Old Plank Road Trail Bridge

Frankfort, Illinois

Jurors Comments

Unique use of skewed A-frame pylon to suspend a plate girder superstructure. A light, airy open design...a unique through-the-leg superstructure...Very interesting concept.

The Old Plank Road Trail (OPRT) Bridge in Frankfort, Illinois carries a bicycle path and pedestrian walkway along an old railway alignment across U.S. Route 45 at a skew of 43 degrees. A new bridge was required because of a major upgrade of U.S. 45 at this location, including a profile raise and widening to four lanes. The bridge was designed under the direction of the Illinois Department of Transportation (IDOT), and completed in 1999.

The defining structural feature of the bridge is an A-frame pylon with its legs straddling the highway at right angles (actually 2 degrees off a perfect right angle, to avoid an existing drainage structure). Thus, the main load carrying component, the pylon, spans the shortest distance across the highway. The skewed deck structure is suspended from the pylon by cables. There are no piers; from abutment to abutment the deck superstructure is supported only by the cables extending from the top of the pylon.

The abutments are set well back from the edges of the highway, yielding a total bridge length of 180' measured along the skewed deck. Four hanger cables from the top of the pylon, two on each side of the deck, divide the 180' length of the skewed superstructure into three 60' segments.

The basic dimensions of the bridge are indicated in its simplified plan and elevation. The pylon is 82' high and its legs are 114' apart at the base. The highway below is 73' wide overall (including four traffic lanes, shoulders and a median). The suspended structure is 180' long, at a skew of 43 degrees.

Details of Structure

The pylon legs are steel pipe sections of 30" outside diameter and 5/8" wall thickness. The material is of 36 ksi yield stress. The lower 12' of each leg is filled with concrete to improve resistance to traffic impact.

The suspended structure is framed in steel. The main longitudinal girders are W27 rolled beams, 12' apart. W14 floor

beams at 12' centers span between the longitudinal girders and support a cast-in-place reinforced concrete deck. The girders and floor beams are of Grade 50 steel. Shear studs connect the steel framing to the concrete. The overall depth of the suspended structure, excluding the custom-designed railings, which are largely open and visually transparent, is only 27".

Four hangers support the suspended deck structure, each a 1½" diameter bridge strand, with standard open strand sockets at both ends.

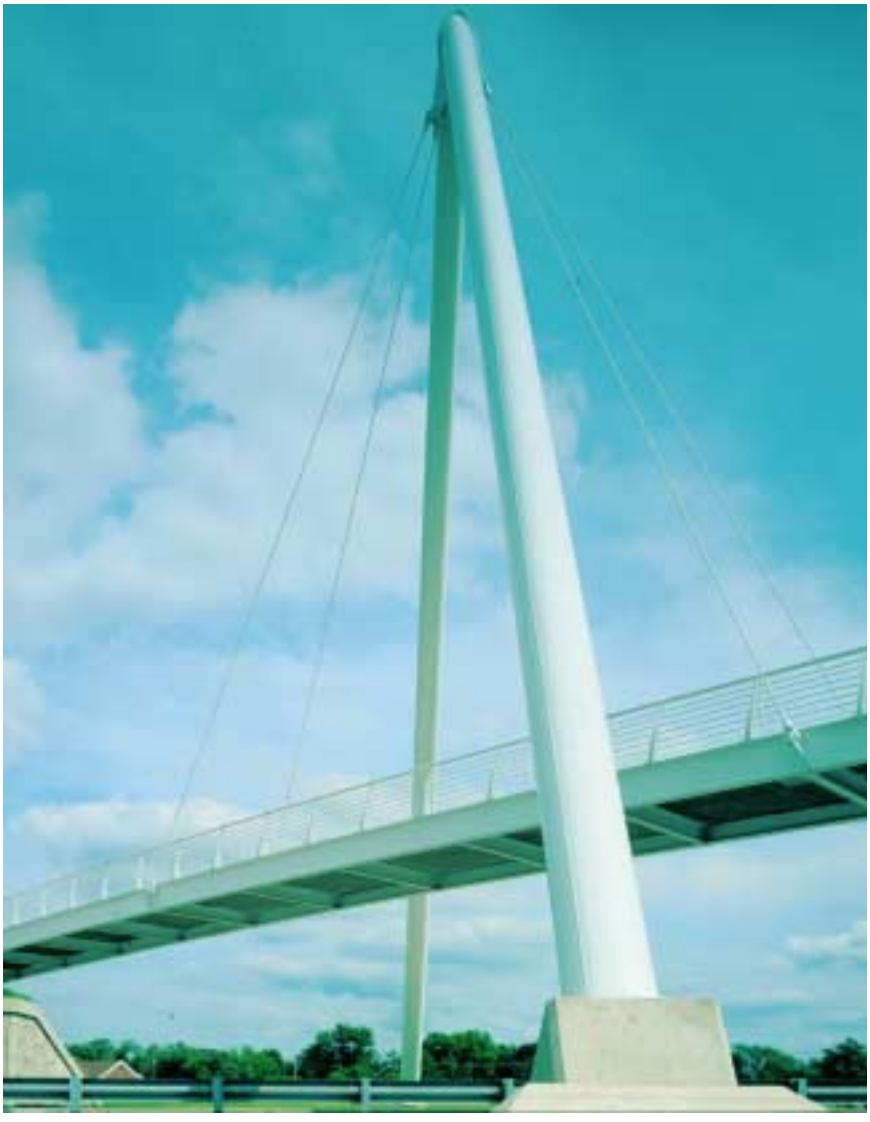
The pylon is supported at the base of each leg by battered and vertical piles. An integral abutment design, with vertical piles at each abutment, is used for the deck structure. Internally reinforced earth walls are used for the abutments and wing walls.

The designers of the OPRT Bridge decided not to use plastic encasement or other heroic measures for protection of the hangers from corrosion. Instead, the hangers were made easily inspectable and replaceable. The bridge was designed to permit removal of one or all of the hangers with a single temporary support in the median of U.S. Route 45. This design feature, which required little additional strength in the structure, was also expected to be useful during erection of the bridge.

Design Criteria and Structure Behavior

Current AASHTO, *Guide Specifications for Design of Pedestrian Bridges*, were used for design of the bridge. The design live load was a distributed pedestrian load or a single H-10 truck. The design was based on complete three-dimensional analysis with finite elements representing the deck (this design did not differ significantly from a preliminary design based on a simple "back-of-an-envelope" analysis).

The calculated live load deflections (2.3' maximum) and the combination of natural frequency (1.0 hertz) and mass are well within the recommendations in the AASHTO, *Guide Specifications*.



Analysis of Cost

The OPRT Bridge was advertised, bid and contracted as part of a much larger project (with a total construction cost of about $10 million). The four bids received were within a 10% band, but the cost of bridge items in the bids ranged from about $422,000 to $857,000. This suggests an artificial breakdown of prices by the bidders and makes it difficult to reliably isolate the cost of the bridge from the overall bid prices. However, the bid prices support estimates prepared during design, which indicated that a conventional crossing with a pier in the median of U.S. 45 would have cost about the same as the design that was adopted. The striking appearance and the elimination of the center pier and the related safety benefits were achieved at little or no extra cost.

Other Potential Applications

The diagonal-pylon concept developed for the OPRT Bridge is applicable to a wide range of crossings for roadways and walkways over land or water and shows a design that was proposed recently for a 40' wide roadway crossing over a rail yard in Chicago—a solution abandoned for urban-planning reasons in favor of a tunnel.

Though the full benefit of the diagonal-pylon concept will not be realized in bridges that are not skewed the concept may prove to be a viable alternative to conventional designs even for certain non-skewed crossings.

Highlights of OPRT Bridge Design

Though the bridge is skewed, the main load carrying component, the pylon, spans the shortest distance across the highway below.

The clear span under the bridge is between the legs of the pylon, rather than on each side of it as in conventional cable-stayed bridges.

The large angle between the plane of the pylon and the deck structure, the skew, allows the deck to restrain or "brace" the pylon in the out-of-plane direction. Thus, the overall structural concept is one in which the pylon supports the deck vertically while the deck supports the pylon laterally.

The challenge presented by the extreme skew of the crossing was turned into an advantage through this unique structural design.

The cost is comparable to that of a conventional bridge with an additional pier at the center of the crossing.

The structural concept developed for this bridge is applicable to a wide range of skewed crossings for roadways and walkways over land or water.

Project Team

Owner
Illinois Department of Transportation

Designer
Teng & Associates, Inc.

Steel Fabricator
Industrial Steel Construction, Inc.

Steel Detailer
B & D Detailing Inc.

Steel Erector
Angus Contractors Inc.

General Contractor
K-Five Construction Corp.

Consulting Firm
Herlihy Mid-Continent Co.