GeoSynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)

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Defiance, Ohio
Defiance County’s GRS Experience
What is GRS?
How does it work?
What are its advantages?
Defiance County’s experience
Lessons learned and advice
What is GRS?

Geosynthetic Reinforced Soil

The combination of closely spaced (<12") geosynthetic layers with compacted select granular material
Reinforcement Spacing Controls Performance
Cut away of GRS mass
A split faced CMU SRW Block
How does it work?
Wall Type

External

- Tieback
- Soil Nails

Internal

- MSE
- GRS

Increased Reinforcement Frequency
From external to internal support

MSE

GRS

metallic

geosynthetic

Strips

Wire Grids

0.8m 0.6m 0.4m 0.2m

Reinforcement Frequency
GRS
- Composite Structure
- Internally stable
- Friction Connections
  - (generic)
- Close Spacing

MSE
- Quasi-tieback/Externally Supported
- Mechanical Connections
- Strong Reinforcement
  - Vendor specific
- Wide Spacing

$B/H < 0.3$

$B/H = 0.7$
2 Factors for Internal Stability

- Good compaction with quality fill
- Close reinforcement spacing
Generalized Comparison

Surcharges on MSE/GRS walls

- Traffic Loads
- Traditional Experimental Limits
- Working Loads for Bridges
- FHWA GRS Experiments

Stress (kPa)
FHWA GRS Pier
FHWA GRS Pier
(Vertical Stress vs Vertical Deformation)

Vertical Stress (kpa)

R² = 0.9853
Defiance County Mini Pier

Strength of Material Test
Defiance County Mini Pier Test
Average Vertical Strain vs. Applied Stress

Average abutment strain = 0.18%

CMU Block frictionally connected to GRS mass

Vertical Stress (kPa) vs. Strain (%)

- 163 kPa
- 1385 mm
- 1940 mm

Mini Pier
GRS Material Assumption

GRS has material properties different from that of soil with predicable behavior.
Applied Vertical Stress vs. Average Vertical Strain
(with 70kN/m at 8 in. spacing)
What are its advantages?
Advantages

- Low Cost Materials
- Non-Proprietary Materials and System
- Simple Design and Details
- Simple Construction
- Nearly All Weather Construction
- Very Flexible and Modular
Construction Advantages

- Same excavation, less expensive materials, lighter weight components and less weather sensitive construction
Can drive steel guardrail through it.
Poured Concrete in voids to tie top courses together
Simple tools & Materials
This is the same as 2 legally loaded semis STACKED

160 kips
Open to Traffic - 47 days
Span half of spill throughs
Defiance County Mini Pier

Strength of Material Test
Pioneer Lessons

- In hindsight, the most important lesson was a willingness to try it with an open mind.
- The initial cost savings is in rapid, flexible construction, reduced superstructure cost and improved approach performance. Cost saving follows.
- GRS-IBS design is about getting comfortable that it acts as a composite material.
Pioneer Lessons

- Take advantage of others’ experiences
- We have structures that have had the wrong type of guardrail used, experienced flood overtopping, etc.
- There is a growing community of GRS-IBS bridge owners that can share their experience
This structure has a 130’ opening, 25’ from deck to water

“Semi Integral” abutments with excellent performance. No bump, no crack, 3 years old

4 ksf dead load like the smaller structures
Superstructure types

- Adjacent Prestressed Box Beams with waterproofing and overlay
- Adjacent and Spread Prestressed Box Beams with composite concrete deck
- Steel Beams with composite concrete deck
- Cast in place slab
- Fiberglass box beams
Adjacent Box Beams

28’x20’-$68,000 - 2008
Spread Box Beams

28’x32’-$85,000 - 2010
Construction Methods

- 17 built entirely by county crew
- 7 structures with abutments built by county and superstructure by contractor
- 5 structures built entirely by contractor (4 different contractors so far)
“Contractor” Conclusions

- We keep a large quantity of fabric on hand, other materials are readily available on very short notice.
- We replenish our fabric supply in truckload intervals and have a number of suppliers.
- We are replacing bridges at around half our previous costs and in substantially less time.
- Our crew can install without engineering in many non abutment applications.
“Contractor” Conclusions-2

- Able to work in many weather conditions including cold and rain
- Smaller superstructure requires smaller crane
- Abutments serve as permanent, engineered crane pads
- Has fit every superstructure type we have considered
Efficiency Gains

- For both our crew and the 4 contractors, the initial projects were similar in cost to traditional deep foundation cost but much faster.
- We are at least twice as fast now over initial with a corresponding savings in cost.
- 3 days for standard abutment.
“Owner” Conclusions

- Easy to design. Gravity abutment with engineered composite material
- Easy change orders. Unit prices
- Easy to inspect construction. 1-2-3
- Easy to maintain. No bump, masonry repairs to cosmetic face if needed
- Easy to inspect.
Financial Impact

- In the 6 years 2000-2005 we replaced 11 structures over 20’ span. 8 with federal funds and 3 with local funds.

- In the 6 years 2006-2011 we replaced 18 structures over 20’ span. 4 with federal funds and 14 with local funds.
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28 of 234 Bridges
21 of 109 Federal Bridges
Implementation Advice

- This is new, change takes effort
- Our initial cost was much higher than today
- Contractors like consistency, worry about risk
- It's often easier to identify threats and risks than opportunities
Implementation Advice

- Good education ahead of bid is vital
- FHWA video, prebid meeting
- Initial costs will be high, but will drop with familiarity and experience
- We saw consistent bids from very large to very small contractors
- Use unit price bids to encourage thought and lower contractor risk