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# Infrastructure

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# The Gold Line Bridge

Overcoming design, seismic, and safety challenges to build California's newest landmark

The Gold Line Bridge, San Gabriel Valley, CA

**V**eteran design and construction crews recently completed the largest, single public art/transit infrastructure project in California: a 584 ft (178 m), dual-track transit bridge over the eastbound lanes of the I-210 freeway in the San Gabriel Valley northeast of Los Angeles. The bridge—comprised of 1.3 million pounds (590,000 kg) of steel reinforcing and 6500 yd<sup>3</sup> (4900 m<sup>3</sup>) of concrete—is the most visible element of the 11.5 mile (18.5 km) Metro Gold Line Foothill Extension light rail project under construction between Pasadena and Azusa, CA, and is quickly becoming a regional icon.

The Metro Gold Line Foothill Extension Construction Authority (Construction Authority), the independent transportation planning and construction agency overseeing the project, reimagined the construction process when planning the Gold Line Bridge. The Construction Authority brought in an artist early to lead the design, well before the design-build team was selected.

“I wanted the bridge to be sculptural, not just an embellished structure,” said Construction Authority CEO Habib F. Balian. “I wanted to create something fantastic, something never done before. I wanted the artist to address the landscape—the mountains—as well as the community and its history and culture. Ultimately, I wanted to meld art and the transit experience, and I think we did that.”

The result is an \$18.6 million bridge that includes two dramatic 25 ft (7.6 m) tall baskets, three 11 ft (3.4 m) diameter cast-in-drilled-hole (CIDH) foundations, a curved underbelly to the superstructure, and seamless markings on all surfaces—a truly unique structure that stirred its designers and tested the skills of the construction crews as they worked above a heavily used freeway and across an active seismic fault. Through ingenuity, craftsmanship, and hard work, the design and construction team completed the artist-designed bridge on time, on budget, and at a cost comparable to that of a standard transit bridge of its size.

## A Bridge Unlike Any Other

With more than 255,000 motorists passing by it each day, the Gold Line Bridge serves as a new Gateway to the San Gabriel Valley. To ensure its appearance reflected this stature, the Construction Authority put out a national call for artists in 2009. A committee of community stakeholders selected the project's design concept advisor—award-winning public artist Andrew Leicester—from a group of 15 highly qualified respondents.

Leicester came on board early in the process to develop the initial concept for the bridge design, and then worked alongside Skanska USA, the project's design-builder, as well as AECOM, the project's lead architecture and engineering firm, to ensure the final design and construction were true to the overall vision.



Workers strip the forms from one of three CIDH foundation piers. The pier flares provide a base for a 25 ft (7.6 m) tall basket feature



Sixty precast segments were installed to form the exterior of each basket feature



Night placements were necessary to minimize traffic disruption on I-210



The bridge's ribbed design was created by fastening polymeric form liners onto curved forms. Here, workers pull the liners from the concrete

The bridge design, which was approved in November 2011, was inspired by the local indigenous peoples and wildlife of the San Gabriel Valley, as well as the oversized iconic roadside attractions of nearby Route 66. These inspirations permeate all elements of the structure. Most notable are the two 25 ft (7.6 m) tall, 17 ft (5 m) diameter sculptural baskets flanking the sides of the main superstructure, which are tied together visually by the relief pattern on the outrigger beam. The curved, serpentine main underbelly of the superstructure features formed grooves and hatch-marks that simulate the patterns found on the Western Diamondback snake and metaphorically reference the connectivity of the transit system.

When Leicester first outlined these concepts, Lead Architect Rivka Night of AECOM said she “had the same reaction as everyone when they first saw it—wow!—because it is very unusual and not at all a traditional design. My immediate thought was, ‘is it really going to be constructed out of concrete?’ It seemed that it might be a very complicated construction because of the unusual shapes.”

Using three-dimensional computer-assisted design tools, Night spent months working out the details of the design before turning it over to Skanska for construction.

“Nearly everything on this project was specially designed and manufactured for the project and required our crews to install them using detailed craftsmanship unlike any bridge I have been involved with to date,” said Lawrence Damore, Skanska Project Executive. “The workers exercised great attention to detail, ensuring that the shape of the structure and the grooves and hatch-marks created the overall effect the Construction Authority and artist wanted.”

### Specialty Aggregates Give Concrete Baskets a Sparkling Finish

Skanska hired Masonry Concepts, Inc., in Santa Fe Springs, CA, and Moonlight Molds, Inc, in Gardena, CA, to create the basket features. Each woven basket is comprised of 60 precast segments. The 16 precast concrete reeds at the top of each basket range from 2 to 10 ft (0.6 to 3 m) in height. The concrete mixture in the precast segments comprises a unique combination of aggregates—black stone and clear, grey, and mirrored glass—developed specifically for the Gold Line Bridge.

Moonlight Molds fabricated custom-made molds to create the curved surfaces needed for the rounded basket shapes. After the segments were removed from the molds, they were power-washed to expose the glass and stone. The company then cured each segment for 28 days before shipment to the bridge site. At the bridge site, Masonry Concepts carefully placed each of the segments, stacking and locking them together into nine rings to create the towering forms atop the bridge's support columns.



Detail of the superstructure, showing the intricate pattern of serpentine grooves and hatch-marks conceived by the artist Andrew Leicester

## Serpentine Underbelly Required Great Precision

For the other main aspect of the design—the serpentine underbelly of the bridge—Skanska worked with the artist to realize his vision. Initially, Leicester wanted the superstructure to be a rounded shape. “However, we saw difficulties in the design and constructibility of that form,” Damore said.

“We proposed a cross section with a flat soffit and curved sides...which Andrew found to be an acceptable alternative,” Damore added. The curved side forms were fabricated off site and hoisted into place atop the structure’s falsework. To create the serpentine, ribbed design along the underbelly, Skanska installed specially designed polymeric formliners onto the curved forms. They created the cross-hatching design by individually nailing chamfer strips to the forms. All of this was done with painstaking accuracy to create a seamless effect to the entire structure. Damore concluded that the crews “are very proud of their work on this bridge and how their efforts have created something truly unique and quite beautiful.”

## “Smart Columns” Will Help Measure Seismic Damage

Adding to the design and construction challenge of this structure was the existence of an active seismic fault (the

Raymond Fault) directly below the bridge. To address the seismic issues, AECOM designed the structure as a three-span, cast-in-place post-tensioned box girder supported by a single column bent and one outrigger bent spanning the freeway. Because of the large vertical and lateral demands expected during an earthquake, AECOM designed three large-diameter CIDH foundations—each approximately 110 ft (33.5 m) deep and 11 ft (3.4 m) in diameter.

AECOM’s design included time domain reflectometry instrumentation in the three CIDH foundations, in what may be the first application of this technology in a reinforced concrete bridge. The system comprises coaxial cables embedded in the piles. After a significant earthquake, a monitoring device can be attached to the cables to assess the integrity of the foundations. Damore reported, “Without this system, a crew would have to excavate up to 20 feet below the ground level to inspect for any obvious signs of concrete cracking.”

## Bridge Completed with No Reportable Incidents

Skanska’s work was done on a uniquely confined site adjacent and above an active freeway, requiring extensive planning, coordination, and nearly 100 nights of work between midnight and 5 a.m. Skanska managed more than a dozen subcontractors and more than 100 trade workers



The completed Gold Line Bridge serves as a gateway to the San Gabriel Valley northeast of Los Angeles, CA

who put in more than 95,000 work-hours on the project after site preparation began in April 2011. “We are extremely proud that in that time, we were able to maintain a clean safety record with no recordable incidents,” said Damore.

The success of the safety program is the result of careful preconstruction planning and diligent oversight by Skanska and the Construction Authority as well as a job-site culture that involved everyone working toward a unified goal of zero workplace incidents.

### **Construction Authority Praised for its Oversight of Bridge Construction**

On December 15, 2012, a project completion ceremony was held to honor the men and women who designed and built the bridge. More than 350 people, including elected leaders, local officials, stakeholders, and project workers and their families, joined the Construction Authority as they gathered on the massive concrete span for a once-in-a-lifetime opportunity to walk across the bridge.

U.S. Rep. Grace Napolitano, who serves on the House Transportation Committee, praised the Construction Authority for its oversight of the project. “Ninety-two

percent of the materials and products used on the bridge were from local sources,” she said. “That meant jobs for the area, and we are very pleased that the leaders of this project saw that this whole region could be involved and benefit from its construction.”

With construction of the concrete superstructure completed, Skanska turned the bridge over to the next engineering and construction team, Foothill Transit Constructors, a Kiewit Parsons Joint Venture, which will lay tracks across the bridge as part of its ongoing construction of the light rail alignment project. The light rail extension from Pasadena to Azusa is scheduled to be completed in 2015.

“The Construction Authority is proud to have created a functional piece of art that will inspire travelers and commuters for generations to come,” said Doug Tessitor, Construction Authority Board Chair and a Glendora, CA, City Council member. “The Gold Line Bridge is representative of the rich and proud heritage of our region, and it will serve as a landmark for the San Gabriel Valley.”

All photos courtesy of the Metro Gold Line Foothill Extension Construction Authority.