RUTTING BEHAVIOUR OF TYPICAL ONTARIO RAP-HMA MIXTURES

Doubra Ambaiowei[1,a], Xiomara Sanchez[1,a], Susan Tighe[2,a], and Vince Aurilio[3,b]

1: Ph.D. Candidate. 2: PEng., Professor and Canada Research Chair, Norman W. McLeod Chair. 3: PEng., Manager Pavement Services (a) Civil & Environmental Engineering, University of Waterloo, Waterloo, Ontario, Canada (b) DBA Engineering Limited

INTRODUCTION

- Incorporating higher (RAP) blends (i.e. > 25% by mass) into Hot Mix Asphalt (HMA) mixtures could compromise pavement performance in terms of rutting and other pavement distresses.
- Rutting also known as permanent deformation is a visible longitudinal depression along the wheel path on flexible pavements.
- Hydroplaning and major structural failures are safety hazards associated with significant rutting.
- Ontario Superpave Mix Design employed to address the issue of rutting in flexible pavements. However, higher RAP blends the following common challenges remain:
  - ✓ Effects on moisture susceptibility, mix stiffening and premature aging.
  - ✓ Binder grade adjustments (*binder bumping*) and loss of desired binder performance grade.
  - ✓ Mix volumetric and inability to meet consensus properties.
  - ✓ Reduced field workability and issues with compactability.

Past Studies:

- General consensus of successful implementation of HMA mixes with RAP.
- High RAP contents rutting performance of HMA mixes can be improved in comparison with conventional mixes.

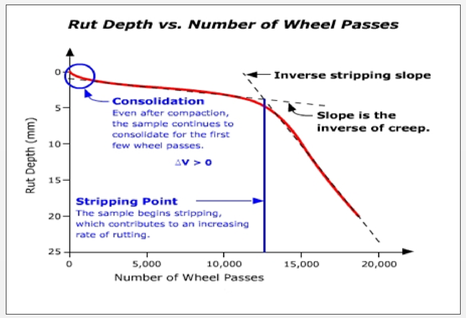
OBJECTIVES

- Research explores feasibility of designing higher RAP Superpave asphalt mixtures without compromising pavement performance.
- Rutting potential of an array of typical Ontario Superpave HMA mixtures with up to 40 percent RAP are evaluated.

METHODOLOGY

The Hamburg Wheel Tracking Device (HWTD) in accordance with AASHTO T324-04 (2008) is employed to evaluate rutting potential.

TYPICAL RUT PLOT



http://www.pavementinteractive.org/article/laboratory-wheel-tracking-devices/

- HWTD is widely used to evaluate the combined effects of rutting, stripping potential and moisture susceptibility of compacted HMA mixtures.
- Indicates post-compaction consolidation on the HMA core after 1, 000 load cycles.
- Creep slope is the portion on the plot where rutting occurs due to consolidation and plastic flow; whereas the stripping slope is related to the severity of the damage due to moisture.
- Stripping inflection point (SIP) the point at the number of passes where the creep slope and stripping slope intercept. Related to the mixture's potential to moisture damage.
- Rut-depth of the HMA mixtures evaluated in this study were based on NCAT's minimum **10 mm** criteria for conventional dense-grade mixes
- After 10, 000 load cycles.

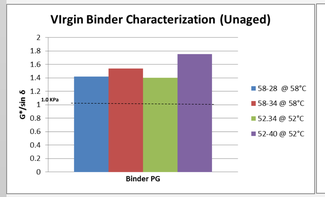
EXPERIMENTAL DESIGN

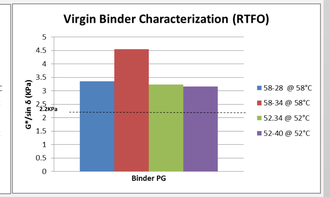
Mix ID	L1	L2	P1	P2	L3	L4	P3	L5	L6
PGAC	58-28				58-34	52-34	64-34	52-40	
RAP Content (%)	0	40	15	20	20	0	20	20	40

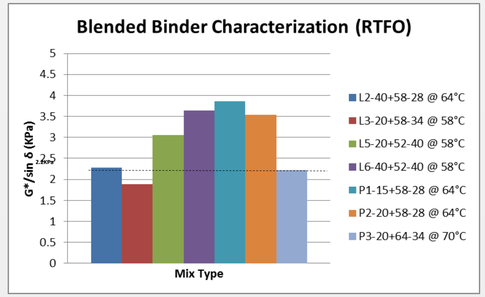
Note: L refers to Lab, P refers to Plant prepared mixtures

- Effects of virgin and blended binder stiffness on rutting performance were evaluated.
- HMA mixtures all met minimum Superpave consensus properties

BINDER STIFFNESS

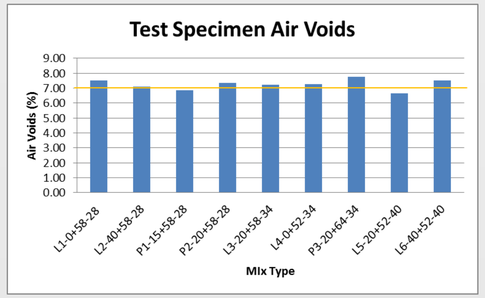




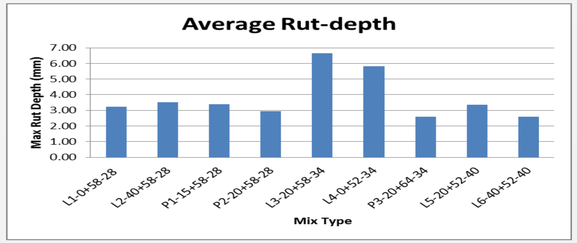


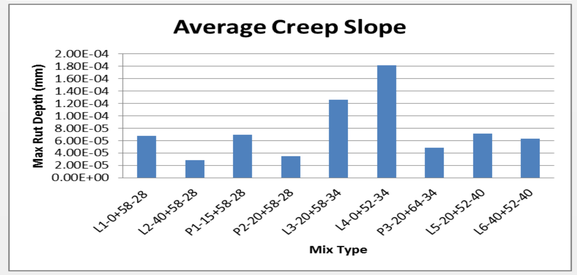
GYRATORY COMPACTION

Mix ID	L1	L2	P1	P2	L3	L4	P3	L5	L6
PGAC	58-28				58-34	52-34	64-34	52-40	
RAP Content (%)	0	40	15	20	20	0	20	20	40
No. of Gyrations	18	15	35	35	15	16	35	11	12



FINDINGS





CONCLUSIONS AND RECOMMENDATIONS

- Overall, all mixtures tested indicate very good rutting resistance relative to MTO's 6 mm very slight rut-depth criteria, except for the
- 20%RAP PG58-34 and control mixture with PG52-34 resulted in higher rut depth and rut potential as per the maximum impression and creep slope results. Obtained rut depths were less than 10mm which is an acceptable value.
- Both binder grade and increase in RAP content affected the rut-depth of the asphalt concrete mixtures.
- All mixtures were highly resistant to stripping and moisture damage.
- HMA mixtures evaluated were previously found to exhibit the potential to withstand thermal cracks arising from low temperatures.
- Proper design, mixing and compaction are key to utilizing RAP content as high as 40% in typical Ontario Superpave HMA mixtures, especially for low-volume roads.
- Highly desirable that the dynamic modulus and flow number tests be conducted to correlate rutting results and validate overall findings.

ACKNOWLEDGEMENTS

The authors sincerely acknowledge support from Ministry of Transportation of Ontario (MTO), Ontario Hot Mix Producers Association (OHMPA), Ontario Tire Stewardship (OTS), and Natural Science and Engineering Research Council of Canada (NSERC) who are collaborating partners for this study. Our thanks also goes to DBA Engineering Limited who provided complimentary support for mixture design and testing. We are equally grateful to Capital Paving Limited., McAsphalt Industries, Canadian Asphalt, Coco Paving, and Bitumar for their in-kind material donations.