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On the Move

Global Transportation: The North America Issue

Delaware's new Indian River Inlet cable-stayed bridge

The new Indian River Inlet Bridge in the Delaware Seashore State Park in Rehoboth Beach, Delaware, is one of the most technologically advanced, visually striking bridges to be constructed in the United States during the new millennium. Scheduled to open to traffic in late 2011, this signature, long-span, cable-stay bridge is an engineering wonder that represents a number of important features designed for long-term durability, structural integrity, sustainability and aesthetic quality.

To realize the vision of developing such a structure, the Delaware Department of Transportation (DelDOT) engaged a design-build team led by Skanska, including AECOM as the lead designer. Working collaboratively, AECOM and Skanska continue a long-standing and successful relationship that dates back to post World War II. As lead designer, AECOM is performing 70 percent of the design work including cable-stay bridge design; cable stay erection and construction engineering; coastal engineering; roadway design; environmental permitting; foundation design; and sand bypass (mechanical) design. AECOM is being supported by some of the industry's leaders in geotechnical and wind engineering. The result is a highly functional bridge that has resolved the challenges associated with building a long-span bridge across a large saltwater tidal inlet that experiences high winds and harsh climatic conditions.

To replace the existing bridge, which was severely damaged by tidal erosion and exposure to salt water and harsh winters, the design team developed a solution that avoids placement of foundations in the corrosive seawater and that compensates for high winds. The team employed the most advanced technologies in bridge design as well as construction materials. The new bridge, in addition to being aesthetically appealing and providing panoramic views from the bridge, was designed for long-term durability, maintainability and operability.

The resulting US$150-million, 2,600-foot-long structure compensates for the harsh maritime environment of the mid-Atlantic coast, is constructed on four independent pylons placed on land, supporting a 950-foot main span over the inlet, two 400-foot side spans, and overland approach structures. The bridge has two 240-foot towers on each side, built on 36-inch precast square piles driven to 1,800-ton capacity. Its superstructure incorporates an impressive 106.2-foot-wide, 6-foot-deep concrete deck, providing four traffic lanes, two shoulders, and a sidewalk and bike path. Its 76 cable stays involve 28 tons of steel with 36 strands of carbon steel per stay and 22,700 miles of strands, all placed to work perfectly with the bridge's foundations and superstructure for maximum structural stability.

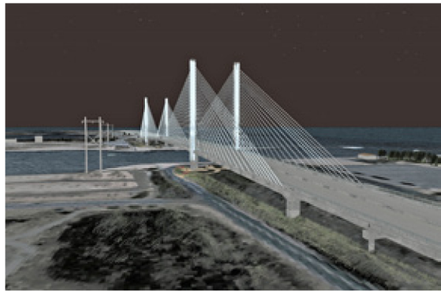
With the bridge exposed directly to the Atlantic Ocean on the east side, this project is a perfect example of the state-of-the-art wind engineering design of a long-span bridge. The minimum design wind for the completed permanent structure is based on the site-specific wind profile corresponding with the 100-year return period.
The design prevents any structural instability, such as buckling or brittle failure. Its extreme event limit state load combination allows wind loads with a 2,000-year return period. Moreover, the bridge is designed not to have any aerodynamic instability, whether from flutter or torsional divergence. It will withstand winds of 140 miles per hour and accommodates a wind event probability with a return period of 10,000 years.

Overall, the design includes a number of innovative features: maximum wind resistance; high load capacity of the cast-in-place and pre-cast concrete components; edge girder transitions that keep the cable stays in plane with the pylons for maximum structural stability; and single mast pylons with no cross struts above or below the deck that contribute to the aesthetic quality as well as constructability and maintainability of the bridge.

In addition, the bridge's functional improvements are a radical departure from its predecessor. First, it markedly improves traffic safety and flow, providing two 12-foot travel lanes, a 10-foot outside shoulder, a four-foot inside shoulder in each direction and a 12-foot-wide sidewalk and bike path on the ocean side of the bridge. Low embankment heights leading onto the bridge provide a panoramic view of the inlet and the surrounding landscape. With its supports out of the water, the bridge's design solves most of the problems associated with the harsh environment of the inlet.

Most of these functional improvements add up to long-term cost savings on a bridge expected to last over 100 years. "Our vision was to create a structure that complements the coastal landscape and is both highly functional and extremely durable," said Ken Butler, AECOM's Chief Bridge Engineer in North America and the Design Team Manager, "the new bridge has exceeded our expectations on every level."

— **Ken Butler**
AECOM Vice President,
U.S. National Bridge
Services Director



Top: The 240-ft tall pylons were built in 18-ft lifts with traveling forms on rails. AECOM's site representative Edwin Salcedo is reviewing pylon details with Skanska's superintendent.

Above: A rendering of the Indian River Inlet Bridge in the Delaware Seashore State Park in Rehoboth Beach, Delaware, United States.