Laboratory Comparison of Wet-mixing and Dry-mixing of Recycled Waste Plastic as a Binder and Asphalt Modifier

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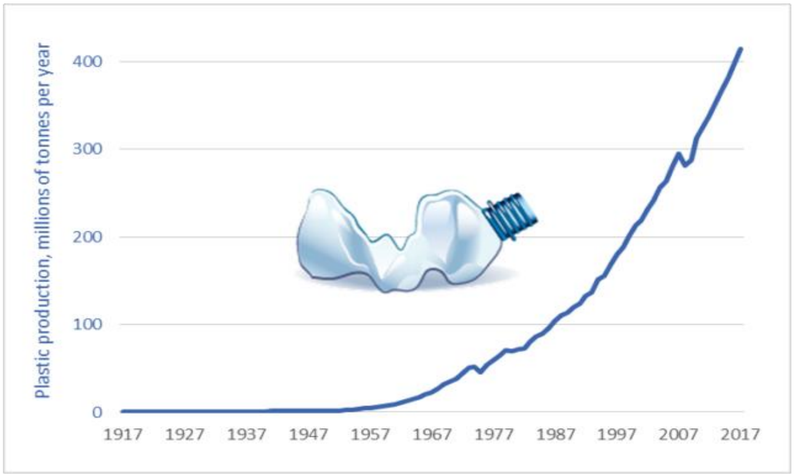
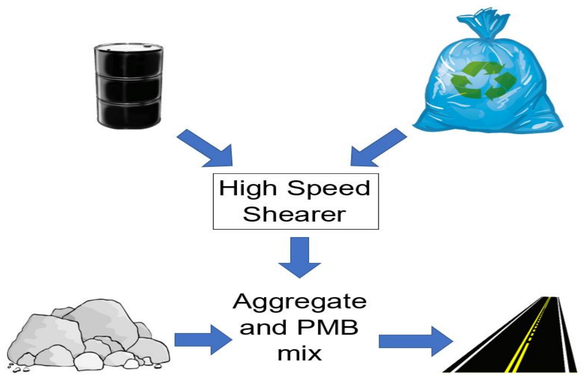
Background



Plastic production has increased exponentially in recent years, causing mass pollution. Technologies utilising waste plastic have attracted attention recently, and one proposed use for recycled waste plastic is in road construction.

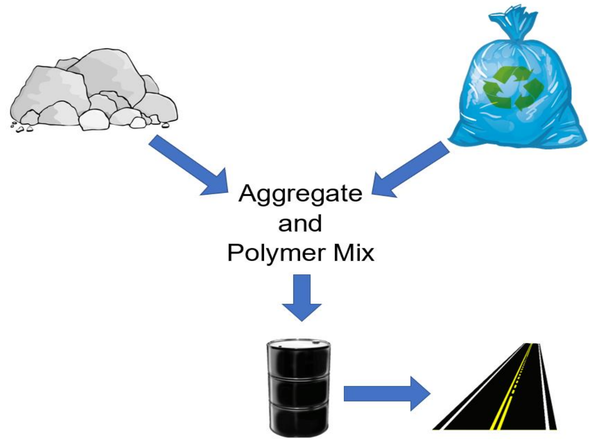
Waste plastics in roads as binder extender and modifiers have displayed significant improvements in engineering properties of asphalt pavements, however practical questions remain, including whether the products should be wet-mixed into the bitumen or dry-mixed by direct addition to the asphalt production plant.

Wet-mixing



Recycled waste polymer is sheared into the bitumen through a high speed shearer ensuring thorough distribution creating a waste polymer modified bitumen. Wet-mixing requires specialized mixing and storage facilities but is generally recognized as providing complete and reliable mixing.

Dry-mixing



Recycled waste polymer is directly added to the aggregate via an asphalt production plant. Dry-mixing is logistically simpler for asphalt production in small quantities and in remote locations, where bitumen blending facilities are not usually available.

Methods

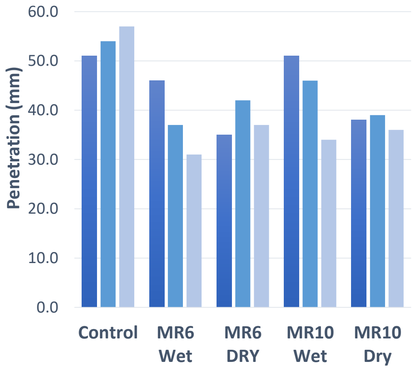
The aim of this investigation was to determine if recycled plastic modified asphalt mixtures prepared through both the wet and dry processes differ in performance, based on mixing method. To achieve the aim asphalt and binder samples were prepared with two commercially available recycled plastic products known as MR6 and MR10, both wet-mixed and dry-mixed, as well as control samples that did not include recycled plastic. The mixtures were subject to asphalt and binder tests indicative of performance to gather a direct comparison between the wet and dry mixing process.

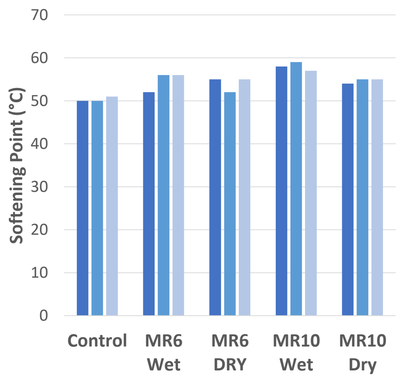
Results were analysed by T-tests for the difference of means. P-values were calculated where P= <0.05 indicated a significant difference between populations (wet or dry mixed).

Binder Tests
Penetration
Softening Point
Elastic Recovery

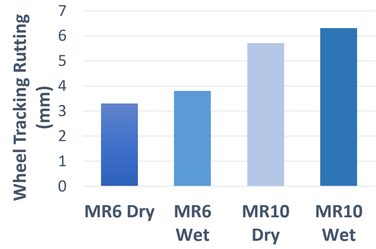
Asphalt Tests
Marshall Stability / Flow
Deformation Resistance
Indirect Tensile Strength
Moisture Sensitivity
Resistance to Fatigue

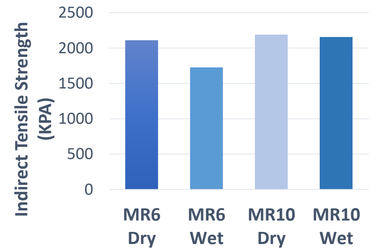
Binder Results





Asphalt Results





Asphalt/ Binder Property	P-value MR6	P-value MR10	Signicantly different?
Marshall Stability	0.64	0.03	No
Marshall Flow	0.46	0.93	No
Deformation resistance	0.31	0.42	No
Moisture resistance	0.61	0.94	No
Tensile strength	0.06	0.84	No
Fatigue resistance	0.89	0.77	No
Penetration	>0.99	0.31	No
Softening point	0.65	0.01	Yes
Elastic recovery	0.84	0.08	No

Conclusion

Recycled plastic significantly improved most binder and asphalt properties. It was concluded that the mixing process was not generally associated with significant differences in the otherwise nominally identical extracted binders and asphalt mixture properties. Both mixing methods result in performance that is significantly different.

Future Recommendations

Further research is recommended on the potential for waste plastic modified asphalt mixtures (both wet mixed and dry mixed) to separate during storage and transportation and other practical issues. .