Geosynthetic Reinforced Soil Integrated Bridge System

by Justin Pelletier, Project Engineer, University of New Hampshire Technology Transfer Center

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increases the soil confinement, thus increasing the vertical stiffness and bearing capacity of the soil. Today, GRS is commonly used in retaining wall construction. A relatively new technology, however, is the incorporation of GRS into bridge abutments and approaches, resulting in a jointless interface between the bridge and the approach. This is known as a GRS Integrated Bridge System (IBS). By integrating the bridge approach with the superstructure of the bridge, the "bump at the bridge" problem caused by differential settlement between bridge abutments and approach roadways virtually disappears. GRS-IBS is a viable technique for many small bridge construction projects.

As a part of the Federal Highway Administration's (FHWA) Every Day Counts Initiative, the main benefits of GRS-IBS include time and cost savings. Since cast-in-place (CIP) concrete is not used, the concrete's cure time (which must be accounted for in most bridge construction projects) is not a part of the construction timeline or budget. Concrete abutments and footings are now being replaced with geosynthetic reinforced soil, providing necessary strength and stiffness to support the bridge superstructure. The GRS abutments are protected with modular facing blocks, providing an aesthetic façade as well as being the more time and budget-concious choice. These construction materials allow GRS-IBS structures to easily be built with common construction equipment and conventional labor practices. No skilled labor or specialized equipment is necessary for these projects. Also, a simpler construction method generally leads to fewer accidents and increased personnel safety.

Another benefit of GRS-IBS is the smooth transition from the approach roadway to the bridge structure. Sometimes, on structures that were not built with the GRS-IBS method, transitions from the roadway to the bridge can be bumpy and jarring. In extreme cases, a bridge bump may be bigger than a typical speed

Typical geosynthetic reinforced soil system

bump. For snow plows, the damage caused by bumps of this size can be tremendous. In turn, the plows may cause significant damage to the roadways. Without these bumps, drivers see increased comfort and the bridge owner tends to see decreased maintenance costs. GRS-IBS decreases the differential settlement between the approach roadway and the bridge substructure by integrating the two, making for seamless transitions. The increased durability of the transition adds to the initial project cost savings throughout the lifespan of the bridge. GRS-IBS is not only more comfortable for drivers, but more cost-effective for both the roadways and bridge owners.

An added bonus to GRS-IBS is the smaller construction footprint. A smaller construction footprint means that a project has a low environmental impact. Considering this slew of significant benefits, it is clear that GRS-IBS is a sustainable, practical, and effective construction option for small bridge projects.

Design Considerations

As previously stated, the construction of GRS consists of alternating layers of compacted granular fill and geosynthetic reinforcement on top of a reinforced soil foundation. GRS-IBS construction follows a simple three step process:

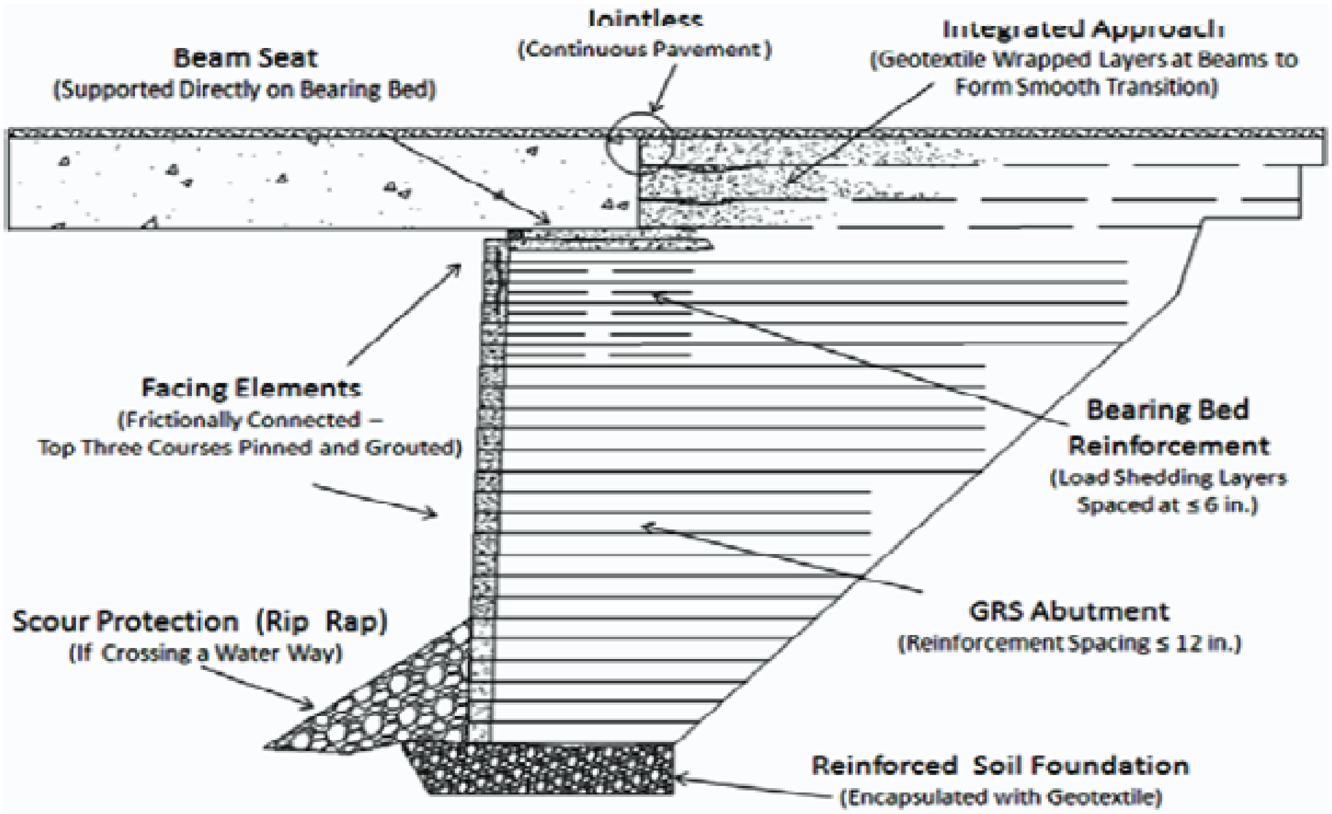

Illustration of a typical GRS-IBS cross section

1. Lay down a row of facing blocks
2. Compact a layer of granular fill material behind the facing blocks
3. Place layer of geosynthetic reinforcement, repeat

The geosynthetic reinforcement is frictionally connected to the face wall blocking, allowing for a highly adaptable design system. The facing blocks should be between eight and twelve inches to allow for composite behavior. The closer the reinforcement spacing is, the better the composite action between the soil and the reinforcement. Contrary to what logical reasoning would suggest, the strength of the geosynthetic fabric does not play a significant role in GRS deformations. GRS deformation is mostly controlled by reinforcement spacing and the level of soil compaction. It is generally accepted that any spacing less than or equal to twelve inches provides sufficient strength and stiffness for a bridge abutment. The top three or four courses of facing blocks should be pinned and grouted. The approach is integrated into the bridge system by constructing layers of GRS directly behind the beams. This also allows for a jointless pavement design.

There should be a Bearing Bed Reinforcement Zone directly under the beam bearing seats in order to accommodate for the increased load on the soil due to the bridge. Generally speaking, the length of the bearing bed reinforcement should be double the beam setback length. The bearing bed reinforcement spacing ought to be at least half the normal reinforcement spacing. The depth of the bearing bed is determined based on internal stability design for required reinforcement strength. GRS-IBS designs should be made following the Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide, which is distributed by the FHWA.

There are limitations on the height of the abutment face as well as the allowable bearing stress. The design method proposed by the FHWA's Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide is limited to GRS Structures with a vertical (or near-vertical) face wall that does not exceed 30 feet. The bearing stress on the GRS abutment is limited to 4000 psf. Also, it is recommended that spans be limited to approximately 140 feet. Longer spans may be permissible in the future, but the demands of longer spans on the GRS-IBS abutments are not fully understood at this time.

Concluding Remarks

Currently, there are 44 bridges in the United States with GRS abutments, 27 of which are GRS-IBS. With the inclusion of GRS-IBS in the Every Day Counts Initiative, the popularity of the technique is expected to increase significantly in the near future. For more information on GRS-IBS, visit the Every Day Counts page on the FHWA website (http://www.fhwa.dot.gov/everydaycounts) and look for GRS-IBS. Also, refer to the Geosynthetic Reinforced Soil Integrated Bridge System Synthesis Report (FHWA) as well as the Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide (FHWA).

References

FHWA. (2011). *Geosynthetic Reinforced Soil Integrated Bridge System: Interim Implementation Guide.* McLean, VA: USDOT Federal Highway Administration.

FHWA. (2011). *Geosynthetic Reinforced Soil Integrated Bridge System: Synthesis Report.* McLean, VA: USDOT Federal Highway Administration.

T² NH State Legislative Updates

by Beth Hamilton, UNH T²

This is the first edition of a summary of current and recent New Hampshire House and Senate Bills that may affect you, your organization, town or city, or operations. At any given time, there are many Bills that could potentially affect the way you and your organization may operate. The Technology Transfer Center would encourage you to be aware by checking www.gencourt.state.nh.us frequently for upcoming Bills. A section of Road Business will be devoted to highlighting some of the Bills that could be important to the readers. If you have any suggestions, please feel free to email e.hamilton@unh.edu or call Beth Hamilton at 603-862-1362 so we can include the most up-to-date information.

•Senate Bill 247 is relative to creating a certification program for municipal culvert installers. It would authorize the Department of Environmental Services to develop the certification program in conjunction with the Technology Transfer Center.

•House Bill 1716 is relative to the State's 10-year Transportation Improvement Program.

•Senate Bill 386 is relative to authorizing the State Treasurer to issue bonds for highway construction.

•Senate Bill 265 is relative to the definition of stormwater to change to "water from precipitation that results in runoff, snowmelt runoff, and surface runoff and drainage, together with debris, chemicals, sediment, or other substances that may be carried along with the water."

These Bills could particularly affect you and your organization. Please take the time to visit www.gencourt.state.nh.us to view these Bills and more. Please be sure to contact your local representatives to voice your opinion on the matters at hand.