



Evaluation of the Buchanan County IBRD Bridge on Victor Avenue over Prairie Creek

tech transfer summary

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RESEARCH PROJECT TITLE

Evaluation of the Buchanan County IBRD Bridge on Victor Avenue over Prairie Creek

SPONSORS

Iowa Department of Transportation
(InTrans Project 12-427)
Federal Highway Administration
Innovative Bridge Research and
Deployment (IBRD) Program

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The Bridge Engineering Center (BEC) is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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This innovative bridge project included the design of a cast-on-site adjacent box beam bridge, concrete mix testing in the laboratory, construction inspection, and performance monitoring and evaluation via data collection and live load tests.

Problem Statement

Recently, there has been increased interest in constructing bridges that last longer, are less expensive, and take less time to construct. The idea is to generally increase the cost-effectiveness of bridges by increasing their durability (i.e., useful life) and minimizing construction disruptions to the traveling public.

Background

With the assistance of the Iowa Department of Transportation (DOT) and three centers at the Institute for Transportation (InTrans) at Iowa State University, Buchanan County, Iowa was awarded a Federal Highway Administration (FHWA) Innovative Bridge Research and Deployment (IBRD) Program grant to help construct and evaluate a replacement bridge that used innovative concepts, while also striving to construct the bridge without the use of a traditional overhead crane, making the bridge system an attractive alternative for county workforces.

The innovative concepts utilized for this bridge included geosynthetic-reinforced soil (GRS) abutments, high-performance concrete (HPC) made with lightweight fine aggregate (LWFA) for internal curing, and a cast-on-site concrete box-beam superstructure.



Buchanan County cast-on-site adjacent box beam bridge on Victor Avenue over Prairie Creek

Objectives and Research Description/ Methodology

This project consisted of four major tasks to encompass its objectives.

- **Preliminary design support and documentation**

To support Buchanan County and the Iowa DOT Office of Bridges and Structures, the Iowa State University team assisted with the preliminary bridge design process. Specifically, the research team assisted Buchanan County with the design of the GRS abutments and the Office of Bridges and Structures with the superstructure design.

The project involved the replacement of an aged timber bridge (the Slattery Bridge) with a cast-on-site adjacent box beam bridge. The replacement bridge is 50 ft long and 30 ft wide with a 0-degree skew. The bridge is located on Victor Avenue over Prairie Creek in Buchanan County.



Elevation view of completed GRS abutment with sheet pile at deck connection



Profile view of completed GRS abutment with sheet pile and underside of bridge instrumented for live load testing

The replacement bridge was designed for HL-93 loading plus 20 lb/ft² for a future wearing surface. It consists of precast box beams and guardrails with a GRS abutment and a sheet pile foundation system. Each of the five precast concrete beams is 6 ft wide, creating the 30 ft bridge width.

- **Testing of concrete materials and mix used for the beams**

HPC (with LWFAs for internal curing) was used to fabricate the precast beams on site. The research team performed laboratory tests on the concrete mix that was used and coordinated the results with both Buchanan County and the Iowa DOT.

- **Construction inspection and documentation**

The research team assisted the Office of Bridges and Structures with inspection of key phases of bridge construction. The construction process was observed and documented using digital images. Of particular interest was the fabrication of the precast bridge components, GRS abutment construction, and placement of the prefabricated superstructure on the GRS abutments.



Close-up of completed top fill of GRS abutment with sheet pile outside of bridge rail

• Bridge inspection

After the construction of the bridge, its performance was monitored for three consecutive years (2014, 2015, and 2016) via live load tests and other data collection mechanisms. The research team mounted external instrumentation for each load test and carried out the tests. The data from pore pressure sensors in the GRS abutments were also collected with all data analyzed to evaluate the structural performance of the bridge.

Key Findings

- The use of LWFAs for the concrete leads to higher strength of concrete and slightly lower weight of the beams.
- The beam weight was too heavy for the tow truck to slide or lift and led to some minor damage of the test girder.
- Lifting the beams from both ends using two backhoes and moving the beams over the creek was a successful approach and did not cause any damage to the beams beyond some minor bottom flange cracking.
- The load tests performed on the bridge over three years indicated that the bridge joints are well connected and performing well.
- The GRS abutments did not show any erosion of backfill or any other issues after a flood event occurred in the spring of 2015.

Implementation Readiness and Benefits

- Using backhoes to lift the cast-on-site beams is recommended.
- The lifting of the cast-on-site beams using backhoes may have a limit of span length, which should be investigated.
- The construction of the beams on-site followed by moving them over the abutments was a time-saving approach, which led to less traffic disruption.
- Concrete should be cured internally in addition to the external curing.
- Results showed that the installation of the vertical sheet drain in one of the abutments provided improved drainage conditions over the abutment without the vertical sheet drain.
- Long-term visual monitoring of these two abutments is recommended to see how they perform with additional flood events. A proper scour design was not performed for this site, although the sheet piles were extended at least 5 ft into the very stiff foundation layer. Scouring near the bottom of the sheet piles should be monitored over time.



Instrumenting the bridge for live load tests



Measuring and marking wheelpath bounds for load tests



Load Case 5 live load testing

Future Research

- The method of cast-on-site beams should be attempted and tested for a longer span or multiple-span bridge.
- A bridge constructed using the philosophy of “get in, get out, stay out” should be inspected for structural soundness for a longer time period.
- The GRS benefits with the inclusion of vertical sheet drains should be further studied for a broader impact using different backfill materials that are typically used in Iowa, with varying fines content and particle size distributions.