Multi-State DOT Sponsored Study of the Performance of 12 Geosynthetics as Subgrade Stabilization

- *First full-scale, side-by-side testing of the operational performance of 12 different geosynthetics.*
- *Which geosynthetics performed the best for subgrade stabilization – Geogrids or Geotextiles?*
- *How did each geosynthetic compare within each product group?*
  Geogrids (integrally formed, welded, woven, knitted); Geotextiles (woven, nonwoven)
- *Which material properties contributed to the performance and anticipated rut depth?*

RELATIVE OPERATIONAL PERFORMANCE OF GEOSYNTHETICS USED AS SUBGRADE STABILIZATION

FHWA/MT-14-002/7712-251 – May 2014

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Location:

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Full Report (331 pages):

http://www.mdt.mt.gov/other/webdata/external/research/docs/research_proj/subgrade/final_report-2.pdf

SYNOPSIS OF REPORT

Introduction

Full-scale test sections were constructed, trafficked and monitored to compare the relative operational performance of geosynthetics used as subgrade stabilization and to determine which material properties are most related to performance.

Test Track

Seventeen, full-scale, 50-ft. long test sections were constructed (Figure 1) – fourteen containing geosynthetic reinforcement and three without (9 geogrids, 2 geotextiles and 1 geogrid/geotextile composite from 7 manufacturers).

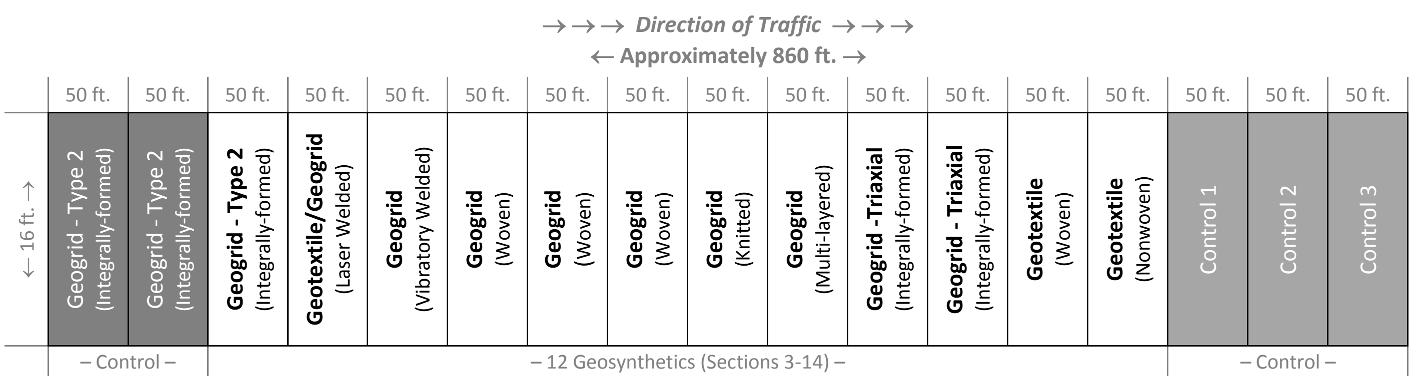

Figure 1: Construction of Test Track (Not to Scale)

Subgrade and Base course

Subgrade was prepared and constructed to an average strength of *1.79 CBR* with the exception of two 'Reinforced' Control test sections.

Base course was prepared and constructed to an average thickness of *10.9 in.* with the exception of two Control sections.

Trafficking

A fully loaded three-axle dump truck that weighed 45,420 lb. with 90 psi tire pressure was driven at 5 mph to traffic the test sections; always in one direction.

Trafficking began on September 13th and continued thru November 7th; after rut level reached 3 in. (defined as failure in this project) they were filled in so that the remaining un-failed sections could be further trafficked for a total of 740 passes.

Rut, geosynthetic displacement and strain, and subgrade pore-water pressure were monitored during trafficking.

Analysis and Results

Performance Evaluation

Performance was based upon the ability of the geosynthetics to help support a given number of truck passes over the weak subgrade, which is measured by changes in longitudinal rut. Two evaluation methods used to compare the relative performance of the test sections are the Base Course Reduction (BCR) analysis and the Traffic Benefit Ratio (TBR) analysis (Table 1).

Base Course Reduction Analysis (BCR factor)

The BCR factor can be used to compare the base course thickness between reinforced and unreinforced Control test sections that perform equally; expressed as a percentage of base course reduction by comparison. These comparisons are valid for situations where additional gravel would be sufficient to allow heavy construction equipment to operate on the weak subgrade without excessive rutting or other deformations (Table 1).

Traffic Benefit Ratio (TBR)

TBR is the ratio of the number of truck passes for a reinforced test section to the number of truck passes for an unreinforced test section. Table 1 reports the TBR @ 2.5" rut level. Analysis was also conducted at 1.0" and 2.0" rut depth; however, the overall performance ranking of the test sections did not change as a function of rut depth (Table 1).

Table 1: Summary of Test Section Performance and Geosynthetic Ranking

Product Type	Structure	Polymer	BCR	TBR @ 2.5" rut
Best Performers				
#1 Geotextile	Woven; High-Performance	PP	26.9%	14.8
#2 Geogrid - Type 2	Integrally-formed; Biaxial	PP	23.8%	10.4
#3 Geogrid / Geotextile	Vibratory-welded; Biaxial	PP	21.9%	8.4
#4 Geotextile	Nonwoven; Medium Weight	PP	21.3%	7.9
Medium Performers				
#5 Geogrid	Laser-welded; Biaxial	PP	19.6%	6.5
#6 Geogrid	Woven; Biaxial	PET	19.3%	6.3
#7 Geogrid	Woven; Biaxial	PET	19.0%	6.1
#8 Geogrid	Extruded; multi-layer; Biaxial	PP	17.7%	5.4
#9 Geogrid	Integrally-formed; Triaxial	PP	17.4%	5.2
Poorest Performers				
#10 Geogrid	Integrally-formed; Triaxial	PP	13.1%	3.4
#11 Geogrid	Woven; Biaxial	PET	11.7%	2.9
#12 Geogrid	Knitted; Biaxial	PP	10.2%	2.5

Highlights of Conclusions and Recommendations

- A woven high-performance geotextile outperformed all other geosynthetics, including all 10 geogrids, with the greatest reduction in base thickness (BCR) at 26.9% corresponding to a difference of 4.0 in. of gravel; the least was a knitted geogrid at 10.2%, corresponding to a difference of 1.2 in. of gravel. (Table 1)
- A nonwoven geotextile, although the weakest product in terms of tensile strength, performed better than all but two of the geogrids, ranking #4 in Top Performers. (Table 1)
- The two triaxial geogrids ranked #9 and #10 respectively (Table 1); and forensic excavations conducted immediately after trafficking in areas of high rut revealed that the ribs of these materials had ruptured.
- The results of this study indicate that strength and stiffness of the junctions and tensile members of geogrids (Aperture Stability Modulus) and wide-width tensile strength numbers in the cross-machine direction correlated well with rut performance, and mainly contribute to the performance of geosynthetics when used as subgrade stabilization. The relative contribution of these material properties depends on the thickness of the base course aggregate layer and the anticipated rut depth.
- Despite the fact that the woven and non-woven geotextiles performed well in the field study, it is unknown which material properties are directly responsible for their performance. Intuitively, surface friction properties and tensile strength of the materials play an important role; however, additional work is needed to evaluate the effect individual geotextile properties have on their performance in subgrade stabilization applications.
- On average, geosynthetics helped support around six to seven times more traffic passes when evaluated at 2.5 inches of rut. (Table 1)
- Full report (331 pages): http://www.mdt.mt.gov/other/webdata/external/research/docs/research_proj/subgrade/final_report-2.pdf

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