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

• GRS-IBS Overview
• GRS-IBS Benefits
• How to Decide if GRS-IBS is a Good Choice
• Design of GRS-IBS
• Construction Materials
• Construction of GRS-IBS
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GRS-IBS Overview
What is **GRS-IBS**?

- **GRS-IBS** go together, and are:
  - Geosynthetic Reinforced Soil (GRS) and
  - Integrated Bridge System (IBS).
- **GRS-IBS** is an innovative way to design and build bridge abutments and piers.
Definitions

• **GRS - Geosynthetic Reinforced Soil**
  – An engineered fill of closely spaced (≤ 12” ) alternating layers of compacted backfill material and geosynthetic reinforcement.

• **IBS - Integrated Bridge System**
  – A fast, cost-effective method of bridge support that blends the roadway into the bridge superstructure using GRS technology.
Typical GRS Bridge Abutment
FHWA has a GRS-IBS website at
GRS-IBS Benefits

• The benefits of GRS-IBS compared to conventional bridge construction methods are described on the following slides.
GRS-IBS Benefits: Speed of Construction

- GRS-IBS bridge abutments / approaches can be built in weeks compared to months for conventional methods.
GRS-IBS Benefits (cont'd.): Easier to Build

- Simple Materials, Machinery and Tools:
  - allow Force Account Crews to construct.
- Simpler design and fewer Parts.
- The GRS-IBS bridge may not need a deep foundation:
  - In many cases, GRS abutments can support heavy loads from the bridge superstructure without needing piles or other deep foundation types.
  - Need Geotechnical investigation of the site to verify.
Easier to build and perform construction inspection because:

– No deep foundation*;
– No approach slab;
– No sleeper slab;
– No parapets;
– No bridge bearings;
– No joint details.

* **Note:** Perform geotechnical reconnaissance and a hydraulic analysis for each project to determine if a deep foundation is needed or not.
A GRS abutment can easily be modified* during construction to fit around unexpected site conditions such as:

– Utilities;
– Obstructions;

Much of the work can be constructed in some rainy or colder weather, as long as the project specifications (moisture, compaction, temperature, etc.) are met.

*Note: Modifications must be reviewed and approved by a Professional Engineer.
GRS-IBS Benefits (cont'd.):
Smoother Transition at ends of bridge
GRS-IBS Benefits (cont'd.): Summary of Benefits

- Reduced construction cost (25 - 60%);
- Reduced construction time;
- Construction less dependent on weather conditions;
- Can use Force Account crews due to simpler construction;
- Flexible design - easily field modified for unforeseen site conditions
- Construction inspection is easier.
How to Decide if GRS-IBS is a Good Choice
Is GRS-IBS a Good Choice for Your Project?

• GRS-IBS will not be feasible for all bridges;

• But it should always be looked at as a possibility when you are performing the planning and scoping for an upcoming bridge project.

• To decide, you need to look at the project site conditions and your project’s requirements.
Is GRS-IBS a Good Choice for Your Project? (cont’d.)

• GRS-IBS may be suitable for these situations:
  – Single span (longest span length currently 140 ft);
  – Up to 30 ft abutment height;
  – Water crossings with low scour potential;
  – Grade separations (highway overpasses);
  – Steel, timber, composite, or concrete beams;
  – New or replacement structures.

• GRS-IBS can handle any traffic volume.
Is GRS-IBS a Good Choice for Your Project? (cont'd.)

• GRS–IBS may **not** be suitable for your project if:
  – Deep foundations or expensive scour counter-measures are needed for your bridge project.

• Perform a hydraulic analysis and a geotechnical investigation early in the bridge design:
  – To determine amount of stream instability, scour, and adverse flow conditions; and
  – To determine need for deep foundations or expensive scour counter-measures.
DESIGN OF GRS-IBS
The Design Process for GRS-IBS is:

• A professional engineer needs to perform the design.
• The steps of the design process (in order) are:
  1) Establish the project’s requirements (bridge width, environmental constraints, etc.);
  2) Evaluate the project site (location of the project)
     – Perform a thorough hydraulic analysis
     – Perform a geotechnical investigation;
  3) Determine if GRS-IBS is a good choice for the site conditions and the project requirements;
  4) If yes, then design the structure using GRS-IBS.
Perform a thorough hydraulic analysis

• A hydraulic analysis is needed early in the design of the bridge.

• A professional hydraulic engineer or hydrologist needs to perform the hydraulic analysis.

• The hydraulic analysis estimates the scour on the proposed abutments and piers, and determines the “freeboard” height.

• The amount of potential scour is one of the main considerations on whether or not to use GRS-IBS on your bridge.
A geotechnical investigation is needed early in the design of the bridge, including the abutments. This is true of conventional bridges as well as GRS-IBS bridges. The geotechnical investigation is needed to determine if deep foundations, piles, etc. will be needed or not. If the geotechnical investigation determines that deep foundations, piles or other expensive foundation items will be needed, then GRS-IBS may not be a good choice for the project.
CONSTRUCTION MATERIALS
Typical Construction Materials are:

- Geosynthetic reinforcement placed in layers;
- Granular backfill, placed and compacted between the layers of geosynthetic;
- Facing for the GRS abutment; and
- Miscellaneous Materials
Typical GRS-IBS Layout (profile view) at the end of a bridge.
Suitable geosynthetic materials are:

- Geotextiles
- Geogrids
Geosynthetic Reinforcement Continued

Biaxial Geotextile

Uniaxial Geogrid
Granular Backfill

Two types:
Open Graded
Well Graded
Facing Blocks
Miscellaneous Materials

- Concrete block wall fill.
- Rebar.
- Aluminum flashing.
- Foam board.
- Bitumen coating.
CONSTRUCTION OF GRS-IBS
Construction inspection (Quality Assurance/Quality Control - QA/QC) performed during construction needs to look at:

- Block alignment;
- Reinforcement placement;
- Backfill compaction;
- Quality of construction materials;
- Scour protection; and
- Drainage.
CONSTRUCTION OF GRS-IBS
Labor and Equipment

• Common labor.
• Equipment, Non-specialized:
  – Hand tools
  – Measuring devices
  – Heavy equipment
CONSTRUCTION OF GRS-IBS
Equipment
CONSTRUCTION OF GRS-IBS

Equipment (cont'd.)
CONSTRUCTION OF GRS-IBS
Equipment (cont'd.)
CONSTRUCTION OF GRS-IBS
Equipment (cont'd.)
CONSTRUCTION OF GRS-IBS

Tools (cont'd.)

- Saw to cut the facing blocks.
CONSTRUCTION OF GRS-IBS

Tools (cont'd.)

- Level
- String Lines
- Shovels
- Rakes
CONSTRUCTION OF GRS-IBS
Tools (cont'd.)

- Rubber Mallet
- Block Tongs
CONSTRUCTION OF GRS-IBS

Excavation
CONSTRUCTION OF GRS-IBS
Excavation (cont'd.)
CONSTRUCTION OF GRS-IBS
Reinforced Soil Foundation
CONSTRUCTION OF GRS-IBS
Reinforced Soil Foundation (cont'd.)
CONSTRUCTION OF GRS-IBS
Reinforced Soil Foundation (cont'd.)
CONSTRUCTION OF GRS-IBS
Block Placement (First Row)
CONSTRUCTION OF GRS-IBS Wall with Leveling Pad
CONSTRUCTION OF GRS-IBS
Placement of Geosynthetic

• Roll out the geosynthetic parallel to abutment face, and with the strong direction perpendicular to abutment face.
CONSTRUCTION OF GRS-IBS
Placement of Geosynthetic (cont'd.)

• Pull reinforcement taut
• Remove wrinkles

No overlaps, especially at the face
CONSTRUCTION OF GRS-IBS
Placement of Geosynthetic (cont'd.)

Trim geosynthetic at block facing

Clean finished face
CONSTRUCTION OF GRS-IBS

Placement of Blocks for Facing Wall
CONSTRUCTION OF GRS-IBS
Placement of Blocks for Facing Wall (cont’d.)
CONSTRUCTION OF GRS-IBS
Placement of Blocks for Facing Wall Corners
CONSTRUCTION OF GRS-IBS
Placement of Blocks for Facing Wall Corners

• This wall corner was made of CMU corner blocks with architectural detail on two sides:

• Some corners are not 90 degrees:
CONSTRUCTION OF GRS-IBS
Placement of Backfill

Place backfill between the layers of geosynthetic.
CONSTRUCTION OF GRS-IBS
Placement of Backfill (cont'd.)
CONSTRUCTION OF GRS-IBS
Placement of Backfill (cont'd.)
CONSTRUCTION OF GRS-IBS
Placement of Backfill (cont'd.)
CONSTRUCTION OF GRS-IBS

Compaction of Backfill

- Layers of backfill and geosynthetic reinforcement make up the abutment;
- So, proper compaction of each layer of the backfill is extremely important.
CONSTRUCTION OF GRS-IBS
Compaction of Backfill (cont’d.)
CONSTRUCTION OF GRS-IBS
Compaction of Backfill (cont’d.)
CONSTRUCTION OF GRS-IBS
Rip Rap Installation
CONSTRUCTION OF GRS-IBS
Rip Rap Installation (cont'd.)
CONSTRUCTION OF GRS-IBS
Top of Facing Wall

- Additional geotextile reinforcement is placed in the layers of backfill under where the beams are to be placed.
- Hollow cores of top three courses of CMU facing block are filled with concrete and pinned together with No. 4 rebar.
CONSTRUCTION OF GRS-IBS
Top of Facing Wall (cont’d.)
CONSTRUCTION OF GRS-IBS
Top of Facing Wall (cont'd.)
Beam Seat at the top of the wall.

• **Beam Seat Procedure:**

  1) Place pre-cut foam board of 4 in” thickness on the top of the bearing bed reinforcement. The foam board should be butted against the back face of the block facing wall.
CONSTRUCTION OF GRS-IBS
Top of Facing Wall (cont'd.)

- Beam Seat Procedure (cont'd.):
  2) Set a 4” solid concrete block on top of the foam board, across the entire length of the bearing area.
CONSTRUCTION OF GRS-IBS
Top of Facing Wall (cont'd.)

• Beam Seat Procedure (cont'd.):
  3) The first 4” wrapped layer of compacted fill is the thickness to the top of the foam board.
  4) The second 4” wrapped layer of compacted backfill is to the top of the 4” solid block creating the clear space.
  5) Grade the surface aggregate of the beam seat slightly high (to about 0.5”) to seat the beams level and maximize contact with the bearing area.
Beams are placed directly on the top layer of geosynthetic reinforcement covering the compacted backfill.

Set Back: The distance between the back of the facing block and the front of the beam seat.
CONSTRUCTION OF GRS-IBS

Placement of Beams (cont'd.)
CONSTRUCTION OF GRS-IBS
Placement of Beams (cont'd.)
Coping cap along the top of the wall:

- After the top three courses of facing block are completed, a thin layer of the same concrete mix is placed on the exposed portions of the top of the wall. This is the “coping cap”.

CONSTRUCTION OF GRS-IBS
Top of Facing Wall (cont'd.)
CONSTRUCTION OF GRS-IBS

Video at

https://www.youtube.com/watch?feature=player_detailpage&v=w_5WFoAdoUw
EXAMPLE PROJECTS
OH – Bowman Rd Bridge
NY – CR 38 St. Lawrence County
PA – Sandy Creek Bridge
IL – Great Western Trail over Grace ST
DE – Chesapeake City Road over Guthrie Run
SD – 8th Street Bridge, Custer
HI - Saddle Rd
ME - Knox County Beach Bridge
MT, US-89 over the S. Fork Dry Fork Marias River
MN – CR 55 over MN Southern Railway
MN – CR 55 over MN Southern Railway
Questions?