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TECHNICAL SUMMARY

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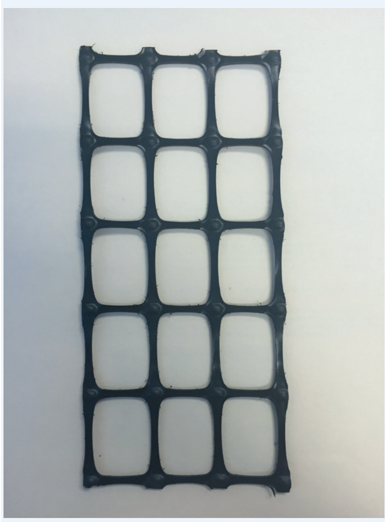
PROJECT COST:
$40,000



Simple, rectangular-shaped geogrid stabilizes aggregate and improves pavement resiliency.

Modeling Demonstrates Benefit of Geogrid-Reinforced Aggregate Base

Improved modeling of geogrid for use with MnPAVE Flexible allows designers to simulate field tests of stiffness and resiliency in pavements over bases with and without geogrid. MnDOT is using modeling results to develop a design input that quantifies the benefit of geogrid in terms of pavement service life and aggregate thickness.

What Was the Need?

Many highways in Minnesota are built upon soft subgrades. These weak subgrades lower the roadway pavement life. In the past, timber and cement have been used to stiffen pavement foundations with mixed success. However, for the last 20 years, geogrids have been shown to be a beneficial and cost-effective method to stiffen the existing pavement structure.

Geogrid is a stiff polymer webbing with apertures that interlock with aggregate in the base. The material is placed within the new or reclaimed aggregate base, usually two-thirds the distance from the top of the base. After the remaining aggregate is placed, the road is paved with either asphalt or concrete.

Geogrid increases the stiffness of the aggregate base layer by locking aggregate in place for improved resilience. Though the benefit of geogrid has been observed in the past, it was not quantified for pavement design purposes, and designers were not able to include the properties in their calculations when designing a pavement. Geogrid was sometimes seen as an extra expense with no calculated benefit.

A 2016 study was also tasked to quantify the benefits of geogrid in mechanistic design, but deflection testing results were inconclusive and did not support a reliable design factor for geogrid use in aggregate base.

What Was Our Goal?

MnDOT pavement designers requested a model to show how using geogrid in the roadway base impacted pavement life. Researchers used new software to evaluate geogrid behavior in different design permutations and to quantify its benefit to pavement performance using MnDOT's pavement design software, MnPAVE Flexible.

What Did We Do?

The updated software was used to expand the geogrid modeling capability and test modeled nonreinforced and geogrid-reinforced bases. Research began by identifying geogrid parameters useful in modeling and as inputs to MnPAVE. Investigators worked with a geogrid manufacturer to specify and code the physical characteristics and properties of triaxial geogrid (with triangular-shaped apertures) used in the field for modeling.

Researchers then worked closely with a software developer to refine modeling capabilities, expanding on previous work that focused on biaxial geogrid (with rectangular-shaped apertures) to include triaxial geogrid, and to model behavior of geogrids in variable parameters for geogrid and aggregate.

Geogrid and aggregate models were tested extensively, adjusting geogrid and aggregate characteristics and simulating dynamic cone penetrometer (DCP) and light weight deflectometer (LWD) tests. Researchers collected numerical modeling results on geogrid

continued

"This innovative study will be especially beneficial for designs in areas with poor subgrade. We worked closely with the geogrid manufacturer to develop codes that accurately simulate geogrid behavior in a pavement."

—Bruce Tanquist,
Pavement Computer Applications Engineer, MnDOT Office of Pavement Design

"We were asked to quantify the benefit of geogrid. It is important to keep the aggregate layer thick for benefits like drainage, so it's important to know that we were getting extra years of life with geogrid-reinforced aggregate base."

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

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Geogrid is placed between layers of aggregate to stabilize the aggregate layers and improve pavement strength.

and aggregate performance to use with MnPAVE design software and to develop design factors that quantify the impact of geogrid on pavement performance.

What Did We Learn?

Field testing from previous research was insufficiently detailed because it did not include specific pavement structure and subgrade conditions below each deflection-tested location. Additionally, lab testing, which evaluated geogrids by testing their behavior within 6-inch by 12-inch cylinders, did not correlate well with the dimensions and shapes of field geogrid installations.

Effective modeling aids in quantifying the benefits of geogrids. The modeling developed in this research effectively began to bridge the gap between field and lab examination by testing forces in 1-foot-square models with 4- to 12-inch aggregate thicknesses, which is more appropriate for estimating geogrid and aggregate behavior in the field.

New modeling capabilities allow testing of various parameters, including geogrid aperture dimensions and configurations, the thickness and shape of geogrid ribs, aggregate roughness and gradation, and moisture content. Test simulations of geogrid and aggregate configurations run for hours or days, and model a wide range of behaviors to capture reliable data from DCP and LWD tests of stiffness, resilience, and strength of bases with and without geogrids.

Test results showed that depending on moisture content and the time of year, bases reinforced with geogrids offer 1.5 to 2.5 times the resiliency under loading compared to nongeogrid-reinforced bases.

What's Next?

Investigators are working with MnDOT designers to codify a geogrid factor in MnPAVE that determines the improved service life or the aggregate thickness equivalent that geogrid provides to aggregate bases in pavements. The geogrid factor could be incorporated early in 2019.

Further research could include comparing modeling results to LWD and DCP field test results of new pavements with geogrid-reinforced aggregate bases. Such implementation and site testing could continue with new pavement installations to collect data to confirm or calibrate geogrid design factors and geogrid modeling for MnPAVE.

This Technical Summary pertains to Report 2018-30, "Performance Specification for Geogrid Reinforced Aggregate Base," published October 2018. The full report can be accessed at mndot.gov/research/reports/2018/201830.pdf.