Cost-Effective Flexible Pavement Design Using Geogrid

Purdue Road School 2017

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Tensar International Corporation
March 7, 2017
17 SEC. 1428. USE OF DURABLE, RESILIENT, AND SUSTAINABLE MATERIALS AND PRACTICES.
18
19 To the extent practicable, the Secretary shall encourage
20 the use of durable, resilient, and sustainable materials
21 and practices, including the use of geosynthetic materials
22 and other innovative technologies, in carrying out the ac-
23 tivities of the Federal Highway Administration.
Geogrid Performance Mechanisms
Lateral Restraint & Improved Bearing

USACOE, Tingle & Webster (2003)
Standard Practice for
Geosynthetic Reinforcement of the Aggregate Base Course of Flexible Pavement Structures

AASHTO Designation: R 50-09

1. SCOPE

1.1. This standard practice provides guidance to pavement designers interested in incorporating geosynthetic reinforcement for the purpose of improving the aggregate base course of flexible pavement structures. Geosynthetic reinforcement is intended to provide structural support of traffic loads over the life of the pavement.

1.1.1. For the purpose of this guide, base reinforcement is the use of a geosynthetic within, or directly beneath, the granular base course.

1.1.2. When referring to geosynthetics, the discussion is limited to geotextiles, geogrids, or geogrid/geotextile composites.

2. REFERENCED DOCUMENTS

2.1. AASHTO Standard:
   - M 285, Geotextile Specification for Highway Applications

2.2. Other References:

3. INTRODUCTION

3.1. Because the benefits of geosynthetic reinforced pavement structures may not be derived theoretically, test sections are necessary to obtain benefit quantification. Studies have been done that demonstrate the value added by a geosynthetic in a pavement structure. These studies, necessarily limited in scope, remain the basis for design in this field.

3.2. This standard practice is very empirical in nature and restricted to applications already demonstrated to be useful. The practitioner will need to consult the references and locate a tested

- Benefit of including geosynthetics in pavement is recognized to:
  - Improve life
  - Reduce thickness

- Benefits cannot be derived theoretically

- Designs not easily translated to other geosynthetics

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- Users are encouraged to affirm their designs with field verification
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Asphalt Pavement Section Cost / Benefit Analysis

Estimated Unit Prices:
- Excavation - $10 / CY
- HMA Surface - $80 / ton
- HMA Intermediate - $75 / ton
- #53 Agg - $25 / ton
- TX5 Geogrid - $3.50 / SY

<table>
<thead>
<tr>
<th>Option</th>
<th>Thickness (in)</th>
<th>ESALs</th>
<th>Cost (SY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstabilized</td>
<td>10</td>
<td>117,000</td>
<td>$35.39</td>
</tr>
<tr>
<td>Stabilized Option 1</td>
<td>10</td>
<td>686,000</td>
<td>$39.15</td>
</tr>
<tr>
<td>Stabilized Option 2</td>
<td>7</td>
<td>120,000</td>
<td>$29.25</td>
</tr>
<tr>
<td>Stabilized Option 3</td>
<td>9</td>
<td>349,000</td>
<td>$35.16</td>
</tr>
</tbody>
</table>
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Army Corps of Engineers – Phase 2
Accelerated Pavement Testing

Control Section
(Lane 4)

Geogrid Section
(Lane 3)

4” HMA

8” Aggregate Base

6% CBR High Plasticity Clay (CH)

3” HMA

6” Aggregate Base

Tensar TX5 Geogrid
Subgrade: CBR = 6%
Results: Tensar TX5 with 1-inch less AC and 2-inches less AB performed the same as thicker conventional section
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Field Performance Validation
Hunt Highway, Arizona

**Research Organization**
Ingios Geotechics, Inc.

**Section Tested**
6-inches of base over TX5

**Testing Conducted**
Mr of the mechanically stabilized base course
Mr of the subgrade
Mr composite modulus
Modulus of subgrade reaction (k)
ev1 and ev2 strain modulus testing
Resilient deflections (scaling exponent)

<table>
<thead>
<tr>
<th>Layer Coefficient</th>
<th>Unstabilized Value</th>
<th>SP4 MSL Design Value</th>
<th>Verified MSL Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr (Ave) base</td>
<td>155,694 psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr (Ave) subgrade</td>
<td>16,144 psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr (Ave) composite</td>
<td>34,251 psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ev2 (top of stabilized base)</td>
<td>15.23 ksi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ev2/Ev1 Ratio</td>
<td>1.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-value (stabilized)</td>
<td>392 pci</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$0.31$ in savings
113% life extension
"For the 10,000 cycle test, the in-situ resilient modulus rapidly increased in the aggregate base layer for the first ~3000 cycles and then continued to increase at a slower rate. Based on a permanent deformation rate of 0.0001 in./cycle the transition from plastic deformation accumulation to near-linear elastic occurs at N* = 8,696 cycles. At N*, the in-situ Mr was about 321,881 psi (2x higher than the average value from the 1000 cycle tests)."
Actual APLT results showed a layer coefficient of 0.31 – providing 113% greater anticipated design life.

Savings >$118,000 for both sections.
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ARA has reviewed Tensar’s software, user manual, and underlying calculations…

We have found the software to be compatible and consistent with AASHTO R50-09…

…software emulates the AASHTO design procedure and produces designs compliant with the methodology…

Sincerely,

William R. Vavrak, Ph.D., P.E.
Vice President & Principal Engineer
Questions?
Comments?

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Tensar International Corporation