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Use of Polymer Fiber to Improve Mechanical Properties of HMA Containing Recycled Asphalt Pavement (RAP)

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Introduction

A great percentage of highways and roads in California are constructed with Hot Mix Asphalt (HMA), and as California infrastructure ages, these highways and roads must be maintained and rehabilitated. Recycling highway construction materials offers economic, environmental, and engineering benefits. Reclaimed Asphalt Pavement (RAP) is a strong alternative to virgin materials, reducing landfill waste and conserving non-renewable resources. Using RAP also cuts energy use by minimizing processing and transport of virgin aggregates. However, the performance of HMA containing RAP depends on the percentage of RAP incorporated in the mix. This laboratory study was conducted to investigate the use of commercial polymer fiber in improving the mechanical properties of HMA with RAP percentages ranging between 15% and 40%.

Study Methods

Three Job Mix Formulas (JMF) were provided by two construction companies, namely CalPortland and Granit Construction. The first mix provided by CalPortland utilized 15% of RAP and PG 64-10 binder grade is commonly used in projects on the Central Coast of California. The second and third mixes provided by Granite Construction utilized 25% and 40% RAP content and PG 58-22 binder grade and is commonly used for projects in the Bay Area.

Two polymer fibers that were recently used in a Caltrans maintenance project on State Route (SR) 1 were investigated in this study. These two fibers are named fiber A (wax coated) and fiber B (not coated). Important properties and performance tests were conducted on the aggregate used in the asphalt mix design. The data provided by the two companies included tests performed on aggregate and asphalt binder. Tests on the aggregates measured things such as density, durability, shape (angularity), and clay content. The asphalt binder was analyzed in both its original (virgin) and aged conditions using a dynamic shear rheometer (DSR), which helps assess how it performs under stress. This laboratory study tested the HMA mixes for other key properties, including maximum theoretical density, Hamburg Wheel Tracker (HWT), and the Cracking Tolerance Index (CTI).

Findings

Results from HWT showed that the two fibers performed significantly differently. In general, fiber type B (treated with liquid emulsion) outperformed fiber type A (wax-coated) in enhancing HMA resistance to rutting. For mixes with 15% RAP, adding fibers (regardless of the type) did not seem to improve resistance to rutting as compared with the control mix. However, when increasing RAP content to 25% and 40%, fiber type B enhanced the mixture's resistance to rutting. For mixes with a high RAP content (40%), fiber type B significantly improved the mixture's resistance to rutting. Both types of fibers (A and B) enhanced the mixtures' resistance to stripping, with the number of passes at the stripping inflection point higher than those for the control mix. For mixes with 15% RAP, the addition of fiber at high dosages (0.10% and 0.15%) improved the mixture's resistance to cracking as compared with the control mix. The control mix with 25% RAP group had the lowest CTindex, but fiber additions significantly improved performance, especially with fiber B at 0.15%, indicating a strong response to both fiber type and dosage. For mixes with a high RAP content (40%), resistance to cracking further improved with the addition of fiber B to the mix, particularly at 0.10% and 0.15% dosages. These findings reveal the potential of fiber type B, especially at higher RAP contents and dosages, to significantly enhance pavement durability by improving resistance to both rutting and cracking—key factors in extending the lifespan of roadway surfaces.

This study has shown that adding polymer fibers to HMA mixes containing RAP has the potential to improve mixes' resistance to rutting, moisture damage, and cracking, depending on fiber dosage and type.

Policy Recommendations

- For mixes with 15% RAP, the addition of fiber at high dosages, improved mixture's resistance to cracking as compared with control mix.
- For HMA mixes with 25% RAP, fiber additions significantly improved performance.
- For mixes with high RAP content (40%), resistance to cracking further improved with the addition of fiber the mix, particularly at high fiber dosages.
- More laboratory investigation for mixes with RAP contents of 50% and above is recommended.
- Development of a testing standard or case studies to evaluate the performance of these additives in the field would further benefit asphalt pavement research.
- It is recommended to conduct a life cycle cost analysis as field performance data for these mixes are available.

Overall, the results indicate that adding polymer fibers to HMA mixes containing RAP has the potential to improve mixes' resistance to rutting, moisture damage, and cracking, depending on fiber dosage and type. This study offers information valuable to the maintenance and rehabilitation of critical transportation infrastructure.

About the Author

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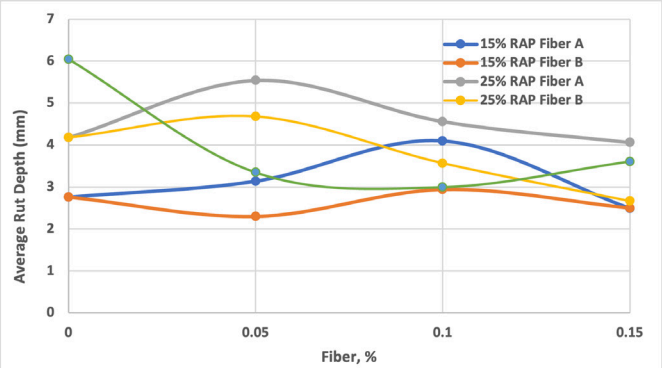
Average rut depth vs. fiber content for mixes with different RAP contents



To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/2462

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