PROJECT

The Dresbach Bridge

A bridge springs forth from nature

by Eric Breitsprecher, Minnesota Department of Transportation, and Courtney C. Oltman, Stephen E. Fultz, and John R. Dvorak, FIGG

Dual 508-ft-long spans over the main channel of the Mississippi River result in large navigational and recreational openings, and only one pier in the river that is away from the bank. All photos: FIGG.

The new Dresbach Bridge, which carries Interstate 90 (I-90) over the Mississippi River, is a highly utilized river crossing that serves as a gateway for regional and interstate needs and is an enhanced local connection for the adjacent communities. The replacement bridge connecting La Crescent, Minn., and La Crosse, Wis., addresses a significant Minnesota Department of Transportation (MnDOT) need and brings greater mobility to the area.

May 2016 view of the completed segmental main channel bridge looking east. The 1667-ft-long bridge was built from the above over the main channel of the Mississippi River.

The Dresbach Bridge is designed to exceed current structural standards and greatly improve roadway geometry on this important regional corridor. Bi-directional precompression of the superstructure from high-strength post-tensioning steel, high-performance concrete, stainless steel deck reinforcement, and integral wearing surfaces on all spans provide MnDOT with a highly durable bridge for long-term performance and far less future maintenance cost. Combined with the concurrent reconstruction of the adjacent Trunk Highway 61 (TH61)/I-90 interchange, the overall project improves safety, capacity, and access while replacing the outdated highway system with a long-life facility for MnDOT and the traveling public.

Aesthetically, the bridge serves as a beautiful companion to the pristine waters and recreational facilities of the Mississippi River. Located within the Upper Mississippi River National Wildlife and Fish Refuge, the Dresbach Bridge serves as a model for how a grand bridge structure can be developed with the community to exist harmoniously

profile

DRESBACH BRIDGE / NEAR DRESBACH, MINNESOTA

BRIDGE DESIGN ENGINEER: FIGG, Denver, Colo.

CONSTRUCTION INSPECTION: WSB, Minneapolis, Minn.

PRIME CONTRACTOR: Ames Construction, Burnsville, Minn.

PRECASTER: County Materials Corporation, Janesville, Wis.—a PCI-certified producer

POST-TENSIONING CONTRACTOR: Schwager Davis Inc., San Jose, Calif.

with, and honor, the landscape and environment.

The existing bridge over the Mississippi River consisted of twin structures each supported by a 12-span, steel, two-girder system with a nonprestressed reinforced concrete deck. The twin-girder superstructure, while typical to the era, featured undesirable details that warranted replacement. Narrow shoulders below current standards made the bridge difficult to traverse and inconvenient for travelers. Emergency vehicles couldn't pass, space for disabled vehicles was non-existent, and routine maintenance required the bridge to be closed.

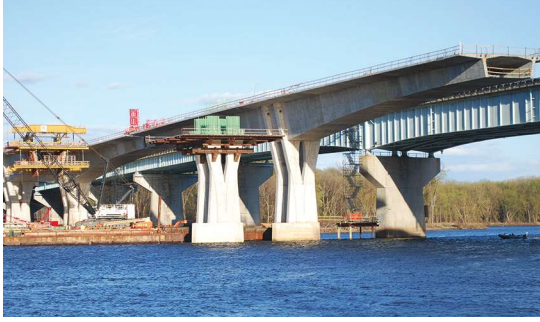
Bridge for the Future

A new, modern, high-performance, ecologically sensitive four-lane concrete bridge was designed to replace the deficient structure. Over the main channel of the Mississippi River, the new four-span bridge features twin, post-tensioned segmental concrete structures with two 508-ft-long main spans, built from above with form travelers in balanced cantilever. Building from above eliminated the need for large ground- and water-based equipment, allowed commercial and recreational river traffic to continue throughout the duration of construction unimpeded, and preserved the environment. Construction is kept to the smallest footprint possible to protect not only the environment, but also recreational facilities along the Minnesota bank, an adjacent rest area, and operations of U.S. Army Corps of Engineer's Lock and Dam No. 7 just upstream.

Beyond the main channel of the river, the east channel is significantly shallower, with a maximum depth of approximately 10 ft. While not commercially navigated, the east channel is a favorite fishing spot for many residents. The new east channel structure is comprised of twin 6-span units that are achieved through the introduction of 82-in.-deep prestressed concrete girders developed by MnDOT and utilized for the first time on this project. The deeper girder section allowed for 154-ft-long spans, minimized the number of substructure elements, and thus reduced the impact of the bridge on the channel.

Each structure typically carries two lanes of traffic with 6-ft-wide inside and 12-ft-wide outside shoulders for a total deck width of 45 ft 4 in. The eastbound bridge widens to 65 ft 10 in. at the Minnesota abutment to accommodate on-ramp traffic from TH61 northbound. The westbound bridge widens to 66 ft 3 in. for off-ramp traffic to the adjacent rest area and park located on the Minnesota bank of the river. The segmental superstructure for each bridge was structurally optimized by using a single-cell trapezoidal box girder with deck cantilever wings. The box girder interior "core" was kept dimensionally constant everywhere to maximize casting efficiency. Variable deck width was accomplished by adjusting wing lengths and by shifting the centerline of box girder to follow the change in deck centerline where width demanded. The prestressed concrete beam spans feature four girders per bridge spaced at 12 ft centers.

Bridge drainage requirements were kept to a minimum by careful design of the roadway longitudinal and transverse deck profile. A drainage conveyance system was designed by MnDOT for remaining flows to carry drainage to detention ponds on each end of the bridge. Pipes were kept to the inside of each bridge as much as possible to hide them from view, and were designed with extra capacity for potential winter freezing, higher than design-level flows, and unexpected blockages.



April 2015 view of the main channel of the Mississippi River looking downstream from the Minnesota bank. The segmental concrete solution built from above allowed uninterrupted commercial and recreational use of the river during construction.

Segmental Solution

MnDOT selects segmental concrete bridges for their many initial and long-term benefits. A concrete segmental bridge for the new I-90 crossing near Dresbach is a sustainable solution for successfully addressing all project constraints, criteria, and goals. The use of concrete spurs the local economy through the utilization of local labor, materials, and resources. Building from above in balanced cantilever minimizes construction impacts, while efficient, cost-effective long spans result in the least-practical permanent bridge footprint for the best environmental stewardship.

The concrete segmental solution provides a highly redundant, low maintenance, and resilient structure with bidirectional pre-compression of the entire concrete superstructure, enhancing the long life of the bridge. Integral wearing surfaces cast with the section are also pre-compressed, resulting in a riding surface highly resistant to deicing chemicals. The likelihood of ever having to replace this surface over the long service life of the segmental bridge is very low. MnDOT is also at the forefront of the use of

MINNESOTA DEPARTMENT OF TRANSPORTATION, OWNER

OTHER CONSULTANTS: Geotechnical Engineering, American Engineering Testing, St. Paul, Minn.; Independent Construction Cost Estimating, Armeni Consulting Services, Suwanee, Ga.; Electrical Engineering, Cain Thomas Associates, White Bear Lake, Minn.; Bridge Aesthetic Lighting, Randy Burkett Lighting Design, St. Louis, Mo.; Construction Inspection and Segmental Geometry Control, Figg Bridge Inspection, Apple Valley, Minn.; and Contractor's Construction Engineer, FINLEY, Tallahassee, Fla.

OTHER MATERIAL SUPPLIERS: Form Travelers, Schwager Davis Inc., San Jose, Calif.; Formwork, EFCO, Des Moines, Iowa; Reinforcing Steel Fabricator, CMC Rebar, Kankakee, Ill.; and Bearings and Expansion Joints, The D.S. Brown Company, North Baltimore, Ohio

BRIDGE DESCRIPTION: Twin, 2593-ft-long structures, each featuring a four-span, 1667-ft-long, cast-in-place, post-tensioned, segmental box-girder unit built from above in balanced cantilever over the main channel, and a six-span, 926-ft-long precast, pretensioned concrete beam unit over the east channel. Segmental spans are 323, 508, 508, and 328 ft, and beam spans are typically 154 ft with a 156-ft end span.

stainless steel reinforcement in bridge decks, providing another layer of deck protection for all of the Dresbach spans. These specified details for the bridge directly benefit MnDOT by significantly reducing life-cycle costs associated with maintenance operations common to other structure types.

High-performance concrete ensures strength and long-term performance. Concrete mixtures featured compressive strengths up to 8 ksi, fly-ash and slag cement, and criteria for alkali-silica reaction (ASR), scaling resistance, shrinkage, permeability (less than 1500 coulombs), visual ratings, and fine/coarse aggregate expansion.

The deck for the prestressed beam spans also includes high-performance concrete, stainless steel reinforcement, and an integral wearing surface for enhanced life.

Context-Sensitive Design

The segmental bridge offered the greatest opportunity for aesthetics, which was important to the local communities and stakeholder group. Aesthetic design inspiration for the Dresbach Bridge comes from the picturesque natural landscape of the surrounding area. Functional requirements of the crossing are enhanced through context-sensitive design developed with an understanding of the prominence, use, and visual features of the Mississippi River and nearby heavily forested bluffs and islands.

The portion of the bridge crossing the main channel requires functionality and contextual aesthetics both within the environment and at a pedestrian level. This portion of the bridge is the most visible from the surrounding areas including many viewpoints along the Minnesota bank, and from commercial river traffic.

After passing over the main channel, the bridge crosses an island covered with old growth trees. This east channel portion of the structure is contextually dominated by the river-level experience of recreational users.

Pier Shape

Perhaps the greatest aesthetic opportunity came in custom shaping the main and east channel bridge piers. The heavily forested surroundings feature old-growth trees that appear to emerge from the water with great size and strength. Bridge piers are shaped to honor the feel of the trees and extend the forest environment across the river. While providing the strength to support the bridge, the pier shape is that of the trunk of a majestic tree supporting its foliage above. The complex three-dimensional layering and tapering of the piers, their extension up and along the outside of the superstructure, and the openings between them reflect the organic nature of a tree that's grown unconstrained in its native surroundings.

Traffic is switched to the new eastbound bridge in November 2015 with completion of the new westbound bridge scheduled for June 2016.

October 2015 view of the main river piers with the high Minnesota bluff beyond. Main channel piers are shaped to honor old-growth trees prevalent in the heavily forested surrounding landscape.

In the main channel, the structural and functional pier pedestals also provide a strong visual base element in the same way that the lower portion of a trunk supports the tree. The shaping of these supporting pedestals carefully considered the forest inspiration in addition to being streamlined for river flow and ice considerations. The complex piers were designed to keep the shape and structural core constant at all locations for schedule, labor, and cost savings.

All reinforcing steel details, bends, and tolerances were provided in the contract plans, eliminating the need for shop drawings. Cages were pre-assembled on the ground and lifted into position. Pier construction progressed seamlessly with outstanding results.

Color

Color selection for the river bridge played a key role in ensuring that the structure would fit with and complement the surrounding environment. In addition to the river and forested environment, the context also includes a high bluff on the Minnesota side. The presence, and often dominance, of a unique light and golden tan palette on the bluff became the driving factor in the community's selection of a rich tan color for the bridge.

Abutment and Retaining Wall Treatments

The Minnesota and Wisconsin abutments and connecting roadway

approaches contain multi-tiered retaining walls with variable treatments for overall project aesthetic compatibility. Stone texturing, sand-blasting, and smooth areas that are single and multi-colored tie the river bridges to the new interchange with consideration of the river, forest, and bluff environments.

Construction

MnDOT awarded the project in early 2013 for a river bridge low bid of $81.5 million. A competitive bidding environment resulted in a 15% project savings for MnDOT compared to pre-bid, independent contractor-based estimates.

Construction began in the spring of 2013 focused on the installation of cofferdams, piling, and seal slabs for the main span piers flanking the river navigational channel. Eighty-foot-tall cofferdams facilitated footing construction below the river mudline in accordance with MnDOT design standards. Pedestals through the water depth (including flood levels) resist barge impact and significant ice loading while being oriented within the flow to minimize drag and scour potential.

Despite spring flooding and difficult Minnesota winter conditions within the first 12 months, significant progress was made including the construction of all nine eastbound bridge piers plus seven of the nine westbound piers. This included four of the six twin-wall main river piers constructed in the tree shape. A cold-weather concreting plan following MnDOT requirements allowed construction to continue throughout the winter. This included thermal analysis, insulation techniques, and continuous monitoring. Construction of the pier footings and pedestals included mass concrete provisions to control the heat of hydration, keeping core and differential temperatures within specified limits. Concrete mixtures with slag cement and a cooling tube system were also used.

Segmental superstructure construction began with the first segment cast on May 21, 2014, located at the eastbound pier table 3. Superstructure casting utilized two pairs of form travelers launched from two adjacent piers operating at the same time for schedule savings. A typical segment production rate of four segments per week was achieved for the first three cantilevers comprising the eastbound bridge. This was increased to a peak rate of six segments per week after moving travelers to the westbound bridge to complete the segmental spans.

The east channel girder spans were erected simultaneously, saving significant time and the schedule. A combination of temporary steel trestles and stone causeways were constructed within the east channel to allow for delivery and erection of the girders while meeting environmental requirements for water passage. A temporary trestle lift-span allowed recreational river users to cross through the construction zone. Girders were shipped to the construction site over interstate and state highways, and were loaded onto the temporary trestle/causeway near the Wisconsin abutment. No special permitting was required for the larger girders since axle loads were kept within limits. Transverse trestle and causeway "fingers" provided work platforms necessary for the movement and staging of cranes for girder placement on the east channel piers.

Milestones in 2015 included the completion and opening of the eastbound bridge in early November, in time for increased holiday traffic volumes. Cantilever 3 for the westbound bridge and all of the east-channel beam spans were also completed. An unusually mild fall and winter that continued into early 2016 enabled acceleration of the westbound bridge construction.

Current Project Status

The Dresbach Bridge is on track for early completion thanks to accelerated segmental bridge construction and good weather. Superstructure work is complete with only barriers, joint installation, and final riding surface texturing remaining. The dual bridges were scheduled to be fully open to traffic in June 2016, several months ahead of schedule.

Traffic has been removed from the existing bridge and demolition activities are underway. The deck is being removed by jack-hammering with debris falling into collection barges stationed on the river below. Cranes on barges will remove the steel girders, followed by demolition of the piers to water level. Portions of the piers below water will be removed by underwater blasting, with debris removed from the river bottom with clam-shell buckets to the satisfaction of the U.S. Coast Guard and Corps of Engineers. Bridge demolition is scheduled for completion in the fall of 2016.

October 2014 view of the eastbound segmental cantilever construction of pier 2 over the main river channel. Superstructure casting progressed quickly achieving a typical rate of four segments per week and a peak rate of six segments per week.

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EDITOR'S NOTE

The final concrete closure placement took place in April 2016 for the new Dresbach Bridge linking the U.S. states of Minnesota and Wisconsin across the Mississippi River.