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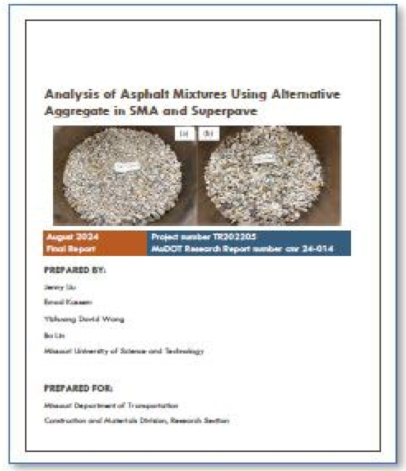
Research Summary


Analysis of Asphalt Mixtures Using Alternative Aggregate in SMA and Superpave

August 2024
Final Report

Project number TR202205
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PREPARED BY:

PREPARED FOR:
Missouri Department of Transportation
Construction and Materials Division, Research Section

Analysis of Asphalt Mixtures Using Alternative Aggregate in SMA and Superpave

Currently, most state highway agencies (SHAs), including Missouri Department of Transportation (MoDOT), require specific aggregates for Stone Matrix Asphalt (SMA) and high-level Hot Mix Asphalt (HMA) mixtures. Meanwhile, to reduce the cost and maintain mixtures' durability, SHAs have been trying to identify locally available, cost-effective, and durable alternative coarse aggregates for SMA and high-level HMA mixes. In this study, a systematic analysis was conducted to identify alterative coarse aggregates that are locally available and durable for SMA and high-level Superpave HMA in MoDOT.

Multiple well-distributed aggregate types were evaluated in this study as alternative coarse aggregate candidates, including traprock (control), chat, gravels, steel slag, limestone, and dolomite. A series of screening tests were conducted, including deleterious materials, Los Angeles (LA) abrasion, aggregate angularity, flat and elongated particles of aggregates, absorption, and sand equivalent. Additionally, the Micro-Deval abrasion test, post-compaction degradation assessment, and soundness tests were also undertaken to assess candidate resistance to polishing, degradation, and freeze-thaw damage, respectively. After the screening tests, SMA and HMA mixtures with qualified candidate aggregates were designed in accordance with the AASHTO R 46 and R35, respectively. Following the volumetric design, performance tests, including the Hamburg Wheel Tracker rutting test (HWTT) and IDEAL-CT cracking tests, were conducted for performance verification. The Balance Mix Design (BMD) method was applied to tune the design candidate if it failed to meet the performance requirements.

After the mix design was completed, a series of performance tests were performed for all mixtures. Performance analysis on both the material and the structural levels was completed. The Life Cycle Cost Analysis (LCCA) was also conducted to evaluate the cost effectiveness of the use of alternative aggregates in SMA and higher level Superpave mixtures.

> *"Mixes with alternative aggregates performed comparably to those with control aggregates."*

This study found that gravel can be utilized as an alternative aggregate in both SMA and HMA, passing the aggregate durability and mixture performance criteria. For limestone and dolomite, the testing results showed that using limestone or dolomite alone as the coarse aggregate in both SMA and HMA mixtures made it difficult to meet the Voids in Mineral Aggregates (VMA) requirement. To resolve this issue, new combinations by blending them with chat were created, which exhibited relatively fine gradation and excellent durability in the screening tests. The mixtures with chat & dolomite and chat & limestone achieved acceptable volumetric properties and promising cracking and rutting resistance. While designing both SMA and HMA with steel slag, the mixtures passed volumetric and moisture susceptibility tests. However, they failed to meet the IDEAL-CT cracking threshold, triggering an adjustment in binder contents. With the adjusted performance optimum binder contents, the SMA and HMA mixtures with steel slag successfully met all requirements for volumetric properties, moisture susceptibility, draindown percentage, workability, and resistances to cracking and rutting. The test results highlighted the significance of incorporating performance tests in the mix design process.

Based on the performance analyses on both the material and pavement structural levels, mixes with alternative aggregates performed comparably to those with control aggregates.

Upon comparing the initial construction cost and net present value (NPV), integrating candidate aggregates as alternatives in SMA and high-quality HMA were considered more cost-effective, while offering comparable performance.

Figure 1: AMPT equipment.

Project Information

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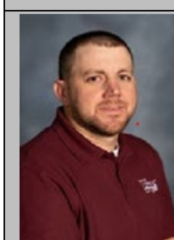

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