Ray Nitschke Memorial Bridge

Green Bay, Wisconsin

The Main Street Bascule Bridge crossing the Fox River in Green Bay, Wisconsin, was experiencing ongoing, expensive machinery problems and increasing misalignment due to unknown foundation problems. Originally constructed in 1929 the bridge had become an historical landmark, however, in the summer of 1992, the City of Green Bay had decided to replace the four-lane bridge with a new bascule span on a different alignment to the north. The designers of the replacement bridge faced and met numerous technical and aesthetic challenges.

A study of options for the new crossing, authorized by the Wisconsin Department of Transportation (WisDOT), included the investigation of various channel and approach roadway alignments, as well as alternatives for the bascule span, the deck type and the drive system. After the final design had been started, in July 1995, WisDOT decided to accelerate the schedule. The project team completed the design in April 1996, several months ahead of the original schedule.

The new double-leaf rolling lift span provides better approach alignments, incorporates a number of new technologies and has been designed to preserve many of the aesthetic attributes of the original bridge. Named after the legendary Green Bay Packer linebacker, Ray Nitschke, the new bridge was opened to traffic in October 1998.

Unique or Innovative Aspects

New or innovative technologies employed in the replacement bridge included the first use of exodermic grid for the bridge deck and the first use of a closed loop hydraulic drive system on a bascule bridge. Another unique and challenging aspect of the project was the use of the metric system.

The exodermic deck, a proprietary system, incorporates a reinforced concrete deck that is cast on top of and composite with a steel grid and the floor beams. This deck system has excellent riding characteristics and low maintenance costs in comparison to open grid decks. The deck system makes maximum use of the compressive strength of the concrete and the tensile strength of the steel grid. The horizontal shear is transferred between the concrete and the grid through partial embedment into the concrete of the steel grid tertiary bars and studs. The concrete slab is 114 mm thick and the total deck thickness is about 246 mm. The concrete is cast full depth over the floor beams and studs are welded to the floor beam to achieve composite action with the floor beams. The deck system spans between floor beams, spaced at 4.1m, eliminating the need for longitudinal stringers.

The hydraulic motor drive, a closed loop hydraulic system, consists of one hydraulic power unit, two hydraulic power motors and two rack and pinion sets per bascule leaf. The motors are coupled to the pinion shaft by the use of a shrink disc, allowing the easy removal of the motor from the shaft for maintenance. The hydraulic power unit allows differential load sharing between the pinions of the same leaf. The hydraulic motors are capable of smooth rotation at very slow speed, which allows very reliable and smooth span control during acceleration, full speed and span seating. Routine maintenance includes checking fluid levels, filters and leaks. This system has the lowest maintenance requirements of the three systems studied.

Economic Benefit or Cost Effectiveness of Design

The estimated construction cost for both of the proposed bridge types, Scherzer bascule and Trunnion bascule, was determined to be very close. The project team decided to use a Scherzer bascule since most of the movable bridges in WisDOT District 3 are Scherzer's, it was believed that in keeping with the familiar bridge design maintenance would be somewhat easier.

Structure Configuration

Each leaf consists of two main girders, 1880 mm deep at the center break and 4300 mm deep at the pinion. The girder flanges vary from 30 mm x 480 mm at the tip to 90 mm x 600 mm at the pinion. Each leaf rolls on a 3 m radius tread casting. The floor beams are spaced at 4.1 m and vary in depth from 1200 mm at the girder to 1376 mm at the center of the roadway. The 2.4 m sidewalks on each side are supported on brackets and cantilevered from the girders. The counterweight is supported by a combination of three vertical beams and two horizontal trusses. Each leaf is braced by a series of three longitudinal cross frames and lateral bracing at the bottom of the floor beams.

Aesthetic Considerations

In deference to the original bridge and its landmark status, the design team incorporated a number of architectural features from the original structure in the design of the new bridge. The new tender tower replicates the octagonal shape of the original tower and includes a clay tile roof of the same type as was used on the original operator's house. A decorative terra cotta cornice from the original house was also salvaged and reused. The design team designed a steel railing to closely match the railing on the original structure and the tender tower was stained red to match the color of the Neville Public Museum and the old C&NW Railroad Depot. Accent lighting installed along the edge of the bridge deck serves further to highlight the structure at night, in particular the graceful arch of the main girders.

Type of bascule

The team considered two types of conventional bascules, a Trunnion bascule and a Scherzer bascule—the type eventually selected. Trunnion bascules pivot about a fixed shaft or trunnion, whereas Scherzer bascules roll backwards as they rotate open. The Scherzer bascule is supported on heavy tread plates. Gravity and pintles, otherwise known as gear teeth, in the tread plate prevent the bridge from moving out of line as it rolls open. The drive machinery is mounted on the movable leaf between the girders. The Scherzer bascule requires a slightly smaller opening angle than the trunnion bascule because it moves away from the channel as it opens.

Roadway deck

Engineers evaluated three roadway deck types: conventional open steel grid, steel grid half-filled with concrete and exodermic. Each deck type was evaluated against three criteria that included first cost, maintenance cost and ride quality. The exodermic deck was chosen for this project based on a reasonable first cost, low maintenance cost and excellent riding characteristics. The exodermic deck is heavier than an open grating deck, but it can span greater distances than either an open grid deck or half-filled grid, thereby simplifying the floor framing.

Mechanical drive system

The project team examined three types of mechanical drive systems: a traditional electric motor and gear drive system, a hydraulic cylinder system and a low-speed/high-torque hydraulic motor drive system. The hydraulic motor system was determined to have a slightly higher first cost than the hydraulic cylinder system, but less than the gear drive system. Maintenance and operational advantages led to the selection of a low-speed/high-torque hydraulic motor system for this project.

Foundation

As the design of the superstructure and mechanical and electrical systems progressed, the team performed a alternative foundation analysis to determine the optimal foundation type for the bascule piers. The new bridge was analyzed in accordance with FHWA HEC-18 and determined to have potential local scour to depths of nearly 14 m in the vicinity of the bascule piers. Soil conditions from the river bottom to the top of bedrock were found to be extremely poor. The selected foundation type was 2.4 m caissons, socketed into sound rock.

Project Team

Co-Owners
- Wisconsin Department of Transportation and the City of Green Bay

Designer
- Parsons Brinckerhoff

Steel Fabricator
- PDM Bridge

Steel Detailer
- Tensor Engineering, Inc.

Steel Erector
- Hi-Boom Erecting, Inc.

General Contractors
- Lunda Construction Company

Consulting Firm
- Graef, Anhalt, Schloemer and Associates, Inc.