NTPEP REGEO Summary of Survey Results
Use of the NTPEP REGEO Program and Installation
damage Protocol Issues

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Introduction

The report summarizes the results of a survey conducted through the AASHTO NTPEP (National Transportation Product Evaluation Program) committee to assess the states’ use of the REGEO program for geosynthetic reinforcement and to assess, more specifically, the geosynthetic reinforcement installation conditions that are typical for state transportation departments for geosynthetic wall and reinforced slope applications. This survey was developed as a result of discussions at the 2014 annual NTPEP meeting, specifically the GTX/REGEO Technical Committee meeting, in Greenville, South Carolina.

The purpose of this survey is to help the AASHTO NTPEP Geosynthetics Technical Committee assess the use among the states of the NTPEP REGEO geosynthetic reinforcement product evaluation program and to specifically assess the installation conditions to which geosynthetic reinforcement products are being subjected in the field when used in geosynthetic walls and/or reinforced slopes. This survey does not address the use of geosynthetic reinforcement in pavement base or subgrade reinforcement. Only geosynthetic reinforcement used in walls and reinforced slopes is addressed by this survey. Geosynthetic reinforcement in this survey is considered to include both geogrids and geotextiles.

A key motivation for this survey is that some of the geosynthetic manufacturers have raised concerns about the severity of the installation damage conditions in the tests NTPEP does as part of its protocol. The national evaluation protocol used for the NTPEP program is AASHTO Standard Practice PP66, and for installation damage, ASTM D5818 is referenced. These protocols were developed with the intent of meeting the AASHTO LRFD Bridge Design Specifications, Articles 11.10.6.4.2b and 11.10.4.6.3b. In those standards, all that is specified is that the installation conditions used in the testing must represent typical full scale installation conditions.

Summary of Results – NTPEP REGEO Program Use by the States

A total of 40 state transportation departments (i.e., DOT’s) responded to the survey. Of those, a total of 38 DOT’s indicated that they do use geosynthetic reinforcement in wall and reinforced slope applications. Of those, just under 50 percent (18 who do versus 20 who do not use that
data) of the states use the NTPEP REGEO evaluation reports as the basis for their long-term reinforcement strengths for design. Six of those states use the NTPEP test results as a required basis for being added to the state DOT qualified or approved products list (i.e., QPL or APL), and two states use the NTPEP results as an optional basis for this purpose. Four additional states (i.e., those that are currently not using NTPEP REGEO test results) are planning on adopting the NTPEP program for their geosynthetic reinforcement approval for their QPL or APL, and one additional state is interested in starting to use the NTPEP results to assist them in reviewing and accepting long-term strength values included in proprietary wall supplier submittals for preapproval. This would bring the total number of states using the NTPEP REGEO evaluations to 23 of the 40 states that responded to this survey. Table 1 summarizes how the states are using the NTPEP REGEO results.

Table 1. Summary of states using the NTPEP REGEO geosynthetic reinforcement evaluations.

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<tr>
<th>States Using the NTPEP REGEO Evaluations</th>
<th>States Requiring the NTPEP Evaluations as the Basis for QPL/APL Acceptance</th>
<th>States Using the NTPEP Evaluations as an Optional Basis for QPL/APL Acceptance</th>
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States Planning on Adopting the NTPEP REGEO program as the basis for selection of geosynthetic reinforcement products:

Vermont
North Dakota
Nevada
Virginia
*Idaho

*Interested in using the NTPEP REGEO test data to assist them in review/approval of geogrid long-term strength properties in proprietary wall submittals for preapproval and for setting up geogrid specifications now that they are aware of the program.

Of the states who do not use the NTPEP results and indicated no plans to do so, 7 states were not aware of the NTPEP REGEO program and that long-term strength data for geosynthetic reinforcement was available through that program (note that one of these 7 states had a PEER
exchange for the REGEO program, but they did not get the right people to the PEER exchange. The others who currently do not use the NTPEP REGEO results either use a different standard than the one used by NTPEP or rely on the MSE wall or geosynthetic suppliers to provide test data and justification for their long term reinforcement strength values, though some of the responses were too vague to characterize their reason for not using the NTPEP results and to determine what they are using in their place. Two states appear to only be using a short-term wide width strength for design (i.e., not a long-term creep, durability and installation damage reduced strength).

Summary of Results – Representative Conditions for Installation Damage

The installation conditions used in the NTPEP REGEO testing for assessing installation damage are as follows:

- Place steel lifting plate
- Place and compact 6 inches of aggregate used for exposure
- Place geosynthetic sample
- Place and compact 6 inches of the same aggregate – place using 15,000 lb wheeled front end loader, spreading aggregate with wheeled loader tracking on aggregate over the geosynthetic, and compact using single drum 25,000 lbs vibratory roller, using the heavy compaction setting (total equipment wt.)

Of the 40 states that responded to the survey in general, with regard to the minimum backfill lift thickness over the geogrid, 24 states require a 6 inch minimum as-compacted lift thickness. Three states require as little as 4 inches over the geosynthetic, and 8 states require a minimum 8 inch as-compacted lift thickness. The others allow 8 to 10 inches loose over the geosynthetic. With regard to the lift thickness over the geosynthetic they normally see, the states were more split, with 12 of the states at 6 inches, 14 states at 8 inches, and 2 states at 10 inches. See Appendix A for more details.

With regard to the compactor size, 14 states typically see compactors that have a weight of greater than 10,000 lbs, 7 states greater than 15,000 lbs, 3 states greater than 20,000 lbs, and 9 states greater than 25,000 lbs. However, it needs to be recognized that this type of information is not regularly tracked by the states.

Regarding the backfill particle sizes, the survey results are summarized in Figure 1 (a and b). The majority of states tend toward the coarse end of the range for both maximum particle size and d50 size (i.e., the particle size at which 50 percent passes by weight).

Regarding the installation regimen currently used to evaluate installation damage in the REGEO program, it appears the majority of the states (22 of the 40 states responding to the overall survey) feel that the installation regimen is representative of the typical installation conditions they see or specify. Only two states felt that the installation regimen was significantly more severe than their typical installation conditions, and one state felt that the installation conditions are more severe, but not significantly more severe, than their typical installation conditions. One state did mention that they felt the 6 inches of cover over the steel plate below the geosynthetic
was likely not enough cushion, though that state admitted their opinion on this issue was a bit speculative.

![Figure 1](image.png)

**Figure 1.** Survey results regarding backfill particle sizes used by the state DOT’s in MSE walls and reinforced slopes (a) maximum backfill particle size, and (b) d$_{50}$ particle size.

**Conclusions**

A total of 40 state transportation departments responded to the survey. With regard to use of the NTPEP REGEO program and the test results it produces, just under 50% of those states are currently using the NTPEP REGEO program test results as the basis of their long-term strength values for geosynthetic reinforcement and for adding products to their approved products list, but only 6 states require the NTPEP test results for this purpose. However, an additional 5 states are in the process, or at least considering, the use of the NTPEP REGEO program results as the basis for their geosynthetic reinforcement approvals. Of the states who are currently not using the NTPEP REGEO test results in some way, many of those were simply not aware of the REGEO program and how they could use it for their product approvals.

Regarding the installation damage exposure regimen used in the current REGEO Installation damage evaluations, the majority of the states (22) felt that the current regimen was representative of the conditions they have during installation of geosynthetic reinforcement, though there is a fairly wide range of variation among the states regarding these conditions.
Appendix A: Detailed Survey Results

The installation regimen used by NTPEP for installation damage assessment is as follows:

- Place steel lifting plate
- Place and compact 6 inches of aggregate used for exposure
- Place geosynthetic sample
- Place and compact 6 inches of the same aggregate – place using 15,000 lb wheeled front end loader, spreading aggregate with wheeled loader tracking on aggregate over the geosynthetic, and compact using single drum 25,000 lbs vibratory roller, using the heavy compaction setting (total equipment wt.)

The intended recipients of this survey are the state DOT staff who are familiar with the design and use of geosynthetic walls and/or reinforced slopes in your state, and/or those who are knowledgeable in this subject from the materials viewpoint.


1. Do you use geosynthetic reinforcement in MSE walls or reinforced slopes?

Response:

   a. Yes (38)
   b. No (2)

2. If not, why not?

Response:

   1. lack expertise in designing and constructing geosynthetic reinforced walls and slopes (1)
   2. lack confidence in the long-term life, i.e., 75 years, of geosynthetic reinforcement (0)
   3. concerned about potential long-term deformation of geosynthetic reinforced wall or slopes (0)
   4. other reason (please specify) _(1) - The contractors do continue to use the standard metallic strips in the MSE walls.
3. If yes, do you use the NTPEP test results as the basis for long-term reinforcement strength design values?

Response:

- a. Yes (18)
- b. No (20)

4. If your response to Question 3 is yes, how do you use them?

Response (select all that apply):

- a. As required basis for DOT Qualified Products List or Approved Products List (6)
- b. As optional basis for Qualified Products List or Approved Products List (2)
- c. As source for acceptable long-term geosynthetic reinforcement design strengths (11)
- d. Other (please specify) (2) - Require manufacturer to test his products according to AASHTO and when we accept his product it is placed on PQL list for RSS or is part of approved MSE system; Is used along with creep deformation and durability as reduction factors to determine allowable tensile strength

5. If your response to Question 3 is no, why not?

Response:

- a. Not aware of the availability of NTPEP geosynthetic reinforcement evaluation data and how to use that data (7)
- b. State DOT approval of geosynthetic reinforcement products is based on a standard that is not consistent with the standard used by NTPEP for its evaluation of geosynthetic reinforcement (i.e., NTPEP uses AASHTO PP66, which was based on WSDOT Standard Practice T925) (3)
- c. Other (please specify) (1) - Currently; geosynthetic properties are provided in Design Standards. These properties are provided by an independent; 3rd party (& reviewed internally) when being requested to be included in the Design Standards. NHDOT only use geogrid for one approved MSE wall system and for reinforced soil slopes; and NTPEP currently does not have strength values for geogrid. Haven't migrated to that data; manufacturer supplied data/certs are required Working on using as basis for Qualified Products List or Approved Products List Approved as a system as recommended by the MSE wall manufacturer. Currently we do not use NTPEP test results; but we are going to move in that direction with our new specifications
We have an approved products list for MSE fabric and specify geogrids on a per project basis.
Considering NTPEP at this time.
We have approved lists of geosynthetics or approved wall lists. We basically accepted man’f literature for approval. We intend to start using NTPEP now that the audit programs are in place; when it was just 3-yr sampling; that was not enough.
Internal stability for MSE walls is performed by the wall supplier/Designer.

6. If your response to Question 3 is no, what do you use to obtain long-term strength design values for geosynthetic reinforcement used in MSE walls and/or reinforced slopes?

Response (please specify):
per SP624...The geosynthetic materials shall be pre-approved by the Department; and shall have certified long-term strength (Tall) determined by: Tall = Tult/RFd*RFid*RFe&CR;&LF; See response for #7. Creep and RF values are provided at time of submission to the Design Standards.
We are only using ASTM D4595.
Strengths at specified strains as reported by manufacturers; with tests performed in accordance with GRI or other approved test methods.
Long term strength design values are based on review of test information provided by the manufacturer. A certificate of compliance is also required at time of construction.
Material certs. from the contractor/manufacturer
Internal DOT lab test data&CR;&LF;Manufacturer's information&CR;&LF;
Manufacturer's certified test results
Based on MSE wall manufacturer’s recommendation.
available data from manufacturers
Currently we construct our MSE walls with a Special Provision put into the plans. This SP requires the contractor to construct the wall the lines and grades shown in the plans and that it be constructed in accordance with AASHTO LRFD and FHWA publication No. FHWA NHI-01-043.
Wall/Slope designer is allowed to determine the value to be used in their design.
ASTM 6637
The required properties are certified by the supplier
Internal stability design completed by MSE Wall manufacture. Strengths verified through manufacture certifications.
We use the default and minimum reduction factors as required by AASHTO.
We use the generic reduction factors along with the ultimate strength to determine the long term design strength.
We review and approve reduction factors for long-term strength loss which are&CR;&LF;used to calculate long-term strength. The reduction factors may be based on
independent tests conducted by the manufacturer; otherwise AASHTO/FHWA compliant RF's are used. We were not aware 3rd party testing programs such as NTPEP provide independent test results.

Special Provisions for MSEW and Department's Geotechnical Engineering Design Guide No. 8; Mechanically Stabilized Earth Wall (MSEW) Design Guide

Use conservative reduction factor approach.

Grid samples tested using ASTM D6637 and D4595 in lab to confirm material consistent with design strengths.

ADOT has its own evaluation system for evaluating MSE Wall Company's. It is a very detailed and comprehensive process that the MSE Wall Manufacturer must go through in order to be approved for placement on ADOT's Approved Products List (APL). ADOT evaluates and approves MSE Walls for placement on the APL as a complete System which includes the reinforcing grid whether it is Geogrid or Steel Grid. This evaluation system is addressed as a Materials Group "Policy and Procedure Directive"; (PPD NO. 24). This PP&D can be viewed on the ADOT Materials Group Web Site.

7. For MSE walls and reinforced slopes, what minimum as-compacted lift thickness over the geosynthetic reinforcement do you allow?

Response (in inches):

a. 4 (3)

b. 6 (24)

c. 8 (8)

d. Other (please specify, in inches) – one at 8 inch loose; one at 10 inch loose; two have no minimum

8. What as compacted lift thickness over the geogrid do you normally see?

Response (in inches):

a. 6 (12)

b. 8 (14)

c. 10 (2)

d. Other (please specify, in inches) – 8 inch for MBW, and 10 inch for all other applications; 10 inch loose lift thickness; 12 inch lift; all depends on reinforcement spacing; no experience since have not used geogrids yet; 8 inch loose lift; have not used geogrids in walls or slopes, but if we did, a loose lift of 8
9. What compactor size (total equipment weight) do you typically see for compacting MSE wall or reinforced slope backfill within the reinforced soil zone?

   a.  ≥ 10,000 lbs (14)
   b.  ≥ 15,000 lbs (7)
   c.  ≥ 20,000 lbs (3)
   d.  ≥ 25,000 lbs? (9)

10. What is the largest likely maximum soil particle size you typically use for MSE wall or geosynthetic reinforced slope backfill, based on your construction specifications?

    Response:

    a.  ≤ 0.75 in. (7)
    b.  0.75 to 1.0 in. (9)
    c.  1.0 to 2.0 in. (16)
    d.  > 2.0 in. (7)

11. What is the largest likely d_{50} size you typically use for MSE wall or geosynthetic reinforced slope backfill, based on your construction specifications?

    Response:

    a.  < 0.08 in. (2 mm) (0)
    b.  < 0.16 in. (4 mm) (5)
    c.  < 0.24 in. (6 mm) (9)
    d.  < 0.39 in. (10 mm) (6)
    e.  ≥ 0.39 in. (10 mm) (13)

12. In the introduction to this survey, the placement and compaction procedures used for the installation damage testing for this NTPEP program was described as follows:

    Place and compact 6 inches of the same aggregate – place using 15,000 lb wheeled front end loader, spreading aggregate with wheeled loader tracking on aggregate over the
geosynthetic, and compact using single drum 25,000 lbs vibratory roller, using the heavy compaction setting (total equipment wt.).

Do you consider this procedure to be representative of typical installation conditions used in your state for geosynthetic layers in MSE walls and/or reinforced slopes?

Response:

a. Yes (22)

b. No, placement and compaction procedures used in our state are significantly less severe than this. (7)

c. No, placement and compaction procedures used in our state are significantly more severe than this. (2)

d. If (b) or (c) is selected, please describe the placement and compaction procedures used in your state DOT:

   For those that selected (b): typically a smaller roller is used; Varies greatly based upon contractor; Material hauled by truck; spread by dozer; 8" loose lifts; compact with 6 to >10 ton vibratory single drum roller; 98% test section MDD; RSS use natural soils; not the 3 feet zone directly behind wall facing;

   For those who selected (c): Backfill shall be compacted to 95% of the maximum density as determined by AASHTO T-99 Method C or D; The methods and lift thickness are similar to NTPEP except larger compaction equipment is typically used on our projects.

   For those who did not specify a response (b or c): place fill in lifts up to 12" thick then compact to 95% of max density as determined by AASHTO T-99; I would not say that NCDOT placement and compaction procedures are significantly less severe than this but they are less - NCDOT typically sees material placed with Bobcat type equipment and our standard spec requires an 8 to 10 ton (16,000 lbs); We allow 8" max lift thickness; disallow sheepsfoot rollers and specify 92% of T180 per lift; the above placement instructions appear to be like the typical installation procedure that ADOT uses. I am a little concerned about only 6 inches of ABC over the steel plate. This may not be sufficient depth of ABC to properly cushion the Geogrid. This comment is speculation on my part. In addition I don't believe that ADOT calls out minimum weights for front loaders and/or compactors.