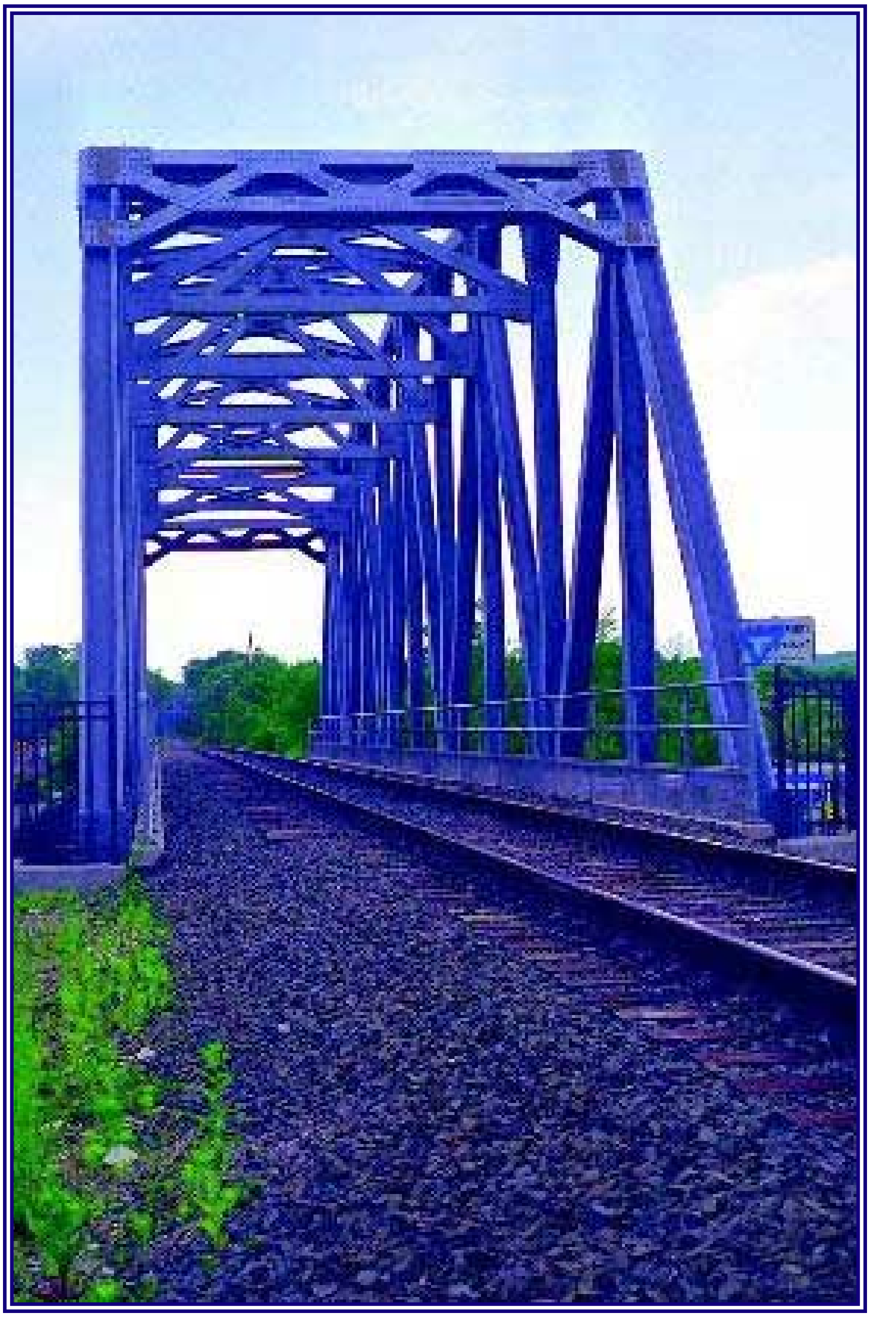
CENTRAL CONNECTICUT RAILROAD OVER RT. 66



Along the Connecticut Central Railroad line, there are numerous small bridges that help carry the trains on its journey through central Connecticut. These bridges were all constructed around the turn of the century. One of those bridges – the one carrying the railroad over Connecticut Route 66 – consisted of a single span riveted steel deck girder span. The span was relatively short, which resulted in a very narrow roadway below that consisted of two 10' lanes and a narrow 2' wide sidewalk. The vertical clearance was also restricted.

Over the years, the growth in the area with its associated traffic exceeded the capacity of the two-lane road. Portions of Route 66 were widened to four lanes, but the roadway under the bridge remained at two lanes, which resulted in a significant bottleneck during morning and afternoon commuting periods.

ORIGINAL DESIGN CONCEPT:

The rail line is privately operated, but the right of way and structures are owned and maintained by the Connecticut Department of Transportation. In 1972, the Department investigated replacing the substandard bridge. The plan was to replace the span with a single span bridge that was long enough to accommodate a four-lane roadway underneath. The roadway alignment is on a significant skew, which resulted in a single span of approximately 185'. A consultant was hired to design the new span. The final design was welded steel through girder. The girders were approximately

11.5' deep and were to be constructed in short segments for shipping. Even with many field splices, the pieces were very large and difficult to transport. The plans for the bridge were eventually shelved due to lack of funding.

PROJECT RE-DESIGN:

In the 1980s, following the collapse of the Mianus River Bridge on Route I-95 in Greenwich, CT, the Connecticut Department of Transportation undertook a major bridge-rebuilding program that involved rehabilitation or replacement of almost two thirds of the bridges in the state. The project to replace the Route 66 Railroad Bridge was resurrected. The original plan was to "dust off" the plans and evaluate the design for code compliance. The design of the bridge was complete and did not need significant changes, but the design of the roadway underneath was being reconsidered.

The roadway design engineers were interested in adding wider shoulders on the roadway and incorporating a sidewalk on one side of the road. A provision for an additional future sidewalk was also being considered. The result of these changes was that the 185' span would need to grow to 200' in order to accommodate the new roadway cross section.

STRUCTURE TYPE STUDIES:

The original design involved a very large welded thru girder with a span of 185'. At this span, the girders are very large and difficult to transport. In addition, the weight of the structural steel per square foot of bridge becomes excessive resulting in an inefficient design. The redesign of the roadway underneath would require a complete new design of the bridge. The design team investigated several other options for superstructures, but a design using a thru-truss was found to be much more efficient. Several variations of truss designs were investigated,

leading to a final structure design of a Modified Warren Truss. The following are some of the key design features: haunched top chord to reduce member sizes and improve the appearance; complete field assemble using high strength bolting; all truss members were designed using 14" rolled sections; the floorbeams were designed with a composite concrete ballasted deck to reduce live load impact and facilitate track maintenance.

FINAL DESIGN:

The significant skew of the bridge with respect to the roadway prompted the design team to square the ends of the bridge. Design of a through truss with a 60-degree skew would be difficult, and detailing would be almost impossible. The design team felt that the extra cost of the extended square span would be offset by the ease of fabrication and construction.

The entire design was undertaken using a three-dimensional space frame analysis using Cooper E80 loading. This allowed the engineers to not only model the forces in the truss members, but also the interaction between the floor beams and the truss. The concrete deck of the bridge acts similarly to a composite bridge deck. When the truss is loaded, horizontal shear develops in a similar fashion to shear connectors in bridge beams. This force was significant in the end floor beams, and was accommodated in the design of the end connections.

The entire structure was also designed for fatigue. Key components of this design included eliminating top interior bolts in the floor beam end connection to allow the floor beams to rotate without developing distortion induced fatigue cracking. The use of non-welded rolled beam members combined with high strength bolting kept the entire structure within fatigue category B, which greatly reduces the potential for future fatigue problems.

CORROSION PROTECTION:

Early in the design process, the Department considered the use of unpainted weathering steel. At the time, there were concerns over the appearance of a very visible weathering steel bridge. The truss depth at mid-span was over 50’, and clearly visible from surrounding homes and businesses. Painted steel was also considered as a means of providing corrosion protection, but there were concerns about the cost and difficulty of re-painting an active rail bridge in the future.

The final solution to corrosion protection was to construct the entire bridge using hot-dipped galvanized components. Several bridges have been constructed in the United States using hot-dipped galvanizing, but they typically have been limited to very short span stringer bridges. In the final design of the Route 66 railroad truss, the longest member was just over 50 feet long.

Central Connecticut Railroad Bridge

Owner:
Connecticut Department of Transportation

Designer:
Connecticut Department of Transportation

General Contractor:
George A. Tomasso Construction, Hartford, CT

Detailer:
Tensor Engineering Co., Indian Harbor Beach, FL

Fabricator:
Trinity Industries Inc., Huston, TX

Erector:
George A. Tomasso Construction, Hartford, CT

Members of this length can easily be hot-dipped after fabrication. The hot-dipped galvanized surface can be expected to survive 50 years without any maintenance. The initial cost of the hot-dipped galvanizing is offset by the reduced life cycle cost when minimal future maintenance is considered.

There was some concern about the appearance of a large truss, especially a truss that would be galvanized. During several public hearings, the design was presented using a rendered CADD animation. The comments received from the town and local residents were that a through truss was "what a railroad bridge should look like." There was some concern with the appearance of the galvanizing. Many steel members that are hot-dipped galvanized take on a very shiny and sometimes flaky appearance. Research by the design team revealed that limiting the chemistry of the steel could control these problems. The driving factor in the appearance of the steel is the amount of silicon in the steel. By controlling the amount of silicon by specification, the flaking could be virtually eliminated. The shiny appearance of the galvanizing can also be controlled by the amount of nickel used at the galvanizing plant.

The last concern with the bridge was the appearance of the abutments. The original bridge was constructed on locally quarried red sandstone known as "brownstone." This stone was used for many years to construct buildings in Connecticut, New York City, and Boston. The stone was quarried in the Connecticut River Valley, which includes the Town of Middletown.

The decision was made to attempt to replicate the brownstone abutments with custom form liners in the concrete. A pattern of 2’ by 4’ stones was chosen to closely replicate the existing brownstone buildings in the area. In order to match the color of brownstone, the design team explored two options. The first involved pigmented concrete, and the second option was to paint the concrete with a colored sealer. The pigmented concrete option was not chosen due to difficulties in obtaining a consistent dark brown color and the cost of coloring all the concrete in the thick wall and abutment stems.

Costs:

The final design of the Connecticut Central Railroad Bridge resulted in a very low cost when compared to the original design of welded steel through girder. The final cost was approximately $450.00 per square foot. This cost is considered low when compared to other railroad bridges in Connecticut. The use of rolled steel sections and field bolting reduced fabrication costs considerably. Hot dipped galvanizing did add to the price, but the life cycle cost of the structure is lower than other options when the costs of minimal future maintenance are considered.