Cost-Effective Flexible Pavement Design Using Geogrid

Purdue Road School 2017

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Tensar International Corporation
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SEC. 1428. USE OF DURABLE, RESILIENT, AND SUSTAINABLE MATERIALS AND PRACTICES.

To the extent practicable, the Secretary shall encourage the use of durable, resilient, and sustainable materials and practices, including the use of geosynthetic materials and other innovative technologies, in carrying out the activities of the Federal Highway Administration.
Geogrid Performance Mechanisms
Lateral Restraint & Improved Bearing

USACOE, Tingle & Webster (2003)
Aggregate Confinement in Mechanically Stabilized Layer

Transition Zone (Partial confinement)

Unconfined Zone

Fully Confined Zone

Magnitude of confinement

Geogrid
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

Test sections are necessary to obtain benefit quantification

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>Layers</th>
<th>ESALs</th>
<th>Unit Price / SY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstabilized</td>
<td>ACC1</td>
<td>117,000</td>
<td>$35.39</td>
</tr>
<tr>
<td></td>
<td>ABC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabilized</td>
<td>ACC1</td>
<td>686,000</td>
<td>$39.15</td>
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<tr>
<td>Option 1</td>
<td>ABC</td>
<td></td>
<td></td>
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<tr>
<td>Stabilized</td>
<td>ACC1</td>
<td>120,000</td>
<td>$29.25</td>
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<tr>
<td>Option 2</td>
<td>ABC</td>
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<tr>
<td>Stabilized</td>
<td>ACC1</td>
<td>349,000</td>
<td>$35.16</td>
</tr>
<tr>
<td>Option 3</td>
<td>ABC</td>
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</tbody>
</table>

*Diagram showing various options for stabilization with corresponding ESALs and unit prices.*
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<thead>
<tr>
<th>Unstabilized</th>
<th>Stabilized Option 1</th>
<th>Stabilized Option 2</th>
<th>Stabilized Option 3</th>
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<tbody>
<tr>
<td>ACC1</td>
<td>ACC1</td>
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<tr>
<td>ABC</td>
<td>ABC</td>
<td>ABC</td>
<td>ABC</td>
</tr>
<tr>
<td>TriAx Geogrid</td>
<td>TriAx Geogrid</td>
<td>TriAx Geogrid</td>
<td>TriAx Geogrid</td>
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</tbody>
</table>

117,000 ESALs | 686,000 ESALs | 120,000 ESALs | 349,000 ESALs

$35.39 / SY | $39.15 / SY | $29.25 / SY | $35.16 / SY
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Army Corps of Engineers – Phase 2
Accelerated Pavement Testing

Control Section
(Lane 4)

- 4” HMA
- 8” Aggregate Base

Geogrid Section
(Lane 3)

- 3” HMA
- 6” Aggregate Base
- 6% CBR High Plasticity Clay (CH)
- 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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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>
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</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>

$118,000 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 0.0001in./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).”
Savings >$118,000 for both sections.
Actual APLT results showed a layer coefficient of 0.31 – providing 113% greater anticipated design life.
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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. Vavrik, Ph.D., P.E.
Vice President & Principal Engineer
Questions?
Comments?

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