Celebrating 200 Years Of Statehood

It was critical that The Tennessee Bicentennial Mall Railroad trestle was completed on time

Top: The 373-foot trestle carries CSX rail lines over the Tennessee Bicentennial Mall, a 19-acre park built on reclaimed land north of Tennessee's Capitol Building in Nashville.

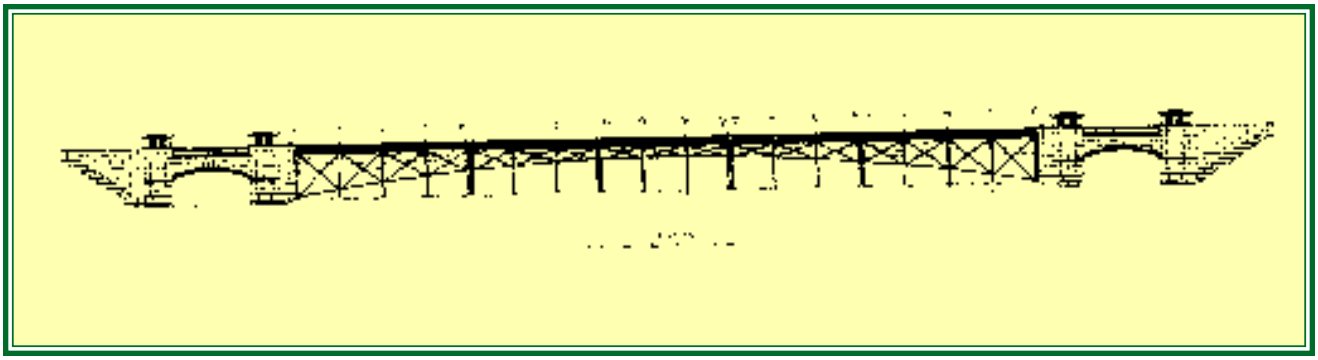
Above: Careful detailing of the limestone and granite veneer on the arches preserves the massive look of stone and pays tribute to William Strickland's Greek revival design for the State Capitol Building.

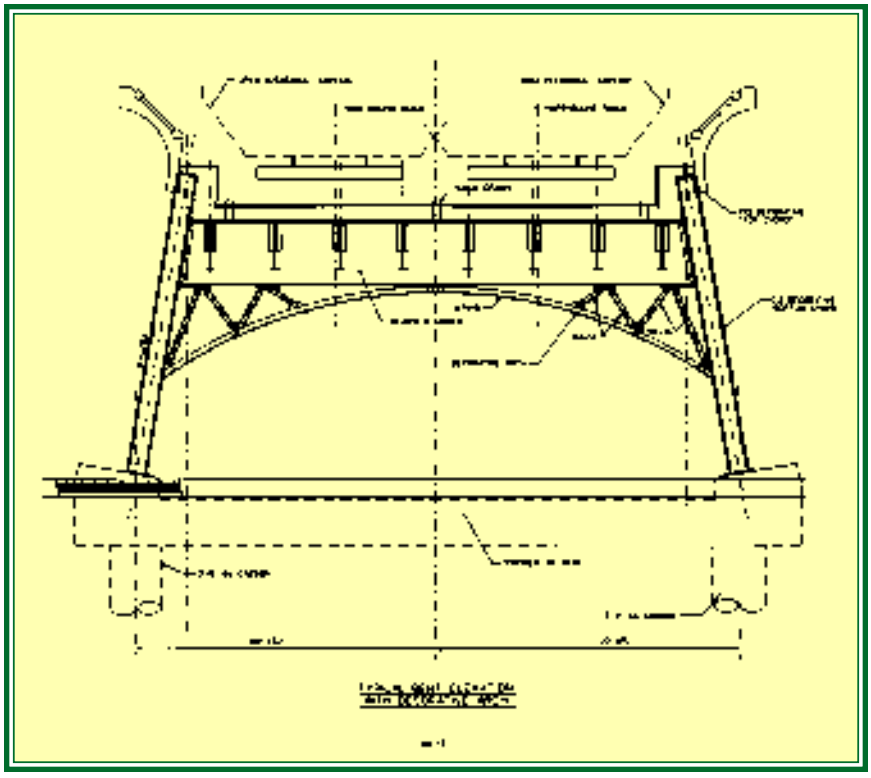
By David E. Hormby, P.E.

To commemorate their state's bicentennial of statehood, Tennessee's legislators approved funding for an ambitious new urban state park to be called The Tennessee Bicentennial Mall. The park, patterned after the Capitol Mall in Washington, D.C., reclaimed 10 underdeveloped city blocks north of Tennessee's Capitol building in Nashville. Like a lot of good ideas, this one was not new. Tennesseans celebrated their first 100 years of statehood by building Centennial Park. That park still serves the people and designers were challenged to create an equally enduring Bicentennial memorial.

The Mall's master planners chose the dramatic site and laid out the park's lines to focus attention on Capitol Hill. The Hill is dominated by William Strickland's classic Greek revival design for the state Capitol building. The site, although a great opportunity, brought with it many architectural and engineering challenges, including realignment of two heavily traveled CSX Railroad tracks.

The dual tracks crossed the site on a 20' tall earthen berm at a skew to the Mall's long axis. If left in place, the berm would have divided the Mall and blocked vistas of Capitol Hill. Designers from a joint venture of Nathan Evans Taylor, architects, and Stanley D. Lindsey and Associates, Ltd. (SDLAL), structural engineers, were asked to replace this obstruction with a





"light and airy" structure consistent with the district's architecture that would serve as an inviting portal to the Mall.

For good reason, the terms "light and airy" and "Cooper E-80 Loading" seldom appear together. Compounding this problem, no interruption of rail traffic was permitted on either line except for the few hours required for track tie-in. Undecked bridges at each end of the project severely limited possibilities for horizontal and vertical realignment, resulting in very tight construction sites and difficult construction sequencing.

The designers tackled these problems by combining architectural sleight of hand, phased construction, and a temporary shoo fly (run around track).

To square the new alignment with the Mall, two bridges outside the park had to be replaced. At the west end of the project, designers used a skewed 85' long plate girder bridge to cross 8th Avenue. On the east end, a 42' long plate girder spans 5th Avenue. Proximity of the new and old rail alignments required phased construction for both bridges and a temporary berm to carry the tracks around construction at 5th Avenue.

The general contractor, Ray Bell Construction, also had to phase demolition of the old berm. Despite the urgent need for clean fill throughout the Mall, none of the spoil from the berm was usable due to contamination resulting from decades of rail traffic.

Within the park boundaries, three separate structures span 7th Avenue, 6th Avenue and the Mall between them. Limestone arches with 32'-tall lighted sentinel towers at the corners span the streets. A 19-span steel trestle connects the two "stone" arches. Shallow, graceful arches sweep the length of the bridge. Transverse arches springing across battered columns echo the form of the longitudinal arch. The architect used short spans, battered columns, and diagonal elements to recall turn-of-the-century trestles and trusses.

The end spans over 6th and 7th Avenues are actually 42'-long cast-in-place concrete T beams that span from box abutments at the ends to concrete piers where they meet the trestle. The beams support a 9" ballasted deck. Flat concrete arches spring from the towers, which are cast integrally with the piers and abutments. The stone on these bridges is limestone and granite veneer with heavy cornices to make them appear more massive. Designers chose concrete on these end spans to dampen vibration on the stone cladding connections and to reduce maintenance near the limestone.

Structural steel was the only material considered for the 373'-long trestle crossing the Mall. Only steel could evoke the image of Tennessee's industry and com-

The trestle is a series of simple spans carried by bolted moment frames. The decorative arches under the plate girders echo the form of the longitudinal arch.

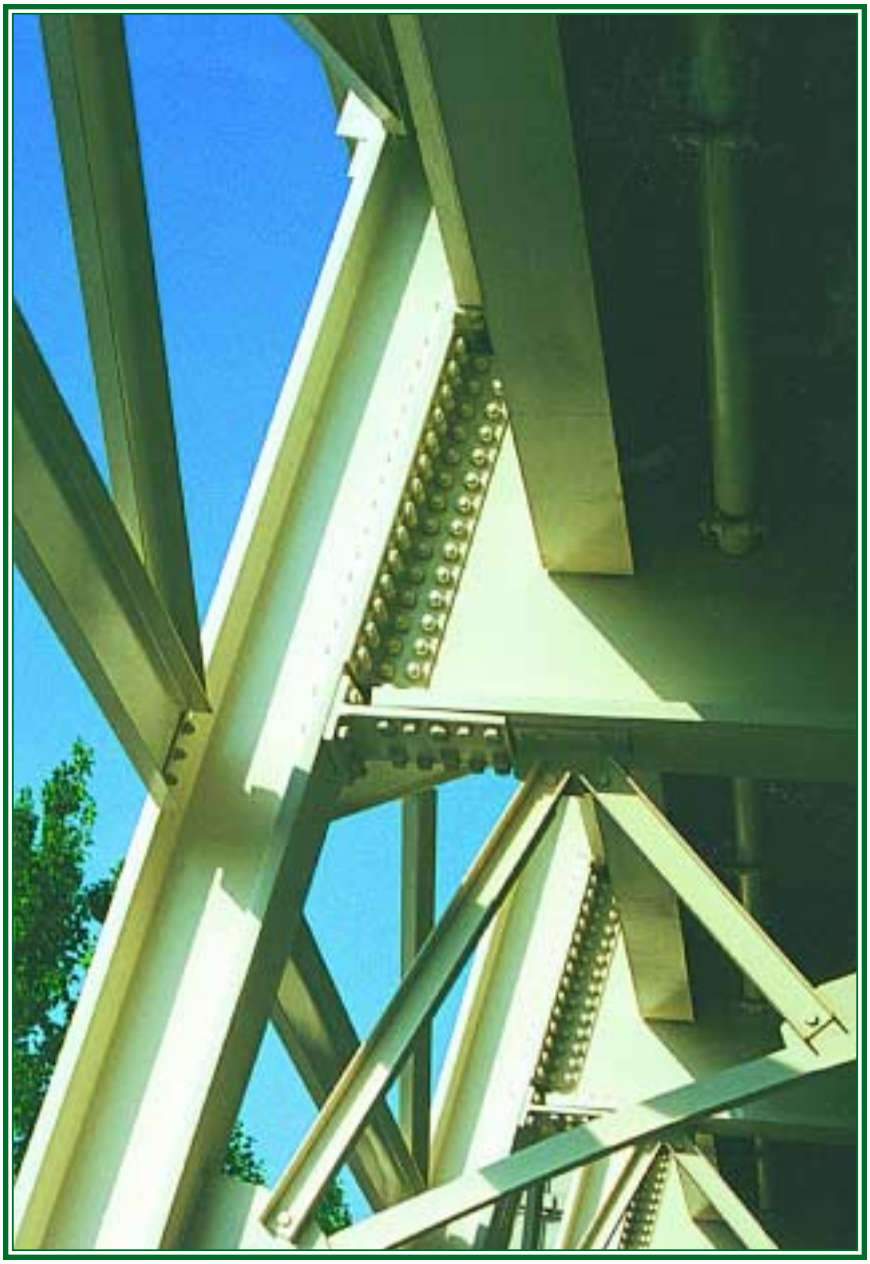
A double bent at bay 7 provides an expansion joint that reduces maximum column tip deflection and secondary forces. William Strickland's 1850 Capitol Building glows in the background.

merce the master planners envisioned. The trestle is a series of simple spans. Composite rolled shapes span from bent to bent supporting a 12" ballasted concrete deck. The longitudinal arch and its diagonals are purely architectural. These "faux arch" elements were detailed to decouple them from the trestle. The bridge supports the arch; the arch does not support the bridge.

The lateral load-resisting steel bents are bolted moment frames with A572 grade 50 plate girder horizontals and A36 W14x283 legs. Plate girders were fabricated to meet AREA standards for fracture critical members. Like the longitudinal arch, the transverse arches below the plate girders are ornamental. Bolted split tees connect the girder flanges to the column and double angles transfer shear. Longitudinal stringers frame into the plate girder web with double angle shear connections. The designers used bolts for all field connections on fracture critical members to avoid high category fatigue details. Engineers analyzed the indeterminate bents for gravity and lateral loads with SANDE, an SDLAL in-house analysis and design program.

The tray formed by the concrete deck holds the roadbed ballast. Keeping railroad runoff away from the Mall and its visitors was critical. The deck is waterproofed with a butyl rubber membrane protected by two layers of asphaltic panels. Three half round deck drains run the length of the bridge with drops located to reduce the maximum run to one 20' span. Longitudinal collectors below the deck required web penetrations in the plate girders. Waterstops and preformed bituminous strips seal the deck joints.

The trestle is pinned at the concrete end piers. A double bent at the seventh bay accommodates an expansion joint. For architectural balance, non-structural dummy columns were



Split tees and double angles connect the welded plate girders and rolled columns.

added at bays 4 and 10. Placing an expansion joint near the middle limits the column tip deflection due to thermal movement and reduces secondary forces in the bents.

Designers battered the columns for architectural effect. Concrete tie beams between column pedestals transfer transverse thrust resulting from the inclined columns. The trestle's uniquely shaped bents posed foundation construction problems similar to those for bent leg frames. CSX standards do not permit the use of cementitious grout under column baseplates, thus precluding the use of leveling nuts. The contractor solved the geometry problem by using a viscous epoxy grout under the column baseplates to level the bearing surfaces. Separating the baseplates from the pedestals are 31-ply elasomeric shock pads.

The new alignment follows the remnants of an old creek bed across the Mall. Poor native soils and unengineered fill in the area necessitated deep foundations for all bridges on the project. trestle columns and tie beams are supported on 42" diameter caissons (drilled piers) socketed into bedrock. Caissons also support the piers under the "stone" arches. The 7th Avenue box abutment is founded on a spread footing bearing on bedrock. For 6th Avenue, the contractor requested permission to use driven steel H piles. Driven piles eliminated the huge excavation required for a box abutment and reduced shoring required on the active rail lines immediately adjacent to the abutment.

The end piers and towers provide enclosed spaces for the park's extensive fountain, irrigation, and lighting equipment. Two service buildings under the trestle house restrooms, a gift shop, and Park Ranger offices. The service buildings, designed and built under a separate contract, sit on raft foundations isolated from the bridge grade beams by styrofoam sheets. Decoupling the structures substantially reduces vibration and noise in the buildings.

Construction on the $43.6 million Bicentennial Mall project began in July 1994 with a target completion date before bicentennial celebrations in June 1996. Designers stressed to contractors that there is no word in the English language for the 201st anniversary of statehood. The project had to come in on time. The state sent home the message with $5,000/day liquidated damages.

The state let the project in seven contracts with the trestle coming in at $9.6M. The scope of work on the trestle contract included the five bridges (two plate girders, two cast-in-place concrete "arches", and the steel trestle), temporary and final rail realignments, relocation of railroad communication facilities, traffic control and various utility relocations. Construction crews for rail tie-ins and all track material was provided directly by CSX under a separate force account agreement with the state.

As a state-owned project serving a private railroad through a public park over state and city streets, the project was a potential administrative snake pit. Nearly every move by the contractor and designers required multi-layered approvals from agencies with often-conflicting interests.

Heery International provided construction management for the Mall under a standing contract with the state. Heery's project manager, Gary Follis, reckoned the job to be one of the most challenging in his career. Faced with the absolute deadline of the Bicentennial, Follis steered the contractors through an obstacle course of shrinking sites, shrinking schedules, shrinking budgets, and shrinking tempers. According to Follis, "The closer we came to the end of the project, the more difficult and critical construction sequencing became. It got to the point in the last two months that a contractor who wanted to excavate had to dig a hole first to put the dirt in."

As a measure of the premium the state put on schedule, substantial completion of Phase I trestle construction was not defined as a percentage of the structure built, but by the date the site could be turned over to the next contractor. For all the rush, Bell Construction still had to accommodate state employee parking, pedestrians, downtown Nashville traffic, and CSX trains.

The payoff for all the work and public investment came for Tennesseans in a mighty celebration on June 1, 1996, the Bicentennial of statehood. Tennessee's native son, Vice President Al Gore, and his family joined citizens and visitors in their introduction to the state's newest park.

Since then, a steady stream of school children, families, and tourists have come daily to the Mall to learn about the history and geography of Tennessee from the park's many monuments. While work on special features like a World War II Memorial and The Court of Three Stars Carillon continues, the Mall stands ready to welcome visitors for the next 100 years.

Project Team

Owner: Bridges - State of Tennessee; Track - CSX Transportation

Designers: Nathan Evans Taylor / Stanlley D. Lindsey & Associates, A Joint Venture (James M. Evans, AIA, Partner, Nathan Evans Taylor Coleman Foster; David E. Hormby, P.E., Design Engineer & Thomas C. Schaeffer, P.E., Project Manager, SDLAL)

Contractor: W. Bruce Nicely, P.E., Vice President, Ray Bell Construction

Detailer: Lannom and Associates

Project Management: Gary Follis, Heery Int'l.

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