

Busy on set

Los Angeles replaces famous Hollywood backdrop

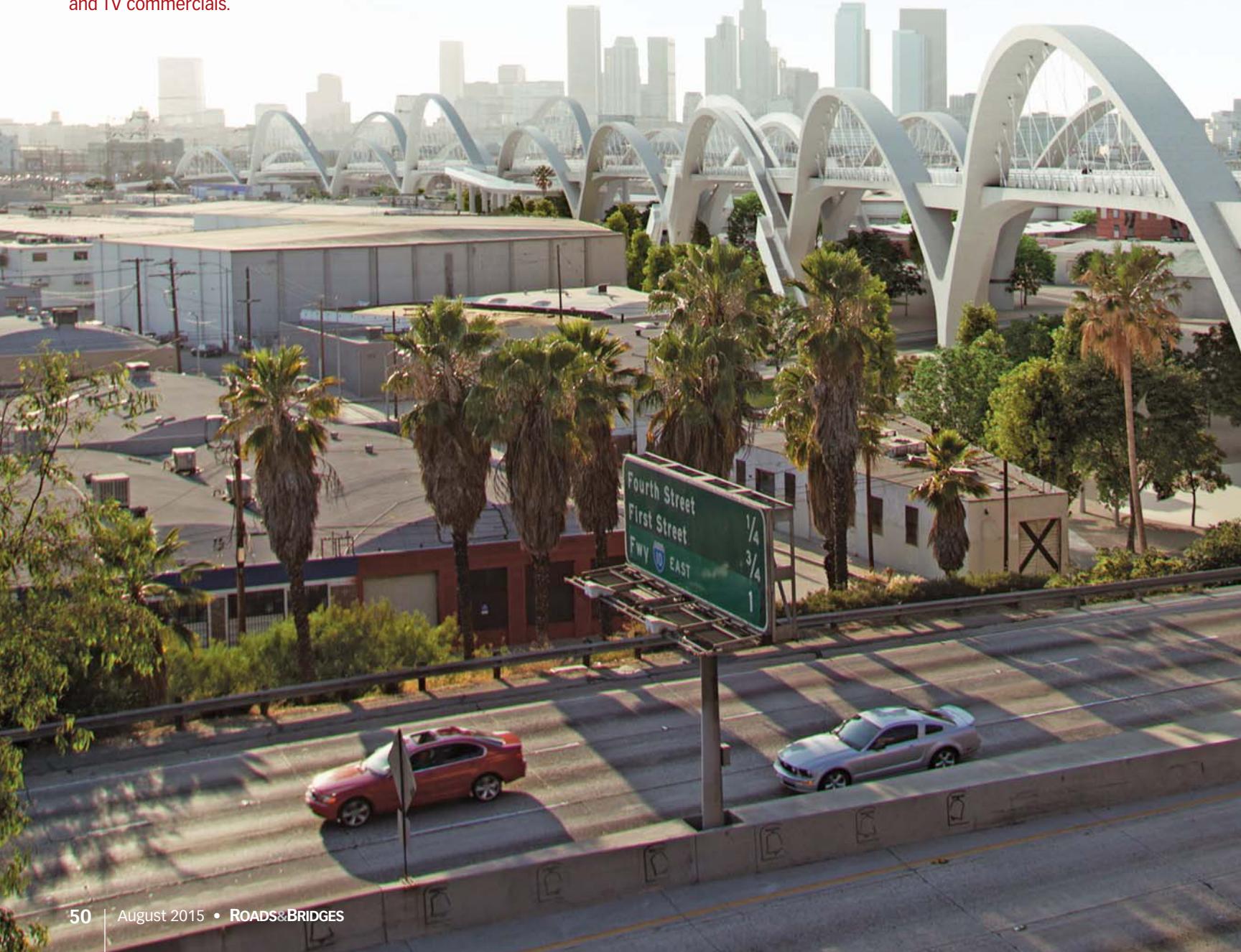
By **Vic Martinez and Michael Jones**
Contributing Authors

One of America's most famous and recognizable bridges, the Sixth Street Viaduct, has been used to represent Los Angeles' more gritty side in countless movies, music videos and TV commercials.

Often seen looming above riverbed car chases along the Los Angeles River, the bridge, like many celebrities, is more complicated underneath the surface than the public persona it has projected since it was built in 1932.

When the bridge was just 20 years old, its concrete supports began to disintegrate, caused by a chemical reaction known as alkali silica reaction. Over the years, costly restorative measures attempted to save the structure, but none worked.

In 2004, a seismic vulnerability study was conducted that concluded the weakened state of the 3,500-ft viaduct put it at high risk for failure in a major earthquake. Due to the viaduct's geometric design and safety deficiencies, the city of Los Angeles' Bureau of Engineering now had a convincing argument for replacing the bridge. What they didn't have was a replacement design concept that would be worthy of the iconic viaduct.





"The Ribbon of Light" features 10 pairs of arches, canted at 9°, forming a single stress ribbon running the whole length of the viaduct.



The initiative to build a new bridge to replace the structure drew worldwide attention in 2012 when the city of Los Angeles held an international competition for a design concept that would capture the imagination of a city that had long ago fallen in love with the Sixth Street Viaduct.

Different song and dance

Nine teams responded to the Bureau of Engineering's call for qualifications. Three entrants made the final short

list: AECOM, HNTB Corp. and Parsons Brinckerhoff.

The selection process for the Sixth Street Viaduct replacement was as extensive as the Bureau had ever experienced. The three finalists submitted proposals complete with architectural design reports. Each team then gave a 90-minute presentation followed by a 90-minute Q&A session. For the next two weeks, each finalist participated in four 20-minute public presentations with Q&A sessions at four separate venues.

Vic Martinez, HNTB's project manager, remembers numerous follow-up calls and meetings, where his team walked Bureau members through HNTB's philosophy, methodologies and cost estimates.

After significant deliberation, members of the Bureau of Engineering and Caltrans selected the concrete network tied arch, a collaboration between HNTB and architect Michael Maltzan. Their decision was unanimously supported by the Design Aesthetic Advisory Committee, nine

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engineering, architecture and urban-planning professionals, as well as residents of surrounding neighborhoods, local businesses and river advocates.

"It felt like we had just won the World Series," Martinez said.

"We asked the Bureau of Engineering to bring the best of the best to the city of Los Angeles to design the new Sixth Street Bridge, and they certainly delivered," said Los Angeles City Councilman José Huizar.

Part of the family

Dubbed "The Ribbon of Light," the distinctive structure features 10 pairs of starchy white arches. A striking visual, the concrete arches are canted at 9°, an industry first, and seem to skip across the urban L.A. landscape, forming an iconic stress ribbon that runs the length of the viaduct.

"We know first-hand the architectural brilliance this new Sixth Street Viaduct design represents and look forward to seeing it come alive," City Engineer Gary Lee Moore said.

Designed to match the family of Los Angeles River bridges and to pay respect to the former bridge, the concept includes an 80-ft arch over a western set of railroad tracks, a 50-ft arch over the river, an 80-ft arch over an eastern set of railroad tracks, a series of 30-ft arches and a 50-ft arch over U.S. Highway 101.

Each arch will be illuminated by LEDs, creating a dramatic, energy-efficient nighttime effect. Rather than using streetlight poles on the bridge, HNTB designed an LED-lighted barrier between the bike lane, sidewalk and



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roadway. The accent lighting will accentuate the arches while lowering light pollution.

"From a distance, it appears as if someone took a long white ribbon and laced together the communities of Boyle Heights, the Arts District and downtown Los Angeles," Martinez said.

Connectivity is one of the Bureau's main project goals, and HNTB built in added features to promote it.

"The new bridge will invite more traffic and improve connectivity with stairway access and bike ramps placed intermittently along its alignment," Martinez said.

As Councilman Huizar said, "The new bridge will not only bring people from Point A to Point B, but to Point C—the bridge itself."

Building off experience

Because of the bridge's unique configuration, HNTB developed project-specific design criteria, including requirements for seismic design.

"We had significant experience developing design criteria for complex Caltrans' projects, including the Tom Lantos Tunnels at Devil's Slide and the Gerald Desmond Replacement Bridge," said Mike Jones, HNTB's lead bridge

engineer. "We leaned on those experiences and they paid off."

The \$419 million Sixth Street Viaduct project went into construction this spring on budget and on schedule with only slight modifications or enhancements to the original concept:

Modified columns meet design criteria.

As HNTB began analysis of its concept against design criteria, it became evident the viaduct's distinct X-shaped column configuration would need to be modified.

"After detailed discussions with the contractor and the architect, we moved to a Y configuration instead," Jones said.

The single Y column rises up from the ground with the arms branching out in opposite directions leading into graceful arches. The concrete arms use grade 80-ksi rebar reinforcement as opposed to 60 ksi, a first for California bridges.

Arch heights reduced to meet design parameters. At the same time HNTB modified the columns, it reduced the height of the arches from 80 ft to 60 ft over the railroad tracks and from 50 ft to 30 ft over the river.

"We were bumping up against the upper design limit," Jones said. "To make the arch rib work at a height greater than 60 ft, we were going to have to make it quite a bit larger, which would cost quite a bit more, so we decided to keep the standard 7-ft by 3-ft structural size."

Sliding seismic isolation bearings increase resiliency, safety. The bridge will be the world's first concrete network tied arch built integrally with Y-bents in a high seismic zone.

HNTB designed the Sixth Street Viaduct replacement to exceed the latest seismic codes by placing sliding seismic isolation bearings at mid-height in the columns, a first for the U.S. bridge industry.

The bearings isolate the viaduct from the damaging effects of seismic ground motions. Seismic isolation is achieved when the force exceeds a certain friction value. At that moment, the bearing breaks free and slides up a concave surface. Once the displacement demand of a 1,000-year event is exceeded by a factor of about two, the bearings gradually stiffen and transfer forces to the structure in



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a conventional way, providing a secondary back-up system.

"Essentially, the bearing moves uphill. The farther it goes uphill, the more resistance it picks up," Jones said. "The second the earthquake stops, the bearing slides back to a neutral position, acting as a self-centering device. When the ground begins shaking, those motions cannot move through the isolator. It's as if the bridge above the isolator doesn't know the earthquake is happening."

Because the bearings are patented by Earthquake Protection Systems, HNTB had to secure approval from the Federal Highway Administration to use a sole-source manufacturer. Permission was granted when HNTB was able to demonstrate that the alternative—a bearing not patented and double the size of the preferred bearing—would require bigger, more costly columns.

Emphasis on sustainability extends longevity. The Sixth Street Viaduct Replacement Project, designed with a 100-year service life, is the first HNTB bridge to implement the Envision sustainable infrastructure rating system. Similar to the Leadership in Energy

& Environmental Design certification for buildings, Envision encourages sustainability and resource efficiency. The Bureau of Engineering's goal is to achieve a platinum-level Envision rating.

Dealing with difficulty

The Sixth Street Viaduct design features 20 complex knuckle joints. According to Jones, they are one of the more difficult design aspects to construct.

"The knuckle joint is where the arch rib comes down to the deck, the arch rib floorbeam transfers to the bridge and the edge girder runs longitudinal to the next arch rib," he said. "The intersection of those three components requires a tremendous amount of steel and concrete in a confined area."

To identify and work through any difficulties before actual construction, Skanska/Stacy and Witbeck (SSW) are building a full-scale model of the connection.

"It's like a dress rehearsal," Jones said.

SSW was awarded the construction contract in December 2013, becoming the Bureau of Engineering's first construction manager/general contractor. From that point to the end

of January 2015, up to eight CM/GC team members co-located in HNTB's office to work through the project details.

"It's indicative of the collaboration the project has enjoyed," Jones said.

Gathering place

On Feb. 20, 2015, the city of Los Angeles held a groundbreaking ceremony for the Sixth Street Viaduct Replacement Project, successfully sending the first of five project packages into construction.

The existing bridge's demolition is scheduled for late summer or early fall of this year. The new bridge's opening is targeted for late 2018.

"The transformative design addresses the need for urban parks and smart, sustainable development. It will improve mobility, enhance safety, stimulate investment and offer people a place to gather, play and connect," said Los Angeles Mayor Eric Garcett. **R&B**

Martinez is a project manager with HNTB Corp. Jones is a lead bridge engineer with HNTB Corp.

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