

Utah Demonstration Project:
Replacement of Manderfield
Bridges, Beaver County

Final Technical Brief
May, 2015



U.S. Department of Transportation
Federal Highway Administration

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

Highways for LIFE (HfL) is the Federal Highway Administration's (FHWA) initiative to advance longer-lasting and promote efficient and safe construction of highways and bridges using innovative technologies and practices. The HfL program provides incentive funding to highway agencies to try proven but little-used innovations on eligible Federal-aid construction projects. The HfL team prioritizes projects that use innovative technologies, manufacturing processes, financing, contracting practices, and performance measures that demonstrate substantial improvements in safety, congestion, quality, and cost-effectiveness. An innovation must be one the applicant State has never or rarely used, even if it is standard practice in other States. Recognizing the challenges associated with deployment of innovations, the HfL program provides incentive funding for up to 15 demonstration construction projects a year. The funding amount typically totals up to 20 percent of the project cost, but not more than \$5 million.

As a part of the HfL initiative, the FHWA provided a \$1 million grant to the Utah Department of Transportation (UDOT) to replace the Manderfield Bridges on I-15 in Beaver County. This project involved the replacement of twin multispan bridge structures (Bridge Number 1D 699 and 3D 699) with an innovative low-weight hybrid composite beam (HCB) in place of the more traditional bridge girder. The UDOT application also included constructing the bridge offsite and sliding it into place. The HCBs and the bridge slide were expected to provide a lightweight superstructure to facilitate a more efficient bridge slide and provide extended service life.

PROJECT BACKGROUND AND LOCATION

The Manderfield Bridges are located 4.6 miles north of the I-15 North Beaver Interchange. Built in 1946, these bridges carry an average of 8,000 vehicle per day of rural interstate traffic over a county road. The bridges are located 75 feet apart.

The northbound bridge was considered structurally deficient based on the poor condition of the deck, superstructure, and substructure. The southbound bridge, too, experienced increased deck deterioration due to severe winter conditions. The acute rate of deterioration of the twin bridges led UDOT to consider a replacement for the structures and to increase the inspection frequency to an annual basis. The condition of the northbound bridge is shown in Figure 1.

I-15 is a vital transportation corridor that serves more than 75 percent of Utah's population as their primary transportation corridor and forms part of the high-priority CANAMEX Corridor, as a result of the North American Free Trade Agreement.



Figure 1. Manderfield Bridges.

INNOVATIONS

Two innovations were proposed on this project: HCB and lateral bridge slide. While UDOT had used bridge slide before, HCB was proposed on this project for the first time in the State. Several factors, including the bridge location on the interstate, higher traffic volumes, criticality of the bridge deterioration, multispan nature, and the extended work zone duration, necessitated the use of accelerated bridge construction (ABC) methods on this project. The State's primary motivations for choosing the HCB technology were the following:

- Lighter weight of the girders.
- Use of smaller equipment, facilitating faster installation and enhanced worker safety.
- Adaptability to ABC.
- Slide effectiveness of the product.
- Lower life cycle, maintenance, and rehabilitation costs.
- Reduced shipping and installation costs.
- Greater corrosion resistance and longer life.
- Environmental benefits:
 - Reduction of greenhouse gases produced during bridge girder fabrication.
 - Reduced shipping for lighter beams, resulting in reduced fuel usage.
 - Reduced fuel consumption by smaller equipment.
 - Reduced substructure as a result of using fewer piles.

Recognizing these benefits, the American Association of State Highway and Transportation Officials (AASHTO) selected HCB as one of the focus technologies.

HCB consists of three main subcomponents:

- A shell consisting of a fiber reinforced polymer (FRP) box beam, compression reinforcement, and tension reinforcement.

- Compression reinforcement consisting of cement or concrete which is pumped into a profiled conduit within the beam shell.
- Tension reinforcement consisting of carbon, glass, or steel fibers anchored at the ends of the compression reinforcement.

For the lateral bridge slide, the plan was to build off alignment on temporary abutments and transversely slide the structure in place. Overall, UDOT anticipated that this project could be completed faster, safer, and more economically than by using traditional methods.

PROJECT INITIATION PROCESS

UDOT applied for an HfL grant of \$1,000,000 in FY10. The grant application was reviewed and approved by the FHWA. However, UDOT could not use HCB due to the procurement challenges explained in the next section of this report. Of the \$1,000,000 grant awarded for this project, UDOT expended \$700,000 and returned \$300,000 to the FHWA.

PROCUREMENT CHALLENGES RELATED TO HCB

The procurement process was initiated in November 2011. UDOT intended to buy the beams directly from a manufacturing firm that designed and fabricated HCB and provide the beams to the contractor selected through a design-bid-build process.

During the bidding process, UDOT faced three key challenges with the procurement. First, UDOT came to know of proprietary issues associated with the HCB technology. UDOT then had to work on getting FHWA's consent on the proprietary item. Second, UDOT wanted the manufacturing firm to provide a quality control (QC) plan, since HCB was not on the list of its approved products. However, the manufacturing firm was not able provide a QC plan on time. Furthermore, as a prerequisite to obtaining the beams and as a contractual requirement, UDOT wanted the manufacturing firm to furnish contract performance bonds on beams. The manufacturing firm, however, did not have enough equity or collateral to obtain performance bonds. In March 2012, when the manufacturing firm failed to furnish the bonds, UDOT could not authorize the beam manufacturer to fabricate the beams for construction. This led to scheduling issues, and UDOT had to modify its original plan of procuring the beams directly from the manufacturer.

UDOT later decided to revert to the regular procurement process, wherein the contractor would procure the beams directly from the UDOT-specified manufacturer. This would overcome the issues related to performance bonds, since the contractor would furnish performance bonds to UDOT, instead of the beam manufacturer, albeit at the higher cost. The bidding package was issued and the contractor was selected; however, the QC of the product was still a concern because the manufacturer could not produce a QC plan. Consequently, the fabrication of HCB beams could not commence until the QC plan was delivered to and approved by UDOT.

The contractor had a hard deadline on the bridge slide. The manufacturing firm was expected to expedite the preparation of the QC plan and fabrication of beams. However, this time, the beam manufacturer failed to produce the QC plan. Although the manufacturing firm cited that their

plant was Texas ISO 9001 certified, the certification did not specifically focus on the quality of the product and could not be substituted for a QC manual. In addition, the manufacturing firm failed to submit the maintenance, repair, inspection, and load rating manuals that UDOT had sought from the contractor.

SCHEDULE AND COST CONCERNS

Between initiating the procurement process and repackaging, the contractor had lost 5 months, leading to scheduling issues and missed deadlines, including a 3-week delay in the slide process. The contractor put in a claim with UDOT for delays, redesign, and fast tracking of concrete beams. Of the HfL grant of \$1 million, UDOT spent \$700,000 to pay the contractor and the beam manufacturer for claims and material expenses, respectively. UDOT returned the remaining \$390,453 to FHWA.

While the traditional beams typically would have cost UDOT around \$300,000, the initial quotes for HCB were much higher, at \$600,000. The HfL grants covered this premium cost, but a change order led to a significant increase in the beam costs, with the final price of the beams totaling \$1.2 million. As UDOT had expected that an amount of around \$1.2 million would also cover the development of manuals, it was in UDOT's best interest not to proceed with this innovation.

FINAL SELECTION

Once UDOT deemed the cost of the HCB option to be exorbitant and notified FHWA of their concerns, UDOT decided to use prestressed concrete beams for the twin bridges. The project work began in July 2012 and was completed by May 2013. The as-built agency costs on this project are presented in table 1.⁽¹⁾

Table 1. As-built agency costs.

Concept Development	\$0
Construction Management	\$408,334
Construction	\$4,929,600
Environmental	\$0
Preliminary Engineering	\$243,554
Right of Way	\$1,751
Utilities	\$0
Miscellaneous	\$0
Total Project Expenditures	\$5,583,240

LESSONS LEARNED

Following are some of the lessons learned on this project:

- UDOT is of the opinion that some innovations, such as HCB, need to be further evaluated to get a thorough understanding of the maturity of the product.
- UDOT recommends that end users be provided additional assistance with developing guidance documents, such as the QC manual and maintenance manual, when deploying a new product. These documents are expected to provide a better understanding of the product, both contractually and from a process standpoint.
- The agency's risks in terms of managing public perception and the political capital, in case of any unexpected hurdles during the innovation deployment process, need to be better accounted for.
- UDOT believes that increased involvement of other stakeholders in the innovation deployment process, such as AASHTO, would be helpful.

REFERENCES

1. Project Summary, I-15; Manderfield Bridge No. D-699 North of Beaver, Utah Department of Transportation, June 2014.
http://www.udot.utah.gov/projects/f?p=250:1000:0::NO:1000:P1000_EPM_PROJ_XREF_NO,P1000_FUND:5485,ST_GF_HCP