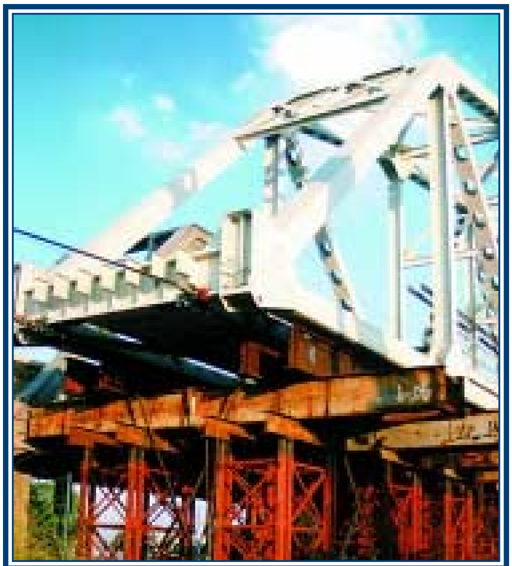
# 1996 Prize Bridge Award: Railroad
# Aviation/Rosecrans Railroad Underpass



## Project Data

**Steel wt./sq. ft. of deck:**
**275 lbs.**

**Cost:**
**$3.57 million**

**Steel Tonnage:**
**760**

In a logistical nightmare, the Atchinson, Topeka and Santa Fe Railroad crosses diagonally above the intersection of Aviation Boulevard and Rosecrans Avenue in the City of Hawthorne, CA. In addition, the Los Angeles Metropolitan Transportation Authority Green Line (light rail) parallels the existing railroad alignment. Growth in this area has been dramatic, and the result has been an increase in traffic congestion.

To accommodate the planned reconstruction of the intersection—including double left turn lanes in all directions and additional through lanes—a new 300'-span bridge was designed and constructed to replace the an existing 158'-span Warren truss bridge.

Due to the geometry requirements on the project site, structural alternatives considered were limited to three steel designs: (1) A conventional Warren truss with a polygonal top chord and vertical members; (2) a Warren truss with parallel top and bottom chords and no vertical members; and (3) a tied arch with a participating tie girder. The three design alternatives were rated for aesthetics, cost, constructability, maintenance and repairability and the polygonal chord Warren truss was chosen as the most viable for the site.

One structural problem that had to be solved was structural depth limitation. The FHWA required the minimum vertical clearance under the bridge be raised to 16' to meet interstate highway standards—with the provision that all future intersection pavement be replaced to its existing elevation and not overlaid. However, the railroad would only allow a small change in grade to the approach tracks, so as not to affect their operations. Additional railroad requirements also included the use of a ballasted deck trough with a minimum of 6" of ballast under the railroad ties.

These requirements dictated that the new deck system must have a maximum depth of 5'-2" from the top of rail to the bottom of steel. Meeting these challenging requirements was accomplished in three ways. First, a kink was put in the truss at the U4-L4 chord point. This allowed the ballast to be set at the minimum 6” under the track ties, at the critical truss midpoint over the center of the intersection where vertical clearance is most important. Second, a proposed 8” concrete ballast deck was replaced with a steel plate deck system. This gained another 7.375” for the structural floor system. Third, a special transverse floor beam was designed to fit into the required floor system envelope. This plate girder beam with 3” flanges and 1” web was essentially a jumbo steel section, but without the tensile stress problems associated with a rolled section. Additionally, the steel plate was tied to the floor stringers with a coil spring clamp detail, which eliminated weld attachment of the deck plate and any associated fatigue stresses and cracks. This all-steel construction of the floor system allowed the project to meet the critical requirement for a 16’ clearance.

While A-325 ⅞”-diameter bolts are common on most steel projects, the high loads associated with this railroad truss made their use impractical on this job. Instead, high-strength A-325 1⅛”-diameters were used. While more expensive, the reduction in raw numbers of bolts required, along with savings in field assembly and final tightening, made their use cost effective.

To streamline the superstructure appearance and simplify the steel fabrication, the design called for fully welded truss members wherever possible. This eliminated costly shop bolting and gave the truss members a sharp, clean appearance. The railroad still required bolted bottom chord members to allow faster field fabrication and repair of members that might be hit by a vehicle from below. All other truss and floor members were fully shop welded.

One traditional problem with trusses is the transfer of forces from the bottom chord members into the floor system. In a steel railroad truss, this problem is normally handled in the floor stringer-to-floor beam connections, with long leg angles used at these connections. The angle legs are allowed to flex under live loads, acting as crude expansion joints to decrease the transfer of main member loads into the floor system. However, as a truss gets longer, the effectiveness of this method is reduced. The 300’-long truss on this project required the introduction of actual expansion joints within the floor system. Using elastomeric bearings pads with angle connections and slotted holes, these expansion joints were added at the approximately third points along the truss. These joints effectively eliminated main member loads from the floor system and any associated steel overstress or long term fatigue problems.

Due to its location, seismic design considerations were important. The bridge is designed to resist a lower level earthquake with no damage and to accrue damage but not to collapse in a higher level seismic event. One difficulty in design, however, was transferring the seismic loads from the steel superstructure to the concrete abutments. Concrete would probably fracture at the upper level earthquake loading condition, so the design solution was to allow the concrete under the bearings to fail and then to pick up the seismic loads with a series of steel retainer rods. During an upper-level earthquake,

## Project Team

**Designer:**
**De Leuw, Cather & Company**
**Pasadena, CA**

**Railroad:**
**The Atchinson, Topeka and Santa Fe Railway**

**G.C. & Erector:**
**Fletcher General Constr., Inc.**
**Irvine, CA**

**Fabricator:**
**Universal Structural, Inc.**
**Irvine, CA**

**Owner:**
**City of Hawthorne**

## Judges Comments:

***"A wonderful design given the difficult site and critical elevations"***

***"An innovative erection technique"***

these retainers will hold the superstructure on the abutments and keep the bridge from falling. The longitudinal retainer rods run through the bottom truss chords and are tied to different panel points along the superstructure. The different lengths of the rods, each with their own natural frequency, induce a forced damping effect within the bridge and helps to reduce the seismic forces to the bridge during an earthquake.

Due to the confined work area, an unusual construction sequencing was employed. The 760-ton Warren truss was constructed behind the northwest abutment, rolled into place, then lowered onto its bearings. On Friday, July 28, 1995, the intersection was closed to vehicle traffic and falsework construction began. The contractor worked around the clock to construct scaffolding in the intersection to support the bridge while it was being launched. After the falsework was completed, the bridge was pulled across the intersection by a Caterpillar tractor aided by a block and tackle arrangement. Rollers were clamped to the bridge and, guided by tracks on the falsework, the bridge was lowered onto its rocker bearings. The falsework was removed and the intersection opened to traffic on Monday, July 31, 1995.

Removal of the old bridge was accomplished by reversing the erection method of the new bridge.