Evaluation of Crumb Rubber Modifier in Ontario Hot Mix Asphalt: A Case Study

UNIVERSITY OF WATERLOO

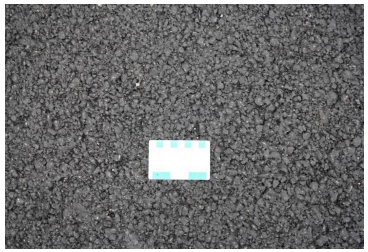
Mohamed Hegazi, MASc Candidate

Susan L. Tighe, PhD, P.Eng, Professor and Canada Research Chair

Centre for Pavement and Transportation Technology, University of Waterloo, Waterloo, ON, Canada, N2L 3G1

Introduction:

- Large move towards more sustainable designs and technology in the asphalt industry
- Moving towards recycling technologies
- Crumb Rubber Modifier (CRM) has successfully been used in improving the mechanical characteristics of hot mix asphalt (HMA) mixtures.



- In 2011, the Center for Pavement and Transportation Technology (CPATT) at the University of Waterloo, the Ontario Tire Stewardship, along with the Ministry of Transportation of Ontario and the Ontario Hot Mix Producers Association partnered to conduct a study of the use of rubber modified asphalt (RMA) and incorporating these mixes into the Hot Mix Asphalt

Objective:

To evaluate the performance of various sections in Ontario constructed with rubber modified asphalt (RMA) to evaluate their performance under the harsh conditions that are faced by pavements in Ontario This requires testing of the following sections paved as part of a pilot program with the MTO:

- Highway 7: Conventional Superpave 12.5 FC1 HMA, Superpave 12.5 FC1R RMA Field Blend, and Superpave 9.5 FC1R RMA Terminal Blend
- Highway 35: Conventional Superpave 12.5 FC1 HMA, Superpave 12.5 FC1R RMA Field Blend
- Highway 115: Conventional Superpave 12.5 FC2 HMA, Superpave 12.5 FC2R RMA Field Blend.

Crumb Rubber:

Ambient Grind:

- Ambient grind crumb rubber is kept at room temperature while being transformed into crumb rubber
- The process involves running tires through an initial stage of grinding, where smaller chips are obtained from whole tires
- Once the rubber is filtered from the fibers and steel, it is then run through further grinding to obtain the required gradation of crumb particles

Cryogenic Grind:

- The rubber is usually frozen to become brittle after it has been reduced to smaller chips and not whole tires
- The freezing is typically conducted using liquid nitrogen and the tires are ground using a hammer mill or other impact methods
- The process of separating the steel from the tire involves using magnets to extract the steel from the rubber

Rubber Modified Asphalt:

Wet Process

- The wet process field blend involves adding crumb rubber from recycled tires into the asphalt cement binder
- The wet process terminal blend utilizes finely ground crumb rubber particles that are mixed with the asphalt cement binder at the asphalt cement refinery or plant and then transported for use
- The wet process, specifically the field blend process, is the more commonly used process for utilizing asphalt rubber

Dry Process

- In the dry process, the crumb rubber is not added to the asphalt binder but added as an aggregate in the mix
- Typical values of rubber content in a dry process mix is between 3 to 5 percent, depending on the application, gradation, and mix design
- The dry process is less commonly used as the added benefit of the rubber is not seen as clearly as when adding rubber with the wet process

2011 Pilot Project:

Highway	Mix type	Lane (km) Placed
Highway 7	Field blend SP 9.5 R Gap-Graded	6
	Terminal Blend SP 12.5 FC2 R Dense-Graded	5.6
	Hot Mix Asphalt SP 12.5 FC2 Dense-Graded	2.8
Highway 35	Field Blend SP 12.5FC1 R Gap-Graded	6
	Hot Mix Asphalt SP 12.5 FC1 Dense-Graded	13.5
Highway 115	Field Blend SP 12.5 FC2 R Gap-Graded	6
	Hot Mix Asphalt SP 12.5 FC2 Dense-Graded	2

Thermal Stress Restrained Specimen Test:

Testing

- Four test specimens prepared for each mix
- Conditioned at 5 degrees for 6 hours
- Temperature drops at constant -10 degrees per hour

Preliminary Results

- Samples are withstanding temperatures beyond the design temperatures
- All mixes performing well under very cold conditions

Highway	Mix	Beam #	Air Voids	Results
115	115-C-1			
		115-C-1-2	7.28%	No Failure
35	35-R-2			
		35-R-2-1	6.64%	In Progress
7	7-C-4			
		7-C-4-1	6.14%	No Failure
		7-C-4-2	6.16%	No Failure
	7-R-FB-1			
		7-R-FB-1-1	7.80%	No Failure
	7-R-TB-1			
		7-R-TB-1-1	6.80%	No Failure
		7-R-TB-1-2	7.60%	No Failure
	7-R-TB-3			
		7-R-TB-3-1	7.78%	In Progress
		7-R-TB-3-2	6.91%	In Progress

Challenges

- Specimens not failing at design temperature
- Cannot test past minimum temperature due to limitation in machinery

Next Steps:

- Repeat the TSRST testing with liquid nitrogen to obtain failure temperature and mode
- Carry out further testing to evaluate performance in Ontario, including Dynamic and Resilient Modulus Testing

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