Texas Department of Transportation

CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY REPORT

5-4829-05: Implementation of Geosynthetic-Stabilized Roadways for Base Course Reduction: Field Monitoring and Design Recommendations

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. Evaluation of unbound aggregate layers stabilized with geogrids in full-scale field test sections would offer key insights and provide significant benefits to TxDOT in terms of modifying its design procedures (built into FPS-21 program) to consider geogrids' contribution to the performance of stabilized flexible pavements.

In addition to evaluating the performance of stabilized test sections over the life of the pavement through the measurement of pavement distresses such as rutting and cracking, instrumentation of the test sections with sensors capable of capturing the internal dynamic response of the pavement layers to vehicular traffic and impact loads such FWD would provide valuable information to predict the test section performance well in advance of the onset of any pavement distress. Further, the information regarding the changes in stresses and strains within the pavement section with or without stabilization due to various loads (traffic, impact, and environmental) would provide a means of determining the mechanisms involved in the stabilization of the base with geogrids. This will facilitate the development and validation of a mechanistic design procedure, as opposed to the commonly adopted empirical procedures involving benefit ratios.

What the Researchers Did

After an extensive literature review of relevant domestic and foreign literature on geosynthetic-stabilized pavement systems, with emphasis on instrumented test sections, the team decided to pursue a full-scale field test section based program, supplemented with instrumentation of those test sections to determine the pavement response to traffic, impact and environmental loading, to meet the project's objectives.

The researchers identified several potential candidate test section locations and chose the final location based on bore-hole data showing uniformity of the subgrade. Since the project involved the full depth rehabilitation of flexible pavement, this facilitated the researchers in instrumenting the chosen test sections from the bottom-up. The sensors installed included moisture sensors in the subgrade, linear potentiometers, soil extensometers, and thermistors in the base, asphalt strain gauges, and thermocouples in the HMA layer, and geophones within each layer of the pavement section. The pavement layers were characterized in-situ through various stiffness testing devices such as the Geogauge, Light Weight Deflectometer (LWD), static Plate Load Test (sPLT), Dynamic Cone Penetrometer (DCP), and Falling Weight Deflectometer (FWD). These tests were conducted on top of each layer during construction and after construction once every 6 to 12 months.

Research Performed by:
Center for Transportation Research

Research Supervisor:
Dr. Jorge Zornberg, CTR

Researchers:
Subramanian Sankaranarayanan
Hossein Roodi
Vinay Kumar Vasanthkumar
Calvin Blake
Abed Mikati
Yagizer Yalcin

Project Completed:
08-31-2023

The data from the sensors were collected under passive traffic over 2.5 years to understand the long-term pavement response under traffic and environmental loads. In addition to the passive data collection from the installed sensors, the response of the sensors under active loading conditions such as their dynamic response under vehicular traffic, their response under impact loads such as FWD were also obtained.

What They Found

Value of Research

The research team prepared a Value of Research (VoR) report that contains economic- based calculations, the description of economic variables used within the calculations, and the qualitative values of TxDOT's selected benefit areas.

Pavement Performance

The researchers found that the geogrid-stabilized pavement sections performed significantly better than their non-stabilized counterparts both in terms of the response of the sensors under active loading such as vehicular traffic and impact, and in terms of their passive response under passive traffic and environmental loads.

Reduction in Fatigue Life

The reduction in tensile strains at the bottom of the asphalt layer indicated that the fatigue life of the pavement with geogrid-stabilization of the base layer improved by 2 to 4 folds when compared to the non-stabilized sections. This improvement was found to be affected by the pavement temperature, vehicular traffic distribution and vehicle speeds.

Reduction in Rutting Potential

The reduction in tensile strains at the bottom of the base layer measured by the soil extensometers indicated that the rutting potential of the unbound aggregate layers reduced significantly (5 to 40%)in the stabilized sections. This was also observed as reduced deflections in the response of the geophones to active traffic and impact loading.

Moduli Improvement

The FWD tests and embedded geophone data showed that with time for mobilization the moduli of the unbound aggregate layers in the vicinity of the geogrid increased in the stabilized sections whereas they remained the same in the control section. The improved moduli translated to a reduction of base layer thickness by 2" to 4".

What This Means

The inclusion of the geogrid resulted in improved performance of the stabilized sections in terms of moduli improvement, reducing rutting potential, improved fatigue life, reduced internal and surface deflections under applied traffic and impact loads.

The robust pavement design meant that the surface distresses were negligible to non- existent over the course of this project. However, the use of sensors provided early insight into the expected pavement performance in the stabilized and control sections.

Since the sensors are still active and the performance of the test section with stabilization showed continuing improvement with time, it might be useful to continue monitoring the test sections to understand the full extent of the benefits of stabilization.

For More Information

Project Manager:
Jade Adediwura, RTI Jade.Adediwura@txdot.gov
Research Supervisor:
Jorge Zornberg, CTR zornberg@mail.utexas.edu
Project Monitoring Committee Members:
Andre Smit, Andres Gonzalez, Gisel Carrasco, Miguel Arellano, Richard Izzo, Seve Sisneros, Ryan Phillips, Ruben Carrasco

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.

This research was sponsored by the Texas Department of Transportation and the Federal Highway Administration. The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented here. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade names were used solely for information and not for product endorsement.