HPS Success

Kristi Van Ooyen

Integrating high-performance 70 ksi steel (HPS) with traditional 50 ksi steel yielded a design that cost 10% less than the lowest concrete bid.

Designed in 1954, the existing Springview South bridge is a 370′-0″ bridge consisting of five spans and a steel girder superstructure with pin and hanger expansion devices. This bridge has a 24′-0″ wide roadway and carries two lanes of traffic. The bridge crosses the Niobrara River on U.S. Highway 183, south of the town of Springview in north central Nebraska.

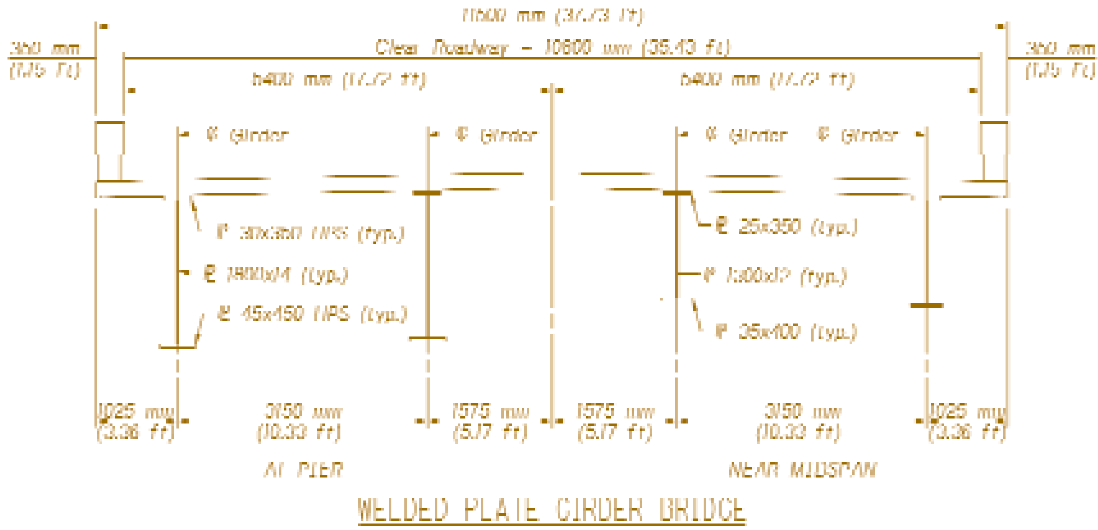
In the late 1990s, the operation of this bridge was assessed and it was determined to be functionally deficient. A preliminary cost investigation revealed that replacing the existing bridge was more cost-effective than widening the existing substructure and superstructure and lengthening the bridge an additional 80 feet. During construction, Highway 183 would be closed to traffic, enabling the bridge to be built without phasing.

CONCRETE VS. STEEL

Two competing bridges were designed for this project—a welded plate girder bridge and a prestressed concrete girder bridge. The concrete alternate was a three span NU2000 prestressed concrete girder bridge. with four longitudinal girders spaced at 3 m (9.84 ft).

The steel alternate, with two end spans of 43.0 m (141.08 ft) and a middle span of 53.0 m (173.88 ft), was comprised of four lines of welded plate girders with a parabolic haunched section at each pier. The girders integrate the use of traditional 50 ksi steel and high performance 70 ksi steel (HPS). The girder cross-section in all positive moment regions is composed entirely of 50 ksi steel.

The negative moment section, however, is a hybrid girder section consisting of HPS in the flanges and traditional 50 ksi steel in the web. A bolted field splice is located 13 m (42.65



The steel alternate ultimately chosen for the Springview bridge features four lines of hybrid plate girders composed of 70 ksi HPS along with more traditional 50 ksi material.

ft) in both directions from the center of the pier. This divides each girder into 5 segments. The first and last segments are 30.0 m (98.43 feet), the segments over the pier are 26.0 m (85.30 feet) and the section in the middle span is 27.0 m (88.58 feet). The girders were designed in accordance with the AASHTO *LRFD Bridge Design Specifications*, Second Edition, 1998, with the 1999 *Interim*. Like the concrete alternate, HP piles support both the abutments and piers.

All sections in the positive moment region are compact sections and subsequently take advantage of providing flange flexural resistance greater than that of the yield strength of that flange. No savings in material are achieved by using HPS over traditional steel in these regions because the plates are of minimal size. Reducing the plate sizes further to accommodate HPS would compromise constructability requirements.

Because of the variable depth of the sections over the pier, the nominal flexural resistance of the flanges is limited to the yield strength of those flanges. However, using HPS in the flanges of these regions results in material and cost savings. To accomplish the same results using strictly 50 ksi steel, the top flange plate would need to be increased from a 30 mm × 350 mm (1¼ in. × 14 in.) to 45 mm × 450 mm (1¾ in. × 18 in.). Likewise, the bottom flange plate from 45 mm × 450 mm (1¾ in. × 18 in.) to 50 mm × 450 mm (2 in. × 18in.). The net savings is a 28% reduction in steel required in the girder segment over the pier when HPS is used in the flanges of that segment. The decreased plate sizes for HPS plates also takes advantage of the cost break that is typically seen when plates are less than 1½ inches thick. Although the high performance steel flange plate sizes required for this project would not be possible with a quench and tempered plate product, the Thermo-Mechanical-Controlled-Processed (TMCP) product is available in lengths longer than 50 feet and up to two inches thick, matching the needs of this project.

If HPS were to be used in the web in an attempt to decrease the plate thickness, additional stiffeners would be required. Since no significant cost savings would be achieved, traditional 50-ksi steel is utilized in the entire web.

COST COMPARISON

Historically, concrete girder bridge designs are bid competitively over their steel girder alternates in the eastern part of Nebraska due to the close proximity of fabricator shops in that region of the state. For the Springview project, the awarded bid was expected to depend on a delicate balance between the cost of girder fabrication and the cost of girder distribution and erection.

For this project, the steel girder alternate was anticipated to be cost-effective to deliver and construct because each girder could be delivered in five segments, with each segment measuring less than 100 feet long and weighing less than 10 tons. It was recognized that concrete girder sections of over 150 feet in length and weighing almost 72 tons each were economically challenging to manage.

In January 2001, the Springview South project was let to bid. The lowest bid for the steel alternate was 10% below the lowest bid for the concrete design and was subsequently awarded the project.

SUMMARY

Although high performance steel is presently more expensive as a raw material than traditional 50 ksi steel, the benefits that were attained by including it in the Springview South steel girder design proved economical. Less material, lighter girder sections and increased strength were realized by utilizing this product. As a result, the welded plate steel girder bridge design incorporating high performance steel not only demonstrates a viable alternative to its traditional 50 ksi steel equivalent, but also competed successfully with a prestressed concrete design.

Kristin Van Ooyen, E.I.T, is a Bridge Engineer at the Nebraska Department of Roads, Lincoln, NE and designed the steel girder alternate for the Springview South project.

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