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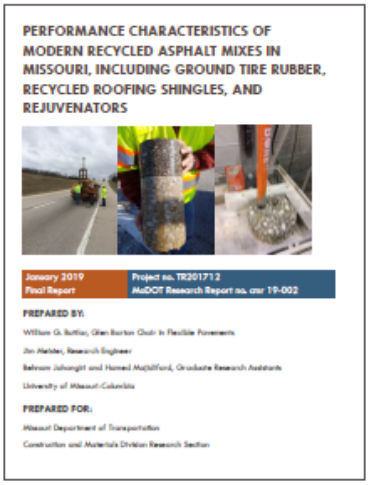
Research Summary

Performance Characteristics of Modern Recycled Asphalt Mixes in Missouri, Including Ground Tire Rubber, Recycled Roofing Shingles, and Rejuvenators


PERFORMANCE CHARACTERISTICS OF MODERN RECYCLED ASPHALT MIXES IN MISSOURI, INCLUDING GROUND TIRE RUBBER, RECYCLED ROOFING SHINGLES, AND REJUVENATORS

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PREPARED BY:

PREPARED FOR:

A comprehensive lab and field investigation was carried out to evaluate the performance of recycled asphalt mixtures in Missouri by researchers at the University of Missouri-Columbia, in collaboration with the Missouri Department of Transportation. Sixteen field sections were evaluated, including a number of sections from the recent Long-Term Pavement Performance (LTPP), Special Pavement Sections (SPS-10) project in Osage, Beach, MO, which was constructed in 2016.

Good and poor performing sections dating back as far as 2003 construction were sampled and tested. Binder testing and mix performance tests were carried out on field cores and laboratory compacted specimens. The study focused on medium traffic volume Superpave mixes. Additional funding was also provided by the Midwest Transportation Center (MTC), which is headquartered at Iowa State University.

This allowed additional advanced laboratory tests to be carried on mixtures having three distinct preparation methods, including field produced - laboratory compacted (reheated plant mix), field cores, and field sampled mixture components – laboratory prepared. In addition to a full suite of Superpave binder testing, including continuous grading and multiple stress creep and recovery, an extensive suite of asphalt mixture performance tests was carried out. This suite included Hamburg wheel track testing (submerged), disk-shaped compact tension, or DC(T) fracture testing, semi-circular bend (SCB) crack testing using the Illinois 'iFIT' procedure, the IDEAL cracking test, indirect tension creep, and DC(T) creep.

A total of 18 sections were sampled and tested, including 4 heavily sampled projects ('level 1' sampling). Field performance data for the 5 oldest sections was collected from MoDOT online PASER rating system, including ARAN video logs, which were used to delineate thermal cracks from block cracks.

Based on the findings of the study, the following **conclusions** were drawn:

(1) Missouri's practices for the responsible and effective use of recycled materials is sound, and continues to improve over time - recent mix designs demonstrate more appropriate balancing between recycled material levels and virgin binder selection, resulting in better performance tests results when compared to older recycled mix designs;

(2) Opportunities exist for further improving recycled mix design methods and recycling optimization in Missouri, including (a) Moving to higher ABR levels, by implementing mixture performance tests (balanced mix design); (b) Increasing the use of recycled ground tire rubber (GTR) in Missouri mixes, by using balanced mix design to certify mixes using new, more economical GTR recycling methods, and; (c) Researching the use of recycled materials in stone-mastic-asphalt (SMA) designs;

(3) The Hamburg-DC(T) plot can be used to quickly and effectively design and adjust recycled mixtures to meet rutting and cracking performance requirements;

(4) A very good performing field section was identified and tested in this study (US54_7). This section has performed very well after 15 years in service, and still has low roughness (IRI=53), low rutting (3 mm) and a high PASER rating (7/10). This, along with performance of the other 4 test sections, tended to validate the recommended long-term aged DC(T) minimum threshold of 400 J/m^2, while the I-FIT results appear to suggest a threshold of around 1.0 for long-term flexibility index;

(5) Most mixes exhibit sufficient 'total' energy to pass Hamburg and DC(T) recommended criteria without major changes in the aggregate structure, recycling level, or binder cost - the use of a softer virgin binder grade will likely suffice.

Based on the conclusions, the following **recommendations** are suggested:

(1) More work is needed to further evaluate and fine-tune mix performance tests for use in balanced mix design, which is particularly important for modern, heterogeneous recycled mixes. This should include: (a) Sampling and testing of additional field sections; (b) Developing a reliability-based approach for setting performance test thresholds; (c) Considering adjustments to the Hamburg test to make it more performance based and climate based; (d) Working to improve the streamlining of and repeatability of mixture performance tests, and determining which tests are most appropriate for design, quality control, and quality assurance; (e) Working towards a Performance Design approach for balanced mix design, where performance testing is given priority over mix volumetrics;

(2) More work is needed to evaluate GTR recycling, especially some of the new dry process techniques that are more economical, and more contractor friendly, and;

(3) A better physical understanding of recycling physics (including micromechanics) and chemistry is needed in order to arrive at even higher recycling amounts in a confident manner.

"Missouri's practices for the responsible and effective use of recycled materials are sound and continue to improve over time."

Project Information
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