The suspended platform on Third Avenue Bridge functions as an access platform for arch repair and as secondary containment for debris

HISTORICAL RECORDS

Maintenance and repair of open-spandrel, reinforced-concrete arch bridges that are prevalent in the USA requires innovative access solutions. Thomas Topolski takes us through a tour of three recent projects

A century ago, the reinforced concrete arch played a dominant role in American bridge design. Open-spandrel reinforced-concrete arches are among the most aesthetically appealing for bridges in a natural setting and are structurally sophisticated as well. Now, however, many of these bridges are slated for maintenance, repair or renovation, and the challenge of accessing these iconic structures often requires innovative engineering, products and services. In many cases, these unique bridges present extreme load restriction limitations. In others, the bridge elements themselves – notably pedestrian walkways and bike paths, which cantilever over the bridge deck – present access challenges. In many instances, supported scaffold alone is not viable nor an economically feasible solution. The following three recent bridge maintenance and repair projects – Third Avenue, Granite Canyon and Tenth Avenue – provide excellent case study examples.

A suspended platform-supported scaffold reshores the upper suspended platform in an area where the bridge could not support the load from above due to load restrictions

Built from 1914 to 1918, Third Avenue Bridge stretches for 678m and was designed using Melan arches, or rigid truss arches, embedded in the concrete instead of steel rebars. Spans one through five have three Melan arch ribs, while spans six and seven have full Melan barrel arches. The bridge has an S-curve shape, so that its eight piers rest on the sturdiest parts of the bedrock and weave around – and over – Anthony Falls and Horseshoe Falls.

Repaired in 1939 and 1979, Third Avenue Bridge is currently being repaired (*see p36*), with the work going on through 2023, and including repairing spalling on the arches and piers, as well as completely replacing the road deck and spandrel columns and caps.

Because the bridge is relatively low, contractors would normally use barges and erect scaffold on top to access the piers and arches. However, Horseshoe Falls made barge access impossible for spans two to five, and the river is too shallow to support a large barge by spans six and seven. It was therefore decided to use suspended platforms as access, which amounted to approximately 9,291m^2 and which would also function as a debris shield. And, as the suspended platforms provide a flat surface for working on, they are safer, reducing trip hazards as well as speeding clean-up. In addition to suspended platforms, a flying/cantilevered load concept was also deployed.

The required material loads created a secondary challenge because the contractor wanted a load rating of 2,394Pa in some areas to support debris removal and higher numbers of workers and scaffold stairs. This was addressed by placing suspension chains at closer intervals, which sufficiently increased the load rating, as well as using shorter trusses to create more suspension points. These actions increased the load rating up to a maximum of 3,591Pa where needed.

A third challenge was designing concrete anchors with suspension points for chains, which would be used on the barrel arches and piers. Here, the Brandsafway engineering team provided a new patented rotating/pivoting suspension assembly that is secured via a concrete anchor with a 25.4mm-diameter bolt. The base plate spins around the bolt, and the chain connection is free to pivot so that the load pulls in a straight line to eliminate unwanted side loads.

Second in the tour is the 1931-built Granite Canyon Bridge, which also presented multiple access challenges. With a total length of 88m, an arch span of 39m and a deck width of 7.3m, Granite Canyon features an abutment with two bents on each side and 10 spandrel columns encompassing the arch. When Caltrans appointed general contractor American Civil Constructors to repair the concrete of the Granite Canyon Bridge in 2021 using an electrochemical chloride extraction process to mitigate corrosion, Brandsafway, the company brought in to engineer access for the project, initially believed it could use the same approach used on the Rocky Creek Bridge.

Built in 1932, just one year after Granite Canyon, and stretching for almost 153m, the Rocky Creek Bridge features a 73m open-spandrel concrete arch rising 46m above its namesake waterway. During previous maintenance work, the Rocky Creek Bridge had posed a unique access challenge, because the bridge's reinforced concrete rails were not designed to support the structural load of a suspended platform. Fortunately, however, it was found that the road surface was capable of supporting the structural load, so the access team used a core drill to drill 119 holes (70mm in diameter) through the 0.3m-thick concrete deck to lower the suspension chain through the hole. The chain that would support the suspended platform was connected to a pad eye, which was then welded to the underside of a structural steel plate, fitting flush with the road surface.

On the Granite Canyon Bridge, the access team realised that core drilling in the centre section of the span would jeopardise the concrete slab's structural integrity. In addition, decay was found at one of the spandrel columns, and spandrels three and eight required a splice zone (overlapping sections of new rebar/concrete), which also reduced the structural load.

The ultimate access solution engineered for Granite Canyon required a unique, multi-tiered configuration of suspended scaffold, supported scaffold, shoring and rolling scaffold – often all combined at once. To help ACC and Caltrans envision an extraordinarily complex access plan on the Granite Canyon Bridge, Brandsafway presented 3D images so they could compare access options and determine the safest, most efficient solution. Brandsafway project manager Greg Mallek said that the use of the technology also improved communication during construction between all parties and trades involved, and was key to completing the project without any incidents and within the allocated budget and timeline.

For both of the Rocky Creek and the Granite Canyon bridges, a suspended access solution was critical to the success of the projects. Its use meant one lane was closed at Rocky Creek for a week, after which access was from beneath. Had a mobile platform truck been used instead, it is estimated there would have been daily lane closures for upwards of three months. Using a rigid suspended platform provided several benefits beyond minimising lane closures: it simplified the erection of the plastic containment barriers that were necessary during blasting and coating, and the flat rigid surface improved worker experience.

Third on our list of projects is the 10th Avenue Bridge in Minneapolis, which was completed in 1921 and listed on the National Register of Historic Places in 1989, but last renovated in 1976. It has an overall length of 657m and consists of 21 spans, seven over the river and 14 as approaches. The bridge is a good example of the monumental reinforced-concrete bridges constructed to span the bluffs of the Mississippi River during the early years of the automobile.

Due to freeze-thaw damage over time, the City of Minneapolis undertook a rehabilitation project, which was completed in late 2021. The scope of work included replacing the road deck and concrete railing; patching piers and arches; replacing and patching deteriorated beams and spandrel columns; corrosion prevention treatment of the arch ribs; and a new surface finish for the entire bridge.

On this bridge, the road deck could support suspended access and core drilling for chain access for a suspended platform. However, getting the platform to the underside of the two main river spans, which rise 31m above the water, was a challenge, because the 21m-wide deck extended past the arch by about 2.8m on either side. In order to reduce the amount of crane lifts and leading-edge work, which would enhance safety, a method using a mobile crane to fly in starter platforms was devised, something which Brandsafway product manager Doug Knapp believes had never been attempted before.

The access team assembled a 4.8m by 9.7m section of platform on the bridge deck. When it came time to lift, they connected a web sling bridle assembly at four locations at one end of the platform. This left a 4.9m by 4.9m section unsupported, which became the cantilevered section and would poke under the bridge, where an access team member working from a mobile platform snooper truck would connect the suspension chains.

To counterbalance the platform, the crew used more suspended platform components: trusses, nodes, pins, toeboards and plywood. Once the starter platform was safely suspended from the chains, workers used the counterbalanced material to build out the platform, which can be erected in the air. In all, the massive arches over the river required 19 tiers of suspended work platforms ■

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A suspended access system featuring supported scaffold provided the most efficient access solution for concrete repair on Granite Canyon Bridge