GRS-IBS: An Overview
Overview

- Components of GRS-IBS
- FHWA Design Process
- Composite Behavior of GRS
- Example Projects
Geosynthetic Reinforced Soil – Integrated Bridge System

- FHWA Every Day Counts (EDC) initiative in 2010.
- GRS- Engineered, well compacted granular fill with closely spaced (<12 inches) layers of geosynthetic reinforcement
- GRS-IBS – A fast, cost-effective method of bridge support that blends the roadway into the superstructure to create a jointless interface between the bridge and approach.
Disney Bridge, Sequoia National Park (2012)

SC – Airline Road (Anderson County) (2014)

MA- SR 7 over Housatonic RR (2012)
Benefits

- Reduced construction time
- 25-60% lower cost than standard construction methods
- Construction less dependent on weather conditions
- Common materials/equipment
- Flexible design to field-modify for unforeseen site conditions
- Easier maintenance due to fewer parts
- Better quality control
- Eliminate the “bump”
- Reinforced Soil Foundation
  - Compacted granular fill encapsulated with a geotextile

- GRS Abutment
  - Closely spaced geosynthetic reinforcement and compacted granular material
  - Bridge is placed directly on the GRS abutment without a joint and no CIP concrete

- Integrated Approach
  - Transition to the superstructure – eliminates the “bump at the bridge” due to the differential settlement of the bridge abutment and the approach
Components of GRS

Facing

Geosynthetic Reinforcement

Granular Backfill
Design: Determine Layout of GRS-IBS

- Define geometry of abutment face/wing walls
- Layout abutment with respect to superstructure

FHWA-HRT-11-026, June 2012
Design: Depth and Volume of Excavation
Reinforced Soil Foundation

• GRS can be built with a truncated base to reduce excavation
• Min Base/Height = 0.3
  • Span $\geq 25$ feet, Base width = 6 feet (minimum)
  • Span $< 25$ feet, Base width = 5 feet (minimum)
  • Placed at calculated scour depth (if crossing water)
Design: GRS Abutment

- Well compacted granular fill alternated with geosynthetic (<12” spacing)
- Minimum Reinforcement Length $B/H = 0.3$
- Increase length to follow the cut slope up to $B/H = 0.7$
- Reinforcement zones provide transition from substructure to superstructure
Load on GRS-IBS
External Stability Analysis

Direct Sliding

Bearing Capacity

Global Stability
Ultimate Capacity

- **Empirical method**
  - Performance test

- **Analytical method**

  \[ q_{ult,an} = \left[ 0.7 \left( \frac{S_v}{6d_{max}} \right) \frac{T_f}{S_v} \right] K_{pr} \]
Deformations

• **Vertical**
  - Performance test curve
  - Limit vertical strain to 0.5%
  - \( D_v = \varepsilon_v H \)

• **Lateral**
  
  \[
  D_L = \frac{2b_{q,vol} D_v}{H} \\
  \varepsilon_L = \frac{D_L}{b_{q,vol} H} = \frac{2D_v}{H} = 2\varepsilon_v
  \]
**Reinforcement Strength**

$T_{req}$ is the required tensile strength of an individual reinforcement layer and should be calculated at each reinforcement layer.

$$T_{req} = \left[ \frac{\sigma_h}{0.7 \left( \frac{S_y}{6d_{max}} \right)} \right] S_v$$

$T_{req}$ must be less than the geosynthetic strength

1) $\leq T_{allow}$, where $T_{allow} = T_f/3.5$ and $T_f$ is the ultimate geosynthetic tensile strength ($T_f \geq 4800$ lb/ft), and

2) $\leq T_{2\%}$, geosynthetic strength at 2% strain

If necessary increase geosynthetic strength or decrease spacing to meet criteria
Integrated Approach

Photos courtesy FHWA EDC
Reinforcement Spacing

Stress - Strain curves

From FHWA-HRT-10-077, July 2013,
After Elton and Patawaraon (2004)
Geosynthetic Strength
Tiffin River Bridge Settlement

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<tr>
<th>Bridge</th>
<th>Abutment</th>
<th>Abutment Height (ft)</th>
<th>Abutment Differential Settlement (AS&lt;sub&gt;abun&lt;/sub&gt;) (ft)</th>
<th>Uniformity of Abutment Settlement (AS&lt;sub&gt;abun&lt;/sub&gt;/width of bridge)</th>
<th>Bridge Differential Settlement (AS) (ft)</th>
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FHWA-HRT-11-027, Jan 2011
Time Lapse Construction Video
Echo Bridge I-84

Video courtesy of Utah DOT
GRS-IBS – Tulsa, Oklahoma
GRS-IBS – Jordan, Utah
Keefer Road Bridge, Michigan

Photos courtesy of Allan Block
Hamilton County Bridge
References

FHWA Every Day Counts – GRS-IBS website

FHWA HRT-11-026, June 2012
FHWA HRT-11-027, January 2011
FHWA HRT-14-094, February 2015
FHWA HRT-10-077, July 2013