GEOSYNTHETIC REINFORCED SOIL – INTEGRATED BRIDGE SYSTEM (GRS-IBS)

GRS-IBS Overview, Case Studies, & MDOT Perspective

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2015 COUNTY ENGINEERS CONFERENCE
February 3-5, 2015
What is GRS-IBS?

- FHWA Every Day Counts-2 (EDC-2) Initiative
  - Technology developed as part of the Accelerated Bridge Construction

- MDOT’s Goal: Develop awareness of GRS-IBS in bridge owners and designers within the state of Michigan. Develop State specific plans and specifications for a demonstration project. Let at least one bridge with this technology.
Conventional Bridge - Design is comprised of
- Foundation
- Substructure
- Superstructure.

GRS-IBS is also comprised of three components
- Reinforced Soil Foundation (RSF) – Aggregate wrapped in layers of geotextile.
- GRS Abutment - Alternating layers of soil and geosynthetic reinforcements. Faced with concrete blocks.
- IBS – Beams, guardrail, and deck (HMA or concrete).
Abutment Cross Section of GRS-IBS

- Jointless (continuous asphalt pavement)
- Beam Seat/Bearing Area
- Secondary Reinforcement ("load shedding" layers beneath beam seat – 4 inch spacing)
- Facing Block (frictionally connected)
- Channel Rock Protection
- GRS Abutment (geotextile reinforcement 8 inch spacing)
- Blended Approach (GRS transitions into pavement section)
- Reinforced Soil Foundation (encapsulated with geotextile)
- GRS Approach ("geotextile wrapped layers at beam ends form smooth road transition")
RSF – Keefer Highway Project
GRS Abutment
Keefer Highway Project
IBS – Pre-Cast Concrete Box Beams
Keefer Highway
GRS IBS - Design Considerations

- Types of Facing Used for GRS IBS

- SRW
  Image source: Utah DOT

- Sheet Pile
  Image source: Scott County, IA

- CMU
  Image source: PA DOT

- Large Wet Cast Block
  Image source: Town of North Haven, ME

- Pre-cast panel
  Image source: Colorado DOT
GRS IBS – Implementation Progress

190 Bridges nationally in 43 states including PR and DC - September 2014

States with GRS IBS projects:
- No GRS projects
- Only Federal agency projects
- Federal & local project
- State DOT utilizing GRS IBS

Map showing the distribution of GRS IBS projects across the United States.

Image source: FHWA
Cross Section of GRS-IBS

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Challenge:
Improve Local Agency Bridges

- Local Agencies
  - Structurally Deficient Bridges > 1000
    - 556 Poor Bridges
    - 459 Serious and Critical
Local Agency
Bridge Replacement Needs

- 675 Single-Span Poor Bridges
Guidelines on Design and Use

At Structure Study, Consider for:
• One-span structures only, less than 140 ft span,
• Low traffic volume county roads and state trunklines,
• Grade crossings or roads crossing streams, creeks, and drains that have suitable hydraulic conditions (i.e., low velocity and scour),
• Abutment heights less than 30 feet.
• “Good” Foundation Soils
Design Development


- Initial Design Steps
  - Establish Project Requirements
  - Perform Site Evaluation
  - Evaluate Project Feasibility
Michigan Department of Transportation
Special Provision for
Geosynthetic Reinforced Soil Abutment
12DS206(G355)

The following definitions apply when used herein and on the plans:

Geotextile Reinforcement. Elastomeric geotextile reinforcement having strength and stiffness that are approximately equal in both the machine and the cross machine directions.

Geosynthetic Reinforced Soil (GRS). Alternating layers of compacted granular fill reinforced with Geotextile Reinforcement. Facing elements are connected to the reinforcement layers to form an outer GRS Wall. Facing elements must consist of segmental block units (SBUs).

GRS Abutment. A GRS retaining wall system designed to support the weight of a bridge superstructure. Usually, GRS abutments have three sides: the abutment face wall and two wing or return walls.

GRS Abutment Face Wall. The vertical or near vertical wall parallel to the center of superstructure bearing seat and designed to support the bridge superstructure.

GRS Wing Wall. A wall attached and adjacent to the GRS abutment face wall. The GRS wing walls are built at the same time as the GRS abutment face wall and at a right or other angle to the GRS abutment face wall.

Reinforced Soil Foundation (RSF). A reinforced soil mass located below the GRS. This mass consists of alternating layers of compacted well graded aggregate and Geotextile Reinforcement.

Retained Soil. Backfill located behind the GRS wall mass.

Clear Space. The vertical distance between the top of the GRS abutment face wall and bottom of the superstructure above the wall. This distance is 3 inches or 2 percent of the GRS wall height, whichever is greater.

Beam Seat Setback. The lateral distance from the back of the GRS SBU to the front of the superstructure beam seat area. This distance is a minimum of 8 inches or as shown on the plans.

b. Materials. The basis of acceptance for all materials not addressed by the standard specifications and specified herein will be a certification in accordance with the Materials Quality...
Design Development


- Initial Design Steps
  - Establish Project Requirements
  - Perform Site Evaluation
  - Evaluate Project Feasibility
GRS-IBS Considerations

- Requires early geotechnical and hydraulic analysis to determine GRS abutment feasibility.
- Requires good communication between structural and geotechnical engineers.

Cross Section of GRS-IBS Abutment
GRS-IBS Considerations (continued)

- Perform thorough QC testing of materials during construction.
- Provide enough lead time between let date and construction start date for block testing.
  - 90 day freeze thaw testing requires 3 to 4 months depending on lab capabilities. Exception: Manufacturer has tested lot already.
Summary

- Encourage CRCs to look at GRS-IBS during Structure Study.
- Plans and special provision for a County/MDOT/FHWA funded project have been developed.
- One project let: Keefer Highway over Sebewa Creek.
- MDOT is actively searching for an appropriate trunkline to use GRS-IBS.
- If technology becomes widely used, develop specific design guidance for MDOT funded projects.
Thank you!

Questions?
GRS-IBS in Luverne, MN
Bridge Length = 77.5 ft, Wall Height ~ 22.5 ft
NY – CR 38, St. Lawrence County
PA – Sandy Creek Bridge
PA – Sandy Creek Bridge
IL – Great Western Trail over Grace Street
FL – Nassau County
SD – 8th Street, Custer
UT – I-84 Echo Project