RESEARCH ADMINISTRATION
Bureau of Field Services
Michigan Department of Transportation

Research Spotlight

Soil stabilization with recycled materials improves subgrade performance

The use of recycled materials for subgrade stabilization can provide the support needed for construction vehicle loading and more typical long-term traffic loading. This is a particular need in Michigan due to the prevalence of weak subgrade soils. Using recycled byproducts from manufacturing processes for soil stabilization reduces the impact on landfills and also reduces the cost of strengthening the soil prior to constructing the upper pavement layers.

Project Information

REPORT NAME: Performance Evaluation of Subgrade Stabilization with Recycled Materials

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TOTAL COST: $216,692

COST SHARING: 20% MDOT, 80% FHWA through the SPR, Part II, Program

MDOT Project Manager

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Problem

As much as 40 percent of the land area in Michigan contains problematic soils that need modification to provide sufficient support for construction vehicles (short-term modification) and for regular traffic on completed roadways (long-term stabilization). If these poor soils are encountered on a project site, they must be dealt with prior to construction.

Weak subgrade soils may lead to significant failures under construction traffic loading.

In order to provide the needed strength to these soils, a technique called undercutting—removing the old soil and replacing it with a new material—may be used. Alternatively, a new material with strengthening properties may be mixed in with the current soil. This process, called subgrade stabilization, is well suited to the use of recycled materials. However, research was

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> *"I believe soil stabilization is very viable and can be used in Michigan right now, certainly more than it currently is. Use of certain recycled materials appears to be somewhat effective in the process."*
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> **Mark Grazioli, P.E.**
> Project Manager

needed to evaluate the long-term performance of Michigan soils that have been stabilized with recycled materials.

Research

To gain a better understanding of the Michigan soils, researchers from Lawrence Technological University examined three samples of weak soils commonly found around the state. These soils were classified and subjected to a number of tests in the lab.

The recycled materials used in this study were selected based on their availability in large quantities within the state. They included cement kiln dust, lime kiln dust, fly ash and concrete fines.

Researchers developed a series of mix designs to determine the minimum percentage of recycled material required for stabilization. They then generated pavement design inputs for the mixes.

Finally, laboratory freeze-thaw tests and a limited number of field tests were conducted to determine the long-term durability of the stabilized subgrade mixes.

Results

For all soil types, cement kiln dust and lime kiln dust mixed with fly ash were identified as feasible long-term stabilizers when mixed into the subgrade at rates of between 4 and 12 percent. Fly ash mixed in at 25 percent was also effective as a long-term stabilizer for one of the problematic soils, but it is not recommended for use due to the high application rate required for stabilization.

Fly ash at 15 percent and high-calcium lime kiln dust at 6 percent were effective for some soil types as short-term modifiers to create a working platform for constructing upper pavement layers. Concrete fines and a second type of lime kiln dust—dolomite lime kiln dust—were both ineffective as either long-term stabilizers or short-term modifiers for all three weak soil types.

Finally, a field study of several projects constructed within the last 10 years in which the subgrades were stabilized, some locations with recycled materials, revealed that the stabilized layers successfully retained their strength after hundreds of freeze-thaw and moisture cycles.

Value

MDOT primarily uses the undercutting process for dealing with weak soils found on project sites and has performed very little subgrade stabilization, especially using recycled materials. This study gives MDOT more information about what types of projects might be good candidates for subgrade stabilization. In particular, subgrade stabilization is a global treatment and provides a uniform support throughout the project. Undercutting is a spot treatment and results in variable subgrade support. When the weak soil is spread out in a larger area of the project, stabilization is a better option than undercutting due to uniform support conditions.

Another benefit of using recycled materials for subgrade stabilization is cost. The decision to stabilize the subgrade or to undercut depends on cost, and that cost is determined by the type of material used for stabilization and the percentage of the project area needing treatment. As part of this study, the research team obtained cost data from MDOT bid documents and used those figures to conduct a comparative cost analysis for dealing with weak subgrades.

The researchers found that if only spot treatments are required to remove weak soil, undercutting may be more economical due to the cost of the mixing equipment used for soil stabilization. However, when treating the entire project site, stabilizing the soil using recycled materials is two to three times less expensive due to the high cost of materials used for undercutting.

Research Administration

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This final report is available online at
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