



Franklin Street Bridge. 2008 photo.

## Investigation of Reinforced Concrete Arch Bridge

**I**n 1977, Rubin M. Zallen Associates

(a predecessor of Zallen Engineering) investigated a concrete arch bridge on Franklin Street, over the Sudbury River, in Framingham, MA. The purpose of the investigation was to determine the bridge's capacity and condition.

The bridge was built in 1934. The main support for the bridge is a reinforced concrete arch as shown in the photograph above, supported by massive plain concrete abutments. The clear span of the arch between the abutments is 60 feet. The bridge has reinforced concrete spandrels (side walls), which are cantilevered off of the arch barrel, and which retain a soil fill on top of the arch barrel. The roadway pavement and the sidewalks are on top of this fill. See Figures 1 (*page 2*)

for a plan of the bridge, and Figures 2 and 3 (*page 3*) for a longitudinal section and transverse section, respectively.

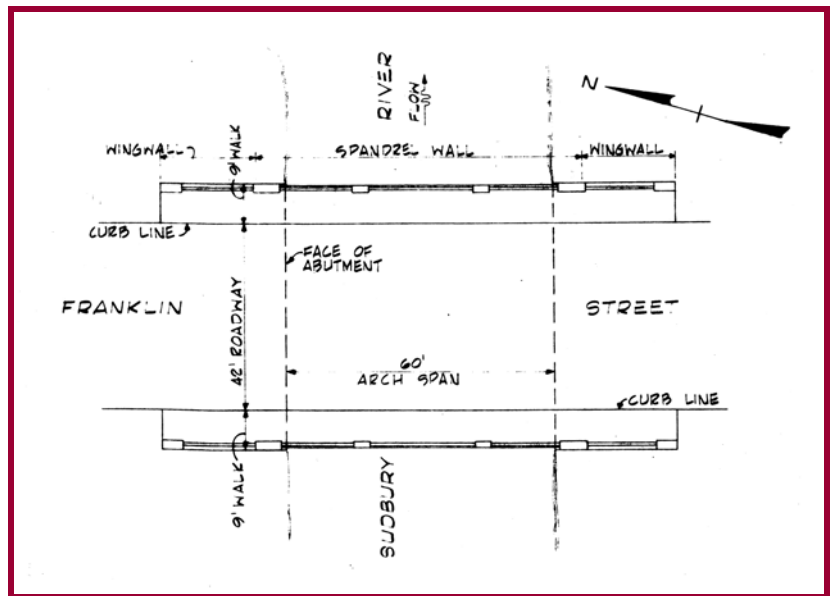
Drawings of the bridge were available from the Town Engineer's office, and were utilized in the investigation. To the extent it could be observed, the bridge was constructed in accordance with the drawings, with some minor deviations, and it was assumed that the reinforcing steel was installed in accordance with the drawings. The bridge structure was in good condition, except for some minor exposed stone aggregate pockets. The concrete bridge rails appeared to be basically sound; however they were deteriorated or spalled in some areas.

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A structural analysis of the bridge was conducted to assess the load capacity of the bridge. The capacity is substantially more than required for trucks loaded legally – 75 tons for a tractor and semi-trailer.

It is interesting to compare the design and capacity of the Franklin Street Bridge to the Union Avenue Bridge, a quarter of a mile downstream (see Issue No. 19 of Forensic Engineering in Construction). Both bridges have concrete arches with a clear span between abutments of 60 feet. The Union Avenue Bridge was built in 1913 when design of reinforced concrete was in its formative years, resulting in an arch barrel that was partially reinforced. The Franklin Street Bridge was built 21 years later when design of reinforced concrete was more mature, resulting in an arch barrel that is fully reinforced. The lack of proper reinforcing steel in the Union Avenue Bridge resulted in very low load capacities relative to that of the Franklin Street Bridge.

■ Principal Rubin M. Zallen lead the investigation of this bridge.



**Figure 1. Plan of Franklin Street Bridge.**

**For more information on the behavior of concrete and masonry arches, see Issue No. 15 of Forensic Engineering in Construction.**

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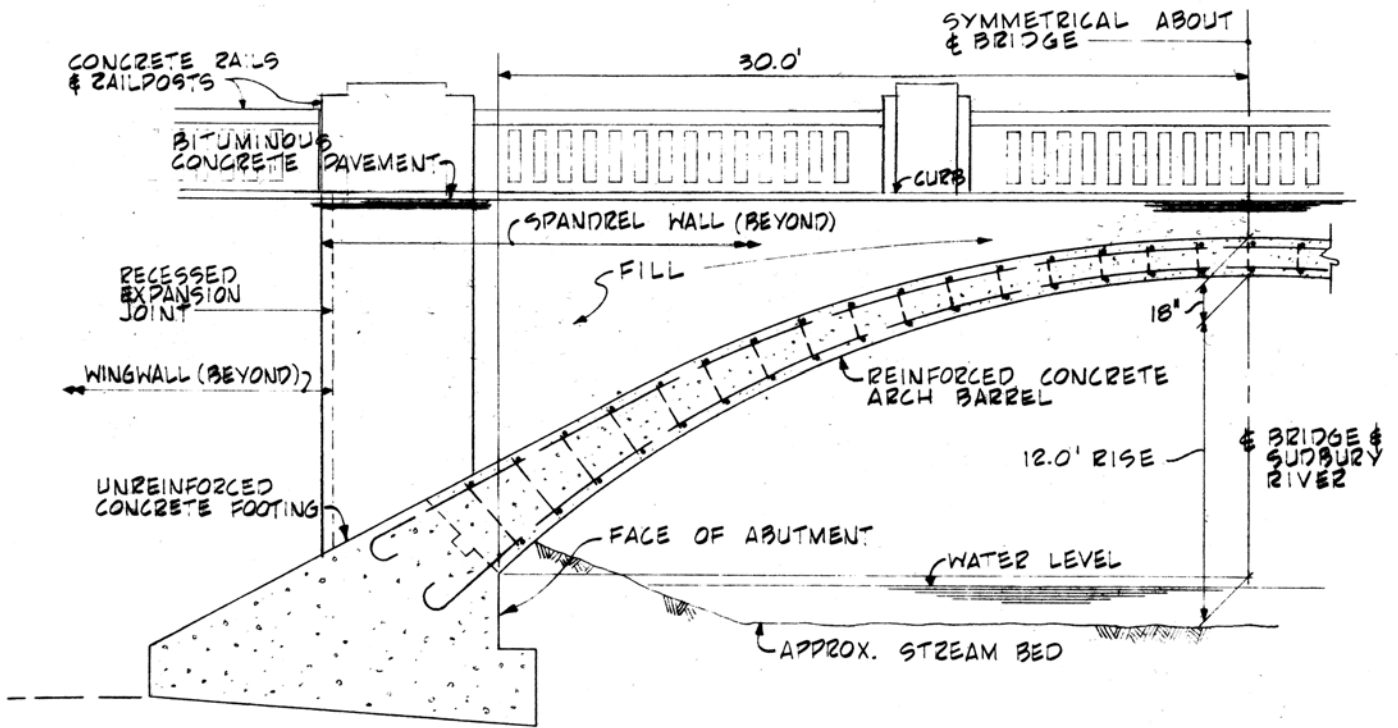


Figure 2. Longitudinal section through Franklin Street Bridge

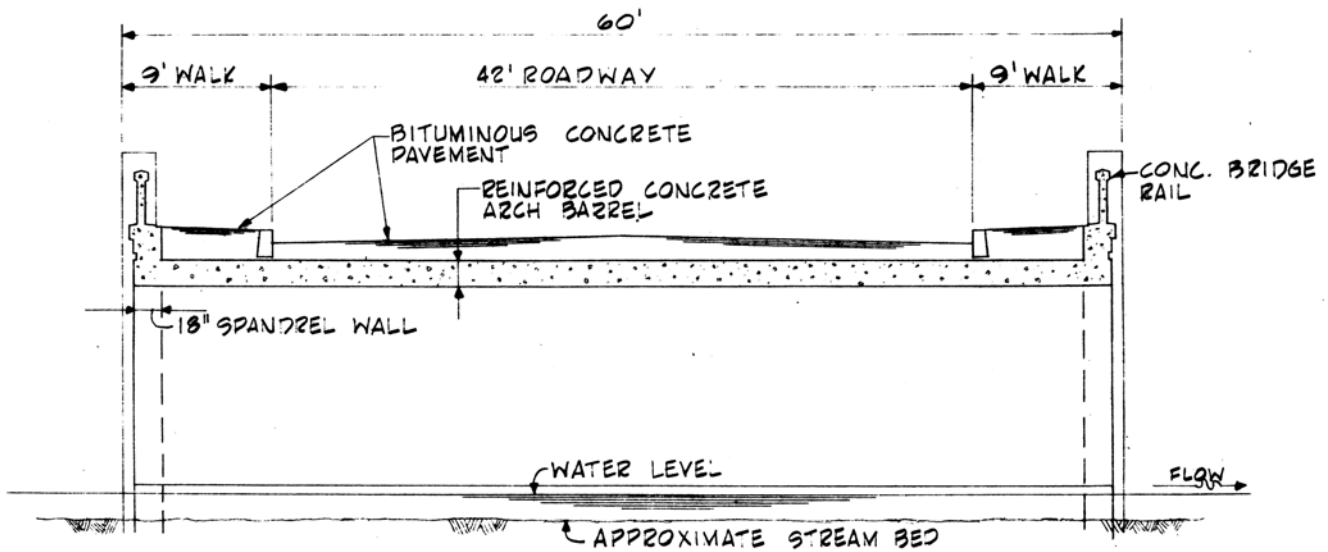


Figure 3. Transverse section through Franklin Street Bridge at the crown of the arch.