Evaluation of Recycled Base Aggregates

Research Objectives

- Compare the performance of hot mix asphalt pavements over crushed stone aggregate (CA), recycled asphalt pavement (RAP) and recycled concrete aggregate (RCA) bases
- Provide guidance for improving performance of pavements with recycled base aggregates

Research Benefits

- Affirmed the performance of RCA and RAP as base course layers as satisfactory and comparable to CA
- Recommended material vetting and construction specifications for improving pavement performance

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Background

Recycled asphalt pavement (RAP) and recycled concrete aggregate (RCA) are materials processed from existing pavements and used in new pavement construction projects. The environmental and economic benefits of reusing waste materials have made RAP and RCA popular in base course applications in Wisconsin for more than 30 years. RAP and RCA have resilient modulus values greater or equal to typical natural aggregates; however, RAP exhibits temperature sensitivities and larger permanent deformation, and RCA may exhibit tufa formation (re-cementation) and potentially lower drainability.

This research sought to compare the performance of hot mix asphalt (HMA) pavements with RAP and RCA base layers to those with crushed stone aggregate (CA) base layers, and to provide guidance on the use of recycled aggregates on base layers to improve performance.

Methodology

HMA pavements with CA, RCA and RAP base course aggregates in 13 counties were identified and subjected to field tests, including: Falling Weight Deflectometer (FWD), Ground-Penetrating Radar (GPR), visual distress survey, pavement surface profile measurement, Dynamic Cone Penetration (DCP) and drainability.

FWD testing on WIS 100 with RCA base layer

Base layer material samples were extracted and subjected to particle size analysis, specific gravity (G_s) and absorption, Micro-Deval (MD) abrasion and hydraulic conductivity.

"This research validates WisDOT's use of recycled materials in base aggregates and provides new quality control measures that will further improve the value of these practices."
– Andrew Zimmer, WisDOT

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WisDOT Research website

Results

The most common pavement surface distresses in the investigated test sections were transverse cracking, longitudinal cracking, alligator (fatigue) cracking and rutting. Fatigue cracking was the most common distress found in surfaces over CA and RAP bases; transverse and longitudinal cracking were the most common distresses found in surfaces over RCA base. Pavement over RAP bases exhibited the smoothest ride quality.

Key material performance findings include:

- CA materials were the coarsest and RAP materials the finest.
- RCA and RAP had smaller gravel-size fractions and higher sand-size fractions compared with CA material; six out of 13 RCA base samples exceeded WisDOT specification limits.
- Pavements over RCA bases exhibited the lowest surface deflections and highest structural capacity.
- Pavements over CA bases exhibited the highest surface deflection and the lowest structural capacity.
- RCA bases had the highest back-calculated layer moduli values and CA the lowest.

Recommendations for implementation

This research affirms the performance of HMA pavements with RCA and RAP base course layers is satisfactory and comparable to the performance of HMA pavements with CA base course layers. The research team recommends WisDOT continue its practice of using RCA and RAP in base course layers of HMA pavements but also implement quality control measures. Source materials should be vetted for origin (RCA preferably from pavement sources), harmful materials (e.g., metal, pavement markings), deleterious materials (e.g., soil, debris), gradation, self-cementing fractions and durability. Base layer construction requirements should be implemented, including lift thickness and compaction.

This brief summarizes Project 0092-17-01,
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