RESEARCH ADMINISTRATION
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Research Spotlight

Project Information

REPORT NAME: Using Recycled Concrete in MDOT's Transportation Infrastructure—Manual of Practice

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Using recycled concrete for sustainable roadways

The use of recycled materials can help reduce the costs and environmental impact of road construction. Care must be taken when selecting materials, however, to ensure that quality and long-term performance of the final product are not compromised. MDOT created a manual for engineers that details applications and methods for successfully incorporating recycled concrete in roadway construction projects.

Problem

To decrease the environmental impact of construction projects, MDOT sometimes uses recycled concrete as a source of aggregate. Called crushed concrete aggregate (CCA), this material is manufactured by removing the broken concrete from the roadway at the end of its service life, and then crushing and processing it into usable CCA.

Although MDOT has used CCA since the 1980s, performance issues in some early projects that used CCA as coarse aggregate in the concrete mixture led the department to limit CCA use primarily to selective applications within the foundational layers beneath the concrete pavement. However, if CCA materials are processed correctly and appropriate accommodations are made in the pavement design, materials handling and construction processes, CCA can be successfully employed in a broad number of applications, helping to save costs and protect the environment.

Pavement demolition equipment such as a multi-head pavement breaker is used to break concrete into manageable fragments. Front-end loaders then haul these fragments to a crushing plant for processing into CCA.

Approach

To help MDOT engineers use CCA successfully in Michigan's transportation infrastructure, researchers developed the *Manual of Practice,* which characterizes CCA for pavement applications. This manual is based on the research report *Efficient Use of Recycled Concrete in Trans-*

(continued)

> *"By focusing on the applications and quality control practices, we can optimize our use of recycled concrete and reduce the negative environmental impacts of road construction."*
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portation Infrastructure that encompasses current nationwide state of the practice on CCA use, as well as MDOT's previous experience and current best practices.

Research

The *Manual of Practice* includes seven chapters that address:

- The processing and production of CCA from existing in situ concrete, including initial characterization of the concrete for recycling suitability, breaking and removal, crushing and sizing, and stockpile management.
- The properties of CCA itself, including physical, mechanical and chemical characteristics as well as typical properties of paving materials incorporating CCA.
- The use of CCA in base layers, asphalt paving layers and portland cement concrete paving layers.

The manual also includes MDOT's standard specifications for construction and special provisions to indicate the department's current usage policies and recommendations regarding CCA.

Results

For all applications, CCA should meet quality requirements similar to those of natural aggregates. The differences that exist between CCA and natural aggregate are largely due to the presence of reclaimed mortar and the mixture of finely crushed particle fractions that could carry high volumes of hydrated cement from the original concrete that may still be attached to CCA particles. Reclaimed mortar also may contain unhydrated cement and chemical contaminants such as deicing salts, which could jeopardize the proper physical and chemical properties of the fresh and hardened concrete. As CCA particle sizes decrease, the relative volume of reclaimed mortar increases so that its influence on the behavior of concrete becomes even greater. For this reason, only coarse CCA particles are commonly used in new concrete mixtures.

CCA performance issues caused by the presence of reclaimed mortar include:

- Increased water absorption caused by the presence of finer particles in reclaimed mortar, which leads to concrete mixtures that may be erratic and less workable for forming and placement during construction.
- Lower specific gravity (density relative to that of water).
- Reduced abrasion resistance, a measure of how well aggregate materials resist crushing, degradation and disintegration, and a factor in the strength of concrete.
- Rogue chemicals and residual hydration products from the original CCA, which can leach into water flowing through a pavement base and leave calcium carbonate deposits that clog the pavement's drainage system.

The manual provides recommendations for mitigating these effects to accommodate CCA in pavement applications, including:

- To ensure workability, limit the use of fine CCA in new concrete mixtures to 30 percent.
- To address lower specific gravity, modify mix designs as necessary.
- To control leaching, refrain from using unbound CCA as a drainable foundation layer.
- Avoid the use of CCA altogether near sensitive environmental areas.
- To limit frost heave, prohibit the use of fine CCA within 3 feet of the subgrade surface of the pavement structure.
- Ensure that the drainage outlets of projects incorporating unbound, open-graded permeable CCA base layers are clean and functioning properly.

Value

Recycling existing deteriorated concrete pavement to create CCA is a cost-effective and environmentally sound approach to minimize waste during construction. MDOT's standard specifications for construction and special provisions offer a number of alternative uses for CCA, giving MDOT engineers a valuable opportunity for improving the sustainability of Michigan's transportation infrastructure.

Research Administration

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