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Quantifying the Effect of Geogrids in Asphalt Pavement Foundation Layers

LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

Questions?
Contact research.dot@state.mn.us.

Technical Liaison:
Michael McCarty, City of Mankato
MMcCarty@mankatomn.gov

Investigators:
Vernon Schaefer and Charles Jahren,
Iowa State University

David White,
Ingios Geotechnics, Inc.

PROJECT COST:
$197,339

Added between pavement layers, geogrid increases the strength and durability of a finished road.

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

What Was the Need?

Soft soils can present a variety of challenges for road designers and builders. When roads are constructed without a sufficiently strong subgrade foundation, traffic loads and other stressors can cause asphalt, or flexible, pavements to crack and show premature distress. However, creating this strong base can mean excavating deeper and replacing the soft soil with aggregates, which adds both time and cost to a project.

For decades, geogrids have offered a solution in Minnesota. When placed between pavement layers during construction, this synthetic material stabilizes the aggregate base and creates a snowshoe effect on soft soils, distributing a load over a larger area. Using geogrids adds structural reinforcement and extends the life of asphalt pavements.

In 2015 MnDOT issued guidance on the structural capability of geogrids, indicating that a layer of geogrid offers the same reinforcement power as 2 inches of the aggregate base material typically used in the state. Since that time, advancements in technology suggest the material may be stronger and able to displace more aggregate than previously thought.

By calculating just how much strength and durability geogrid material can add to an asphalt pavement and integrating the findings into MnDOT's design software, researchers sought to provide engineers with information and resources that will make it easier to decide whether to use geogrids in road construction projects.

What Was Our Goal?

Through field and laboratory tests, the research sought to evaluate the short- and long-term benefits of using geogrids in asphalt pavements, as well as identify where in the pavement's layers geogrids should be placed for maximum effect. An additional objective was to develop a module for MnPAVE, MnDOT's flexible pavement design computer program, that would allow engineers across the state to easily incorporate geogrids into pavements designed according to MnDOT specifications. With a more accurate understanding of what geogrids can do and where and when they offer the most benefit, local transportation agency engineers will be better-equipped to design an effective pavement solution for their projects' individual circumstances and budget.

What Did We Do?

Researchers began by reviewing the published literature documenting the reinforcement capabilities of geogrids.

Next, partnering with a geotechnical engineering firm, the researchers conducted a series of laboratory tests to investigate how geogrids affect pavement performance in a controlled environment. Using four types of proprietary geogrid material—light- and heavy-duty biaxial (square-patterned) and light- and heavy-duty triaxial (triangle-patterned)—the tests simulated vehicle loads with custom, state-of-the-art equipment.

Then, the teams collaborated to evaluate the same geogrid materials under realistic conditions. Constructing 10 sections of roadway, the researchers used heavy machinery to subject each site to a variety of stress tests while gathering data and assessing performance.

Finally, the research team outlined how MnDOT could incorporate the findings with its MnPAVE design software.

continued

"Thanks to this project, engineers and design professionals across the state will have another tool they can use as they make road design decisions in their area."

—Michael McCarty,
Assistant City Engineer, City of Mankato

"Aggregate is expensive and in short supply. This project showed how geogrids can be used to reduce the need for aggregates in road construction to save time and money while increasing the long-term performance of the pavements."

—Vernon Schaefer,
Professor, Iowa State University Department of Civil, Construction and Environmental Engineering

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Minnesota Department of Transportation
Office of Research & Innovation
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research

The synthetic geogrid material comes in rolls, allowing the material to be easily placed over an aggregate subgrade.

What Did We Learn?

The research showed that because a number of variables affect how a geogrid performs in the finished pavement, less aggregate may be needed for some projects, depending upon local site conditions and other factors. As asphalt pavements are a product of layering, the success of the final result ultimately depends upon the thickness and quality of each component layer. The depth of the subgrade, amount and size of aggregate, type of geogrid, its position in the structure and the surface asphalt mixture all contribute to a successful finished pavement.

Researchers offered some general design observations, including the following:

- Triaxial geogrids perform better than their biaxial counterparts, but they are also more expensive and less economical for use in pavements.
- Biaxial light-duty is the most economical geogrid for use in pavements followed by triaxial light-duty geogrids.
- Geogrids provide the most reinforcement when located at the center of a thick base layer.
- For typical road sections with a base of 10 inches, both light-duty biaxial and light-duty triaxial geogrids can be positioned at the bottom of the base layer.
- For roadways with thin base layers, light-duty biaxial geogrids should be used and placed at the bottom of the base layer.

What's Next?

This research provided much-needed clarity regarding when and where geogrids can be used effectively in flexible pavement construction projects. Each day across the state, local road designers and engineers consider a variety of factors as they weigh which materials and methods to choose for projects in their community.

With the objective data from this study in hand, these stakeholders will be able to more accurately estimate a geogrid's true costs and benefits, leading to better-informed decisions about whether and where they can offer the most value.

This Technical Summary pertains to Report 2021-26, "Effectiveness of Geotextiles/Geogrids in Roadway Construction; Determine a Granular Equivalent (GE) Factor," published November 2021. The full report can be accessed at mndot.gov/research/reports/2021/202126.pdf.