement (AC) modification to resist fatigue cracking

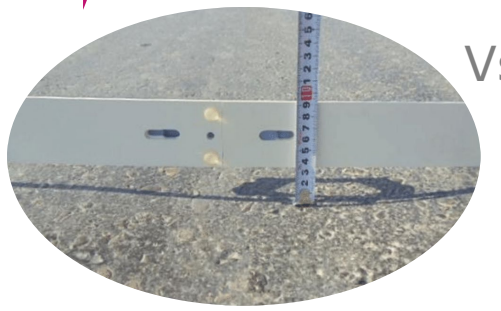
3 Performance-Modified Volumetric Design

Adjustment of mix proportions to resist a specific distress
Example:

4 Performance-Based Design

Durability
Performance testing for **Pavement design input**
Conduct volumetric for QA





Vs.

ASPHALT MIXTURE

Considering Performance in Structural Design

1 **Recipe & Volumetric Selection**

2 **Performance-Verified Volumetric Design**

Verification of resistant to a specific distress
Example: Asphalt Cement (AC) modification to resist fatigue cracking

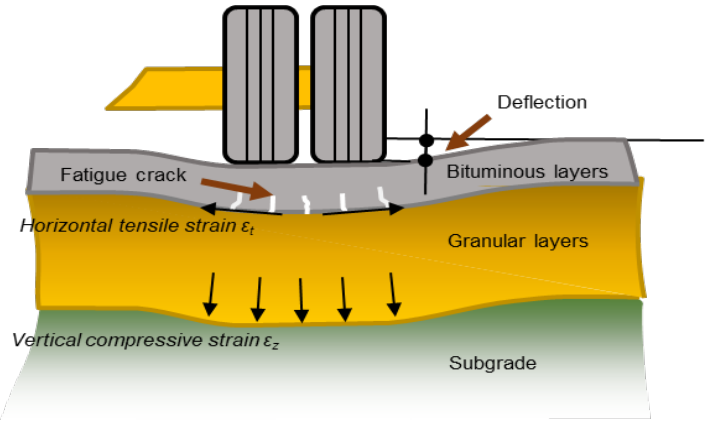
3 **Performance-Modified Volumetric Design**

Adjustment of mix proportions to resist a specific distress
Example:

4 **Performance-Based Design**

Durability
Performance testing for **Pavement design input**
Conduct volumetric for QA

Mechanistic Input to Structural Design



PERFORMANCE INDEX TESTING

Selected Laboratory Torture Testing

Proposed Test for Benchmarking, Performance-Modification Forensic

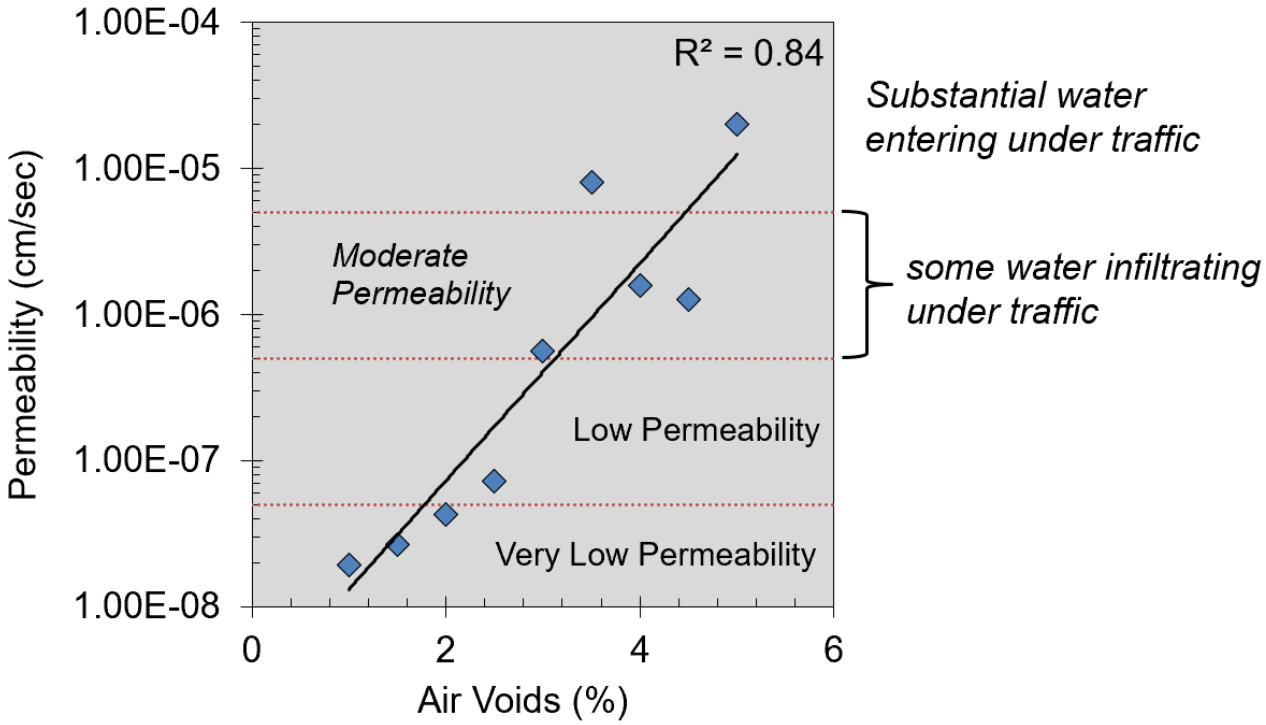
2 3

ASPHALT MIXTURE

Test Methods

Permeability: In-Place Density Related to Durability

Important mix attribute when used on bridge or parking decks

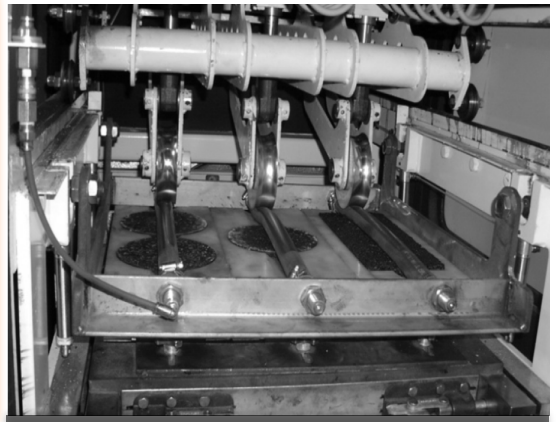


Research work Done by Dr. Varamini – CTAA 2019 "Development of Low Permeability Asphalt Mix"
Permeability ranges corresponding to those listed in Vardanega P, Waters T. "Analysis of Asphalt Concrete Permeability Data Using Representative Pore Size", Journal of Materials in Civil Engineering, American Society of Civil Engineers (ASCE), Reston, Virginia, Volume 23, Issue 2 (February 2011).

ASPHALT MIXTURE

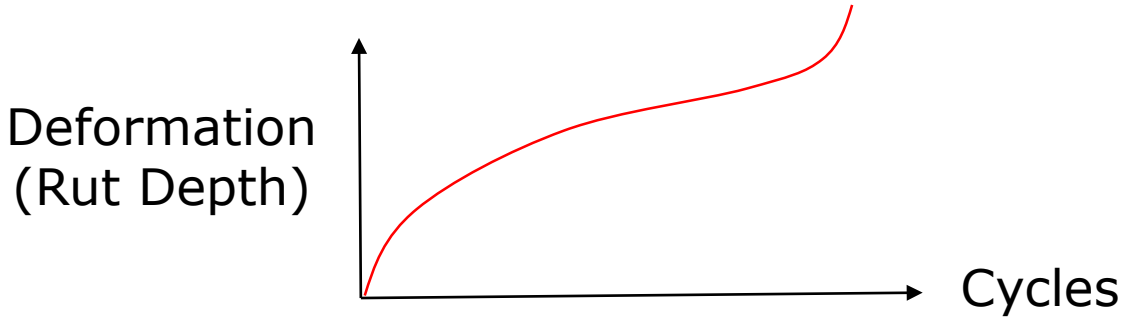
Test Methods – Permanent Deformation/Rutting

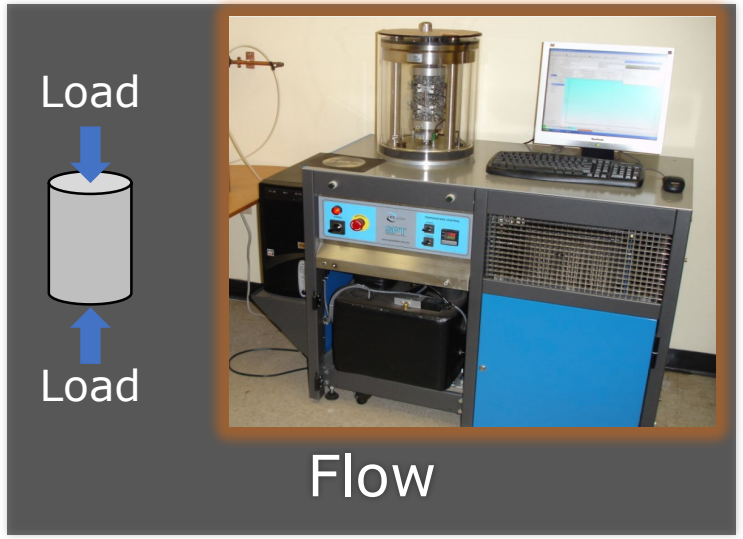
Hamburg Wheel Tracking



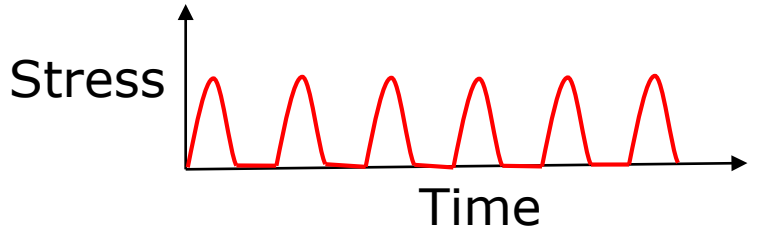
Asphalt Pavement Analyzer

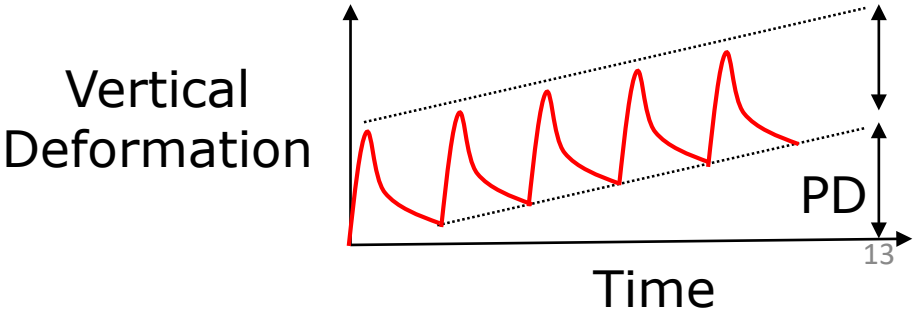
Simulative





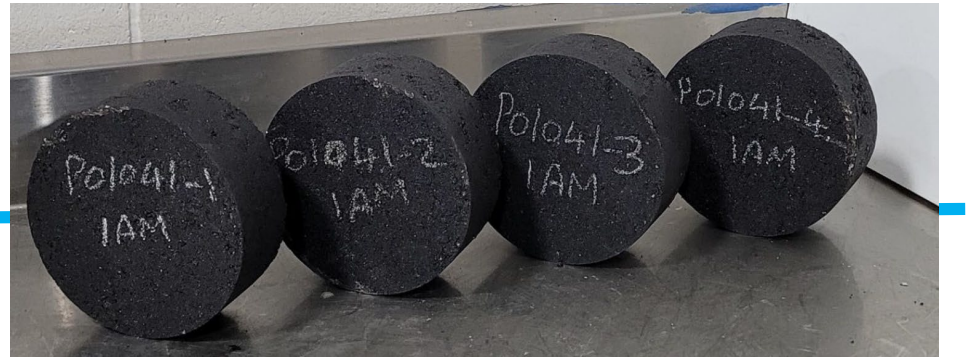
Flow





ASPHALT MIXTURE

Hamburg Wheel Tracking Test – AASHTO T 342



Superpave Gyratory Compacted

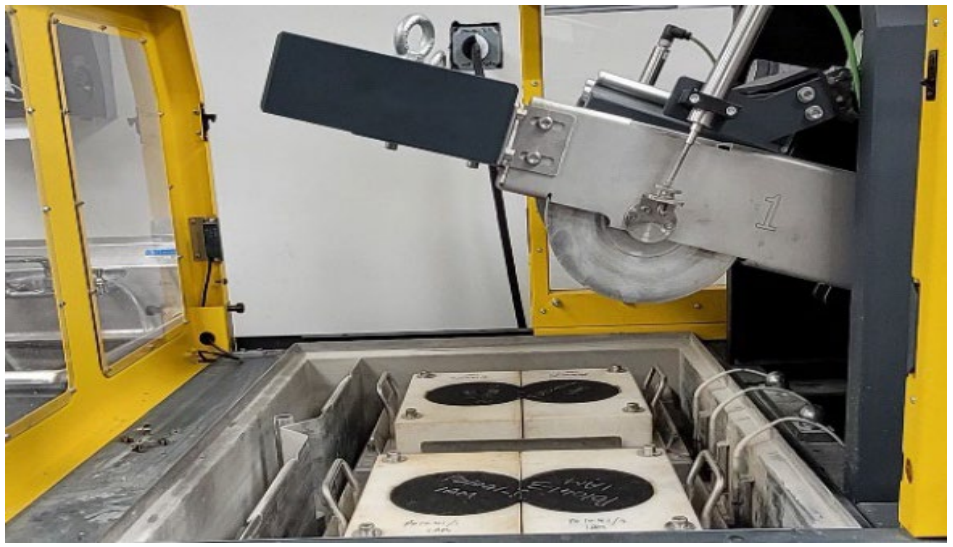
***60-mm** thickness*

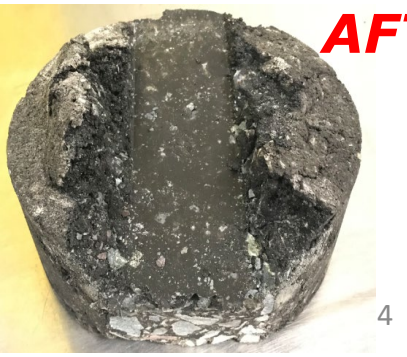
*Tested at **50°C** or **44°C***
(water submerged – Potential for moisture damage)

MTO Preliminary Thresholds

Max. 6-mm after 20k passes for PG 64-YY & 70-YY

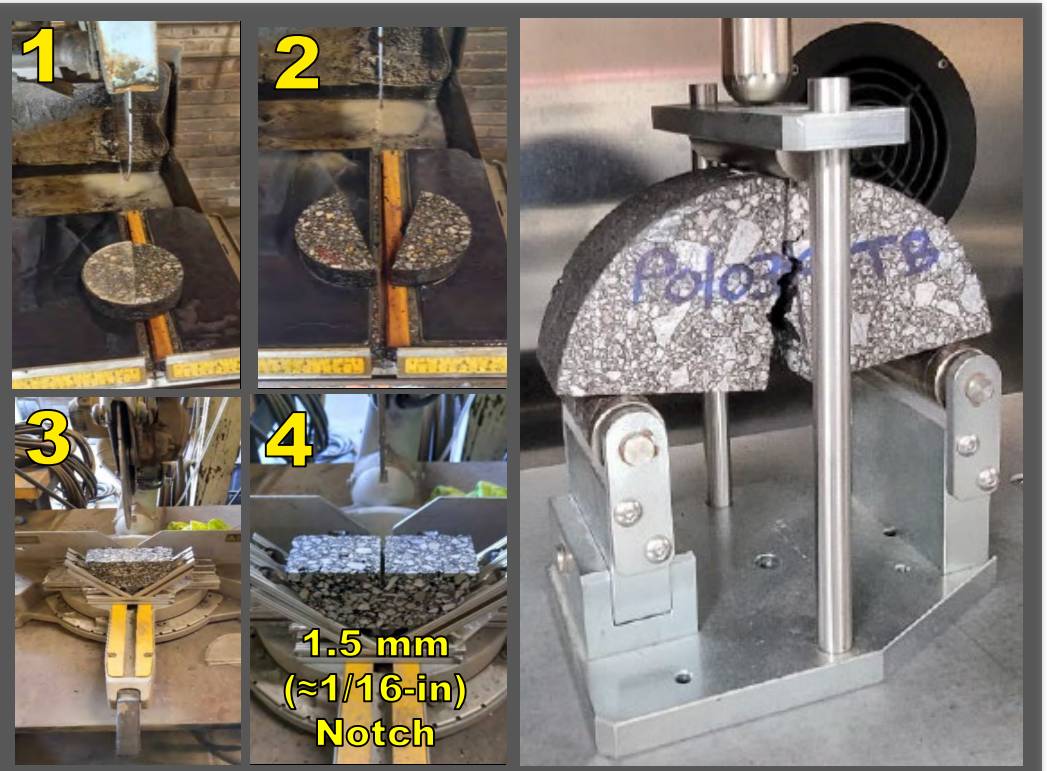
Max. 12.5-mm for PG 58-YY & 52-YY



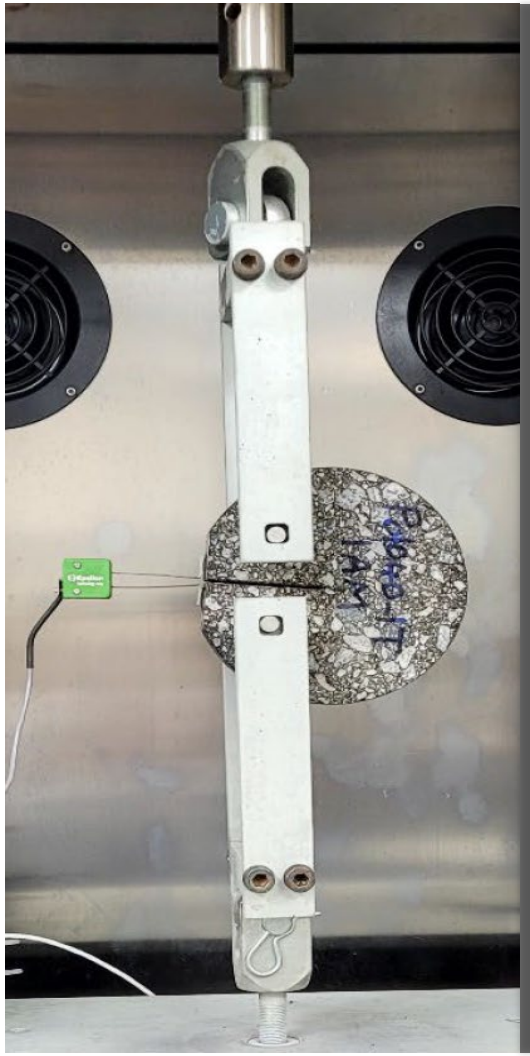


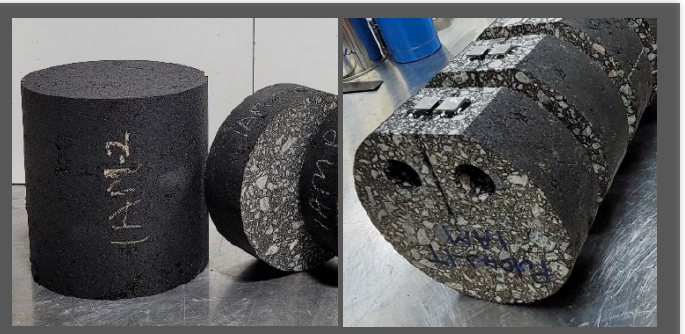
ASPHALT MIXTURE

Test Methods – Intermediate & Low Temperature Cracking



Semi Circular Bend (SCB)
Test
Fatigue Index at 25°C





Disk Shape Tension
(DCT)
Test
Low Temperature
Relaxation Index at
Temperature
10°C warm than
PG YY
(i.e. -18°C for PG 58-28)

Ontario Asphalt Expert Task Group (OAETG)

MIX ASPHALT PROGRAM (MAP) ROUND-1

OBJECTIVES (WHAT)

Understanding **Variability**

- Inherent variability within test method – test variability
- Variability due to mix properties – volumetrics variability
- Interlaboratory variability – equipment(s) and technician(s)

Bridge the knowledge gap in “Performance Testing Methods and Acceptance”

Ontario Asphalt Expert Task Group (OAETG)

MIX ASPHALT PROGRAM (MAP) ROUND-1

OBJECTIVES (WHAT)

RESOURCES (HOW)

Plant-Produced Loose-Mix Donated by **Two (2)** contractors

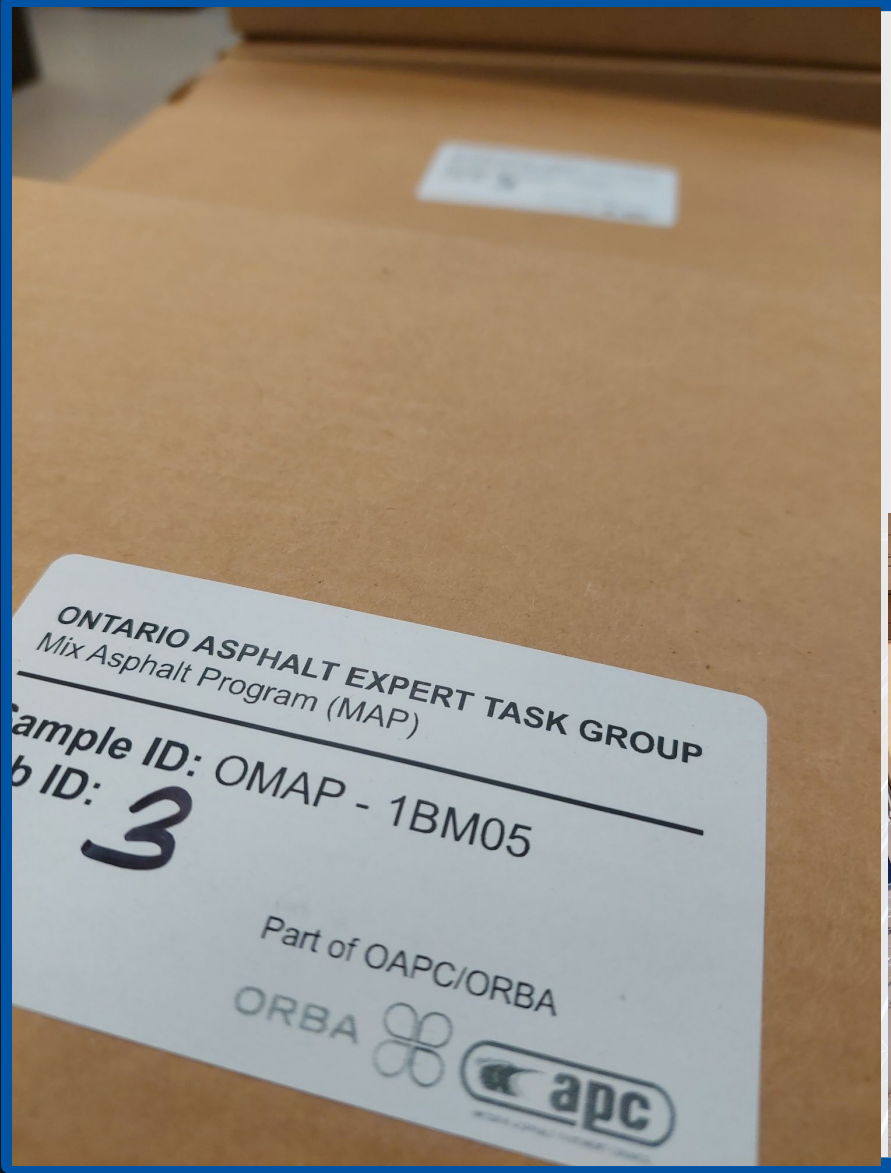
- Sampled Summer 2021
- Representative of SP12.5 “CAT-E” – Zone 3 (PGAC 70-28 XJ)

Test Methods

- Hamburg Wheel Tracking Test (**HWT**)
- Semi-Circular Bend Test – Flexibility Index (**FI**)
- Disk-Shaped Compact Tension Test (**DCT**)
- **PGAC** on tank samples and RAC

Four (4) Testing Labs with full to partial capabilities

O-MAP ROUND 1


ONTARIO ASPHALT EXPERT TASK GROUP
Mix Asphalt Program (MAP)
ample ID: OMAP - 1BM05
b ID: 3
Part of OAPC/ORBA
ORBA
apc


BOÎTE DE RANGEMENT
STORAGE BOX


HEALTH
FLAMMABIL
REACTIVITY
PERSONAL PRO

Ontario Asphalt Expert Task Group (OAETG)

MIX ASPHALT PROGRAM (MAP) ROUND-1

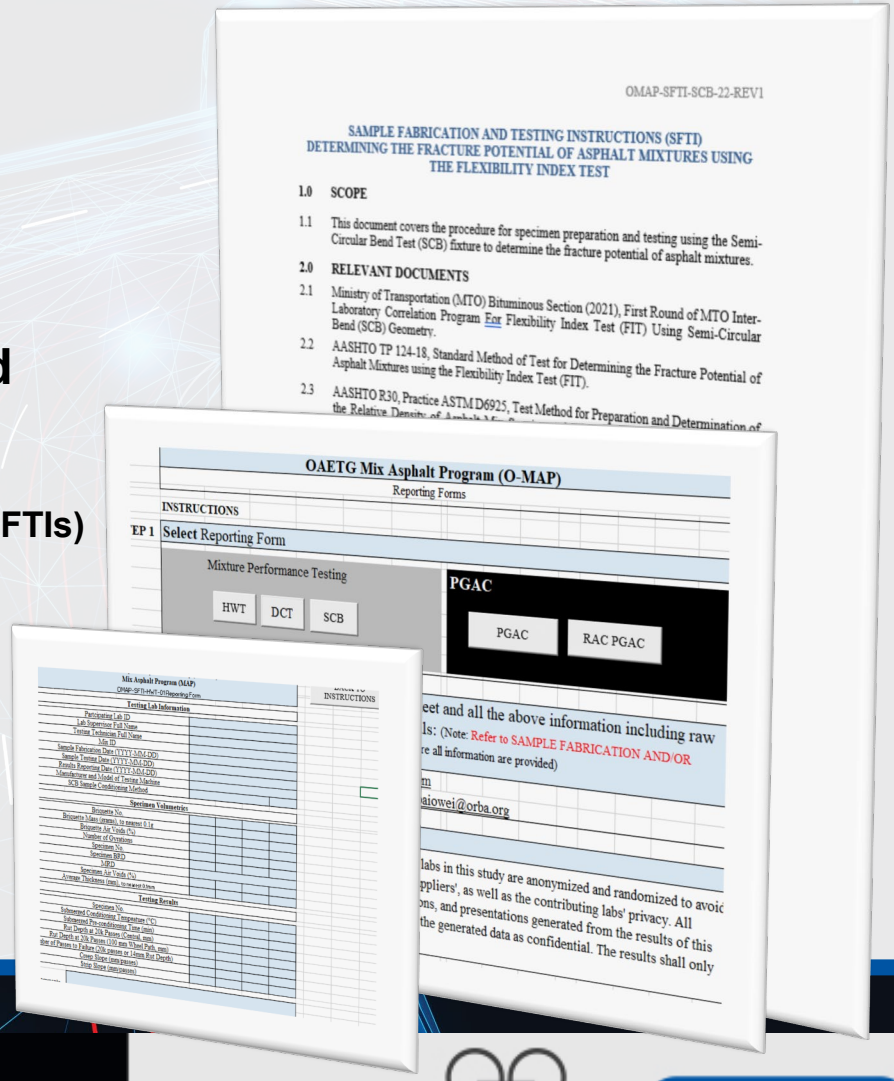
OBJECTIVES (WHAT)

RESOURCES (HOW)

Procedures and Instructions Developed

Controlling consistency

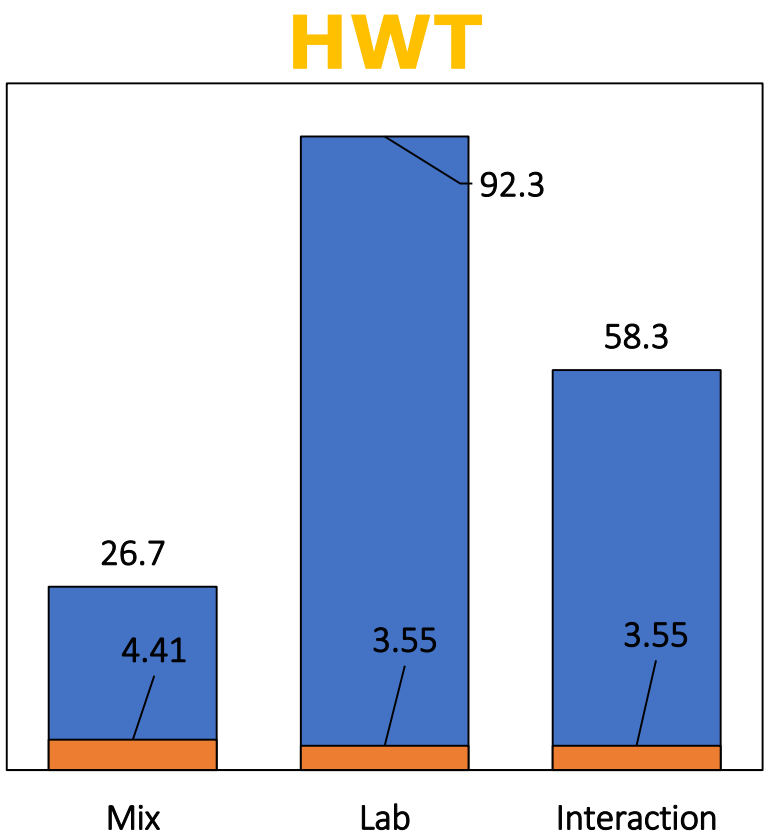
- Sample Fabrication and Testing Instructions **(SFTIs)**
- Interactive Reporting Forms **(IRFs)**
- Large Input from MTO's round of correlations

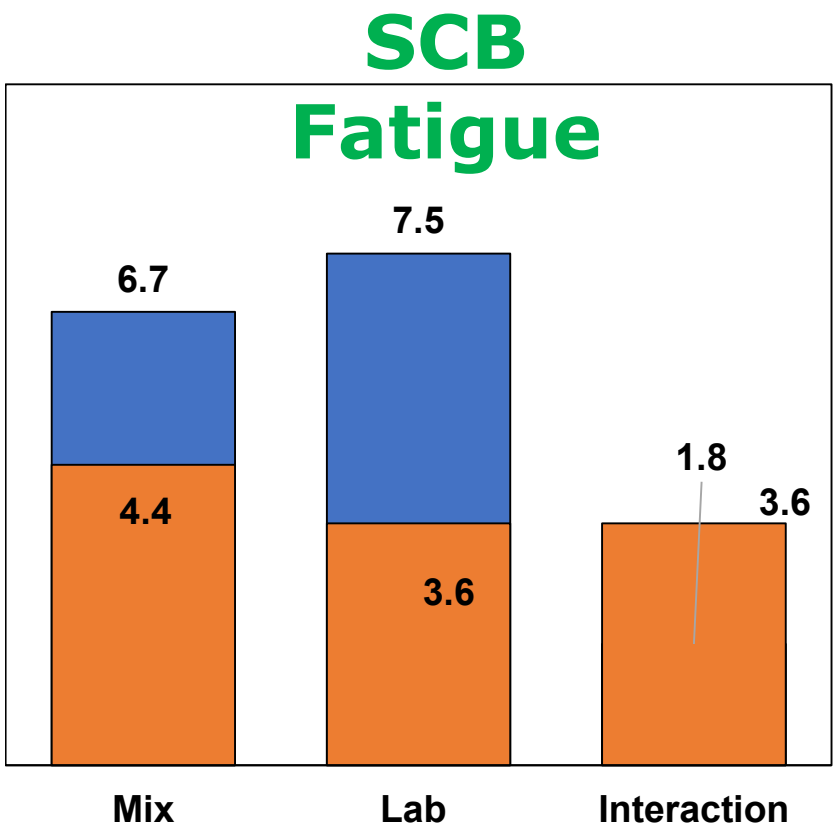


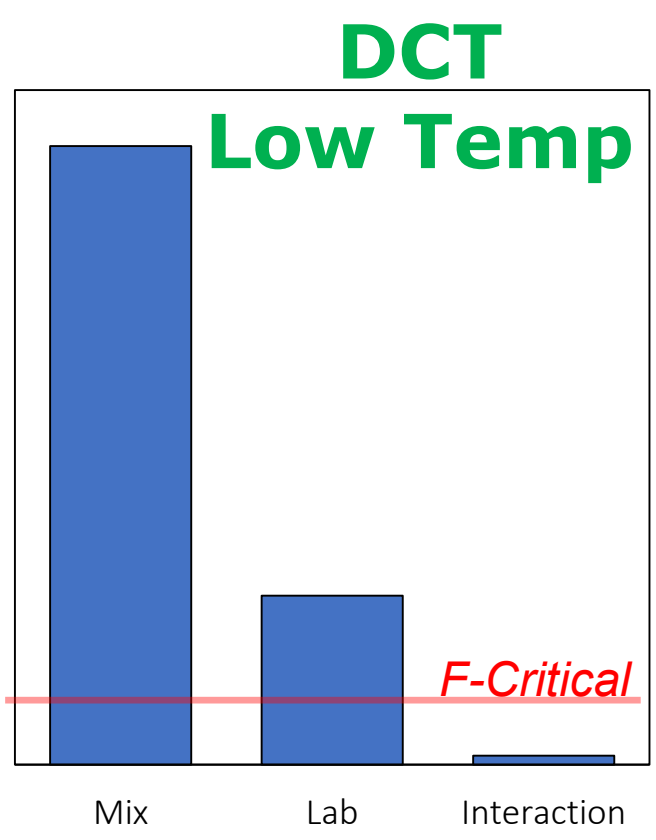
O-MAP EXECUTIVE SUMMARY

ANOVA (F-Value vs F-Critical) Analysis

Understanding source of Variability







Ontario Asphalt Expert Task Group (OAETG)

MIX ASPHALT PROGRAM (MAP) ROUND-1

FINDINGS

Mix Properties

Both binder and mix properties do play a role in performance – inclusion of mix performance check part of design & production

Procedures and Instructions Developed

Controlling consistency

Sample Fabrication and Testing Instructions **(SFTIs)** requires refinement on sample heating, splitting, compaction and cutting

Collaboration

Work Closely with MTO and other agencies considering performance-verified or based designs on coarse and fine tunning sample fabrication, as well as testing parameters (including temperature)

FUTURE STEPS

Research work on effect of cuts, gyratory frame stiffness, and testing temperature on variability of HWT, SCB & DCT

Evaluating IDEAL type of tests such as Cracking and Rutting test (CT & RT), or any other test methods

Considerations for Municipalities

BENCHMARK

- Understand your mix performance
- Multiple temperature sweeps for testing
- Control consistency
- Identify sources of variability

COLLECT PURPOSEFULLY

- Select High, Moderate, Low Traffic Sections
- Be consistent with Benchmarking
- Understand the thresholds implications

Questions and Discussions

Sina Varamini, Ph.D., P.Eng.

Director, Pavements and Materials Group (Engtec Consulting Inc.)
Chair, Ontario Asphalt Expert Task Group (OAETG)

Engtec Consulting Inc.

| Pavement and Materials | Earth an Environmental
| Materials Testing and Evaluation | Forensic Engineering
| Contract Administration | Infrastructure