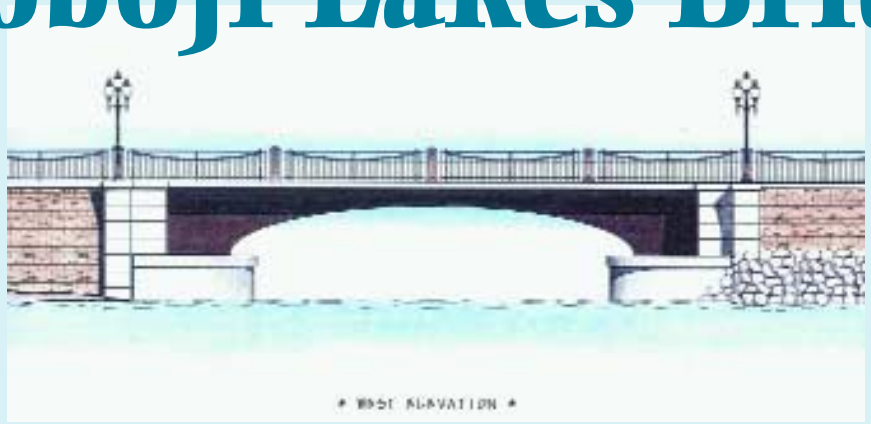
Okoboji Lakes Bridge



By Kimball Olson and Dean Bierwagen

The replacement of the causeway bridge between East and West Okoboji Lakes was part of a larger reconstruction effort for the rebuilding of US 71 through the resort towns of Okoboji and Arnold's Park in northwest Iowa. Because of the resort area and the large number of people that vacation there, the aesthetics of the new bridge concerned the people in the area. A joint partnership formed between the people in the community and the Iowa Department of Transportation to agree on the appearance of the bridge along with the rest of the causeway.

Aesthetics

The Okoboji Lakes Bridge and Causeway on U.S. Highway 71 received many aesthetic touches as a result of input gained from an intense local partnering effort. The project benefited from the formation of a local beautification task force charged with overseeing the aesthetic enhancement of the project corridor. The success of this part of the partnering effort depended on the Iowa DOT's ability to quickly assimilate, evaluate and illustrate the ideas generated by the task force.

Aesthetic concepts and detail issues were the subjects of ongoing team discussion during the formative stages of the corridor's development, particularly the issues of bridge girder shape, traffic barrier design, pedestrian railing design, retaining wall materials and ornamental lighting. The project involved replacement of an arched concrete beam structure over the narrow 12 m (40′) waterway between two lakes, with consistent architectural treatment extending through the 300 m (1,000′) length of the approach causeway. As requested by the local constituents, any proposed enhancements had to address the appearance of the project from the boater's point of view, as well as views for motorists using the highway.

Local interest in maintaining a similar appearance in the new bridge structure led to the choice of an elliptical-arch, steel box girder design. Iowa DOT's bridge designers chose a steel box girder design that gives the illusion of an arch bearing upon the old abutments, while in fact hovering over them and bearing on new abutments placed just beyond the original structure. In this way, the older structures are invited into the new design, avoiding a potential eyesore.

The new abutments incorporate special shaping to accommodate placement of ornamental lighting, and formwork included horizontal recesses for a "stone masonry" look. Similar details were used at the pedestrian underpass portals and at cast-in-place light pole bases along the approach roadway. All concrete surfaces—except the bridge deck, roadway and sidewalk—are either architectural white cement concrete or treated with a near-white cementitious coating.

The traffic barrier design consists of a 685 mm (27″) white cement concrete base with recessed panels, topped with a custom-designed metal railing. The Iowa DOT designed a pedestrian railing that responds to local desires for "wave-like" imagery by incorporating a large curved tube within each 4.9 m. (16.1′) painted-steel rail panel. Colored cast stone pedestals accent the railing design and complement the lakeside context, recalling the rope-and-bollard railing systems commonly found on wharves and waterside boardwalks. A mechanically stabilized earth retaining wall system sup-

porting the causeway features colored concrete with a stone masonry pattern for a more human-scaled appearance, capped with a white cement concrete coping.

Bridge Description

The steel girder was selected because of the need for a lightweight girder and the flexibility that steel aesthetically offered for an elliptical shape and a shallower depth for improved clearance for boaters.

The Iowa Department of Transportation Office of Bridges and Structures did the design and inspection of the replacement. Because of environmental concerns, the existing abutments were left in place, and the replacement bridge was constructed around them. The steel box girder bridge was detailed in metric and consisted of a 13,200 mm (43.3′) roadway with an 1835 mm (6′) sidewalk. The four box girders spaced at 3,970 mm (13′) spanned 19,100 mm (62.66′) and crossed the existing abutments as well as the water channel. The girders are supported on integral abutments cast around the exiting abutments as well as an existing rock pier that had been left buried in the approaches from a previous bridge. Galvanized stay-in-place steel forms supported the cast-in-place concrete deck between the top flanges.

The pedestrian railing on the outside of the sidewalk has decorative steel railing sections with cast stone pedestals. The traffic barrier rail system consists of a continuous rectangular section of cast- in-place concrete topped with decorative steel railing panels with a cast stone pedestal designed to match the pedestrian railing. To reduce the maintenance on the steel railing, a dual coating system was used where the railing was galvanized and then painted.

Girder Description

Sixteen-millimeter (0.63″) thick plate was used for the varying depth web, which varied from a maximum of 2,584 mm (8.48′) at the abutment to 695 mm (2.28′) at the centerline of the span. The top flanges are 310 mm (12.2″) by 20 mm (0.787″) and the bottom flange is 1,850 mm (72.8″) by 20 mm (0.787″). The girder ends were cast integrally into the abutment by providing holes in the web and bottom flange and running the reinforcing continuous through the girders. Access covers were provided at each of the girder ends for inspection.

Bridge girders during fabrication.

View of construction staging during girder placement.

Corrosion Protection

The bottom flanges and 450 mm (18″) of the web, metalized inside and out before painting, provided additional corrosions protection in the area of the existing abutments. There was concern that corrosion could be a problem in this area because of the clearance between the bottom flange and the ground. The remainder of the steel was primed with an inorganic zinc silicate primer, an epoxy intermediate coat and then a polyurethane topcoat. The inside of the box was painted white for easier maintenance inspections. All painting was done in the shop.

Design

Because of the concern for aesthetics, changes to the appearance of the bridge because of the design were discussed with the local citi-

View of the complete bridge.

zens from the partnering committee. Design issues considered during the plan preparation were the need to stage the construction to maintain traffic and the need to keep in operation a 610 mm (24″) diameter sewer main hanging from the existing bridge. This work took place in the confined area of the causeway.

As described earlier, the new abutments had to fit around the existing concrete abutments and a buried rock pier left in place from a previous structure. Because of the size of girders required for aesthetics, design stresses generally were not a problem. Heavier webs were required by design because of concern that the welding of the stiffeners on the inside would reflect throughout the web. However, there was concern with the welded connection between the elliptical flange and bottom horizontal flange. A single bevel full penetration weld was selected for the connection with an eight-millimeter fillet weld provided along the inside of the connection. UT inspection was done of splice when completed. Exact metric plates were used for the flanges and webs, while English sections soft converted to metric were used for stiffeners and rolled sections. Design was based on the 1996 AASHTO Standard Specifications for Highway Bridges Sixteenth Edition, 1996

Beam Fabrication

Egger Steel of Sioux Falls, SD fabricated the beams. Because of concerns of the flexibility of the web and beam during fabrication, the girders were assembled as follows:

- Cut the overall shape of the beam web
- Welded top flanges onto the web
- Welded stiffeners onto the webs and cut the ellipse into the web
- Connected webs together with the diaphragms and cross braces to form the overall shape of the girder
- Welded horizontal bottom flanges at each girder end onto the webs
- Welded pre-bent bottom flange into place for the ellipse
- Made the full penetration welded splice connection between the horizontal bottom flange and the curved bottom flange

Construction

Construction did not take place during the summer tourist season because of the resort status of the towns involved. With the help of a mild winter, Christensen Bros., Inc. of Cherokee, IA, constructed the new bridge from September 1998 to May 1999. The roadwork for the causeway was done the following year from September 1999 to May 2000 with the finished project opened in May 2000.

The project received a Marvin M. Black Award for Excellence in Partnering from the Associated General Contractors of America (AGC) earlier this year.

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Structural Engineer:
Offices of Bridges and Structures, Iowa DOT

Fabricator:
Egger Steel, Sioux Falls, SD
(AISC member)

Software:
Mathcad