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TRANSPORTATION POOLED FUND PROGRAM

TECHNICAL SUMMARY

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PROJECT COST:
N/A

PARTICIPATING AGENCIES:
IA, MI, MN, ND, NY, WI, FHWA

Mixing cement into subgrade soils increases their stiffness, strength and durability.

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Strengthening Road Foundations with Cement Stabilization

What Was the Need?

To help increase the strength and stiffness of road foundations, many state departments of transportation mix cement or other materials into the soil foundation beneath upper pavement layers. Stabilization is especially important in locations where soils are too weak to provide adequate support for pavements. Other stabilization materials include fly ash (a byproduct of coal burning) as well as asphalt, lime and geosynthetics.

The use of cement stabilization to strengthen road foundations can reduce construction costs by 50 percent by allowing thinner pavement and foundation layers and eliminating the need to haul aggregates long distances when soils are weak.

While MnDOT has used cement stabilization, it does not make use of this practice as commonly as some other states. With other states reporting the benefits of stabilization on their construction projects, research was needed to evaluate the potential benefits in Minnesota. MnDOT was particularly interested in developing a specification on the use of cement stabilization in roadway design since cement is widely available and its environmental effects are better understood than those of fly ash and other materials.

Consequently, MnDOT teamed with the Federal Highway Administration's State Transportation Innovation Council and pooled fund sponsor states to fund research to develop best practices allowing the wider use of cement stabilization in Minnesota.

What Was Our Goal?

The goal of this project was to determine the effects of cement stabilization on pavement design and develop a specification for construction projects in Minnesota. Researchers were also interested in how the use of cement stabilization might provide an opportunity for greater cost-effectiveness. Finally, they set out to clarify the environmental approval process for the use of other potential stabilization materials in subgrade soils.

What Did We Do?

Researchers surveyed members of both pooled fund sponsors and other regional partner states to determine what agencies had developed specifications related to soil stabilization and how they had incorporated soil stabilization into their pavement design.

Researchers then used MnPAVE pavement design software to evaluate how cement stabilization could improve MnDOT pavement design. Because it stiffens underlying soils, cement stabilization might allow for a reduction in the thickness of the engineered soil or other pavement layers, leading to cost savings. This evaluation included a case study of the effects of using cement stabilization near Red Wing, Minnesota, for a project where soils are problematic because of their poor strength and stiffness. Researchers developed three pavement designs: The first did not include the effects of improved foundation soils; the second had an equivalent service life and was based on a lower bound improved stiffness of the foundation soil; the third was based on the expected average improved stiffness of the foundation soil.

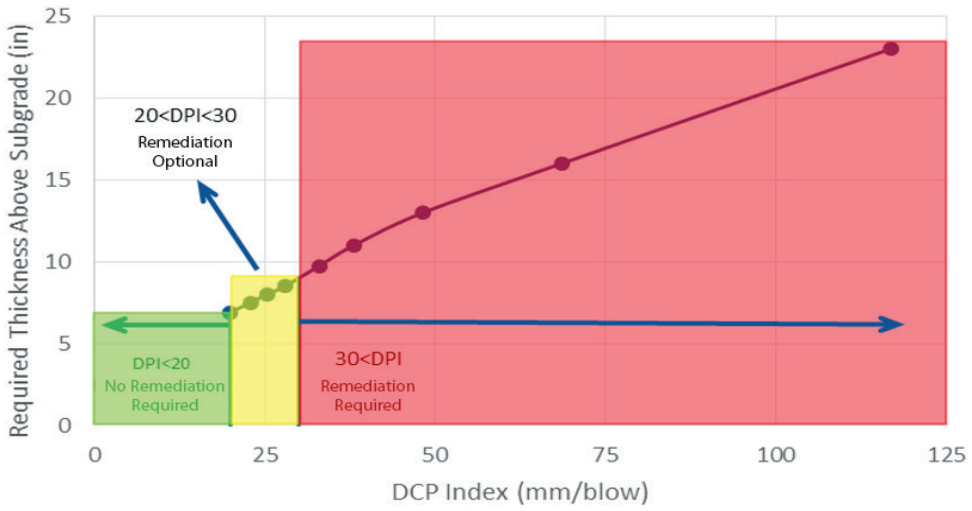
continued

"Many contractors and engineers are eager to make use of cement stabilization. The enhanced methods and specifications being developed by MnDOT will make that possible."

—John Siekmeier,
Research Engineer,
MnDOT Office of Materials and Road Research

"It's cheaper to add cement during soil compaction than to increase asphalt thickness. That makes cement stabilization a great option for building roads that are just as durable at a lower cost."

—Aaron Budge,
Professor, Minnesota State University, Mankato, Department of Mechanical & Civil Engineering



The specification being developed by MnDOT as a result of this project establishes the required subgrade stiffness (as measured by the dynamic cone penetrometer) to be obtained by cement stabilization and compaction.

Researchers also examined Minnesota's environmental approval process for soil stabilization. This included procedures for testing and reviewing new products to ensure they are environmentally safe.

Finally, researchers created a draft specification for implementing cement stabilization in Minnesota projects.

What Did We Learn?

Results show that for some Minnesota soils, the pavement construction savings may greatly outweigh the costs associated with cement stabilization. Cement stabilization can be less expensive than using thicker foundation or pavement layers, or hauling aggregate long distances. In some cases, cement stabilization can reduce costs by more than 50 percent. The Red Wing case study showed that using cement stabilization to increase soil stiffness reduced the required foundation soil thickness by 5 to 7 inches, significantly lowering project costs, especially when quality aggregate base material is not readily available.

Beyond its use in strengthening foundations for new roads, cement can also be used for upgrading gravel roads or rehabilitating existing roads. Cement also expedites construction. Additionally, devices for measuring pavement strength and stiffness in the field, such as the lightweight deflectometer and dynamic cone penetrometer, can be used to monitor the gain in stiffness and strength as curing occurs.

The draft specification developed in this project aids in identifying which projects may benefit from cement stabilization along with how the projected soil improvement should be accounted for during the design phase.

What's Next?

MnDOT will modify the draft specification developed in this project. It is anticipated that the final procedures will be included in MnDOT's design manuals and specifications. MnDOT is also planning to use cement stabilization on a project in 2016.

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This Technical Summary pertains to project TPF-5(215), "Best Practices for Soil Stabilization Design and Construction," completed September 2015. Information about the pooled fund project under which the research was performed can be found at www.pooledfund.org/Details/Study/443.