1996 Prize Bridge Award: Long Span
Clark Bridge

THE CLARK BRIDGE OVER THE MISSISSIPPI RIVER BETWEEN ALTON, IL, AND NORTH ST. CHARLES COUNTY, MO, does more than just handle 20,000 cars daily: It's breath-taking—almost traffic-stopping—beauty has helped to boost civic pride in surrounding communities as well as increase economic development.

In January 1985, the Illinois Department of Transportation hired Hanson Engineers Inc. as the prime design consultant for the bridge, which replaces a structure opened to traffic in 1928. As on most large public works bid in the 1980s, the FHWA required both concrete and steel design alternatives, so Figg Engineers Inc. was hired as a subconsultant to prepare the concrete alternative design and to provide technical consulting on the steel design.

The winning proposal was the nation's first steel, cable-stayed, single pylon, common saddle bridge. And, in a somewhat unusual occurrence for a new technology, the bridge had no major construction claims. But perhaps even more impressive, the bridge opened only one month behind schedule—despite the major flooding in 1993 that disabled much of the St. Louis and Alton areas. To make up for the problems, the contractors worked in flood conditions and accelerated schedules whenever possible.

The design of the cable-stayed 756' main span was based on concepts prepared by Figg, which included the single pylon concept in both the steel and concrete alternatives. Figg also reviewed final contract documents and prepared contract special provisions for the cable-stayed portion of the bridge, and also provided on-site assistance to IDOT during construction of the cable-stayed main span.

Design Innovations

IN MOST CABLE-STAYED BRIDGES, the span is supported by cables strung at an angle directly from the tops of the towers, or pylons, to the bridge deck (much like the ribs of a fan). In the remainder of cable-stayed bridges, continuous cable stays anchor at deck level in the main span, pass over the individual saddles mounted near the top of the pylon, and anchor at deck level in the tail spans. All of these bridges have used a single plane of cable stays to support a concrete box girder superstructure. Clark Bridge is the first to use the single pylon with two sloping planes of cable stays to support a composite steel floor system. The single pylons with their supporting piers were chosen to reduce the obstruction to the skewed navigation channel. Piers supporting dual pylons require massive crash walls for protection from vessel collisions.

A top-mounted common saddle was chosen for a number of reasons. Non-continuous stays internally anchored in the pylon impose large splitting (or tensile) forces in the concrete pylon. A saddle is an effective way of eliminating those splitting forces. The use of saddles reduces the number of very expensive stay anchors by half. In the past when this technique was used, individual saddles would be evenly spaced near the top of the pylon. Using a common saddle mounted at the very top of the pylon improves the efficiency of stays by maximizing slope of the stays relative to the deck. The more vertical a stay is, the more efficient it is. To achieve an equivalent level of efficiency for a given set of stays, the pylon height can be minimized, which saves costs.

The dual sloping planes of stays provide an additional benefit. They provide a very efficient method for torsionally stabilizing the slab and girder floor system. In cross section, the stays, pylon and deck form a series of triangles. This shape is the basic building block of all trusses and is a very stable configuration that has been used by engineers for centuries.

The cable stay system uses basic components originally developed by the post-tensioning industry but improved for application to the cable-stay industry. The seven-wire strand used is similar to—but has a larger diameter than—those used for most post-tensioning applications. The strands are coated with an epoxy resin, similar to that used on conventional reinforcement bars, for corrosion protection. A polyethylene pipe sheath encompasses the strand

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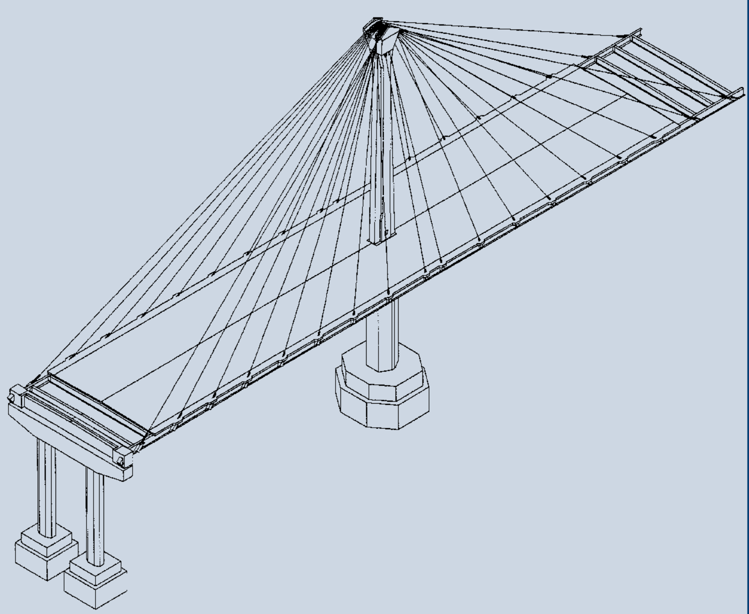
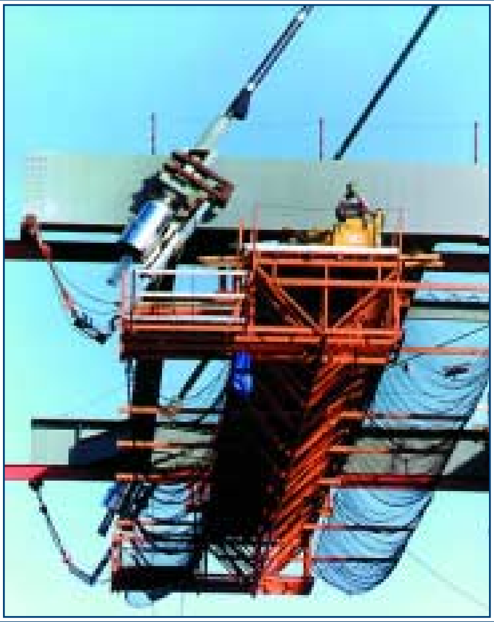
Judges Comments:

"The bridge's double fans create a very dramatic appearance"

"The single pylon reduces obstructions in the waterway and the cables contribute to the torsional stiffness of the roadway"





Project Team

Designer:
Hanson Engineers Inc.
Springfield, IL

Consultant (navigation unit):
Figg Engineers Inc.
Tallahassee, FL

General Contractor (MO):
Massman/Ben Hur
Kansas City, MO

General Contractor (IL):
Keller/Gen-Con
Arnold, MO

Fabricator (MO & IL):
PDM Bridge (formerly Hartwig Mfg. Co.)
Wausau, WI *

Fabricator (navigation unit):
PDM Structural Group
Des Moines *

Erector (MO):
Rednour Steel Erectors, Inc.
Cutler, IL

Erector (navigation unit):
McCarthy/PCL, St. Louis

Erector (IL):
Rednour and Craig, Cutler, IL

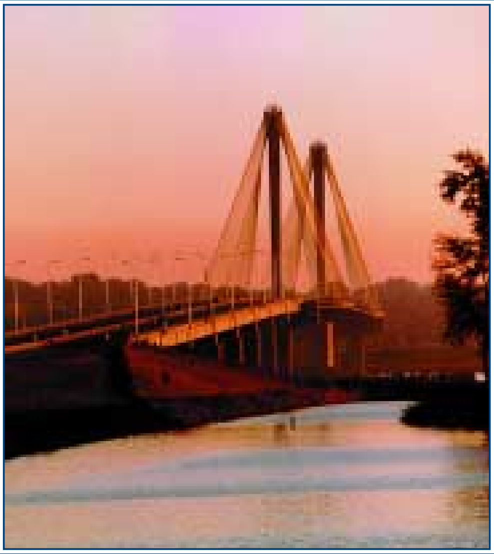
Owner:
Illinois Department of Transportation

Please note that red text denotes an AISC member

bundle and is the first line of defense against the elements. The anchorage mechanism is a more sophisticated version of a post-tensioning anchorage with much of the development effort devoted to improving its fatigue characteristics.

The use of a simple modular steel framing plan and precast concrete deck panels allowed the contractor to erect the main unit superstructure in just 10 months. The contractor was able to partially erect each framing module at a site near the bridge. Each 35' module consisted of two 35'-long steel edge girders, two 100'-long floor beams and a small amount of bracing. The module was floated in on the barge used for partial erection and lifted into place. After a splice was installed on each edge girder, a pair of cable stays were draped over the pylon and connected to the steel frame. Four precast concrete deck panels were placed along with a small amount of cast-in-place concrete, which completed a 35' section of the deck on either side of the pylon.

The approach spans utilize parallel steel plate girders made composite with a cast-in-place concrete slab. The Missouri approach is comprised of eight 200' spans on a tangent alignment. The majority of the Illinois approach, comprised on nine 154' spans and one 115' span, is located on a horizontal curve with a 1,910' radius. Once the approach piers were located, Hanson Engineers enlisted AISC Marketing, Inc. to prepare a preliminary design study to optimize girder spacing and depth. Using the recommendations of the preliminary study and remaining within some client-



Project Data

Steel wt./sq. ft. of deck:
33.7 lbs. (MO)
38.6 lbs. (IL)

Cost:
$86 million

Steel tonnage:
2,326 (MO)
2,172 (IL)
3,616 (nav.)

defined parameters, seven plate girders spaced 13' on center were selected. A 90" girder depth was used for the Missouri spans and a 75" depth was used for the Illinois spans. ASTM A572 Gr. 50 steel was used throughout.

A particularly interesting and challenging problem arose during the preliminary design phase of this project. After the locations of the piers had been set, the drillers were sent to the site to take soil borings. They discovered that a very deep hole exists along the alignment between Piers 2 and 7 of the Missouri approach. At some pier locations, conventional cofferdams would have had to be designed to resist a water depth of as much as 75'. Instead, it was decided to support the footings at a point as much as 40' above the river bottom. Concrete-filled, 30"-diameter steel pipe piles were chosen to support the footings. These piles were chosen for their ability to resist the imposed forces with 40' of unsupported length.

Precast concrete templates were temporarily supported 20' under the water using four 30"-diameter unfilled pipe piles. The template also served as a support for the re-usable steel cofferdam and as a stay-in-place form for a concrete seal coat used to enable the contractor to dewater the cofferdam and construct the footing and pier stem.

Total construction cost of the bridge was approximately $86 million.