

HEAVY-DUTY RUNWAY ACCESS

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Cast-in-place concrete taxiway at Tampa International Airport creates smoother access for world's largest aircraft

Executives at the Tampa International Airport wanted to provide better access between runways for all types of airport vehicles. Those requirements meant creating a bridge that could accommodate airplanes including the Airbus A380, the largest (and heaviest)

passenger aircraft in the world. To meet the variety of goals, the design and construction team created a 227-ft 6-in.-long cast-in-place, post-tensioned concrete bridge. Constraints of time and geometry created a challenging design project.

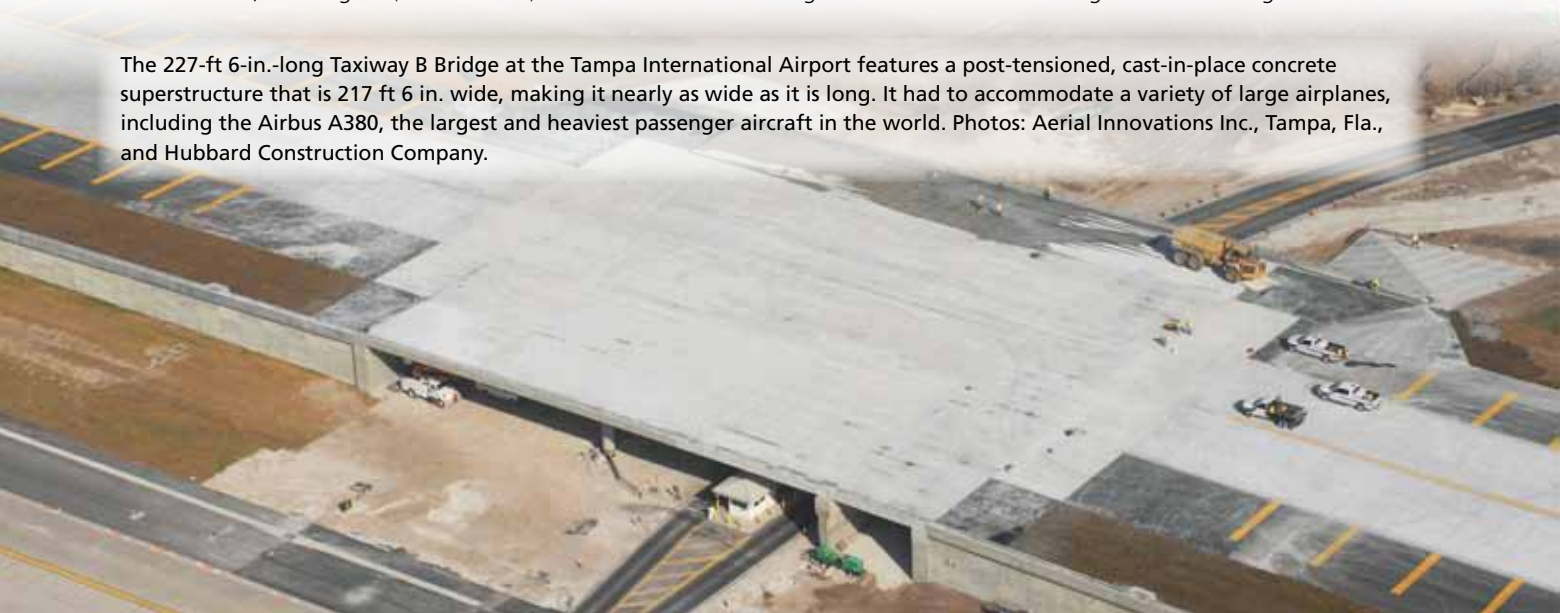
The Taxiway B Bridge, a fast-track design-build project, is part of a new \$950-million terminal complex partially funded by the American Recovery and Reinvestment Act. The bridge allows aircraft to move between the main north-south runways.

Spanning a new access way that includes vehicular traffic as well as a future light rail system and utility corridors, the bridge features three spans that are 97 ft 3 in., 94 ft 3 in., and 36 ft 0 in. in length. To ensure safe

movement of the world's largest aircraft, the bridge is nearly as wide as it is long, at 217 ft 6 in. for a single aircraft travel lane. To meet the low taxiway grade requirements as well as underlying roadway profile and vertical-clearance requirements, a shallow superstructure depth varying from 3 ft 3 in. to 5 ft 0 in. was necessary for the main spans.

The bridge was designed using the *AASHTO LRFD Bridge Design Specifications*, supplemented by the Florida Department of Transportation's *Structures Design Guidelines* and aircraft design loads specified by the Hillsborough County Aviation Authority. The structure was designed to carry the Boeing 747, Boeing 777, and the Airbus A380. In addition to the extreme vertical loads produced by these aircraft, the bridge was also designed to resist 70%

The 227-ft 6-in.-long Taxiway B Bridge at the Tampa International Airport features a post-tensioned, cast-in-place concrete superstructure that is 217 ft 6 in. wide, making it nearly as wide as it is long. It had to accommodate a variety of large airplanes, including the Airbus A380, the largest and heaviest passenger aircraft in the world. Photos: Aerial Innovations Inc., Tampa, Fla., and Hubbard Construction Company.



profile

TAMPA INTERNATIONAL AIRPORT TAXIWAY B BRIDGE/ TAMPA, FLORIDA

ENGINEER: FINLEY Engineering Group, Tallahassee, Fla.

PRIME CONTRACTOR: Hubbard Construction Co., Winter Park, Fla.

POST-TENSIONING SUPPLIER: VSL, Hanover, Md.

CONCRETE SUPPLIER: CEMEX, Largo, Fla.

The bridge was the first in Florida to use 31-strand tendons. The total longitudinal stressing force is more than 80,000 kips.

of the vertical load applied longitudinally as a braking force, as well as a 30% vertical impact factor on all live loads.

31-Strand Tendons Used

The cast-in-place concrete voided superstructure for Spans 1 and 2 consists of 25 evenly spaced webs, a 14-in.-thick, transversely post-tensioned top slab, and an 8-in.-thick bottom slab. The bottom slab contains seven 0.6-in.-diameter strand tendons located between each 20-in.-thick web. Each web contains two, thirty-one 0.6-in.-diameter strand tendons. The taxiway bridge was the first in the State of Florida to use the 31-strand tendons. The total longitudinal stressing force in the bridge is more than 80,000 kips.

Pier 2 is integrally connected to the superstructure, and consists of 48-in.-diameter columns, supported by 48-in.-diameter drilled shafts. Pier 3, which has pinned connections to the superstructure, was designed as a continuous 3-ft-wide wall also supported by drilled shafts. The rigid wall allows the longitudinal forces to be distributed to all of the drilled shafts, minimizing the number of shafts required.

The third span, supported by walls at Pier 3 and Abutment 4, was designed to serve as the corridor for a future light-rail track. With a required minimum vertical clearance of 17 ft, the maximum allowable superstructure depth was only 2 ft 6 in. Although the span is only 36 ft, this presented several challenges due to the magnitude of the aircraft design loads. It was decided to integrally connect the superstructure to the abutment. The fixed connection reduced the bending moments in the

superstructure, allowing a shallow section to be created that did not require post-tensioning. This created significant cost savings for the general contractor.

Innovative Modeling Techniques

The bridge was a fast-track design-build project from the start. There was less than 3 weeks to prepare the prebid conceptual design. Although the owner provided a preliminary design concept, the designer produced optimized substructure and superstructure designs, estimated quantities, and proposed alternative construction techniques that allowed the contractor to be more competitive with its bid.

To speed this process and ensure the structure could support the required loads, multiple design models were used to accurately reflect the behavior and distribution of loads, as well as to achieve concurrence between models. RM-Bridge and LUSAS 3D were used for the longitudinal and transverse analysis and design of the superstructure.

The results of the two models were superimposed to determine the maximum stresses at all locations during all phases of construction. This 3-D, finite-element modeling, combined with an independent check analysis, allowed the design to be fast-tracked while providing the design-build team with the confidence to proceed with foundation installation while superstructure details were finalized.

In addition to their use in designing the superstructure, these models helped determine the distribution of loads to the substructure. Due to the



The bridge's bottom slab contains seven 0.6-in.-diameter strand tendons located between each 20-in.-thick web. Each web contains two, thirty-one 0.6-in.-diameter strand tendons. It is the first bridge in Florida to use 31-strand tendons.

large longitudinal loads, the abutments and piers were connected to the post-tensioned superstructure, providing the most efficient use of the entire bridge substructure. This produced a better distribution of loads to the columns and drilled shafts. Maximizing the use of the entire structure created significant cost savings, as it reduced the size and number of drilled shafts and columns.

Models Provide Fast Start

This extensive modeling and early calculations allowed the design-build team to get a running start once its proposal was accepted. To meet the aggressive construction schedule, final substructure design plans were submitted to the owner within 4 weeks. The contractor began drilled-shaft installation a few weeks later, before the final superstructure design was submitted. The final superstructure design plans were submitted less than 4 weeks after the substructure plans. This rapid process allowed the contractor to fast-track construction and complete construction slightly more than 1 year after it commenced.

227-FT-LONG, THREE-SPAN, CAST-IN-PLACE CONCRETE VOIDED SUPERSTRUCTURE BRIDGE / TAMPA INTERNATIONAL AIRPORT, OWNER

REINFORCEMENT SUPPLIER: Gerdau Ameristeel, Plant City, Fla.

BRIDGE DESCRIPTION: Three-span (97 ft 3 in., 94 ft 3 in., and 36 ft 0 in.) cast-in-place concrete bridge with a superstructure depth varying between 3 ft 3 in. and 5 ft 0 in. and a width of 217 ft 6 in.

BRIDGE CONSTRUCTION COST: \$34 million



The main pier, integrally connected to the superstructure, consists of 48-in.-diameter columns, supported by 48-in.-diameter drilled shafts.

The bridge was designed to be constructed in three phases, with two construction joints running longitudinally down the bridge. The center phase was constructed first, followed by the two adjacent phases.

The post-tensioning forces required to support the live load presented several challenges to the phased-construction method. First, the interface shear between the three faces would be extremely large if all of the post-tensioning tendons in a phase were stressed at once. Additionally, each phase was built on falsework, which then was re-used to construct the next phase.

Since the outer phases were cast directly against the middle phase, the differential deflection due to post-tensioning stressing had to be evaluated to prevent cracking and to ensure the target finish-grade elevations could be achieved. These challenges were addressed by designing the bridge to be self-supporting with only half of the tendons stressed in each phase. After construction of the individual phases was complete, all falsework was removed, and the remaining tendons were stressed.

Why Cast-In-Place Concrete?

Cast-in-place concrete was selected for several reasons. The required minimum vertical clearance was 17 ft, which

combined with a shallow roadway profile to limit the superstructure depth. Deflection also had to be minimized, creating a separate challenge because of the cross-sectional requirements. The maximum anticipated deflection of the final design is only 1 ¼ in. under full aircraft loading.

In addition to the design benefits, there were several construction benefits to specifying cast-in-place concrete. It eliminated the lead time required for prefabricated elements which minimized delays before construction could begin. The contractor also was able to construct the bridge on shoring, eliminating the need for cranes to lift the superstructure components. This was especially important given the location of the project, the volume of air traffic, and height restrictions for construction equipment.

This post-tensioned, cast-in-place

The taxiway bridge will eliminate the grade crossing of the existing taxiway and road.



The contractor constructed the bridge on shoring, eliminating the need for cranes to lift the superstructure components. The falsework was reused on each phase as the preceding phase was completed.

The shallow superstructure depth varies from 3 ft 3 in. to 5 ft 0 in.

concrete bridge will serve the Tampa airport for several decades to come. The fast-track, design-build approach resulted in a successful, functional, and aesthetically pleasing bridge that was completed within the required schedule.

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