PROJECT SUMMARY REPORT

0-6834: Optimization of the Design of Flexible Pavements with Unbound Bases Reinforced with Geogrids using APT

Background

Geogrids are used within the base or as a subgrade/base interface layer for enhancing the performance of flexible and rigid pavements. While there has been significant use, particularly in Texas, of geogrid-reinforced pavements, limited research has dealt with the methodologies of quantifying their influence on pavement performance. In the state of Texas, while extensively used for environmental loads, limited work has been done on the development of design procedures against traffic loads for pavement structures containing geogrids. Therefore, significant benefits to TxDOT will result from modifying its design procedures built into FPS-21 program to consider geogrids' contribution to the performance of reinforced flexible pavements.

Geogrid reinforcements are often selected based on the manufacturer's recommendations without a validated test method to evaluate the efficiency of the reinforcements for different conditions and designs. The specifications established by DOTs nation-wide, including TxDOT, to select geogrids involve the conventional characteristics of geosynthetics which are tested in isolation (i.e. without involvement of surrounding soil) or for failure conditions (i.e. large displacements). However, the performance of the geogrid reinforcements in the granular base layer is governed by interaction between geogrid and surrounding soil under small displacements. The index parameter KSGI from the soil-geogrid interaction test, captures exactly the performance under these conditions (small displacements and confinement). While the KSGI values show a positive correlation to the performance of actual field sections under environmental loading, further validation of these results needs to be conducted under traffic loading. The validated results will help TxDOT establish the geogrid selection guideline based on actual mechanisms involved in the geogrid reinforcement of base layer.

What the Researchers Did

After an extensive literature review of all relevant domestic and foreign literature on geosynthetic-reinforced pavement systems, with emphasis on accelerated pavement testing techniques, the team decided to pursue a reduced-scale accelerated pavement testing program, supplemented with field performance data from reinforced pavement sections under traffic loading, to meet the project's objectives.

The researchers then built several unreinforced and reinforced reduced-scale pavement sections of different configurations with different materials in a controlled-environment laboratory. The sections were instrumented with pressure sensors, particle displacement tell-tales and geogrid displacement tell-tales. Other in-house instrumentations were developed to measure the performance of the various test sections under tracking wheel loads.

Each test section built, was trafficked with the MMLS up to 0.5" of rutting or 100,000 cycles whichever came first. The research team studied the progression of pavement distresses, especially rutting, with the number of wheel passes, as well as particle displacement and pressure distribution data.

The relative performance of the various configurations of the reinforced sections were evaluated with their respective counterparts. Traffic Performance Ratios such as the Traffic Benefit Ratio, Rutting Reduction ratio and particle displacement levels were summarized.

Lastly, these results were compared with the KSGI

Research Performed by:
Center for Transportation Research

Research Supervisor:
Dr. Jorge Zornberg CTR

Researchers:
Subu Sankaranarayanan
Hossein Roodi

Project Completed:
08-31-2018

values obtained from the soil-geogrid interaction tests and correlations were found. These correlations were then used to develop design procedures by modifying the performance equation built into FPS-21. Several approaches were adopted in modifying the performance equation and the best approach was identified.

What They Found

The researchers found that the geogrid-reinforced pavement sections performed significantly better than their unreinforced counterparts both in the reduced-scale laboratory sections and in the field. The performance of the reinforced sections was found to be a function of the type of geogrid used, properties of base material used, location of the geogrid in the base material and the stiffness of the subgrade materials.

The researchers identified that the traffic benefit ratio of the reinforced section with a particular geogrid is directly linearly correlated to the KSGI value of the geogrid with the base material.

They also found that the most optimum location of the geogrid within the base layer is that location where the horizontal tensile strain is maximum in a linear elastic analysis. However, the zone of influence of the geogrid also governs the maximum allowable depth of placement of a geogrid within the base layer.

To modify the FPS-21 to enable design of flexible pavement systems with geogrid- reinforced base layers, the approach to modify the modulus of the zone of influence in the base layer was found to be best suited. It was noted that three correction factors were involved, namely correction for base material – geogrid composite interaction stiffness, correction for location of geogrid and correction for subgrade stiffness.

What This Means

The index parameter obtained from the soil-geosynthetic interaction test (KSGI) is a unique parameter that can be used directly in the design of geogrid reinforced pavement structures. Thus, a single parameter, that can be used in both the design of geogrid reinforced pavements and hence, in the selection of geogrids for the same has been identified.

The existing design procedure for the design of flexible pavements built into FPS-21 can be directly adopted for the design of geogrid reinforced pavements, subject to the modifications recommended by the research team.

Upon validation of these modifications in the full-scale APT program and using field section performance data, they can be adopted into FPS-21 for the design of flexible pavements with geogrid-reinforced base layers.

For More Information

Project Manager:
Chris Glancy, RTI Chris.Glancy@txdot.gov

Research Supervisor:
Jorge Zornberg, CTR zornberg@mail.utexas.edu

Project Monitoring Committee Members:
Boon Thian, Brett Haggerty, Jimmy Si, Miguel Arellano, Richard Izzo, Richard Williammee, Jr., Wade Blackmon

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research

Technical reports when published are available at
https://library.ctr.utexas.edu.