

A historic concrete bridge near New York City
was replicated—in steel. And most people will never know.

HIDDEN Marvel

BY CHRISTIAN WIEDERHOLZ, PE

WHEN YOU HEAR “MUSHROOM BRIDGE,” you may very well think of Mario Kart.

But it's also the nickname of a portion of the Crane Road Bridge, a nearly century-old crossing in north suburban New York City.

Comprising two bridges, it carries the Bronx River Parkway through a forest preserve in the Village of Scarsdale and the Town of Greenburgh in Westchester County. The southern bridge is a multi-span concrete bridge (the Mushroom Bridge portion) that crosses the Bronx River, while the northern bridge is a single-span steel through-girder bridge that crosses



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the two-track Metro-North Railroad Harlem Line (accordingly called the MNR Bridge).

Dating back to 1925, both bridges have been rehabilitated over the years. But when two separate incidents, both of which involved holes punched completely through the concrete deck, resulted in emergency closures and repairs, the Westchester County Department of Public Works and Transportation took immediate action.

An in-depth bridge inspection revealed that the concrete deck slab of the Mushroom Bridge was in a state of advanced deterioration. The reinforcing steel exposed through the spalled concrete had advanced section loss, and the concrete slab around the holes was completely pulverized. The concrete brackets had numerous cracks and spalls, and the overall condition of the deck was rated poor and quickly approaching severe.

Furthermore, traffic safety along this stretch of the Bronx River Parkway continued to be a major concern. Within the project limits, narrow travel lanes with minimum shoulders, sharp curves and limited sight distance had led to an accident rate six times higher than the statewide average. As a result, the County hired a team led by structural engineer Stantec, contractor EE Cruz and construction inspector LKB, Inc., to inspect, repair and design replacement bridges for the aging structures.



Photos: Stantec



- ▲ Pedestrian use and access to the bridge was improved with the reconstruction.
- ◀ The new bridge alignment enhances the historic bridge's roadway geometry.

Blending History with Innovation

From the outset, the County and the other agencies involved with funding and approving the project recognized that preserving the unique historic and environmental character of the bridge was a crucial factor. After an exhaustive public screening process and inter-agency coordination, the County selected a replacement alternative of constructing a new bridge that replicated the existing Mushroom Bridge structure.

This alternative provided wider replacement structures immediately south of the existing bridges, allowing for construction phasing such that traffic could continue to use the highway while improving the roadway geometry. The proposed modifications included:

- ▶ Replacing the Mushroom Bridge superstructure and substructure with a substantially wider deck
- ▶ Replacing the MNR Bridge with a redundant type structure (composite prestressed concrete box beam bridge)
- ▶ Replicating the existing Mushroom Bridge piers to maintain the form of the historic pier configuration while relocating them along a similar alignment
- ▶ Completing the project's construction within an approximately \$39 million budget and three-year schedule

Achieving these vast improvements was no easy task. While the bridge was to be widened, the number and size of the piers were required to remain more or less the same due to flow concerns, which presented obstacles for the structural design. Each existing mushroom superstructure panel was approximately 40 ft by 40 ft, or 1,600 sq. ft. The proposed configuration for each panel was approximately 60 ft by 60 ft, or 3,600 sq. ft, so each panel more than doubled in size. Therefore, the loads that each bracket and pier needed to carry were increased substantially.

The design codes had also changed since the original bridge was built, requiring the replacement structure to carry much heavier traffic loads than the original design. Additionally, each bracket has needed to be significantly longer in order to reach the ends of the enlarged panel. Deflections at the tips of these brackets played a large role in the design of the structure.

The Steel Solution

Most of the Bronx River Parkway bridges are made of concrete, including the existing Mushroom Bridge. Reinforced concrete arch brackets radiated from the central piers, and the center of the deck panel directly over the piers was heavily reinforced with bars from each bracket that converged and overlapped. Since the new brackets are longer and carry more load,



▲ The partially erected Mushroom Bridge, showing steel core and steel brackets.



◀ The bridge's concrete-encased brackets and core.



using reinforced concrete brackets in the new design proved to be impossible due to rebar congestion. In order to address the unique configuration of the superstructure, an innovative steel option was used in which an octagonal core made up of steel plates was fastened to the concrete pier.

The steel core is made up of 1¼-in. steel side plates and 2½-in. top plates. Steel brackets protrude from each face of the core and are spliced to steel ring plates at the top of the core. To provide access for bolting, the top plates were designed as rings, leaving a 3-ft diameter opening in the center. A bottom flange shelf support and web connection, along with horizontal stiffeners to combat the prying action, complete the bracket connection to the core.

Further complicating the custom steel core were the longitudinal and transverse slopes of the roadway, as well as the curvature of the bridge. As a result, each octagonal core was unique. But while the top of the core was sloped in two directions, the top flanges of the brackets were level, so tapered shims were required to facilitate the bolted connection.

The steel core was secured to the concrete pier via anchor bolts and studs. The



◀ Existing bridge in the background; replicated structure in the foreground.



▲ The bridge's uniquely shaped piers gave it its Mushroom Bridge nickname.

built-up plate brackets were designed with varying depths to decrease the weight and allow replication of the existing curved arch brackets. The perimeter of each 60-ft by 60-ft deck panel was lined with rolled steel edge and fascia beams that connect to the tips of the cantilever built-up steel brackets. The entire steel solution was encased in concrete to maintain the overall aesthetic of the existing bridge.

In order to provide for a redundant structure, the bridge was designed to remain in service even after complete failure of one bracket per panel. Additionally, each panel of the superstructure can behave independently, gaining no necessary support from an adjacent panel.

Built to Last

Despite the tight parameters, the project team designed a replacement structure that has vastly improved the crossing's safety. The entire bridge is wider, including all four travel lanes and shoulders. There are also acceleration/deceleration lanes now, which

were virtually nonexistent before. In addition, a merging roadway was raised so that drivers on the Bronx River Parkway and the road can easily see one another and merge safely, and the curved alignment was softened to improve sight distances.

And beneath a facade of salvaged stone facing lies the Crane Road Bridge's most unique and crucial feature: its steel core. While the replacement bridge continues to be a striking and historic fixture of the Bronx River Reservation, the true marvel of its reconstruction will remain hidden from the public eye. ■

Owner

Westchester County Department of Public Works and Transportation

General Contractor

EE Cruz, New York

Structural Engineer

Stantec, Rochelle Park, N.J.

Steel Fabricator

American Bridge, Coraopolis, Pa. 