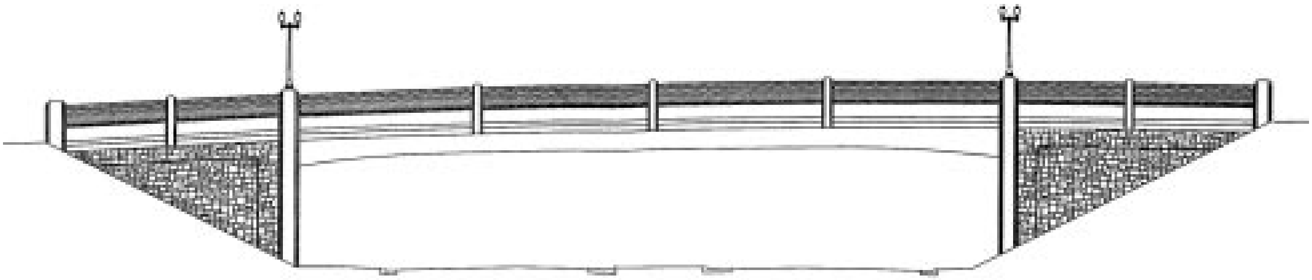
AESTHETIC *Appeal*

Jim Pierce, P.E.



Hidden end-spans are the secret behind the rusticated façades of the steel bridge carrying St. Anthony Boulevard over Minnesota Highway 47 in Minneapolis.

In 1998, the bridge carrying St. Anthony Boulevard over Minnesota Trunk Highway 47 near the border between the city of Minneapolis and the suburb of Fridley was replaced. The bridge chosen to replace it was a unique solution for a grade separation structure. The design used steel to achieve aesthetic goals set forth by the City planners: an unobstructed main span over the roadway below, a slender and graceful appearance, and retention of some similarity to the original bridge.

PROJECT DESCRIPTION

The original bridge was built in 1936. It had three spans: the center span was a rigid concrete frame with a haunched slab and the end spans were cast-in-place concrete deck girders. The end spans were enclosed and partially backfilled. The roadway under the bridge carried two 10′ lanes in each direction, a 3 ft wide raised median, and narrow shoulders. This bridge had insufficient lateral clearance and poor vertical clearance (14′-8″ at the edge of the outside lane). The bridge replacement was included in a project to replace four bridges along a 1.5 mile portion of Trunk Highway 47. Total project cost, including roadway improvements and four bridges was $8 million.

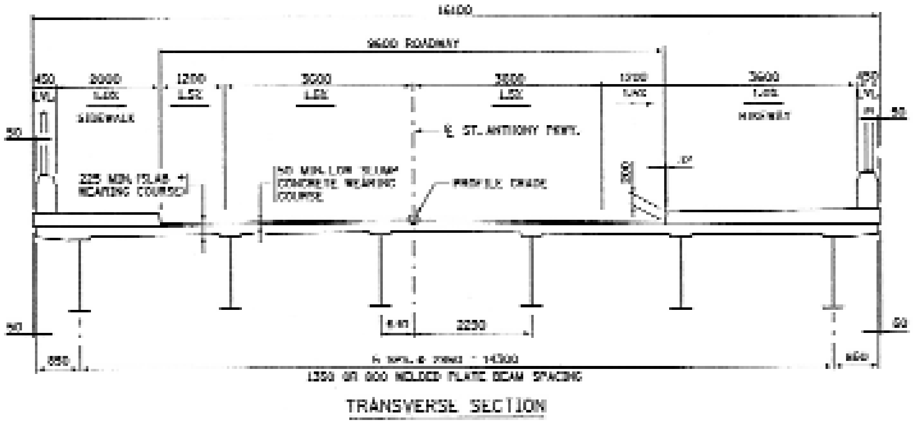
THE NEW BRIDGE

The new bridge is 230 ft long and 53 ft wide. It carries one lane in each direction, a 6.5 ft sidewalk, and a 12 ft bikeway. Underneath the bridge, TH 47 carries two lanes of traffic in each direction, a 4 ft wide raised median, and 10 ft outside shoulders.

The span configuration is one of the imaginative features of this bridge. It is a continuous three span design. The center span is 37.75 m (124′), with end spans of 15.7 m (51.5′) each. With end spans considerably shorter than the main span, counterweights were provided to prevent uplift and remove the requirement for tie-downs. Another unique aesthetic feature is the enclosed end spans. This makes the bridge appear to be a single span structure.

AESTHETICS

The new bridge is located near residential housing, parks, and an industrial area. Since this bridge is on the road leading into a golf course and park area, the city and MN/DOT agreed to include some extraordinary



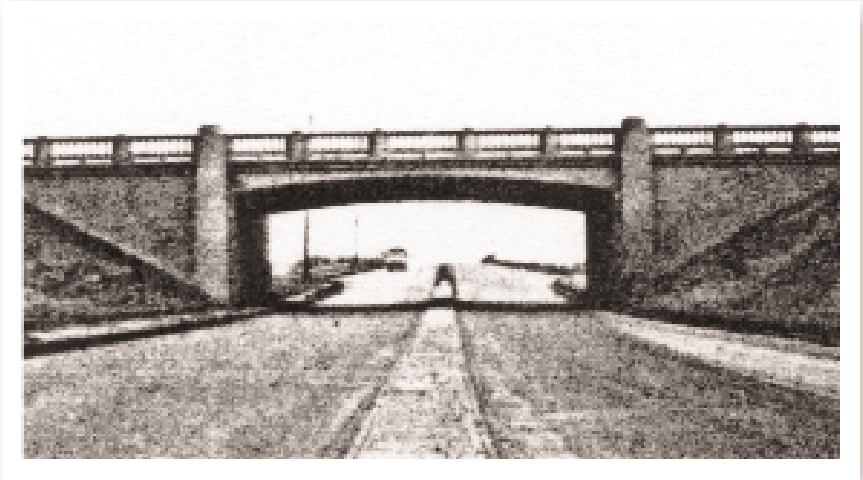
The upper roadway is carried by six haunched steel plate girders.

aesthetic features and treatments. These aesthetic concerns affected not only the appearance of the bridge, but also the bridge configuration and design.

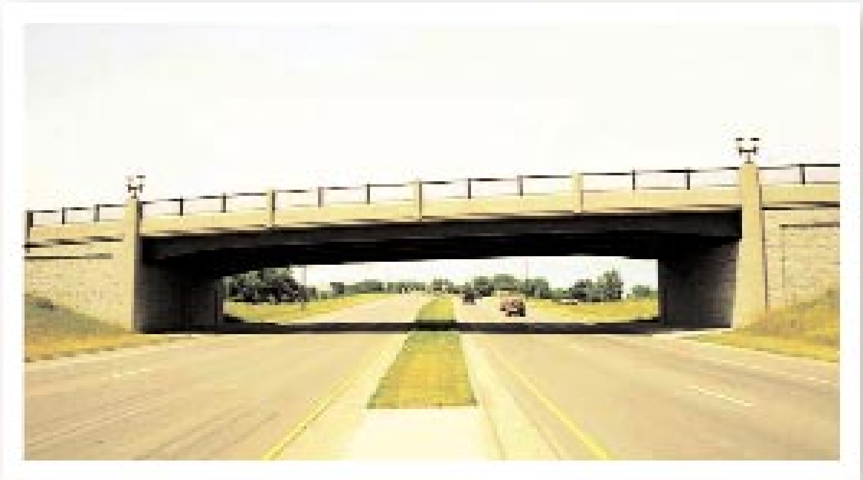
The originally proposed bridge was 160' long, two-span prestressed concrete beam structure. The city of Minneapolis considered this bridge a gateway to the city and requested a bridge with no center pier in the median. MN/DOT then considered three alternative structure types: A three span bridge with very short end spans and tie-downs at the ends of the beams, a "grasshopper" steel frame bridge, and the chosen alternate—a three span steel beam span with short end spans and counterweights.

The last alternate was selected because it would allow an unobstructed view under the bridge and the haunched beams, enclosed end spans, and pilasters would retain a visual similarity to the original bridge. Also, MN/DOT had concerns regarding use of tie-downs because a bridge with tie-downs had recently experienced a tie rod failure.

Form liner was used on the end span enclosures to provide a textured surface, which was stained with a variety of colors to give the appearance of a random stone finish. The city of Minneapolis wanted the "Minneapolis" type pedestrian railing on both sides of the bridge. This railing costs signifi-



The original bridge, constructed in 1936, featured a concrete rigid-frame center span with a haunched slab. The bridge spanned four 10' lanes with a 3' median and no shoulders.



The new bridge is a continuous three-span steel design with hidden end-spans. Rather than tie-downs, the end-spans are anchored by concrete counterweights. The new bridge spans four lanes of traffic with a 4' median and 10' shoulders.

cantly more than standard MN/DOT pedestrian railings, and in accordance with our aesthetic cost participation guidelines, the city paid for the additional railing costs.

DESIGN

The design and detailing of this bridge employed imaginative uses of steel. For a typical three-span bridge, the end spans would usually be about 80% of the main span length (or about 30 m [98′] for this bridge). It was felt that long end spans would have a negative aesthetic impact on the bridge. Several end span lengths and counterweight size combinations were considered in order to achieve shorter end spans. Preliminary end span length was estimated to be 12 m based on a 2:1 ground line slope along the end span enclosure wall. The counterweight for that span length would have been 4.5 m to 5 m (approximately 15′), or 40% of the end span length. A decision was made to lengthen the end spans and use a smaller counterweight. A "middle of the road" combination was chosen. Using end spans of 15.7 m (51.5′), the required counterweight was 1.5 meters long (4.9′), approximately 10% of the end span length. The ground line slope along the wall was about 3:1 for this case, which gave a slightly flatter slope than shown on the preliminary plan. This 3:1 slope provided a more aesthetically pleasing ground line along the "wing wall." The counterweights were designed to eliminate uplift due to dead load plus live load. AASHTO Standard Specification requires no uplift for dead load plus twice the service live load with impact (Sec 3.17.1).

The beams are haunched in the center span and constant depth in the end spans. The end span web depth is 1350 mm (4′-5″). The center span web depth is 800 mm (2′-7 1/2″) with haunches near the piers. The span-to-depth ratio of the main span composite beams is about 40:1. AASHTO LRFD suggests about 30:1 for continuous steel composite beams. The span-to-depth ratio of the beams alone is about 47:1, giving the main span a slender appearance. The minimum vertical clearance is 16′-4″ at the edge of the shoulder. The beams were designed as three span continuous using Merlin Dash line girder analysis. The beams were designed for HS25 live load. HS20 live load was used to compute live load deflections.

Steel diaphragms at the piers were detailed to cover most of the area between beams. Screens were used to cover the remaining gaps to keep out rodents and pigeons. Screens were also placed behind the gap between the slab coping and top of wall in the end spans. Access to the enclosed end spans is through a steel door in the pier diaphragm.

PROJECT AT-A-GLANCE

- Total bridge cost
  $1,100,000
- Deck area
  12,230 sq. ft.
- Cost
  $90 per sq. ft.
- Structural steel weight
  333,230 lbs.
- 2000 NSBA Prize Bridge Award for the short span category.

CONSTRUCTION

Lunda Construction Company of Black River Falls, Wisconsin was the General Contractor for the project. During forming and pouring of the counterweights, the ends of the beams were held down by placing temporary concrete median barriers on the beam ends. No uplift-related problems occurred during beam erection and slab placement. After the counterweights were in place, the temporary counterweights were removed and the structural slab was placed from one abutment to the other in one pour.

A three coat inorganic zinc-rich epoxy urethane paint system was used on the structural steel. The primer was shop-applied, and the intermediate and finish coats were field-applied. The metal pedestrian railings were galvanized and painted.

CONCLUSION

This bridge used steel to achieve the aesthetic goals of the project. The cost was higher than typical bridges constructed in Minnesota. However, the increased cost was warranted for the level of aesthetics in this project. The imaginative use of steel gives the bridge a modern look and also preserves a link to the past. This bridge makes a pleasing visual statement as a gateway to the park area and as a gateway to Minneapolis.

Jim Pierce is the Bridge Management Engineer for the Minnesota Department of Transportation.

OWNER AND DESIGNER

Minnesota Department of Transportation

STEEL FABRICATOR

Egger Steel Company,
Sioux Falls, SD (AISC member)

STEEL DETAILER

Egger Steel Company,
Sioux Falls, SD (AISC member)

GENERAL CONTRACTOR

Lunda Construction Co.,
Rosemount, MN