NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

WINNER:
RECONSTRUCTED

I-440 Ramp over I-24

Nashville, TN

The original structure, a four span continuous steel twin tub girder bridge with composite deck, was constructed in 1983 as a one-lane ramp bridge. Its intermediate supports are composed of integral steel box girder bent caps resting on single reinforced concrete filled steel shell composite columns. This substructure configuration was chosen because of a lack of room for pier placement within the interchange, as well as the desire to keep the substructures oriented radially for its curved alignment over a highly skewed crossing. Due to increasing traffic volumes in the intervening years, it became necessary to widen the bridge from its original 30′ roadway to provide a 42′ wide two-lane facility.

Because of the tight, highly skewed configuration of the lanes beneath, choices of how to widen the bridge were limited. If widened to one side only, the substructure for the new portion would have had to be skewed for column placement, and the new integral caps would not have aligned with those existing. Otherwise, the columns and caps of the widened portion would have had to be staggered. In either case, differential deflections between the existing and new girders would have been a substantial problem.

Widening symmetrically and forgoing additional columns solved the aforementioned problems. This choice, however, created several difficulties for the designer. The first problem was how to add extensions to the presently constructed integral bent caps. Second, while the columns had adequate reserve capacity, the existing bearing pins and pin plates as configured could not support additional dead and live loads required. The third problem was the need to control the non-composite new girders during the slab pouring phase to assure a smooth continuation of the existing superelevated cross slope. Fourth, could the resulting four-girder system equally share in the distribution of dead and live loads? Finally, could the construction work be accomplished with minimal traffic disruption?

Innovations

To create the integral cap extension, holes were drilled in the outside half of the existing top flange of the longitudinal tub girders at each intermediate support. The bottom flange was similarly drilled. The cap beam extensions were designed as cubes with one side open. Opposite the open face, the side in contact with the existing girder web was fabricated with a porthole. The completed extensions were first bolted to the flanges and exterior web of the existing longitudinal girders. After connection, a porthole was then cut in the existing web of the tub girders, providing access during construction and for future inspections.

In order to increase the bearing capacity of the existing bearing pins, the retaining nuts were removed from the pins and replaced with machined caps internally threaded and turned to the approximate diameter of the existing pins. Next, new pin plates fitting the cap extensions were installed and welded to the bottom of the cap beam and the outside of the steel shell of the composite column.

New stiffener/connection angles were bolted to the outside of the external webs of the existing tub girders collinear with the existing transverse stiffeners. To these new angles, narrow connection plates were bolted to the outstanding legs. Subsequently, diagonal high strength rods, in pairs, were installed. These rods eventually would pass through the top flanges of the new box girders. The leading edge of the narrow connection plates contained a line of drilled holes matching the external stiffener/connection plates of the new girders. The top-and-bottom most holes in the narrow connection plates were slotted. During the erection of the new longitudinal box girders, bolts were only installed in the two slotted

holes finger-tight, and the diagonal high strength rods tensioned so that the new box beams were lowered while the adjacent tub girders were raised to obtain equal elevations. The hand tight bolts in the slotted holes of the connection plates guided the new girders during the jacking process to prevent transverse rotation of the new box girders. This process of pre-loading the new girders decreased the load on the existing girders so that future loadings would be equally shared by the total system.

Owner
Tennessee Department of Transportation, Nashville, TN

Structural Engineer
Tennessee Department of Transportation, Nashville, TN

Steel Fabricator
Carolina Steel Corporation, Greensboro, NC (AISC member)

Steel Detailer
ABS Structural Corporation, Melbourne, FL (AISC & NISD members)

General Contractor
Ray Bell Construction Company, Inc., Brentwood, TN

Software
In-house