THE CONGRESS AVENUE BRIDGE: 100 YEARS OF AN AUSTIN-CHANGING ICON

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Introduction

The Congress Avenue Bridge over the Lady Bird Lake has been an icon of the city of Austin for just over a hundred years and still is. Over all these years, however, the shape, size and structural system of the bridge have evolved, sometimes slightly and sometimes dramatically.

This concrete arch bridge was built between 1909 and 1910 to replace an old steel truss structure. It became an unequaled icon of downtown Austin for a number of reasons. First due to its transportation value: it originally linked central Austin with South Austin, then linked Austin with San Antonio and now is part of a main arterial road in Central/South Austin. The bridge is a city treasure for its aesthetic value – to both the downtown area and water sports enthusiasts. Most recently, this iconic structure has become an important tourist attraction, primarily because of its unconventional "residents" – the Mexican Free-tail bats that inhabit its crevices.

Recent studies conducted by the City of Austin have identified this bridge as a possible candidate to support the crossing of the lake by a line of Light Rail Transit (Reference 1). As part of a preliminary structural evaluation, an investigation of the evolution of the bridge was performed (Reference 2).

As the bridge has just marked its first century of service, an overview of its past, present and future reveals how a bridge can adjust to transportation needs without losing its identity and maintaining its structural soundness.

This article attempts to trace the milestones that have marked the evolution of the bridge since its construction until today, mostly from a structural engineer's point of view. It is not meant to be a complete historical record.

Before 1869, crossing the Colorado River from downtown Austin into South Austin was done by ferry. That year, a pontoon bridge was built along Brazos Street (very close to Congress Avenue) but less than a year later, it was destroyed by flood. After this disaster, ferries continued providing river crossings until 1876, when a wooden bridge was built.

In 1883, a span of the wooden bridge collapsed when a cattle herd was crossing it. The following year, a wrought iron truss replacement was built. That structure was manufactured by the King Iron Bridge and Manufacturing Company of Cleveland, Ohio, and had a roadway width of 20 ft and a total length of 910 ft (see Figure 1).

When Travis County purchased the iron bridge in 1886, the river crossing, which had always been tolled, became free for the first time. Later that year, a local newspaper article declared that this bridge was expected "to stand as long as time lasts."

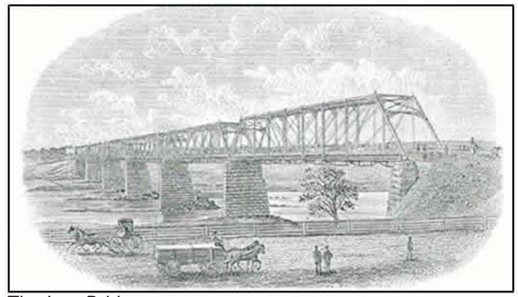

Figure 1 – The Iron Bridge

The Concrete Bridge (1909-1910)

In the early twentieth century, it was clear that due to increased traffic, a wider bridge was necessary, so a new concrete bridge was conceived. Figure 2 shows a view of the bridge from the south bank of the river.

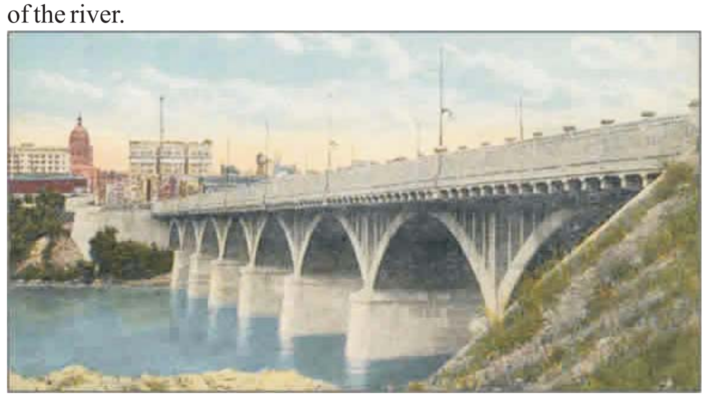

Figure 2 – Congress Avenue Bridge (circa 1940)

Between 1909 and 1910, contractor William P. Carmichael Company from Williamsport, Indiana, built the new bridge for Travis County after moving the old iron bridge onto new piers for use while the new bridge was constructed. The old iron bridge was later relocated to Moore's crossing over Onion Creek (south side of what is now the Austin Bergstrom International Airport near Burleson road).

The design of the bridge incorporated a 38-ft wide roadway and two 5-ft wide sidewalks, protected with heavy aesthetic concrete rails. To accommodate this configuration, a total deck with of 51 feet 10 inches was built. On each side of the bridge centerline, 10-ft electric railway tracks were installed for use by the electric streetcar of the Austin Rapid Transit established in 1891.

The eight-span concrete bridge built totaled 950 ft, using 30-ft wide barrel arches. The arches, supported by heavy concrete piers founded on the river bed limestone, had a thickness of 5 ft at the spring line and 2.75 ft at the crown, and a rise of 19.5 ft.

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Spandrel walls initiating at the arches served as supports for the bridge deck (see Figure 3). The Spandrel walls, running transverse to the bridge centerline, are supported by the arches; they are 29.5 ft long by 1.25 ft wide and are spaced at 7.25 ft on center.

On both sides of each spandrel wall, short beam overhangs extended to support the deck beyond the edge of the arches (as shown in Figure 3).

Figure 3 – Structural System of the Congress Avenue Bridge

A typical original interior bent was composed of a concrete pier wall, 30.0 ft wide by 4.0 ft thick, supported by a 25-ft tall tapered pier below. The pier varied in width from 38 ft at the top to 42.25 ft at the bottom and has rounded ends. The depth of the pier tapered from 8 ft at the top to 12 ft at the bottom. The pier was supported on a rectangular footing with a width of 44 ft, depth of 16 ft and variable height (depending on the depth of the rock layer on the riverbed).

The gravity-type abutments were built using massive unreinforced concrete. In the north abutment, existing wingwalls (lateral walls that retain the abutment fill) were re-used while in the south abutment, new reinforced concrete wingwalls with timber piles were built.

At the time of construction, the foundation soil was reported as blue shale rock. A thin layer of "white" rock, presumably limestone, was found above the shale near the south end of the bridge. In the drawings of the original 1909 design, test holes are shown at many of the piers. They also show the bearing rock stratum at elevations varying from 410 ft to 420 ft.

In the early years of the bridge, the Colorado River did not have a flood control system.As a result, the water level fluctuated greatly depending on the weather and the season. Records and resident accounts describe extreme changes from almost drought conditions with no water crossing under the bridge to river flooding which overtopped the bridge on more than one occasion. In the original 1909 bridge drawings, the low and high water elevations are shown as 427.0 ft and 449.0 ft, respectively. (For reference, the elevation at the top of the deck is approximately 472 ft.)

Several attempts to regulate the river level with dams were tried over the years. Austin Dam was built between 1890 and 1893 upstream of the bridge. It stabilized the river level at about 16 ft below the pier copings and created a 20-mile man-made lake (originally called Lake McDonald). The dam, however, was destroyed by a flood in 1900.

A second Austin Dam was built from 1909 to 1912 at the same location as the first one. A massive flood destroyed this second dam as well. The flooding issue then continued and in 1935 a major flood overtopped the bridge. Fortunately, the bridge was not damaged during this event.

Finally, a new Austin Dam was built atop the remains of two earlier structures between 1938 and 1940, fifty years after the first dam was built. After it was completed, it was re-named the Tom Miller Dam, in honor of one of Austin's most famous mayors. It re-created the 20-mile lake which extended to the downtown district and which was named Lake Austin on the west side (near the dam) and Town Lake on the East side. In addition to flood control, the dam also provided hydroelectric power and water storage for the city.

Several bridges with similar structural systems were built in the early 1900s across Texas. Dallas, Houston and Fort Worth had this type of bridge built to cross rivers and a few of them have been included in historical registries. Figure 4 shows two such bridges that are still in use today: the Houston Street Viaduct in Dallas and the North Main Street Bridge in Fort Worth.

Figure 4 – Houston Street Viaduct (Dallas) and N. Main Street Bridge (Fort Worth)

1955-1956 Widening

With the increase in popularity of private vehicles, the streetcars lost favor and eventually the rail tracks were removed from the bridge to provide more space for vehicular traffic.

In the 1955-1956 period, the bridge deck was slightly widened to a 53-ft overall width. The main purpose of this widening was to increase the roadway width by 6 ft to a total of 44 ft to accommodate four 11-ft lanes of vehicular traffic. The deck structure was not modified except for a newly added layer of pavement and modifications to the sidewalks described below.

The original decorative but heavy concrete railings, including regularly spaced pedestals, were removed from both sides of the bridge. The sidewalks were removed, or rebuilt using a reinforced concrete beam-and-slab structure, preserving the existing utility conduits which ran below them. The width of the new sidewalks was reduced to 4.5 feet from the original 5.0 ft.

New light aluminum railing was bolted to the side of the deck completely clearing the sidewalk surface. New utility lines, added to those exiting from the bridge construction, were installed under the new sidewalk. Additional light poles were also installed along the bridge, at pier locations, supported by concrete brackets.

At that time, the substructure (arches, piers and foundations) was not modified. Figure 5 shows a view of the widened bridge from the river. *(continued on page 7)*

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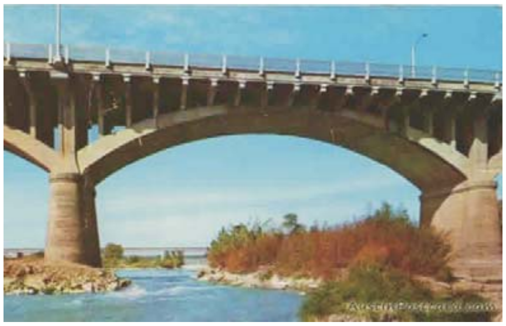

Figure 5 – Congress Avenue Bridge after widening (circa 1959)

1977-1980 Reconstruction

In the early 1970s, deterioration of the deck and elements of the substructure was evident and eventually led to the partial closure of the bridge in 1974. In 1976, the City retained a consultant to conduct an improvement study of the bridge, including the possibility of widening of the structure (see Reference 6). As part of this study a detailed inspection of the bridge was conducted both above and under water.

Based on the recommendations of this study, the bridge superstructure was replaced and significantly widened between 1977 and 1980, following the provisions of the AASHTO Standard Specification for Highway Bridges (1977 Interim). Precast prestressed box beams were used to entirely replace the original superstructure of the bridge (see Figure 6).

Figure 6 – Precast Concrete Box Beams

Beams were transversely tied using post-tensioning strands at their 1/5 points and void spaces between beams (shear keys) were filled with structural concrete. A 12-in slotted drain pipe ran below the curbs, embedded in a cast-in-place concrete beam formed between the second and third precast beams from the edge. A 1/2-in two course surface treatment was provided over the 1 1/2-in ACP layer.

The bridge deck was widened to 81 feet 2 inches and the roadway width increased to 60 ft to accommodate five lanes of vehicular traffic (two 11-ft lanes in each direction and a 12-ft middle lane). The centerline of the entire bridge deck was maintained level at an elevation of 471.9 ft.

The sidewalks were widened to 8 ft and 1 ft 4inch curbs were added. A concrete parapet 13 in wide by 3 in high was provided at the exterior edge of the sidewalks for the aluminum combination rail type C3-E. Lighting standard supports were provided at various locations at both edges of the deck. *(Continued on page 8)*

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Although the original arches were not modified, the tops of the original spandrel walls were cut 6 inches under bottom of box beams (at elevation 467.3 ft), effectively unloading the arches, which then carried only their self weight and the weight of the spandrel walls. Two 14-in x 5-in precast concrete beams were added at the top of the spandrel walls to tie them together and anchor them to the piers and abutments. Unloading the arch was highly desirable as the 1976 study referenced above cited significant cracking and deterioration in the arches (this was backed up by calculated overstress).

Figure 7 – Pier Cantilever Extensions

The upper part of every pier was removed above elevation 451.0, and the remaining portion of the pier wall was extended by 3.0 ft on either end. A flared reinforced concrete bent cap was added with a base of 36.0 ft and a total length of 81.2 ft at top of cap (Elev. 467.93), generating 22.6 ft tapered cantilevers on both ends. These extensions were necessary to support all the box beams. These modifications effectively transformed the pier walls into deep-cap hammerhead bents. Figures 7 and 8 show these cantilevers.

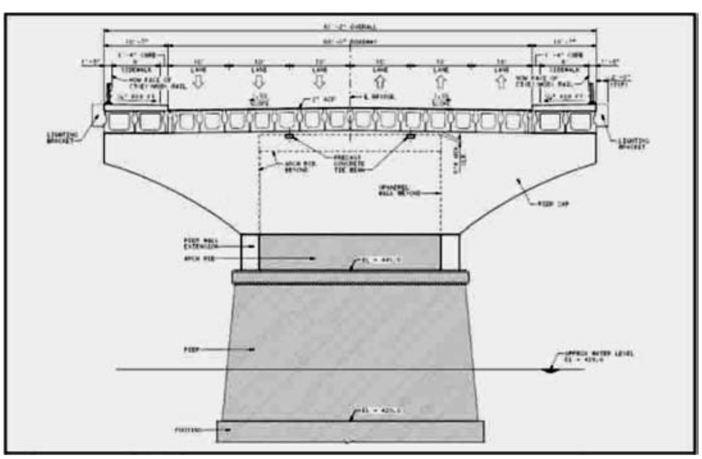

Figure 8 – Current configuration of the bridge

In the 1977 construction drawings, results of geotechnical test holes showed gray limestone at an elevation of about 415 ft in the channel. In the south abutment, soft shale was found between 400 ft and 405 ft. In the north abutment gray limestone was found above elevation 430 ft.

The approximate normal water level shown in the 1977 drawings is 428.6 ft, which is about 43 ft under the deck level.

At some date after the 1980 widening, the deck was re-striped to add a lane. Currently, the bridge accommodates six 10-ft lanes of vehicular traffic (3 in each direction). See Figure 8 for a typical section of the bridge showing its current configuration.

The Bats

In the early 1980s, a large Mexican Free-tail bat colony of about 1.5 million bats moved to the bridge, spending the summer of every year there and nesting in the 1.75-inch gaps between box beam bottom flanges.

At the time, limited knowledge about the effect of bats on bridges led the public and concerned professionals to ask for their eradication as a pest. However, studies led first by the Texas Department of Transportation (TxDOT) in 1995 (see Reference 4) and then, by Bat Conservation International in 1999 (see Reference 5) concluded that no bridge damage would result. These studies also included an evaluation of the potential impact on the health and safety of bridge maintenance workers and the public, the effect on water quality, the significance of bridges to bat populations and the conditions bats require to nest.

Nowadays, the bats living under the deck of the bridge are a major tourist attraction of downtown Austin during the summer months. They also help the local agriculture by consuming large quantities of insect pests.

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Today's Bridge

In November 2006, the bridge was renamed the Ann W. Richards Congress Avenue Bridge in honor of the late Ann W. Richards, the 45th Governor of Texas and an Austin resident. Figure 9 shows a dedicatory plaque installed on the south abutment of the bridge. A year later, Town Lake was renamed the Lady Bird Lake in honor of the late Lady Bird Johnson, former First Lady of the United States and also a long-time Austin resident.

Figure 9 – Dedicatory Plaque

The bridge is currently in good condition with some minor problems. TxDOT condition assessments and load ratings, performed periodically, show minor vertical cracks in abutments and wingwalls, some diagonal shear/ flexural cracking in the flared pier extensions, longitudinal cracks in the asphalt deck surface, clogged deck slotted drains, transverse hairline cracks along the curbs and bulging expansion joints in the sidewalks.

A recent detailed inspection of the bridge (see Reference 2) confirmed the findings of the TxDOT inspection reports. Additionally, vertical stains from possible water infiltration were noticed on overhangs of every pier cap. The precast concrete box beams appeared to be in good condition with no visible signs of distress as seen from under the bridge. Staining on the bottom of some beams was observed at longitudinal joints, which could be due to water infiltration and/or bat droppings.

Relatively minor variations of the river bed had been measured in recent years but no pier scour had been observed. During the recent construction of a pedestrian bridge over the lake not far from the Congress Avenue Bridge, the normal water surface elevation was measured at 428.3 ft and the 100-year flood water surface elevation estimated as 446 ft. These elevations were consistent with previous measurements.

In summary, the bridge is in good structural shape and only minor repairs are required to avoid internal damage generated by penetrating water or other substances through the observed cracks.

The Future of the Bridge

The City of Austin is planning to build a new Urban Rail system that would travel in multiple directions north and south of downtown. One such line would cross the Lady Bird Lake and extend to South Austin and eventually to the airport. The Congress Avenue Bridge has been identified in several studies sponsored by the City (see References 1 and 8) as an alternative for the light rail transit line that would cross the lake. Other alternatives include using a different existing bridge or building a new bridge in the vicinity.

If the proposed inclusion of this bridge along one of the Austin Urban Rail lines is approved, it would bring back the rail tracks to the bridge that were part of its original design about 100 years ago. This time, however, the tracks would carry modern light rail vehicles that would have almost no resemblance to the old streetcars.

A preliminary bridge evaluation of the structural capacity of the bridge to accommodate and support the light rail vehicles and the associated infrastructure (see Reference 2) determined that strengthening of the superstructure and possibly the substructure would be necessary, but that the cost of this work would probably be lower than the construction of a completely new bridge. To avoid any effect on the bridge's bat population, any retrofit would have to be completed between late fall and spring, when the colony travels south.

Acknowledgments

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