Honolulu Rapid Transit Viaduct Phase 1 & 2

Category: Mass Transit/Rail Bridges

This $850M project is the first ten miles of concrete segmental elevated rapid transit guideway that connects West Oahu with downtown Honolulu and the Ala Moana Center via the Honolulu International Airport on Oahu, Hawaii. Honolulu Authority for Rapid Transportation (HART) developed the project to improve mobility, enhance reliability, and address the island's increasing congestion.

The guideway alignment consists of straight and curved sections with a minimum radius of 1,100′ for precast sections and 800′ for cast-in-place sections with a maximum vertical profile grade of 5.5%.

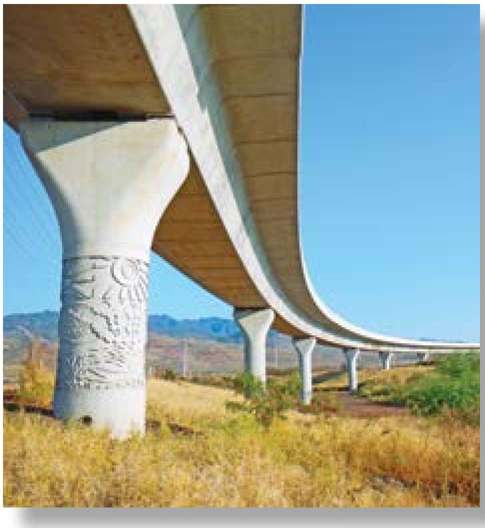
The superstructure is made of 5,238 precast and 129 cast-in-place trapezoidal segments that are 30′ wide with spans between 68′ and 151′ long. The top slab deck varies in thickness from 8″ to 15″. The length of precast segments (11′) maximizes the legal transporting limits on the roads, eliminating almost 10% of the precast segments that would have been required if typical 10′ lengths were used. The precast concrete spans are longitudinally post-tensioned typically using 3 or 4 external tendons that consist of twelve to twenty-seven 0.6″ diameter strands. The tendons are anchored in the expansion joint segments and all deviate in the span at about the third points of the span. The cast-in-place spans are longitudinally post-tensioned using internal tendons with twelve 0.6″ diameter strands. The top slab is transversely post-tensioned using tendons with two and four 0.6″ diameter strands.

Innovation of Design and/or Construction

To maximize safety and mobility while rapidly constructing the project, the majority of its 5,238 segments were precast while road widening and substructure construction were in progress. The barriers were cast with each segment form saving time. The precast segments were erected using the span-by-span method with underslung girders supported on temporary pier brackets that rest on the top of the columns and leap-frogged forward as the girders launched. The structural system used simple spans of matchcast segments that only required epoxy at the joints. The structure was designed to support a crane so that it could be taken off the ground and eliminate any traffic disruption. The segments were typically delivered on the ground at night and lifted by deck-mounted crane and placed onto the girders. Then, the external post-tensioning was installed and stressed, temporary girders launched to the next span, and the crane moved forward to begin the erection of the next span. Most spans took one to two days to complete. Inside the superstructure, the team applied an innovative solution to mitigate against stray current. Wire connections were used between the top slab's reinforcing bar and post-tensioning anchors that were grounded to the drilled shaft reinforcing bar. This allows any stray current in the deck to be safely conducted to the ground.

Rapid Construction and Cost Competitiveness

The project was accelerated with the use of precast segments – typically a precast concrete trapezoidal box girder section 30' wide and 7' 2" deep cast approximately five miles from the project site. The team of Kiewit and FIGG proposed the segments be 11 feet long to take advantage of the maximum legal transporting limits. This change reduced shipping and construction time. Kiewit used 6.5-ksi compressive strength concrete that allowed for quick stripping of the forms to accelerate fabrication. Cast off-site, they greatly reduced the duration of on-site construction, minimizing road user impacts. The erection method, repeated 5,238 times, benefited quality control. Spans were erected at maximum speeds of ten to twelve spans per week using three erection truss headings. The project has a total of 438 spans; 430 of which are precast. The remaining were cast-in-place.



The Team of Kiewit, HNTB and FIGG achieved the highest overall score for technical plus cost. The concrete segmental design and erection method used by Kiewit could be expected to greatly reduce road users' costs when compared to other structure types and means and methods. Additionally, concrete segmental guideway bridges are incredibly robust. This project's use of post-tensioning and high-quality concrete provide HART with a low-maintenance bridge with low life cycle costs.

Jury Comments

The use of precast segments allowed the project to take full advantage of the bridge's consistent girder cross-section and deliver a very long bridge in rapid fashion while minimally disrupting the traveling public. This is an aesthetically pleasing bridge which has become an integral compliment to the environment, considering its 10-mile length, and is an attractive bridge for light rail.

Aesthetics and/or Harmony with Environment

This project is in harmony with its cultural environment and the history of Oahu. The piers at each station location celebrate local culture with a visual representation of Hawaiian culture with artistic designs cast into the concrete. The segmental concrete structure provides a ribbon that undulates along the varied landscape between West Oahu and Honolulu International Airport in a uniform design.

Minimization of Construction Impact on the Traveling Public

Avoiding traffic impacts was very important on this project, as 7½ of its 10 miles of superstructure needed to be built over and along congested roadways and intersections.

Precasting the segments greatly reduced the amount and duration of work performed over and along roadways. Using precast concrete segments lifted from cranes positioned on top of the structure allowed the superstructure to be built from above without erection equipment in the roadway. To minimize the number of deliveries on the road, the team changed the length of the segments from ten feet to eleven feet. This eliminated almost ten percent of the segments that needed to be delivered. The Project Team's site-specific traffic management plans and strategies maximized mobility and enhanced safety for workers and road users. Thanks to segmental construction, they maintained the carrying capacity of the highway and kept roads fully open during peak hours keeping traffic moving.

Segmental concrete, both precast and cast-in-place, provided the best and most economical technical solution for building a 10-mile transit rail guideway through varied terrain and along and over active, congested roadways while keeping traffic moving.

CREDITS

Owner:
Honolulu Authority for Rapid Transit (HART)

Owner's Engineer: **CH2M**

Designer:
FIGG Bridge Engineers, Inc.

Design-Build Team:
Kiewit Infrastructure West Co./ HNTB Corporation/FIGG

Contractor:
Kiewit Infrastructure West Co.

Construction Engineering Services:
McNary Bergeron and Associates/ FIGG

Construction Engineering Inspection:
HNTB Corporation/FIGG

Precast Producer:
Kiewit Infrastructure West Co.

Formwork for Precast Segments:
EFCO Corp.

Post-Tensioning Materials:
Schwager Davis, Inc.

Bearings:
D.S. Brown Company

Photos Courtesy of FIGG