PROJECT

I-35W ST. ANTHONY FALLS BRIDGE

SOARING ACROSS THE

A new crossing with sustainability, redundancy, and fast construction.

The side spans over land were cast-in-place on falsework using the same box girder shape as the main span. Photo: Mn/DOT.

Carefully planned design and construction strategies by the Flatiron-Manson Joint Venture, with FIGG as designer, focused on a new I-35W Mississippi River crossing with sustainability, redundancy, and fast construction. This modern concrete bridge for the future maximized the use of local labor, local materials, and multiple concurrent construction operations to optimize construction through the Minneapolis winter.

The Minnesota Department of Transportation (Mn/DOT) set requirements and expectations centered on a bridge life beyond 100 years. Mn/DOT's vision allowed innovation and enhancements to traditional quality standards. The mission was to design and build a 10-lane wide, transit-ready, interstate bridge over the Mississippi River, with a 504-ft-long main span, in 15 months. The opening on September 18 meant a design-build delivery in 11 months while achieving the quality standards set for a long bridge life.

Eight long-line casting beds were set up for the main span segments. Photo: Mn/DOT.

The bridge consists of twin 1223-ft-long concrete structures, each 90 ft 4 in. wide using two box girders per structure. In addition to crossing the river, there is an overpass at 2nd Street, a crossing of an historic stone bridge abutment wall, a railroad track, hazardous materials site, multiple underground and overhead utilities, local street crossings, and National Park Service land. Shortly after the October 8, 2007, Notice-to-Proceed,

profile

I-35W ST. ANTHONY FALLS BRIDGE / MINNEAPOLIS, MINN.

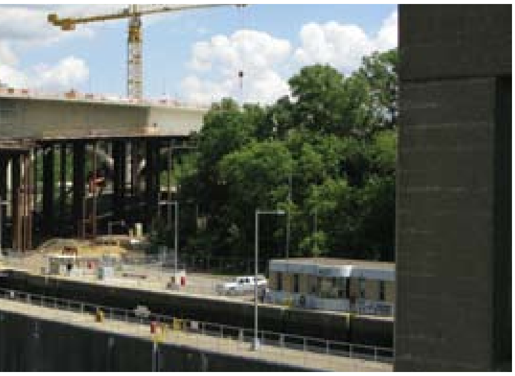
CONTRACTOR: Flatiron-Manson (a joint venture of Flatiron Construction Corporation, Longmont, Colo., and Manson Construction Company, Seattle, Wash.)

BRIDGE DESIGNER: FIGG, Tallahassee, Fla.

CONCRETE SUPPLIER: Cemstone Products Co., Mendota Heights, Minn.

POST-TENSIONING SUPPLIER: DSI, Bolingbrook, Ill.

FORMWORK SUPPLIER: EFCO, Avondale, Ariz. (Segments and Piers 2 and 3); Symons, Bloomington, Minn. (Pier 4)



Main span segments were precast while side spans were cast-in-place.

After precasting, the 120 main span segments were moved to a riverside staging area prior to transporting by barge to the bridge site. Photo: © FIGG.

MISSISSIPPI RIVER

by Linda Figg and Alan R. Phipps, FIGG

a special design meeting, known as a FIGG Bridge Design Charette™, was held with 88 people from local communities, so they could choose various design features. They chose a curved pier shape, open railing style for vistas of the river, white bridge color, aesthetic lighting of the bridge using LEDs, and local stone abutment walls. This community involvement took place concurrently with some of the design in order to begin construction as soon as possible. Construction could only begin after detailed design plans had received the official "Released for Construction" approval, and long lead-time items had to be addressed early so that all scheduling could be optimized.

Building a Strong Foundation

Construction of the bridge began on November 1, 2007, (Day 17 from start of construction) with the drilling of a test/demonstration shaft for the foundations. The team selected 7-ft- and 8-ft-diameter drilled shafts for the main bridge pier foundations. The larger shaft diameters reduced the number of construction operations necessary at each foundation and worked within the site constraints. After successful completion of the test shaft on Thanksgiving Day, four drill rigs went to work at multiple locations. A total of 40 shafts up to 95-ft deep and socketed into rock support the main bridge piers. An additional sixty-nine 4-ft-diameter shafts up to 27-ft long support the north abutment and the 2nd Street overpass, north of the main bridge. To speed placement and achieve a monolithic, high-quality concrete, self-consolidating concrete (SCC) was used in the shafts. The SCC mix, supplied by Cemstone Products, obtained better than expected strengths. The design called for 5000 psi compressive strength concrete. Actual strengths averaged 8360 psi at 28 days. At 56 days, strengths of 9890

Rolling structures moved along the long-line casting beds to provide a heated work and curing environment during the winter months. Photo: © FIGG.

SEGMENTAL / MINNESOTA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Twin 1223-ft-long box girder bridges

REINFORCEMENT: Gerdau Ameristeel, West Allis, Wisc.

DISK BEARINGS: R.J. Watson, Amherst, N.Y.

EXPANSION JOINTS: D.S. Brown, Andover, Minn.

STRUCTURAL COMPONENTS: 139 drilled shafts, four main pier footings, eight columns, and four-parallel box girders for the superstructures with precast segments for the main spans and cast-in-place construction for the side spans psi were achieved. The last drilled shaft was completed on January 12, 2008, (Day 89).

Mass Concrete Footings and Piers

The first mass concrete footing placement for the main piers occurred on January 15, 2008, (Day 92) and the final footing was completed on February 25, 2008, (Day 133). Each rectangular footing supports two 70-ft-tall concrete piers and two concrete box girders. The four main pier footings vary in length from 34 ft to 43 ft, in width from 81 ft to 112 ft, and in depth from 13 ft to 16 ft. The footings were designed to span sections of the remaining unused foundation of the old bridge, large drainage tunnels, and other existing utilities. These mass concrete footing placements were made with careful control of curing temperatures and thermal gradients using embedded cooling pipes and a custom concrete mix design.

The curved 70-ft-tall piers were cast beginning on January 23, 2008, (Day 100) with all piers of the bridge cast by March 14, 2008, (Day 151). Pier formwork was made for each pier so that casting could take place concurrently. The sculpted pier shape had been selected at the design charette and is discussed in more detail in the Winter 2008 Issue of *ASPIRE*.™ The sweeping curves of the piers were developed to complement the parabolic curves of the variable depth concrete superstructure. In the longitudinal direction, each pier has a 26-ft-wide base, curves in to an 8-ft width at mid height and then outward to 31 ft 8 in. at the top. The concrete placement of the pier columns followed a similar process as the footings. The superstructure rests on large disc bearings at the top of the piers. Each main pier has three bearings; each bearing has a service load capacity of 5800 kips. The shape of the pier includes concrete extensions to protect and conceal the bearings.

Precast Segments for the Main Span

The main span superstructure segments were prefabricated using the long-line casting method. Eight casting beds, each approximately 250-ft long, were set up on the existing I-35W roadway on the south side of the project. The 120 segments were precast and then trucked and stored at the adjacent river staging area. Once the formwork was removed from the casting site, the new I-35W roadway was built with alignment geometry enhancements. The close proximity of the precasting operation provided good access to the river and centralized, direct coordination between construction crews and the management and engineering teams. Precast segments vary in length from 13.5 ft to 16.5 ft, vary in depth from 25 ft at the pier to 11 ft at midspan, and weigh from 380 kips to 216 kips. As with the piers, the use of multiple segment beds allowed segment production to proceed quickly; all eight beds were in production simultaneously. Concrete for the first precast segment was placed on January 30, 2008, (Day 107). Rolling heated structures moved with the segment casting to provide a reliable work and curing environment during the cold winter months. Concrete was placed even on the coldest day, February 10, 2008, when the high temperature was -4° F and the low was -14° F, with a wind chill of -36° F. The final concrete segment was cast on June 6, 2008—128 days after precasting began.

The segments were lifted into place using a 600-ton, barge-mounted crane. Photo: Mn/DOT.

Concurrent Casting of Side Spans

While the main span superstructure segments were being precast, the adjacent side spans over land were being cast-in-place on falsework. Using the same box girder shape, the formwork was installed. Then all reinforcing and longitudinal and transverse post-tensioning was placed. These spans were scheduled for an early spring concrete casting, which began on April 2, 2008, (Day 170) and was completed by the end of May. The entire bridge deck is transversely post-tensioned for added riding surface durability.

The power of creativity and innovation.

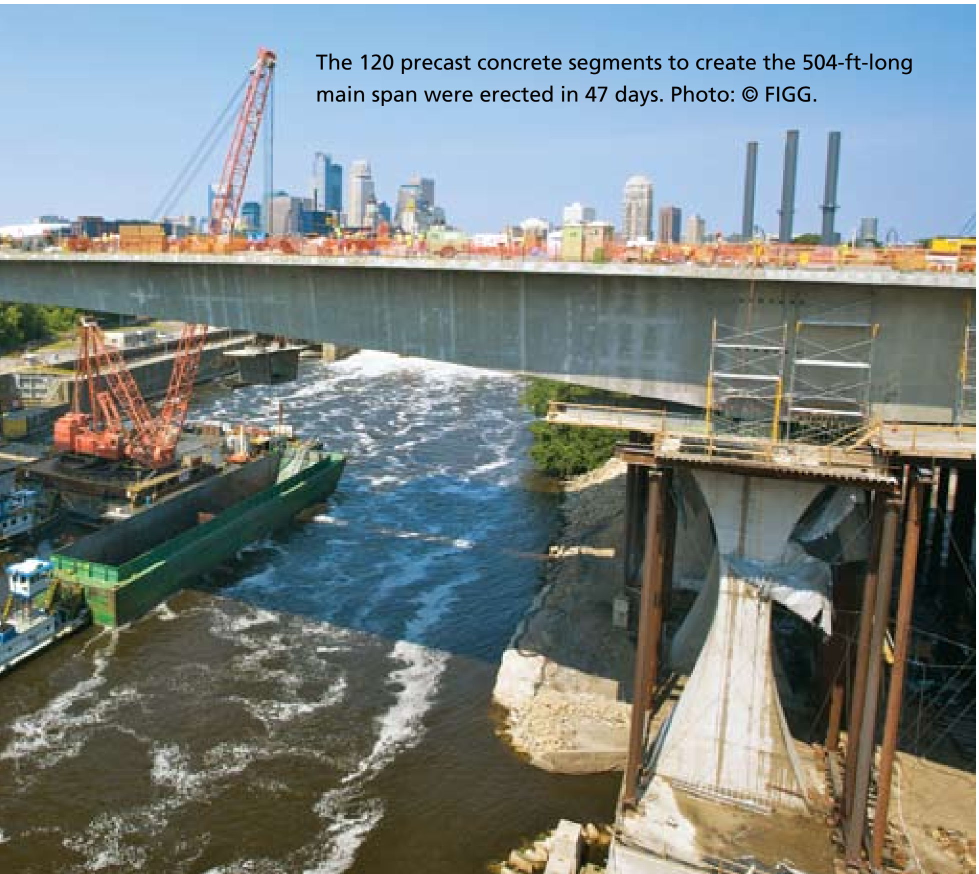
Main Span Erection—120 Concrete Segments in 47 Days

After completion of the concrete side spans, the starter precast segments in each of the eight cantilevers were erected. Precast segments were delivered to the erection site by barge from the riverfront just downstream from the nearby 10th Avenue Bridge and lifted into place using a 600-ton, barge-mounted ringer crane. The first segment placed at the pier to begin the one-directional cantilever construction began by using a 1-ft 6-in.-wide concrete closure pour to optimize precise geometric set-up. This was fine-tuned using a series of jacks on a support frame attached to the pier cap. The match-cast faces of subsequent precast segments were coated with epoxy and then connected to those previously erected using longitudinal post-tensioning. The first precast concrete segments were placed on May 25, 2008, (Day 223), while a crowd estimated at 800-1000 watched closely from the walkway of the adjacent 10th Avenue Bridge. Each pair of adjacent precast concrete segments was connected with a longitudinal cast-in-place concrete deck closure slab. After achieving a minimum compressive strength of 4000 psi, the segment pair and the connecting longitudinal closure were post-tensioned with a series of transverse, top-slab deck tendons and longitudinal, top-slab cantilever tendons. Segment erection operations continued at all eight cantilever headings, with four segments typically placed each day. The bridge's last concrete segment was erected on July 10, 2008, (Day 269) taking only 47 days to erect the main span segments. A 7-ft-long long closure pour was made at midspan in each of the four cantilevers with final stressing of longitudinal post-tensioning tendons to complete major bridge construction operations. From Notice-to-Proceed of the design-build contract to erection of the final main span segment was 9 months.

A Smart Bridge with High-Tech Bridge Monitoring

The new bridge contains approximately 323 sensors that will serve as a data resource to verify the long-term service of the bridge and provide an important tool for future bridge designs. Mn/DOT has formed a partnership with the University of Minnesota Department of Civil Engineering and the Federal Highway Administration for use of the information from the sensors.

Precast segments weighing up to 200 tons were erected quickly. Photo: © FIGG.



The 120 precast concrete segments to create the 504-ft-long main span were erected in 47 days. Photo: © FIGG.

A Modern Concrete Bridge for the Future

I-35W is a modern concrete bridge designed for the future—a sustainable, redundant, high-strength, high-performance concrete bridge. This major concrete bridge will serve as an important resource in the delivery of other major bridges in the re-building of America's infrastructure. Ultimately, the success of this bridge is a reflection of remarkable teamwork of some 400 to 600 local skilled workers, the construction team, the design team, the subcontractors and suppliers, Mn/DOT, FHWA, and the community. Mn/DOT's vision proved to be achievable, demonstrating the power of creativity and innovation.

Linda Figg is president/chief executive officer of FIGG and served as I-35W visual quality manager. Alan R. Phipps is senior vice president/director of operations of FIGG and served as I-35W design manager.