Early Adopter

BY JOHN W. LITZINGER, P.E.

Photos: Courtesy of HNTB Corporation

A new steel bicycle and pedestrian bridge in Cupertino is the first cabled-stayed bridge crossing an Interstate highway in California.

THE TERMS "INNOVATIVE" AND "CUTTING-EDGE" HAVE BEEN ASSOCIATED WITH SILICON VALLEY FOR DECADES. Typically referring to the region's role in computer and software development, they now also apply to a new bicycle and footbridge in the area.

Scheduled to open in early 2009, the steel Mary Avenue Bicycle Footbridge is the first cabled-stay bridge crossing an Interstate in the state of California. The 500-ft-long by 16.3-ft-wide connector spans I-280 in Cupertino and closes a gap in a regional bike route joining suburban communities to work centers such as De Anza Community College, Homestead High School, and multiple technology companies in Cupertino and Sunnyvale. Complete with a structural steel girder-and-beam superstructure and a 13.5-ft-wide precast concrete panel deck, it is supported by 44 locked coil-stay cables, suspended from two 90-ft steel towers, with a clear span of 325 ft over the eight-lane Interstate and adjacent ramps. There are roughly 240 tons of steel in the project split evenly between the towers (W shapes) and superstructure rolled sections.

Twelve, 3-ft-diameter, 86-ft-deep cast-in-drilled-hole (CIDH) piles, with concrete footings and pile caps, make up the abutments and tower foundations. Nearly 12 acres of native landscaping, complete with soundwall reconstruction, complement the bridge, as does 2,000 ft of lighted bicycle and pedestrian trails. The total project budget is $14.8 million, with $9.07 million going directly to bridge construction.

The bridge was originally designed with concrete, but this design bid out substantially over the planned budget. As such, the design team conducted a value engineering study to develop a budget responsive to alternatives and concluded that changing the pylons and superstructure to structural steel was the best option for multiple reasons, including speed of erection and seismic performance.

"In terms of seismic performance, the reduction in superstructure and pylon mass leads to large reductions in lateral forces and therefore foundations size," says Ted Zoli, Vice President and Technical Director-Bridges, with the bridge's designer, HNTB Corporation. "In the transverse direction, the superstructure is designed using the deck as a shear wall and the non-composite steel edge girders and floor beams as an eccentrically based frame. This is similar to a hybrid-coupled shear wall system used in seismically resistant building design."

Lightness and aesthetics were also factors. Terry Greene, an architect for the City of Cupertino, notes that the bridge weighs 1,700 lb per linear ft compared to the concrete design, which would have weighed 4,300 lb per linear ft.

"[The bridge's] lack of mass uses little airspace, which is important for visual impact," he explains. "Steel gives a lot of support and capacity for the airspace used. In terms of actually using it and enjoying it, what one sees is the structural capacity of steel being used in its very best way. It's not intrusive on the landscape and is very gentle in the way it populates the visual environment."

In addition, adds Zoli, the diamond-shaped towers optimize the bridge's torsional performance—ideal for edge girder-type cross sections—while adhering to the visual characteristics of the original design. This configuration also assisted in fabrication and erection, as it allowed the towers to be fabricated, transported, and erected in two pieces spliced only at the strut and the top. The geometry of the half-tower was designed so that it would be vertical in its free-standing condition, eliminating the need for temporary or shore bracing.

With the bridge being built over a busy freeway, lane closures were, of course, a concern. Fortunately, the steel design also resulted in a reduced

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construction schedule, which in turn resulted in fewer lane closures.

"Fewer, shorter lane closures were part of our intent to develop a project that is cost-responsible and efficient," Zoli says. "That's the idea behind the pylons and superstructure. Each tower can be erected in a single night and complete superstructure erection in three nights, compared to a cast-in-place concrete alternative that would take months."

Seismically Sound, Wind Resistant

Without question, a long-span bridge in this region must be designed for seismic considerations and wind stability. The Mary Avenue Bridge was designed to behave elastically under the design-level seismic event, and the unique cross section proved to have excellent wind stability, far exceeding design requirements.

According to Zoli, the gap between edge girder and deck proved to be extremely effective at enhancing aeroelastic behavior, both for flutter and for vortex shedding excitation. The section is also stable up to wind speeds exceeding 120 mph.

The pylons are W-shapes with both web and flanges tapered, and they bolt together at only two locations to minimize the number of field connections. The superstructure's floor beams and edge girders are comprised of W14 rolled sections and are proportioned to optimize seismic performance. Adina finite element structural software enhanced the HNTB team's seismic analysis and was supported by an in-house service software referred to as T187.

Reconnection

Beyond being the first cabled-stayed bridge crossing an Interstate in California, the bridge is also a symbol of reconnection in a day and age when major highways interrupt the flow of neighborhoods.

"Pedestrian bridges in urban areas serve to reconnect neighbors the Interstate system has divided," summarizes Zoli. "The premise that we don't build pedestrian bridges because they're too expensive isn't a solution for pedestrian safety. The engineering and construction industry should continue to develop elegant and inexpensive pedestrian bridges. It's up to us to ensure that the number of these types of opportunities continues to grow." MSC

John Litzinger is the office leader for HNTB Corporation in San Jose, Calif. His current focus is on rail and other transportation-related projects.

Owner/Client

California Department of Transportation/ City of Cupertino, Calif.

Designer

HNTB Corporation, San Jose, Calif. and New York

Steel Fabricator

Oregon Iron Works, Vancouver, Wash. (AISC/NSBA Member)

Steel Detailer

Tensor Engineering, Indian Harbor Beach, Fla. (AISC/NSBA Member)