RESEARCH SUMMARY

DEPARTMENT OF TRANSPORTATION

LOCAL ROAD RESEARCH BOARD

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Testing Recycled Plastics in Asphalt and Concrete Pavement Mixes

Addressing the increasing need for pavement materials coincides with an increasing supply of plastic waste. Incorporating recycled plastic into aggregate for transportation infrastructure is of growing interest. Testing plastic waste material in both asphalt and concrete pavement mixtures revealed promising results and the need to explore long-term performance and durability.

What Was the Need?

Availability of good quality aggregate materials for local roads and highways is often insufficient to meet increasing demand. Supplies of plastic waste, however, are plentiful. Plastic is a significant contributor to the U.S. waste stream. Less than 10% of the material is recycled. Transforming plastic waste into useful material such as pavement could have numerous environmental and economic benefits.

But many questions remain about the feasibility and material performance of plastic-enhanced pavement mixes. Local agencies and MnDOT were interested in exploring whether upcycling plastic—using waste plastic to create a product of greater value—in pavement applications can meet specifications and performance needs while contributing to agencies' sustainability goals and addressing the accumulation of plastic waste.

What Did We Do?

A comprehensive review of existing practices, pilot efforts and other research about incorporating recycled plastic waste materials into asphalt and concrete roadway paving explored the properties, performance and durability of proprietary and nonproprietary products such as binders, additives, fiber reinforcement and sealants.

Two online surveys of more than 30 recovery facilities and suppliers of a variety of recycled plastic material, including fibers made from wind turbine blades, helped

"This research was very informative regarding the pros and cons of incorporating plastic content into bituminous and concrete pavements. Understanding the long-term performance of plastic fibers in concrete would support the viability of a sustainable pavement option."

—JIM JOHNSON, PUBLIC WORKS ADMINISTRATOR, CITY OF CHISHOLM

researchers identify and characterize plastic waste materials to test. Interviews with select respondents elaborated on the characteristics of products, disposal methods, capacities for recycling different plastic types and challenges related to processing plastic waste.

In the laboratory, researchers evaluated the effects of adding plastic waste to both asphalt and concrete mixtures. Asphalt testing included incorporating recycled plastic in pellet form from two separate sources into a typical MnDOT binder to determine appropriate mixing time, performance grade and separation tendency. Finally, asphalt mixtures with and without the plastic-fortified binder were tested for temperature cracking resistance and moisture susceptibility.

Researchers then assessed concrete mixes using one virgin and three recycled plastic materials—both fibers and sand—as aggregate replacements. Fresh and hardened properties tested included workability and air content, compressive and flexural strength, and durability.

What Did We Learn?

Plastics suppliers queried in this project described an increasing trend of upcycling plastic materials into transportation infrastructure but indicated the need for investigation into the long-term performance and durability of pavements constructed with those materials. Companies encounter challenges with food and liquid contamination of materials, high processing costs and technical complexities in recycling and reprocessing plastics, and a limited market to support production.

The optimal mixing time for upcycling waste plastic into asphalt binder was 15 minutes. Because some plastic separated from the modified binder, researchers concluded the binders should be mixed and used immediately rather than stored. The quantity of plastic material added to the binder was 1.5% by weight of the virgin binder and resulted in a reduced cracking resistance of the mixture.

Incorporating waste plastic into the concrete mix reduced its workability by approximately 50%. The plastic fibers resulted in a higher compressive and flexural strength than the control mix, while the plastic sand-modified mix showed a lower compressive strength. The plastic waste materials enhanced the durability of the concrete mixtures. These materials replaced 20% of the aggregate, which is significantly more waste material than was used in the asphalt mixes.

What's Next?

The concrete mix modified with upcycled plastic showed high potential for equal or improved performance and could have significant environmental benefits. However, further research and field testing is needed. Potential research issues involved variability in plastic quality and processing technologies, asphalt separation issues and long-term performance.

Related research, both in Minnesota and in other states, will advance the state of knowledge, moving local agencies and MnDOT closer to integrating waste plastic into sustainable pavements.

About This Project

REPORT 2025-28
"Use of Plastics in Road Materials (Paving)."
Find it at mdl.mndot.gov.

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