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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

Technical Liaison:
Bruce Tanquist, MnDOT
Bruce.Tanquist@state.mn.us

Project Coordinator:
Bruce Holdhusen, MnDOT
Bruce.Holdhusen@state.mn.us

Principal Investigator:
John Siekmeier, MnDOT
John.Siekmeier@state.mn.us

PROJECT COST:
$50,000

Crews unroll geogrid in the field.

Geogrids Increase Aggregate Base Stiffness

Researchers used field and lab stiffness testing and improved software to model pavement base course performance with and without geogrids. Results showed that geogrids improve pavement base stiffness. A geogrid format commonly employed in Minnesota can now be used in MnPAVE Flexible design procedures to estimate its benefit in particular pavement designs.

What Was the Need?

Soft subgrades put road designs to the test. When the ground below the structure is soft, pavements may experience cracking, rutting and other types of failure.

One response to this challenge is to build a stiffer pavement foundation to prevent damage to the pavement structure. For about 20 years, Minnesota road designers have used geogrids to improve aggregate base performance over soft subgrades. Usually placed beneath or between aggregate base layers, these geogrids stabilize base courses and help prevent damage. Some of these installations involve full-depth reclamation, where the existing pavement is milled and used as aggregate base for new asphalt pavements. This type of base course is designed to desired performance levels, making it a strong candidate for stabilization enhancements like geogrids.

In recent years, MnDOT's MnPAVE Flexible pavement design software has incorporated a mechanistic-empirical pavement design methodology, which allows for more accurate prediction of pavement performance based on design characteristics. The mechanistic properties of geogrids, however, had not been determined for use in MnPAVE. Engineers knew from experience that geogrids improve performance over soft subgrades, and they widely believed it was because geogrids improve base stiffness, but designers did not have the inputs necessary to include a geogrid's structural contributions in MnPAVE's design protocols.

What Was Our Goal?

This research sought to quantify the performance benefits of geogrids in pavement structures over soft soils. Researchers combined field and lab testing with sophisticated modeling to identify the extent to which a geogrid improves structural stiffness, so that its benefit can be assessed by designers constructing or reconstructing roads over soft subgrades.

What Did We Do?

In spring 2013, falling weight deflectometer testing by Braun Intertec on Trunk Highway (TH) 11 and TH 72 near Bemidji enabled researchers to compare the surface deflection of roadways with geosynthetics to that of roadways without geosynthetics.

In 2014, MnDOT contracted with Itasca Consulting Group to enhance one of Itasca's modeling software packages so that MnDOT could use it in concert with MnPAVE Flexible to estimate the increased stiffness of geogrid-reinforced aggregate base.

Researchers then used this improved software and MnPAVE to numerically model the mechanistic contributions of geogrids. The modeled geogrid was based on a biaxial polymer grid with 0.5-inch square apertures, a type of geogrid often used in Minnesota.

continued

"This modeling work shows that geogrids give more stiffness to the pavement structure. It validates what we're already doing. In some cases, we may be able to use less asphalt once we have implemented these results into our pavement tools."

—Jim Bittmann,
Materials Engineer,
MnDOT District 2

"The performance of geogrid-reinforced roadways demonstrates that geogrids provide value, but until now there hasn't been a way to quantify that benefit in pavement design. This project put numbers on a process that we're already carrying out."

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

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Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research

Sandwiched between aggregate base layers, geogrid matting stabilizes and stiffens aggregate base courses, strengthening pavement over soft subgrades.

What Did We Learn?

Falling weight deflectometer tests had shown that geogrids generally reduce pavement deflection. However, the structural benefit of geogrids was difficult to quantify because of variability in in-situ soil layers, in the thickness of recycled aggregate base and in the material properties of full-depth reclamation.

The Itasca software enhancements improved MnDOT's ability to extend laboratory testing to recycled aggregate bases containing geogrids. Drawing on laboratory and field testing and on the improved software, researchers modeled geogrid-enhanced base courses for pavement use. Findings included:

- Geogrids improve aggregate base resilient modulus, a mechanistic measure of stiffness.
- Geogrids provide lateral restraint to aggregate base through interlocking of aggregate and friction between aggregate and a geogrid.
- Aggregate base gradation, roughness, moisture content and porosity affect the performance of aggregate bases enhanced with geogrids.
- The improved analytical process provides mechanistic behavior models for aggregate-geogrid interaction that support reducing aggregate thickness for base courses enhanced with geogrids.

By improving aggregate base stiffness, geogrids extend pavement life. This benefit varies during the year due to moisture and seasonal effects. By including seasonal effects during design, designers can more accurately estimate fatigue and rutting over the expected life of the pavement.

What's Next?

Researchers are working to develop a simple table of geogrid gain factors that can be used to adjust pavement designs in projects using geogrids. This gain factor, expressed as a simple ratio, can be used to calculate aggregate base needs during design, with the expectation that in certain circumstances the use of geogrids can reduce the required aggregate base thickness. Geogrid gain factors are expected to be implemented into MnPAVE Flexible software.

This Technical Summary pertains to Report 2016-24, "Geogrid Reinforced Aggregate Base Stiffness for Mechanistic Pavement Design," published July 2016. The full report can be accessed at mndot.gov/research/TS/2016/201624.pdf.