



Advancing Implementation of Geosynthetic Reinforced Soil-Integrated Bridge Systems (GRS-IBS)

tech transfer summary

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MTC RESEARCH PROJECT TITLES

Advancing Implementation of Geosynthetic Reinforced Soil-Integrated Bridge Systems (GRS-IBS) and Implementation Evaluation of the Rustic Road Geosynthetic Reinforced Soil-Integrated Bridge System

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PRINCIPAL INVESTIGATORS

John Bowders, Professor
Andrew Boeckmann, Research Engineer
University of Missouri - Columbia
boeckmanna@missouri.edu
573-884-7613

MORE INFORMATION

www.intrans.iastate.edu/

MTC

Iowa State University
2711 S. Loop Drive, Suite 4700
Ames, IA 50010-8664
515-294-8103

The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC). Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

MTC's research focus area is State of Good Repair, a key program under the 2012 federal transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MTC research focuses on data-driven performance measures of transportation infrastructure, traffic safety, and project construction.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the project sponsors.

Geosynthetic reinforced soil-integrated bridge system (GRS-IBS) designs include a reinforced soil foundation, a GRS abutment, and a GRS integrated bridge approach.

Goal and Objectives

The goal of this work is to advance the implementation of geosynthetic-reinforced-soil integrated bridge systems (GRS-IBS) technology. The objectives were to document relevant technical literature, summarize transportation agency experiences, and evaluate the construction and early service life performance of a GRS-IBS.

Problem Statement

Despite the cost and time savings and performance benefits associated with GRS-IBS technology, it has not experienced widespread implementation. Use of the technology is likely becoming more common and widespread, particularly with several agencies deploying GRS-IBS on numerous occasions. However, other agencies have likely not implemented GRS-IBS because of a lack of familiarity with the technology and its implementation benefits.

Research Description

The research team documented recent implementations focusing on technical performance and practical lessons from agency experiences in contracting and constructing these types of bridges. These GRS-IBS experiences were culled from a literature review, interviews with agency and contractor personnel, and the research team's direct observations.



Completed Rustic Road GRS-IBS from the northeast

The review centered on analysis of the following case studies:

- Defiance County, Ohio, which constructed its first GRS-IBS in 2005, making it an early adopter of GRS-IBS
- Pennsylvania Department of Transportation (PennDOT), which between 2011 and 2014 constructed six GRS-IBS bridges, while local agencies in Pennsylvania constructed an additional seven
- Previous contractor perspective and implementation challenges on two GRS-IBS projects in Missouri
- Construction and performance of the Rustic Road GRS-IBS project in Boone County, Missouri

Rustic Road GRS-IBS Project

Rustic Road is a low-volume road just east of Columbia, Missouri. In 2013, deterioration of the original Rustic Road bridge led to a load rating that precluded fire trucks from crossing the bridge. In response, the City of Columbia and Boone County initiated a bridge replacement project.

The replacement project was identified as a candidate for the GRS-IBS because the bridge is relatively short in span (50 ft) and height (14 ft) and because of the need for rapid replacement, given there are no detours for the roadway south of the bridge and that relatively frequent flooding of the project site made the project an interesting GRS-IBS test case.

Missouri DOT (MoDOT) personnel had considered use of GRS-IBS for several years, but had difficulty identifying an appropriate bridge project for trial use, primarily because the agency does not have many single-span bridges. MoDOT enlisted the research team to monitor the Rustic Road GRS-IBS project for approximately 18 months after construction of the bridge, which included documenting the following: design, bidding, construction, monitoring, and performance.



Original Rustic Road bridge showing deterioration of the outer girder, including corrosion through an entire portion of the web near the abutment



Compaction of second layer of beam seat

Performance of the Rustic Road GRS-IBS was monitored closely for 19 months after construction, with regular visual observations, land surveys, and measurements from telltale devices for settlement, inclinometers, earth pressure cells, and piezometers.

Key Findings

Technical and Performance Observations

- The Rustic Road GRS-IBS performed as intended: external and internal displacements were negligible and the backfill was typically dry and drained quickly after precipitation events, even with the project site experiencing water levels that approached the bottom of the bridge girders.
- Cracking of some concrete masonry unit (CMU) wall facing blocks was observed on top of the Rustic Road GRS-IBS wing walls shortly after construction, but the cracks did not expand in the ensuing 19 months.

GRS-IBS Construction Insights

Based on the experience of the Rustic Road GRS-IBS contractor, working with the modular wall facing blocks for this particular bridge design was likely the most significant challenge of their construction learning curve, because the blocks that were used can be difficult to level (especially for bottom rows on rock foundations), to align (especially at skewed corners), and to stabilize (especially during vibratory compaction).

Interviews with agency and contractor personnel provided several important insights regarding the construction of GRS-IBS:

- For cost and schedule success, it is important contractors find a “rhythm” to the GRS-IBS construction procedure, which is associated with the repetitive nature of constructing bridge abutments with thin (typically 8 in.) lifts.
- The majority of bridges constructed with GRS-IBS had been with open-graded backfill, which is generally compacted in accordance with method specifications requiring a certain number of passes with a vibratory compactor; however, to satisfy requirements, the contractor may need to use heavier equipment and wet the well-graded backfill.
- Congested project sites present challenges for most construction projects, but they can be particularly problematic for GRS-IBS projects, which require space for a large volume of backfill and facing materials.

Bidding and Cost Lessons Learned

- Interviews with agency and contractor personnel provided the following lessons learned:
- The GRS-IBS technology is a useful tool for achieving cost savings and schedule efficiency, especially for bridge replacements on low-volume roads.
- Prices were seen to decrease with the number of applications as engineers and contractors became more familiar with the technology.
- Cost savings and simplicity of construction operations make the technology particularly well suited for local agencies, which also generally own a relatively high proportion of small bridges.
- Specifying GRS-IBS backfill that is readily available locally is important for achieving cost savings.

Implementation Readiness and Benefits

Deficient small bridges are a significant concern for the nation’s transportation infrastructure, and GRS-IBS is an emerging technology for delivering accelerated bridge construction economically, primarily for relatively small bridges.

The technology harnesses the stiffness of GRS, which consists of closely-spaced layers of geosynthetic reinforcement and compacted granular fill material, to eliminate the need for piling or other conventional foundation systems. Eliminating piling typically results in cost and schedule benefits.

Another benefit is the integrated bridge approach, which reduces the likelihood of the “bump at the end of the bridge” that is often associated with pile foundations.

GRS-IBS construction will likely be associated with a learning curve for contractors. Boone County enlisted the FHWA to help educate potential bidders about GRS-IBS for the Rustic Road project, since most bidders were unfamiliar with the technology.

All of the agencies and contractors interviewed by the researchers agreed that FHWA guidance regarding construction of GRS-IBS, including the number of personnel and recommended equipment, was generally accurate, although some project-specific considerations required deviations from the guidance.

Resources, tools, webinars, and videos are available at the FHWA Center for Accelerating Innovation [Every Day Counts webpage for GRS-IBS](#).

A review of the technical literature, interviews with agency and contractor personnel, and a detailed examination of the Rustic Road GRS-IBS project from design through early service life revealed many valuable conclusions that could advance implementation of these types of bridge systems.

The research team took their findings and repackaged them into a standalone [Implementation Aid](#) document, which aims to encourage implementation of GRS-IBS technology.



GRS-IBS was not the only innovative initiative included in the Rustic Road bridge replacement project. The superstructure consists of four tub girders with attached precast bridge deck sections. The four pieces were fabricated off-site, and placement of the girders was completed during the course of one day.