

Short Span Shake-Up: Missouri Short Span Bridge Study Finds Steel Saved 25 Percent Over Concrete

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It's a common industry perception that precast bridges are less expensive than short span steel bridges. Like many perceptions, this one is not based on current standards of practice, as proven in the following study. Recently, a bridge consultant in Missouri had the unique opportunity to compare nearly identical short span bridges in his state.

Michael G. Barker, P.E., a professor in the College of Engineering and Applied Sciences at the University of Wyoming, collaborated with Missouri bridge engineering consultant, John Mann, P.E., to perform a true "apples-to-apples" comparison of superstructure costs for steel versus precast concrete in short span applications. The study also included the total construction costs for the project.

"We have one steel beam bridge and one hollow core slab precast concrete bridge that are nearly identical in all aspects," said Barker. "They were both built in 2012 with the same location and topography and with nearly identical roadway length and width, abutments, structural depth and guardrail systems. Even the same local work crew was used to build both bridges."

The results? In a side-by-side comparison of construction square footage costs, the steel short span superstructure provided a 25.8 percent cost savings, with an overall 19.3 percent savings in the total cost of the structure. Here's a look inside the study.

The Basics

Built in 2012, Audrain County Steel Bridge 411 has a 47.5-ft. span and 24-ft. roadway width with 2-ft. structure depth plus slab and no skew. The basic superstructure design consists of four weathering steel stringers fabricated by Oden Enterprises in Wahoo, Neb. The total cost for the project was \$111,853 (\$97.48 / sq. ft.).



Audrain County Bridge 411

Also built in 2012, Audrain County Concrete Bridge 336 has a span of 50.5-ft. with 24-ft. roadway width and 2-ft. structural depth on a 20 degree skew. It consists of six hollow core precast slab girders. The total cost for the project was \$154,035 (\$120.83 / sq. ft.). Concrete was selected in this case because the county engineer believed the structure would experience occasional water inundation and assumed that concrete would allow the bridge to reopen to traffic sooner.



Audrain County Bridge 336

In both cases, Audrain County engineers tracked detailed costs for all components of the bridges, from the beginning of design to the end of construction. All superstructure-only costs were tracked separately for the “apples-to-apples” comparison.

Steel

Concrete

Superstructure Costs

Superstructure Costs

Material		
Girders	=	\$ 21,463
Deck Panels	=	\$ 7,999
Reinf Steel	=	\$ 3,135
Concrete	=	\$ 4,180
Labor	=	\$ 5,522
Equipment*	=	\$ 500
SUPER TOTAL	=	\$42,799
SUPER TOTAL	=	\$37.54 / sq. ft.

Material		
Slab Girders	=	\$50,765
Deck Panels	=	\$0
Reinf Steel	=	\$ 724
Concrete	=	\$ 965
Labor	=	\$ 4,884
Equipment*	=	\$ 4,000
SUPER TOTAL	=	\$61,338
SUPER TOTAL	=	\$50.61 / sq. ft.

*County-owned crane (30 ton) used for steel, while a larger rented crane was required for concrete.
(Equivalent county crane cost of \$1,520 would result in steel cost of \$38.88 / sq. ft.).

25.8 percent savings in total superstructure costs

When all of the actual costs were tallied, the short span steel bridge superstructure-only construction savings were 25.8 percent in comparison to the precast concrete superstructure. The steel Bridge 411 superstructure cost - including material (girders, deck panels, reinforcing steel and concrete), labor and equipment - came to \$37.54 / sq. ft. The precast Bridge 336 superstructure costs - which included material (slab girders, reinforcing steel and concrete for parapet walls and grout), labor and equipment - came to \$50.61 / sq. ft.



Mann noted that the lower price per square-foot for the steel bridge was driven by the fact that the steel girders were less than half the price of the slab girders. Crane costs also created some of the savings.

“With the steel bridge construction (Bridge 411), Audrain County was able to use its own 30-ton crane,” said Mann. “For precast Bridge 336, the county had to rent a 100-ton crane to handle the heavier load.”

Barker added, “Many county engineers forget about the cost of cranes. Steel bridges do not require the heavier equipment needed for heavier concrete bridges. On a small bridge, the cost is significant. The two-day rental and miscellaneous equipment cost was \$4,000 for the bridge noted above, compared to \$500 for miscellaneous equipment for the steel bridge.”

Another advantage to steel is the potential use of simple Geosynthetically Reinforced Soil (GRS) bridge abutments to handle lighter loads. In the comparison above, the county could have saved additional dollars on the project if the abutments had been designed for the lighter steel bridge. GRS abutments are innovative foundation systems available at a lower cost than other conventional foundation materials. The installation process is simple and they can be rapidly constructed - in some situations, in five days or less.

“A short span bridge in the range of 50-ft. is almost always the best value when constructed of steel.”
- John Mann

“As a veteran bridge consultant, I believe that engineers who are educated on the cost-effective design of short span steel bridges, with simple and practical details, can realize significant savings with steel,” said Mann. “Experienced contractors can typically erect and construct a steel bridge in less time and with lighter equipment for additional savings.”

Barker adds, “Details, such as the use of elastomeric bearings, save money because they are easy to install and cost less. Also, there’s the advantage of weathering or galvanized steel. I think we’ll continue to see wider-spread use of galvanized bridges across the country because you dip them and you’re done - providing reduced maintenance and life-cycle costs. County agencies will find that steel bridges are often a better option than concrete. They just need to make the comparison.”

According to the Short Span Steel Bridge Alliance (SSSBA), there are many benefits in using steel in the construction of all types of crossings. According to Mike Engestrom, chairman of the SSSBA, steel provides sustainable, accelerated, durable and cost-effective design solutions for engineers, architects, builders, code officials and other construction professionals.

“Studies have shown that prefabricated steel bridges are cost-competitive with other materials when labor, including the use of local crews, and time to install are considered,” Engestrom explains. “When ABC (accelerated bridge construction) is preferred, steel provides many options to save both time and money. This information is further validated by comparing the facts and figures of the Audrain County bridges.”

Steel Considerations

Audrain County has a long history of selecting steel for bridge construction.

According to Mann, “In our experience, a short span bridge in the range of 50-ft. is almost always the best value when constructed of steel. At 70-ft. or longer, we’ll perform a more in-depth analysis to evaluate variables, such as proximity to the precast plant and overall cost. There are some cases where we consider precast hollow core slabs for a super-fast turnaround, but we know we’ll have to pay a premium. Overall, I’ve found that steel is the better buy.”

Since 2008, Audrain County has constructed five short span steel bridges with an average length of 53-ft. for an average total project construction cost of \$86.09 / sq. ft. In that same time, the county has constructed four concrete bridges with an average length of 37.5-ft. for an average total project cost of \$96.32 / sq. ft.

Total Constructed Bridge Cost Comparison

Steel Average Cost of Five Bridges			Concrete Average Cost of Four Bridges		
Total Cost	=	\$ 86.09 / sq. ft.	Total Cost	=	\$ 96.32 / sq. ft.

Case Study Video

To view a video that provides additional images and more details about this “apples-to-apples” superstructure comparison, visit the SSSBA website at www.ShortSpanSteelBridges.org.

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Web-Based Tool Delivers Short Span Options

A short span steel bridge, such as Bridge 411 in Audrain County, Mo, could be designed in short order, possibly in minutes, using eSPAN140, a free online design tool. This tool was developed by the SSSBA working in concert with more than 30 companies and organizations from all areas of the steel bridge industry. eSPAN140 (<http://www.espan140.com/>) is a highly beneficial tool that provides customized steel designs for bridges up to 140-ft.



Developed with county engineers in mind, eSPAN140 requires no complex engineering inputs. In just three easy steps, the tool provides a range of available options for standard designs and details of short span steel crossings, including rolled beam and plate girders, modular and truss solutions, buried soil steel bridge structures (corrugated steel pipe and corrugated

structural plate), as well as durability solutions. Industry contacts included in the tool can assist the bridge engineer with budget estimates and pricing information. Using eSPAN I 40 is simple and quick. A user creates a free account and then inputs project information (location and bridge length), general dimensions (traffic lanes, roadway width, parapet width, etc.), pedestrian access options (number of sidewalks and estimated widths), as well as skew angles, expected daily traffic and design speed. However, a steel short span solution can be completed with as few as three dimensions - length, width and the number of striped traffic lanes. Once data is entered, the design tool instantly produces a customized Steel Solutions Book. Visit <http://www.eSPAN I 40.com> for more information or to get started on a steel bridge design.

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Drs. Barth and Barker are expert consultants to the SSSBA and the directors of the Bridge Technology Center (BTC). The BTC provides complimentary design support for questions relating to bridge and culvert design.

About the SSSBA

The SSSBA provides essential information to bridge owners and designers on the unique benefits, innovative designs, cost competitiveness and performance related to using steel in short span installations up to 140-ft. in length. SSSBA partners comprise bridge industry leaders, including steel manufacturers, fabricators, designers, fasteners, service centers, coaters, researchers and representatives of related associations and government organizations. For news or information, visit www.ShortSpanSteelBridges.org or follow us on Twitter at www.twitter.com/shortspansteel.

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