Geogrid Specifications for Base Reinforcement

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Use of geogrids for base reinforcement

- Over 30 years here in the US
- Data show there is a benefit when a geogrids is included
- Why do we (owners, designers, specifiers) have such trouble with this application?
  - Validation of predicted performance
  - Contradictory information
  - No mechanistic approach to predict performance
  - Disparity in use by state DOTs - not a standard practice
  - Inconsistent specifications
Specifications

Definition – *(after wikipedia web site)*

- An explicit set of requirements defining an exact description of an object or a process.

- For base reinforcement, the specification is based on index properties that represent the material used in a test section which matches the desired performance.
How have the current material specifications been developed?

Tests of pavement structural sections
- Test parameters are defined
- Materials are selected
- Loading is performed
- Performance is documented (rather than failure)

Material properties are then analyzed
- Intent is to model the observed performance
- Selection of material properties that represent the product that delivered this performance
What do state material specifications currently look like?

Typically specify material properties:

- Strength
- May limit strength to a strain level such as 2 or 5 percent
- Modulus
- Stiffness in different directions (aperture stability, flexural)
- Geometry of geogrid (aperture size, thickness of ribs)
- Interaction coefficients (friction and pullout)

Do any of these properties directly reflect the predicted long-term performance of a pavement section reinforced with the geosynthetic?
State of Practice

Texas DOT recently (November 2009) completed a survey to determine the criteria other states are employing for accepting or rejecting geogrids for use in highway pavements for base stabilization.

- They received 33 responses out of 52 divisions.
- 26 out of 33 use geogrids for base and subgrade applications.
- 18 of 26 have geogrid material specifications.
- Of those that don’t:
  - 2 have a pre-approved list.
  - 3 use project by project special provisions.
  - 1 manufacturer certification.
  - 2 not sure/no response.
What is the FHWA geosynthetics guidance?

- NHI Geotechnical Aspects of Pavements Manual, dated 05/2006, FHWA NHI-05-037
What’s in the FHWA geosynthetics manual?

- Chapter 5 – Geosynthetics in Roadways and Pavements
- Table 1 Geogrid properties for subgrade restraint (Intended for survivability)
- Table 1a & 1b Geogrid properties for base reinforcement
Issues with this material specification based procedure

1. Test parameters do not get incorporated into the specifications
   - Subgrade strength
   - Water content of subgrade
   - Fill properties and thickness
   - Pavement thickness
   - Location of geogrid
   - Performance criteria

2. Material properties
   - Only the geogrid properties are specified
Issues with this material specification-based procedure (continued)

3. The performance is empirically based
   • Under different conditions, the material properties being specified may not predict performance of the composite pavement structural section
   • The properties that are important for one product may not be for another

4. This is essentially a method specification?
   • The assumption is that the geogrid meeting these properties will provide the performance intended

5. Results in questions by the designer
   • How do I specify the performance I need?
   • How will I know if the geogrid will perform as intended?
   • So many products, how do I stay out of trouble?
This summarizes FHWA Experience to Date

Alternate ideas are presented for discussion and future consideration
What is the alternative?

Performance-based specifications

• The prediction of future performance of a product by using construction tests and measurements to design (FHWA publication “Performance Specifications Strategic Roadmap: A Vision for the Future”, Spring 2004)

AASHTO and FHWA (after AASHTO, PP 46-01)

• The recommended practice is empirical and restricted to applications already demonstrated to be useful. The practitioner would need to reference a test section similar to that which is expected in their design.
• The demonstrated performance may then be applied to the project being designed.
How do we include geogrids in the design?

Use experimentally derived parameters

- Compare performance of reinforced and unreinforced sections
- The traffic benefit ratio (TBR) represents this comparison

\[ TBR = \frac{\# \text{ of reinforced load cycles}}{\# \text{ of unreinforced load cycles}} \]

- Performance measured is dependent on the material and test conditions
- The further the actual project conditions are from the test conditions the less relevant are the test data
Design steps

Using AASHTO 1993 procedures and PP 46-01

- Calculate a required structural number for the loading (ESAL)
- If increasing the design life then multiply the ESAL unreinforced by the TBR
- If decreasing the section thickness:
  - Divide the required ESAL by the TBR
  - Calculate the structural number for the modified ESALs
  - Adjust layer thickness
What do we want to specify?

Specify TBR plus boundaries for its application

• TBR greater than or equal to required design value
• Specify test conditions:
  – Range for subgrade CBR
  – Range for base course thickness
  – Range for base course CBR
  – Range for asphalt thickness
  – Limiting performance criteria
• Performance-based specifications predict how the composite section should perform over time

This application is a complex system based on the composite properties of all the components acting together under specific conditions
What would we need to make this work?

- Data base of different test sections with their test parameters
- Properties of composite material
- M-E design parameters with limiting conditions
- Guidelines/rules

What are possible shortcomings?

- Were to get the data? (Availability)
- Can we rely on manufacturer for the data?
- Large range of TBR values, what is appropriate?
- Acceptability of Laboratory or full scale accelerated tests?
- TBR sensitivity to components other than geogrid?
QUESTIONS/DISCUSSION