Research Brief

Wisconsin Highway Research Program
Project 0092-19-06
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Comparison of ASTM Standards for the Evaluation of Geogrid Strength

Research Objectives

- Assess and compare test methods ASTM D4595, ASTM D6637 and ASTM D7737 for determining geogrid tensile strength
- Determine minimum standard guidelines based on ASTM D6637 and ASTM D7737
- Provide recommendations to WisDOT on geogrid tension strength values for implementation in geogrid specifications

Research Benefits

- Concluded ASTM D6637 more accurately and consistently represents the tension strength of geogrid materials than ASTM D4595.
- Recommended average minimum tension strength for accepting geogrids in WisDOT projects
- Recommended sampling from both edges and center of geogrid rolls to reduce variability in testing

Principal Investigator

Rani El Hajjar
University of Wisconsin - Milwaukee
elhajjar@uwm.edu

Project Manager

Andrew Zimmer
WisDOT
andrew.zimmer@dot.wi.gov

Background

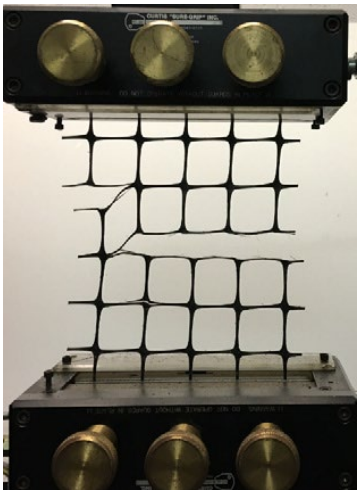
Geogrids are grid-patterned geosynthetic materials used to reinforce soils, retaining walls and other structures. Geogrids interlock with soil, providing stabilization through tension in the ribs and junctions.

Geogrid material and aperture shapes vary by manufacturer, and there are multiple test methods for determining strength. WisDOT currently uses ASTM D4595, which was originally developed for geotextiles, a different type of geosynthetic. ASTM D6637 Method B has gained popularity, as agencies and producers have found it more representative of geogrid structure and observed load redistribution. The objective of this study was to assess and compare test methods ASTM D4595, ASTM D6637 and ASTM D7737 for determining geogrid tensile strength.

Methodology

The research team investigated the application of ASTM D4595, ASTM D6637 (methods A and B) and ASTM D7737 on 987 geogrids specimens taken from 31 geogrid rolls from nine manufacturers supplying WisDOT projects. Specimens were primarily biaxial types, but also included uniaxial and triaxial types.

Specimens for the ASTM D4595 are eight inches tall and at least eight inches wide; this method does not take into account the number of ribs per specimen. ASTM D6637 – Method A measures six single-rib specimens at least eight inches long from junction to junction. ASTM D6637 – Method B is a multi-rib test, where specimens must have five parallel ribs eight inches or greater in length in the direction in which the specimen is going to be tested. ASTM D7737 tests a single junction in isolation from the ribs. In each test, tensile loads are applied until rupture to determine strength.



A biaxial geogrid ruptures during ASTM D6637 Method B testing.

"This research will allow WisDOT to transition to testing geogrids via method ASTM 6637 and revise our specifications accordingly."
– Andrew Zimmer, WisDOT

Interested in finding out more?

Final report is available at:
WisDOT Research website

Results

Current WisDOT specifications based on ASTM D4595 standard procedure require geogrid tension strength at five percent elongation to achieve a minimum average of 450 lb/ft for both machine and cross machine direction. Based on statistical analysis results, 3.6 percent of geogrid specimens will not pass the current WisDOT tension strength specifications (based on ASTM D6637), and 2.77 percent of geogrid specimens will not pass the corresponding tension strength threshold based on ASTM D6637 Method B.

Results show ASTM D6637 results in less scatter in tension strength compared to ASTM D4595, with the strength at five percent elongation yielding consistent results and accounting for the material nonlinearity. ASTM D6637 Method A tracks the results with ASTM D6637 Method B when ultimate strengths are used, but not when using five percent elongation, which complicates correlation between the two methods. Method A also does not capture variability in aperture sizes.

Statistical analysis conducted on biaxial tension strength test results at five percent elongation, including the use of Monte Carlo simulations based on ASTM D4595 and D6637 Method A and Method B, exhibit a lognormal distribution. A simulation using 10,000 geogrid tension tests showed consistency between lognormal distribution, based on the actual test results and simulated test results for both methods.

Junction strength from ASTM D7737 showed consistently favorable junction strength compared to rib tension strength ASTM D6637 in all test specimens examined.

Recommendations for implementation

The research team concluded that ASTM D6637 more accurately and consistently represents the tension strength of geogrid materials, with less variability and more accuracy across the roll, than ASTM D4595. The team recommends an average minimum tension strength of 500 lb/ft for biaxial geogrid in both machine and cross machine directions based on ASTM D6637 Method B for accepting geogrid in WisDOT projects for subgrade improvement and stabilization and base reinforcement.

Variability in tension strength of a geogrid roll can be captured by sampling from both edges and center of the roll. While weight per unit area of the geogrid can be correlated to the tension strength, it is not recommended that the weight per unit area be used as a criterion for geogrid material selection to indicate tension strength. Variability in machine and cross-machine direction showed the importance of testing both directions.

This brief summarizes Project 0092-19-06,
"Comparison of ASTM Standards for the Evaluation of Geogrid Strength"
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