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Mini Review

Rubber Modified Asphalt in Michigan: A Mini Review

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Abstract

The incorporation of recycled waste tires in asphalt paving materials is an economical and sustainable construction method that has gained prominence in recent times. This review summarizes the laboratory and field performance of rubber-modified asphalt based on studies conducted in Michigan. In general, the mechanical performance of rubber-modified pavements exhibited improvement compared to the control pavements.

Introduction

The disposal of waste tires in landfills poses an environmental and public health risk since they are non-biodegradable. Moreover, waste tires take up limited landfill space. In a bid to solve this challenge, and maintain environmental sustainability, waste tires have been recycled and used in diverse applications in the construction industry. In the asphalt pavement industry, waste tires are shredded into coarse particles and used as tire-derived aggregates. The waste tires can be further reduced into finer and smaller sizes either by way of grinding at room temperature (ambient crumb rubber) or by freezing and shattering at very cold temperatures using liquid nitrogen (cryogenic crumb rubber) [1]. Studies indicate that modifying asphalt binders and mixtures with recycled rubber particles enhances resistance to cracking and reduce noise in pavements [2,3]. Extensive research has been conducted on the performance of asphalt paving materials (binders & mixtures) modified with waste tire rubber in Michigan. The laboratory findings and field studies are discussed in this review.

Laboratory Assessment

Laboratory evaluation of rubber-modified pavements is carried out by either testing samples made in the laboratory or testing field compacted samples in the laboratory. The effect of the addition of rubber on rutting, cracking, strength, and pavement deterioration with time was evaluated by laboratory testing. A summary of the laboratory performance of rubber-modified pavement is shown in table 1.

Table 1: Effect of rubber modification on pavement performance.

Performance indicator	Test/Method	Study Reference	Performance vs. Control Materials
Rutting	Hamburg wheel track	Chen et al. [2]	+
Low temperature and fatigue cracking	Disc-shaped compact tension and flexural fatigue	Chen et al. [3]	+
Strength and stress distribution	Indirect tensile strength (Discrete element method simulation)	Zhou et al. [4]	-
Fatigue cracking resistance	Linear amplitude sweep	Kocak and Kutay [5]	+
Creep stiffness and m-value	Bending beam rheometer	Chen et al. [6]	+
Rutting	Hamburg wheel track	Jin et al. [7]	+
Rutting	Repeated load permanent deformation	Farina et al. [8]	-

+ better, = equal, - worse

Field Demonstration Projects

Dozens of field projects have been constructed across Michigan to evaluate the performance of rubber-modified asphalt pavements. Such projects can be categorized into two. Projects where samples are obtained from test sections with laboratory analysis assessment and other projects where laboratory analysis is not conducted. The latter usually focuses on the demonstration of the feasibility of using new rubber asphalt technologies in the field. The locations of both types of projects can be found in figure 1. Michigan is one of the most active states in implementing rubber asphalt with dozens of projects statewide.

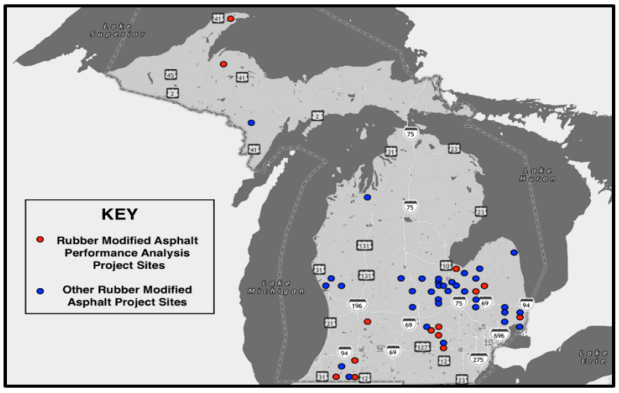

Figure 1: Locations of rubber-modified asphalt project sites in Michigan (courtesy of Resource Recycling Systems, Michigan).

These construction projects have explored pavement preservation, treatment, maintenance, rehabilitation, and construction techniques. In Keweenaw and Muskegon counties, a terminal blended rubber asphalt project with warm mix technology and hot mix asphalt was constructed in 2015. In Dickinson County, a test section was constructed to evaluate the performance of the rubber asphalt mixture for reconstruction in 2019. Another test section was constructed in Muskegon County to study tire rubber asphalt emulsion usage for chip-seal application in 2018. In Kalamazoo County, a hot rubber chip seal project was constructed in 2018. In most projects, the performance of a previously deteriorated road is improved when tire rubber is used in overlay mixtures. A typical example is the 2-inch overlay constructed in Kent County [9] shown in figure 2. The five-lane road was subjected to an average daily traffic (ADT) of 16,500.

Figure 2: Rubber-modified asphalt rehabilitation project in Kent county (courtesy of Kent County Road Commission, Michigan).

Summary

This review summarizes laboratory and field studies of rubber-modified asphalt.

It is observed that the mechanical properties of asphalt mixtures such as cracking, resistance to permanent deformation, and creep stiffness shows an improvement when rubber from waste tires is incorporated into asphalt binders and mixtures. More assessment is underway in order to build all the experience into specifications.

Acknowledgment

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