GRS-IBS:
An Overview

4685 South Ash Ave.
Suite H-4
Tempe, Arizona 85282

Phone: (480) 897 8200

Terracon.com

Terracon

Overview

- **Components of GRS-IBS**
- **FHWA Design Process**
- **Composite Behavior of GRS**
- **Example Projects**

Terracon

Geosynthetic Reinforced Soil – Integrated Bridge System

Photo courtesy FHWA EDC

- **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.**

FHWA-HRT-11-026, June 2012


Disney Bridge, Sequoia National Park (2012)


SC – Airline Road (Anderson County) (2014)


MA- SR 7 over
Housatonic RR (2012)

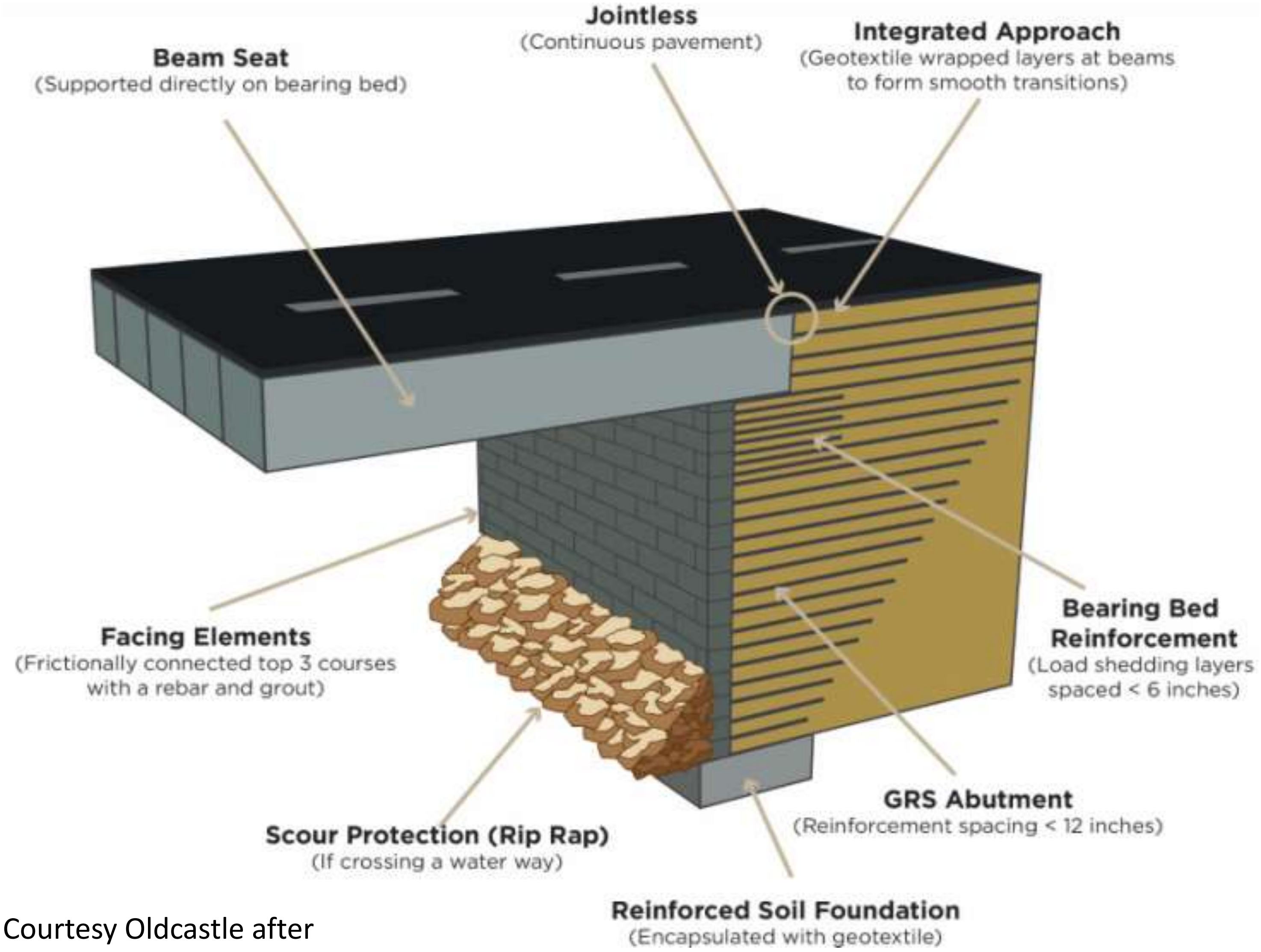
Photos courtesy FHWA EDC

Photo courtesy Oldcastle

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”

Parts of GRS-IBS



Courtesy Oldcastle after
FHWA-HRT-11-026, June 2012

- **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

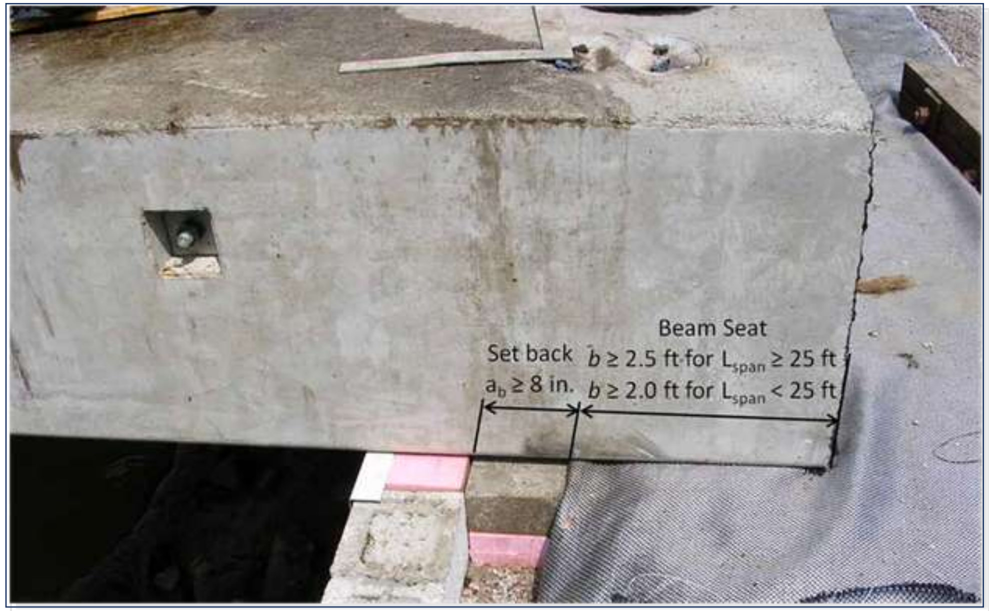
Granular Backfill

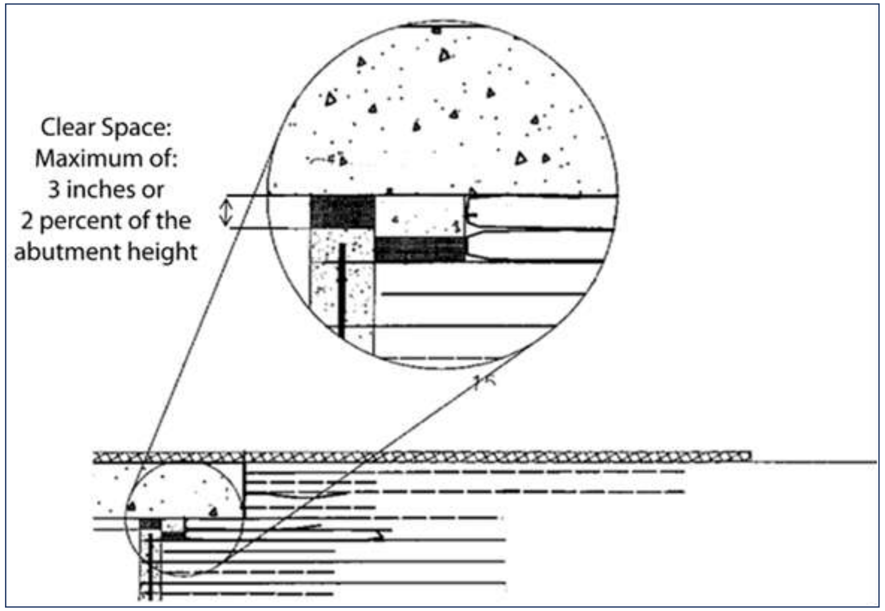
FHWA-HRT-11-026, June 2012

Terracon

Design: Determine Layout of GRS-IBS

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



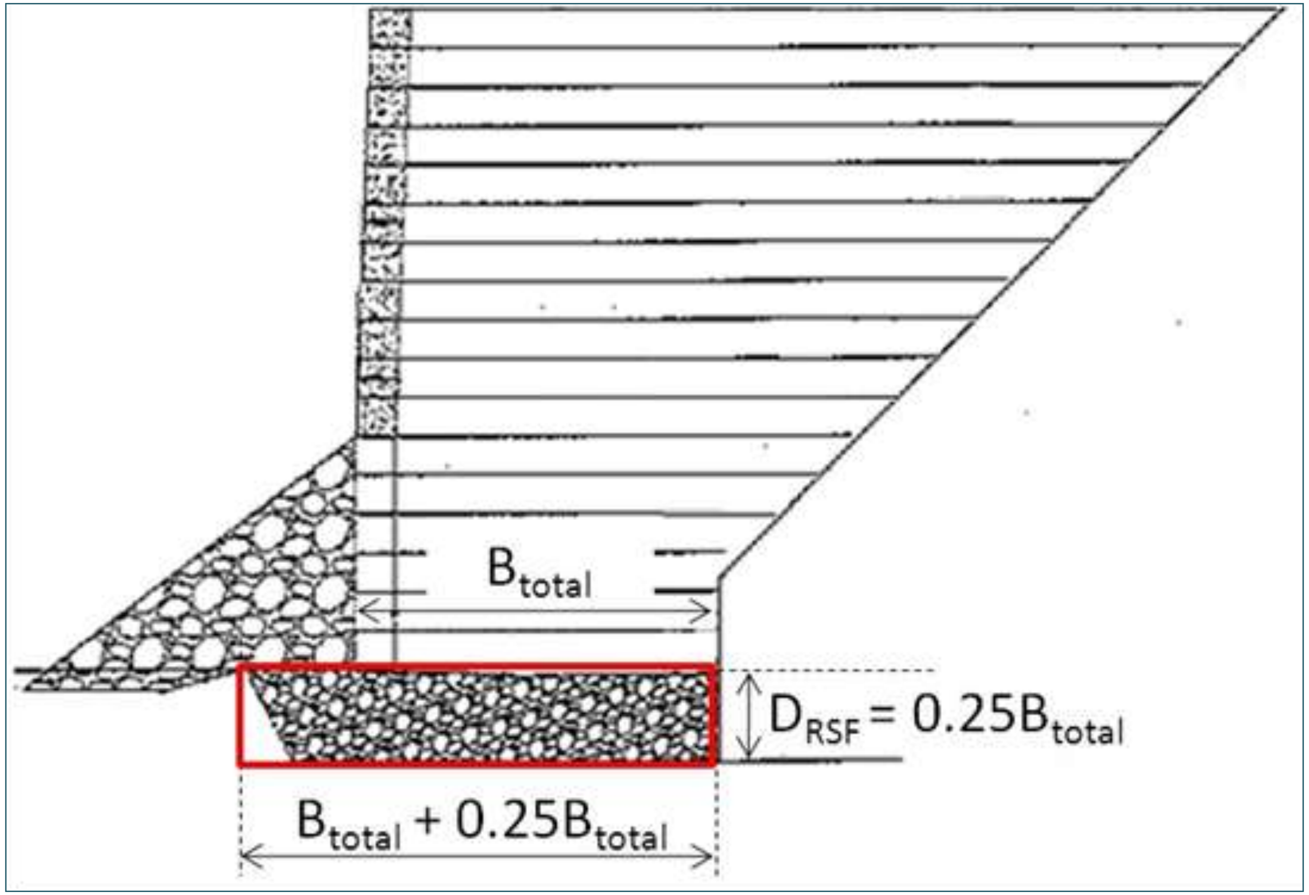


Terracon

FHWA-HRT-11-026, June 2012

Design: Depth and Volume of Excavation Reinforced Soil Foundation

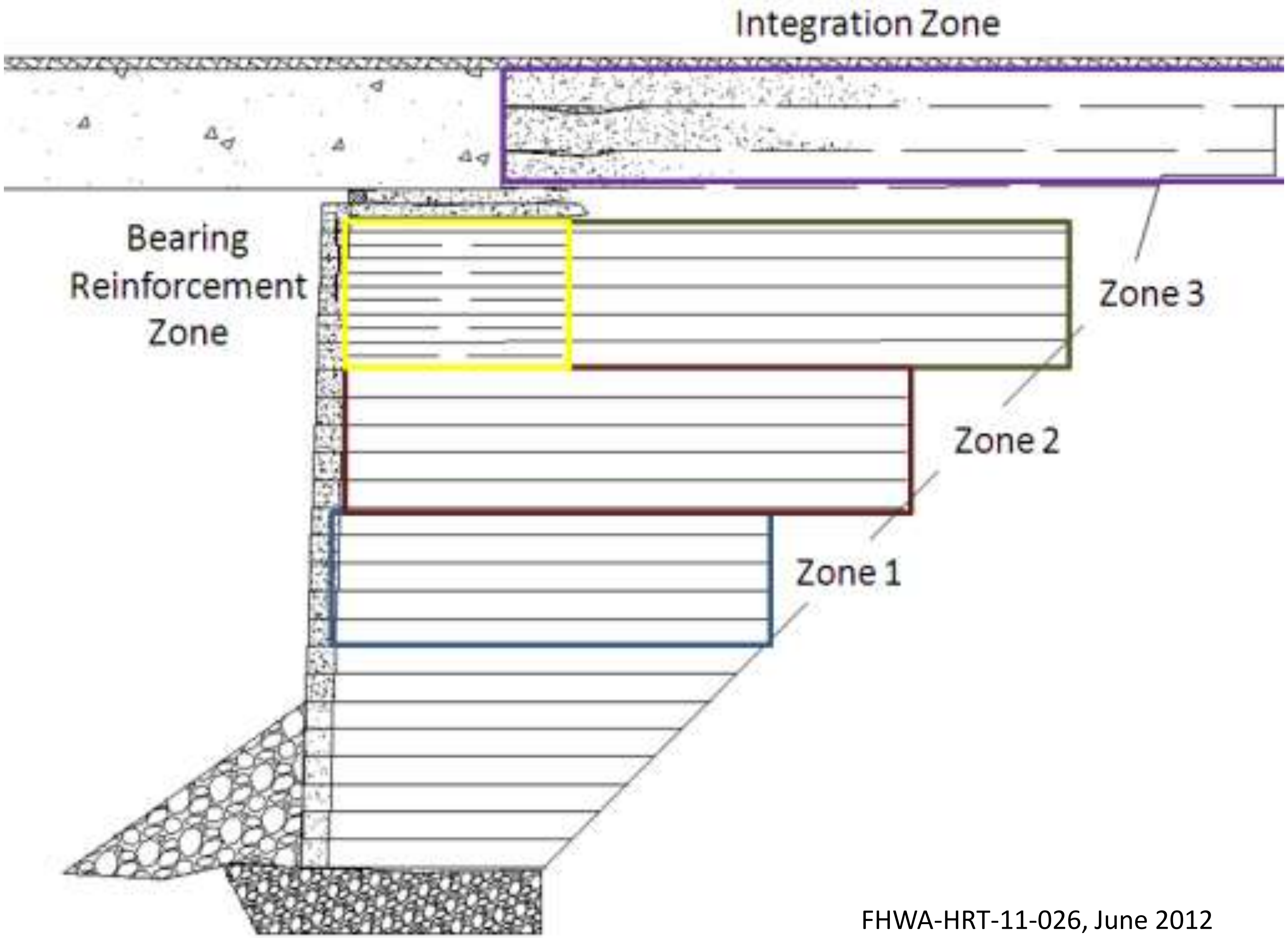
- **GRS can be built with a truncated base to reduce excavation**
- **Min Base/Height = 0.3**
  - Span >= 25 feet, Base width = 6 feet (minimum)
  - Span < 25 feet, Base width = 5 feet (minimum)
  - Placed at calculated scour depth (if crossing water)



FHWA-HRT-11-026, June 2012

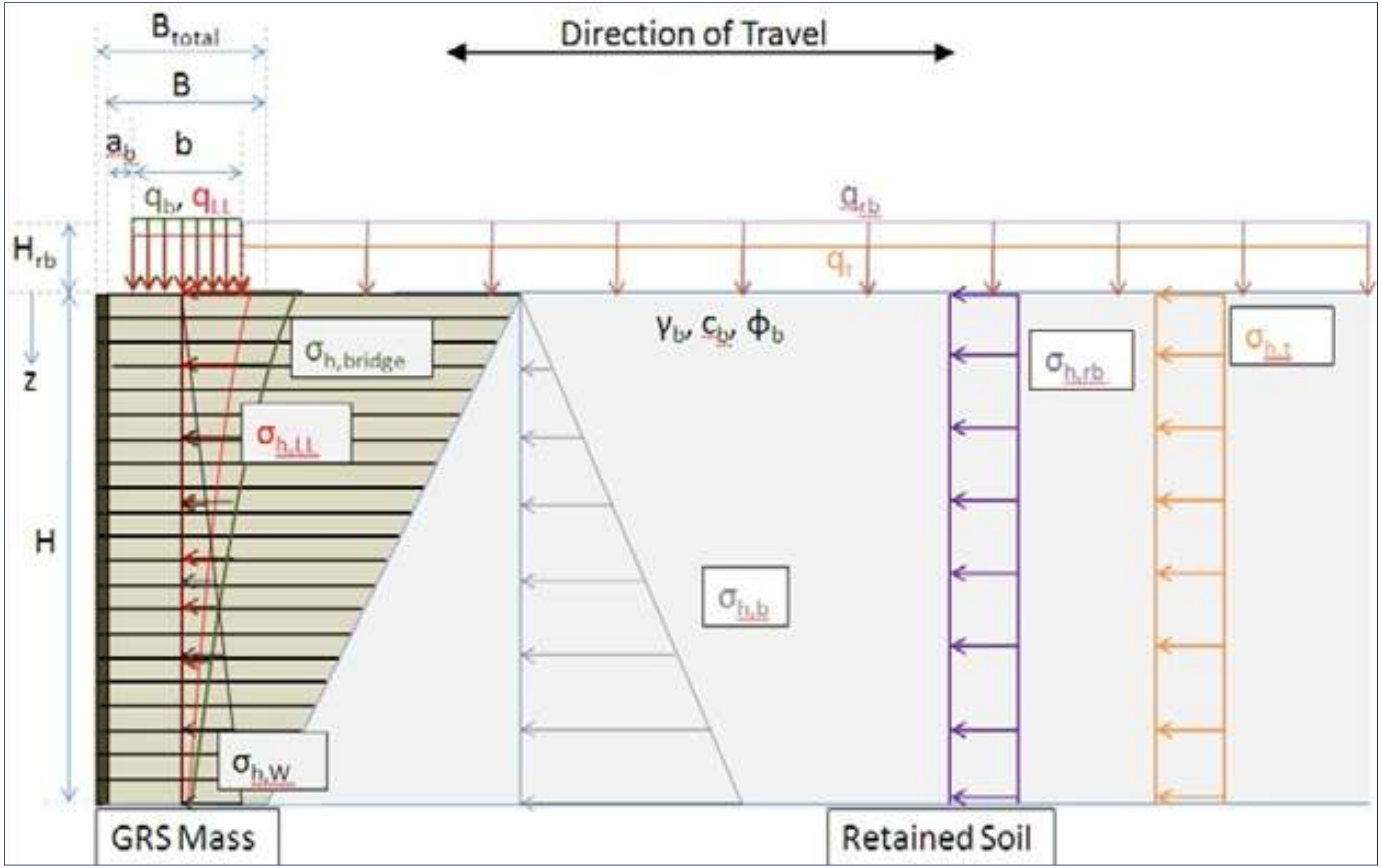
Design: GRS Abutment

- **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**



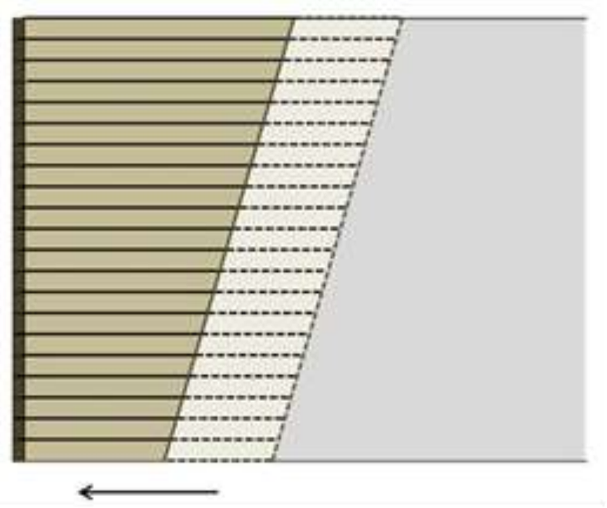
FHWA-HRT-11-026, June 2012

Load on GRS-IBS

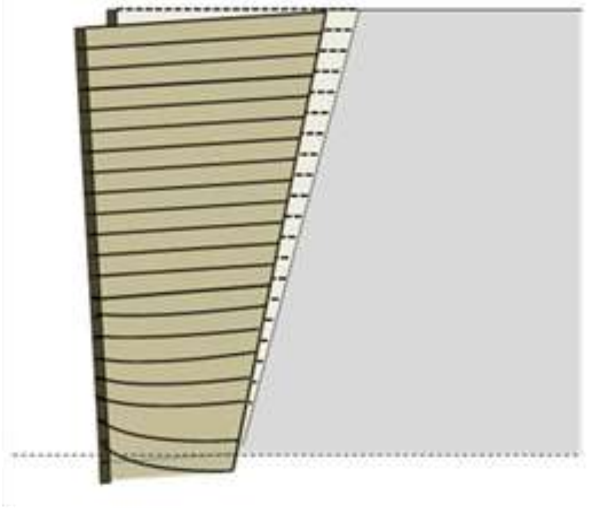


External Stability Analysis

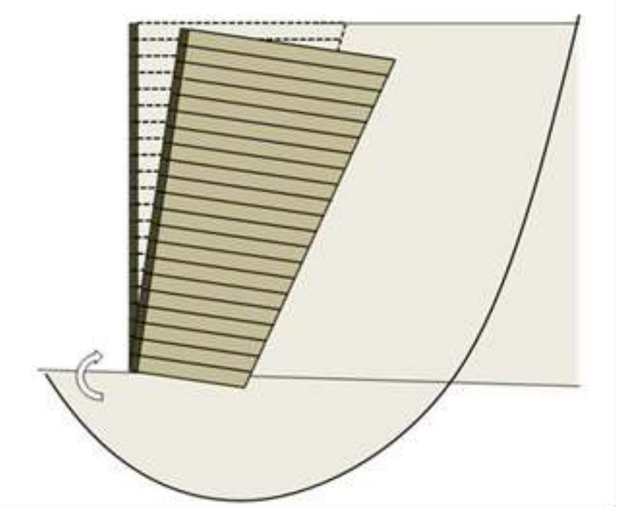
Direct Sliding



Bearing Capacity



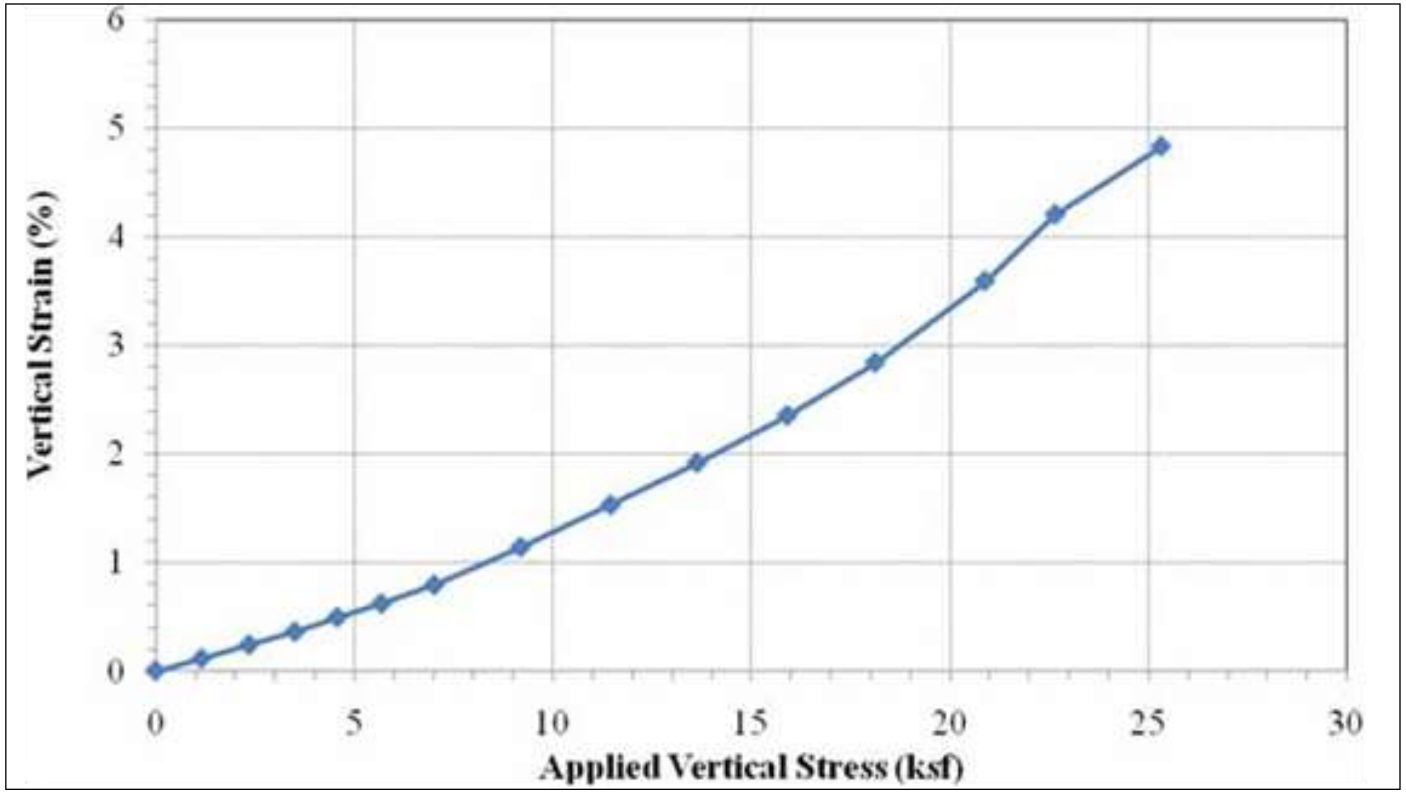
Global Stability



Ultimate Capacity

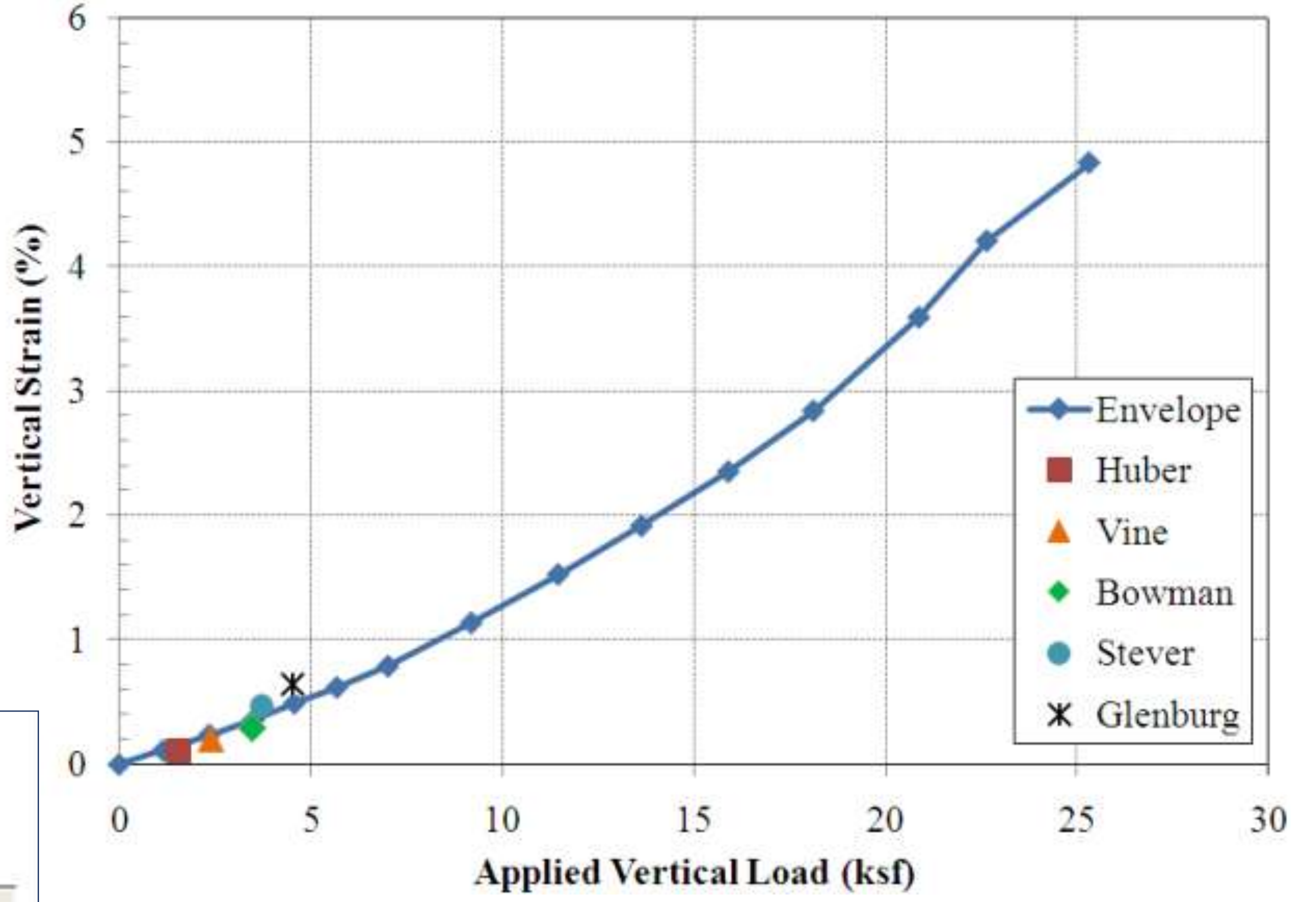
- **Empirical method**
  - Performance test
- **Analytical method**

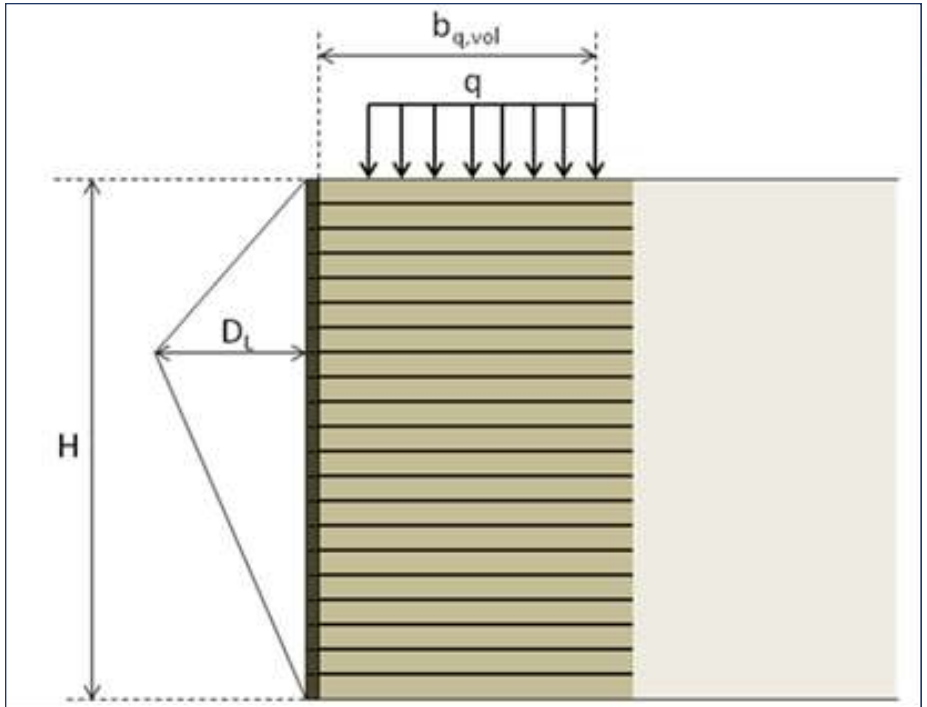
$$q_{ult,an} = \left[0.7^{\left(\frac{S_v}{6d_{max}}\right)} \frac{T_f}{S_V}\right] K_{pr}$$



Deformations

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





- **Lateral**

$$D_L = \frac{2 b_{q,vol} D_v}{H}$$

$$\varepsilon_L = \frac{D_L}{b_{q,vol}} = \frac{2D_v}{H} = 2\varepsilon_v$$

Terracon

FHWA-HRT-11-027, Jan 2011

Reinforcement Strength

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

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

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

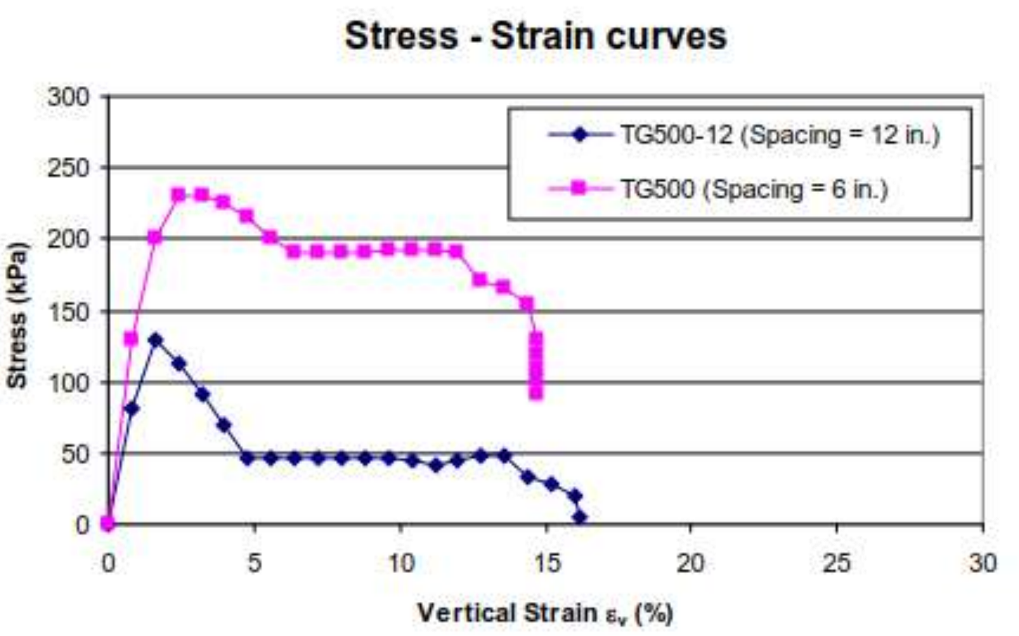
If necessary increase geosynthetic strength or decrease spacing to meet criteria

Integrated Approach

Photos courtesy FHWA EDC

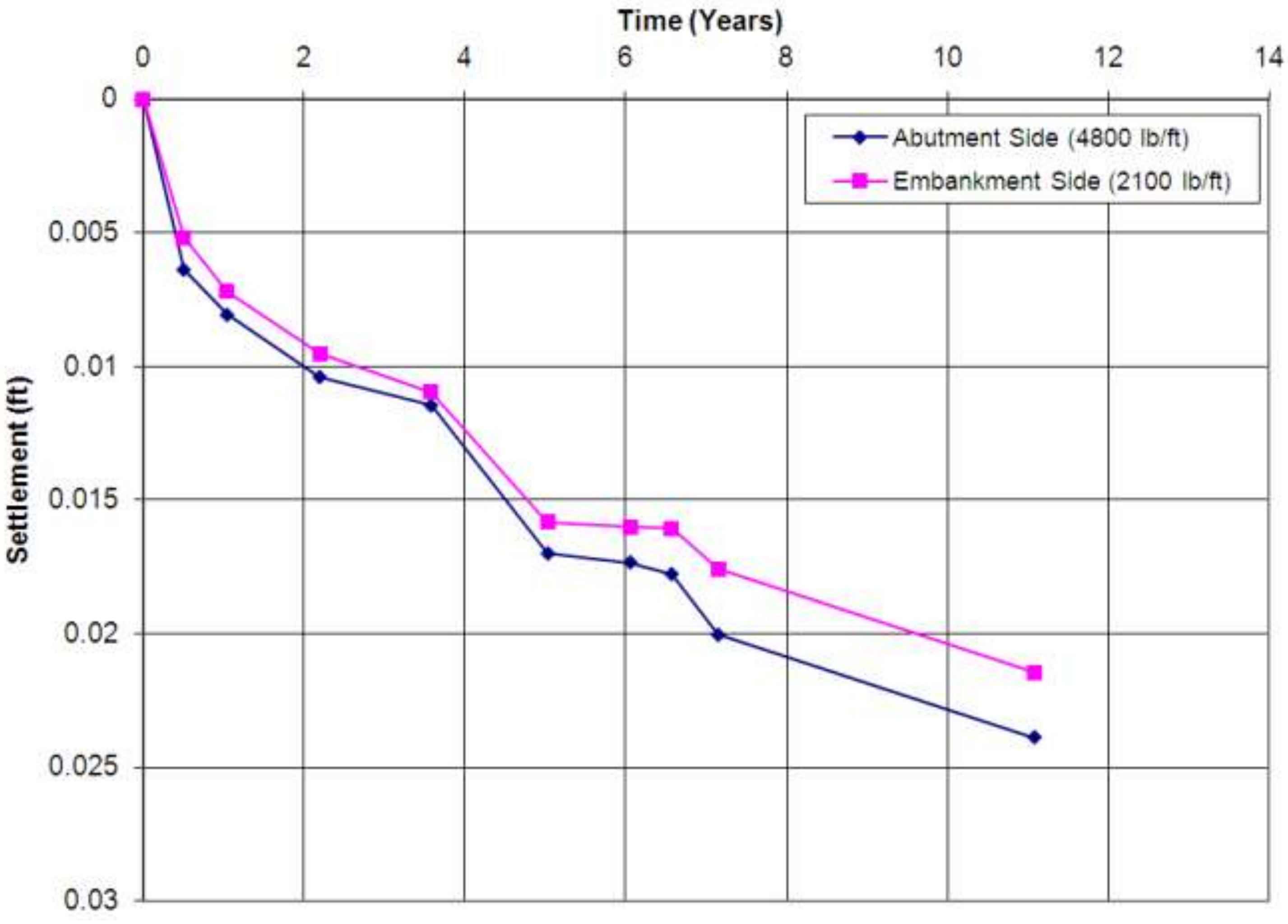
Terracon

Reinforcement Spacing



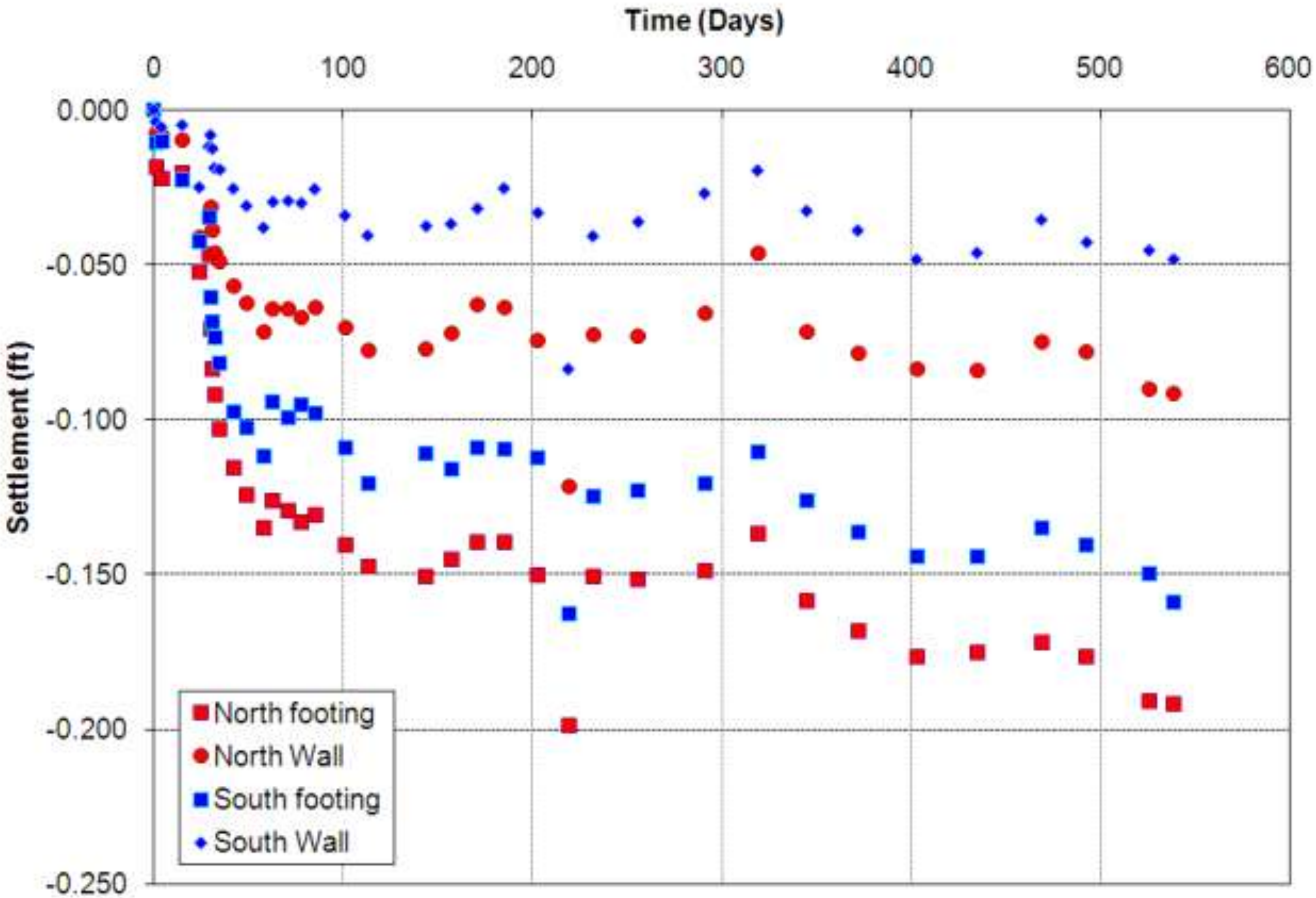
From FHWA-HRT-10-077, July 2013,
After Elton and Patawaraon (2004)

Geosynthetic Strength



FHWA-HRT-11-027, Jan 2011

Tiffin River Bridge Settlement



Bridge	Abutment	Abutment Height (ft)	Abutment Differential Settlement (ΔS_{abut}) (ft)	Uniformity of Abutment Settlement (ΔS_{abut}/ width of bridge)	Bridge Differential Settlement (ΔS) (ft)
Tiffin	North	20.52	0.003	0.0001	
River	South	18.00	0.005	0.0003	0.033

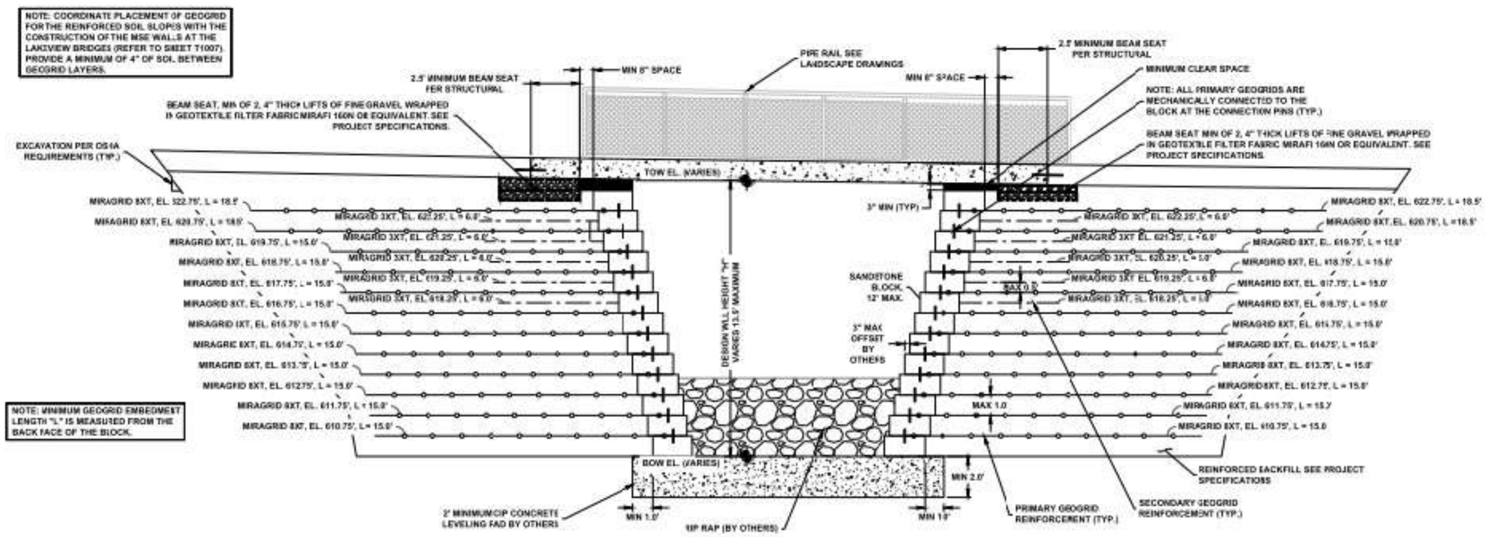
Terracon

FHWA-HRT-11-027, Jan 2011

Time Lapse Construction Video
Echo Bridge I-84

Video courtesy of Utah DOT

GRS-IBS – Tulsa, Oklahoma

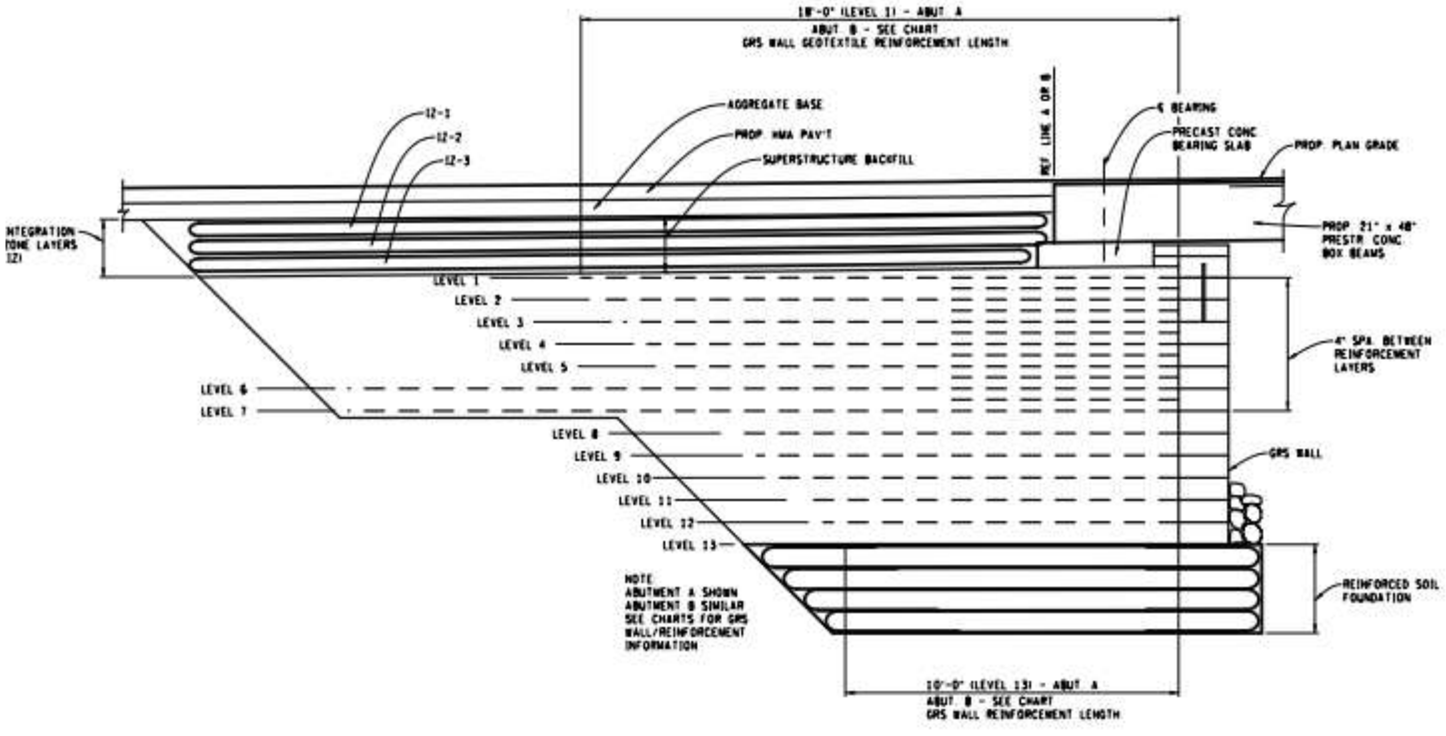


Terracon

GRS-IBS – Jordan, Utah

Terracon

Keefer Road Bridge, Michigan



SECTION – GRS WALL/REINFORCEMENT

Terracon

Photos courtesy of Allan Block

Hamilton County Bridge

References

FHWA Every Day Counts – GRS-IBS website

http://www.fhwa.dot.gov/innovation/everydaycounts/edc-3/grs-ibs.cfm

FHWA HRT-11-026, June 2012

FHWA HRT-11-027, January 2011

FHWA HRT-14-094, February 2015

FHWA HRT-10-077, July 2013

RESPONSIVE.
RESOURCEFUL.
RELIABLE.

4685 South Ash Ave.
Suite H-4
Tempe, Arizona 85282

Phone: (480) 897 8200

Terracon.com