Research Notes

Program Steering Committee (PSC): Pavement

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Title: Using Recycled Materials in Roadway Foundations

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TITLE:
Using Recycled Materials in Roadway Foundations

Better understanding of the properties of recycled materials helps achieve more cost-effective use of resources

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WHAT IS THE NEED?

The pavement layer of a road is supported by layers of aggregate materials consisting of gravel, crushed rock and sand. With these materials being depleted in the United States, the use of recycled materials from pavements that have reached the end of their service lives, such as recycled asphalt pavement (RAP) and recycled concrete aggregate (RCA), is becoming increasingly common. While the current specifications of most state highway agencies allow the use of recycled materials in road foundations, it is not well understood how their properties—including strength, stiffness and sensitivity to climate—will affect performance.

Current design procedures assume that recycled materials have very similar properties to those of typical virgin aggregates. Better understanding of these properties will help in using mechanistic design procedures to predict pavement performance using computer models and ensure that recycled materials are environmentally safe. This pooled-fund study was initiated to address these issues and help establish the properties of recycled unbound pavement materials.

WHAT ARE WE DOING?

Six states, including California, Michigan, Minnesota, Ohio, Texas and Wisconsin, have participated in this pooled fund study, and the Minnesota Department of Transportation (MnDOT) was the lead agency. Principal investigator was Dr. Turner Edil at the University of Wisconsin. Researchers conducted a literature review and a survey of states on the use of RCA and RAP as aggregate base courses. Then they obtained and tested samples from eight geographically diverse states. As a control, they used a conventional Class 5 gradation base course from MnDOT. Researchers conducted numerous laboratory tests on these samples and field tests of test sections to investigate the following properties (for both RCA and RAP, unless specified):

- Grain size distribution, fines content, asphalt content (RAP only), mortar content (RCA only), specific gravity, absorption and impurities.
- Proctor test compaction characteristics, plastic deformation, resilient modulus and the effects on resilient modulus of varying effort of compaction and freeze-thaw cycling. Moduli back-calculated from the cyclical loading of MnROAD test sections were compared to laboratory and field measurements.
- Hydraulic properties for both materials and for RCA, pH and metal leaching characteristics.
- Mechanical properties under different climatic conditions as well as the effects of wet-dry cycling on particle degradation.
- The deflection of various MnROAD aggregate base course materials from 2009 to 2013 via falling weight deflectometer tests, from which moduli were back-calculated.

WHAT IS OUR GOAL?

The objective of this study was to determine how the material properties of recycled materials used in aggregate base layers of roadways affect pavement performance by conducting laboratory tests and monitoring newly constructed field test sections in the MnROAD facility in Minnesota.

WHAT IS THE BENEFIT?

The study provided extensive data showing the properties of recycled paving materials and how they affect pavement performance when they are used in unbound aggregate base layers. Engineers can use the data to achieve more accurate prediction of pavement performance in the design procedures leading to more optimized design with most cost-effective use of resources.

WHAT IS THE PROGRESS TO DATE?

This pooled fund research project is completed and to be closed. Here is a summary of findings.

RAP and RCA pass all necessary standards for being a suitable base course material. They are structurally and mechanically comparable, if not superior, to many natural aggregates. Resilient moduli of RAP and RCA are higher than the natural aggregates used as a control material. Hydraulic properties are also similar or superior to that of natural aggregate, and they withstand the extreme effects of climate very similarly as natural aggregate. It is noted, however, that some RAP may be sensitive to temperature change that may lead to rutting. This aspect needs to be considered in design.