A new accelerated bridge construction solution makes its commercial debut in a statewide bridge replacement project in Pennsylvania.

A NEW TAKE on Plate Girders

BY TOM STOCKHAUSEN

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THE PENNSYLVANIA Rapid Bridge Replacement Project (PRBRP) is ambitious in scope, to say the least.

The project involves replacing 558 structurally deficient bridges over a three-year span, and the majority of the bridges in the project are short spans proposed to be replaced with concrete structures. Approximately 10% of the bridges restricted the general contractor (Walsh/Granite) to a five-week maximum detour, thereby necessitating accelerated bridge construction (ABC).

As an alternative to concrete, general contractor Walsh/Granite turned to the folded steel plate girder (FSPG) system for multiple restricted-detour bridge projects under the PRBRP. FSPG bridges were first constructed as demonstration projects in Massachusetts and Nebraska using Accelerated Innovation Deployment Grants from the Federal Highway Administration (FHWA). When compared to concrete, they can be erected faster, last longer, require roughly the same level of

Installing the first section.

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maintenance and compete in terms of cost. As of publication, four of the seven bridges ordered by Walsh/Granite have been manufactured and two have been erected. The three others are currently being manufactured.

Concurrent Construction

Conventional construction of a typical precast 60-ft bridge was estimated by Walsh/Granite to take about 11 weeks following design and manufacturing of the bridge beams. In many rural areas where detours are quite lengthy, the 11-week detour placed a severe impact on local residents, in particular emergency vehicles and school buses. However, the FSPG solution moved much of the construction process off-site, where it was performed concurrently with demolition of the old bridge and construction of new abutments—which reduced the typical detour time frame by more than 50% as well as accelerated design and manufacturing. An added benefit was the improved quality of the deck concrete because it was constructed in a controlled environment.

The ability to standardize the FSPG process is part of what significantly reduced the design and manufacturing time. With 11 standard sizes, design basically involves selecting the appropriate size girder for the span length and opening, then detailing the horizontal and vertical geometry of the specified deck. This allowed superstructure design for the Pennsylvania projects to be accomplished in a matter of days.

CDR Bridge, which designs and manufactures the FSPG system, was also able to reduce total production time for the Pennsylvania bridges to as little as 14 weeks, including steel procurement. Manufacturing took place in three steps: forming

Installing the third section.

Folded Steel Plate Girders

What is a folded steel plate girder (FSPG)?

Developed at the University of Nebraska-Lincoln, the girders are fabricated from a single steel plate of uniform thickness that is bent along multiple lines using a hydraulic metal press brake, forming a trapezoidal-shaped section that is open at the bottom. The plate thickness of either ⅜ in. or ½ in. can accommodate all span lengths by simply changing the location of the bends. Only the width of the top and bottom flanges and the depth of the web vary depending on span length. However, the maximum span length for FSPG bridges is currently limited to 60 ft.

The FSPG system eliminates the need for internal and external cross frames due to the large amount of lateral stiffness generated by the design. The absence of cross frames in the system results in less costly details, and the need for welding is significantly reduced. The open bottom geometry of the girders simplifies inspection, and the hot-dip galvanization process is used for corrosion protection.

Two companies—CDR Bridge Systems and HBS—have been granted exclusive distribution rights, and the steel is fabricated by approved fabricators. (You can view standard drawings at **www.cdrbridges.com**.)

the steel, galvanizing it and then precasting the deck panels. For this project, the girders were formed by cold bending ½-in. plate steel. Shear studs, sole plates and bearing stiffeners were welded and flange separators were bolted to complete the first step. The steel fabrication process took less than three weeks for four girders of a typical two-lane bridge.

The second step in the process was applying corrosion protection via hot-dip galvanizing, which took only a few days to complete. The galvanizing has a guarantee of 25 years and reduces maintenance over that time frame to a level equivalent to or better than that of concrete. Removable, galvanized bird screens were added to the open bottom of the FSPG girders and allow easy inspection of the girders while still keeping birds and other critters from nesting on the bottom flanges.

The final step in the manufacturing process was precasting the deck panels to form the composite system. Precasting the panels (for the four folded steel plate girders) took about three weeks. Once the precast decks were completed, the prefabricated units making up the superstructure were ready for shipment to the construction site for erection.

The first of the Pennsylvania FSPG bridges—a two-lane, 50-ft bridge near Bradford, Pa.—was erected this past October in less than three hours. Closure pours (to complete construction of the superstructure) took only a few days, which enabled the bridge to be reopened in 30 calendar days, five days ahead of the accelerated, five-week schedule for the project detour. This is a full month faster than it would have taken using conventional cast construction. The second Pennsylvania FSPG bridge was erected near Lewiston, Pa., just two weeks later—and took only 2½ hours.

Enhanced Accelerated Construction

These first few FSPG units have provided our steel fabrication and precast concrete partners with valuable experience that has led to improvements in their processes and further reductions in manufacturing time for future bridges. It also reinforced the need for communication throughout the process. The team maintained constant communication with the contractor, so that everyone knew precisely where each bridge was in the design and production process. We were able to adjust schedules through the supply chain without interrupting our other team members' business. The responsiveness of the team resulted in the completion of production in advance of scheduled erection for every bridge despite changing erection dates.

In addition, the Walsh/Granite design-build team proactively managed the schedule, thanks to such practices as a weekly discussion of detailed preproduction tasks between the teams. CDR shared changes with its team and coordinated adjustments to its production priorities to meet Walsh/Granite's changing schedule. That proactive coordination enabled the team to meet every erection schedule—especially important on an ongoing project involving multiple bridges spread over a large area.

Another benefit of this proactive approach was that each member of the team brought ideas and energy to the table that improved the process and the system. The engineers aggressively responded to design changes to substructure and roadway design, shop drawings and RFIs. The fabricator procured extra material so that it was prepared for any changes during fabrication. And the design and precast teams worked together to solve an issue with lifting the exterior girders, adding inserts into the barriers to balance the lift and keep the exterior units from rolling during erection.

The entire team worked together to create a better, faster and more constructable product. It also proved that ABC is not just about accelerating the schedule at the job site but rather accelerating the *entire* process of design, manufacturing and construction.

Owner
Plenary Walsh Keystone Partners

General Contractor
Walsh/Granite JV

Architect and Engineer
HDR, Inc.

Superstructure Engineer/Supplier
CDR Bridge Systems, LLC, Pittsburgh