Research Drives Designs in

Louisiana

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The 18-mile-long bridge being built on the LA 1 Highway near Leeville, La., will be one of the longest bridges in the Americas when completed. It spans a sensitive wetlands area that has been subjected to coastal erosion and ground subsidence.

The new bridge on the LA 1 Highway is being constructed from the top down to minimize impact on the coastal wetlands areas over which the bridge is being constructed.

The Louisiana Department of Transportation and Development (LADOTD) has built its bridges predominantly with cast-in-place and precast concrete for decades, especially for short- and medium-span designs. That decision has been driven both by environmental conditions that require high durability and by long-running studies that have made the state a leader in techniques and research involving high-performance concrete (HPC).

The state has unique conditions that create challenges, including a large number of waterways and hurricane issues (storm surge, wave forces, and high winds). The state's bread-and-butter design consists of precast, prestressed concrete girders and cast-in-place concrete decks for short- to medium-span length structures.

The bridges north of I-10, which account for about 80% of the state's bridge area, are similar to concrete structures designed in other states. However, there are a host of extremely long bridges along and south of I-10. Although the state ranks 21st in total number of bridges, it ranks fourth in total bridge area, indicating the large length of many of its bridges. The region south of I-10 features many navigational crossings and a tremendous number of waterways. For this reason, Louisiana has a large number of movable bridges. In all, the annual budget for fixed- and movable-bridge replacements is about $140 million.

An example of the extraordinarily long projects that arise is the replacement work underway on an 18-mile-long bridge on the LA 1 highway near Leeville, La. Currently 9 miles are under construction and 9 miles are

Nine miles of the LA 1 Highway Bridge are currently being constructed, while an additional 9 miles are being planned and designed. Here a precast concrete pile bent cap is being moved into position for installation.

under planning and design. The project spans a sensitive wetlands area that has been subjected to coastal erosion and ground subsidence, resulting in the existing highway literally sinking.

When complete, the structure will be one of the longest bridges in the Americas, nearly as long as the Pontchartrain Causeway north of New Orleans. That precast concrete structure is generally regarded as the world's longest bridge at 23.87 miles. The LA 1 project will be built in phases as funding permits, with the most critical sections built first.

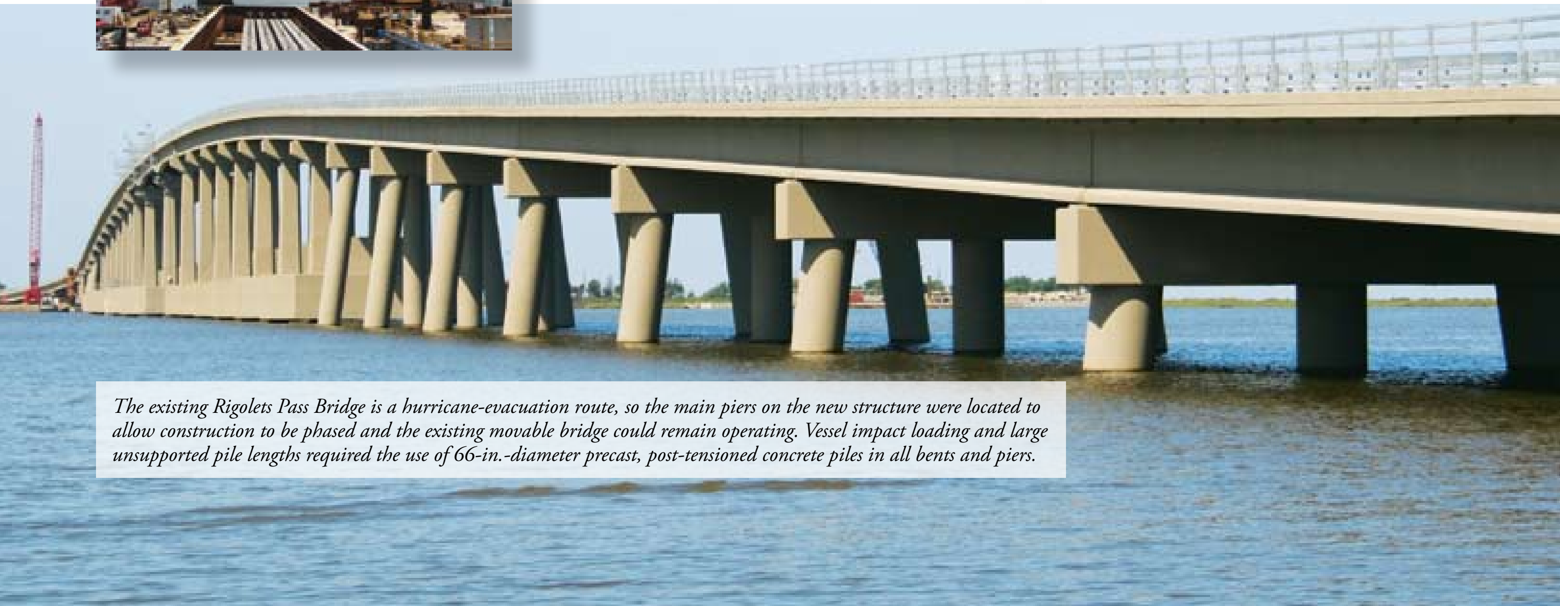
Concrete Replaces Steel

A majority of projects, as in other states, are replacement bridges and upgrades to existing structures, including a variety of widening projects. In some cases, an existing steel bridge is replaced with a more durable and efficient concrete design. That was the case with the Rigolets Pass Bridge recently completed near Slidell, La. The $50-million bridge replaced an existing main steel truss swing span with a high-level spliced girder concrete bridge that provided 65 ft of vertical and 200 ft of horizontal clearance for marine traffic.

The pass itself created an unusual challenge for design and construction. It is one of two main passages between Lake Pontchartrain and the Gulf of Mexico, with the main tidal flow through this narrow channel and one at Chef Menteur Pass. To meet the requirements of unsupported pile length and vessel-impact loadings, 66-in.-diameter precast, post-tensioned concrete cylinder piles were used in all bents and piers located within the channel.

Precast concrete forms were used to support the low-clearance slab span construction. This eliminated the need for falsework during construction. For other approach spans, both

The $50-million Rigolets Pass Bridge replaced a steel-truss swing-span structure with a high-level spliced girder concrete bridge that provided 65 ft of vertical and 200 ft of horizontal clearance for marine traffic.



The existing Rigolets Pass Bridge is a hurricane-evacuation route, so the main piers on the new structure were located to allow construction to be phased and the existing movable bridge could remain operating. Vessel impact loading and large unsupported pile lengths required the use of 66-in.-diameter precast, post-tensioned concrete piles in all bents and piers.

The I-10 Twin Spans as they approach the main channel. The goals for these replacement structures include better storm protection, safe accommodation of six traffic lanes, enhanced barge collision resistance, and utilization of well-known materials and techniques to provide for low maintenance and long service life.

AASHTO Type II and 78-in.-deep bulb-tee precast, prestressed concrete girders were used with stay-in-place steel forms to support the cast-in-place concrete deck. The typical bulb-tee girder spans were designed with optimum span lengths of 131 ft and girder spacing of 9.4 ft with concrete compressive strengths of 6000 psi at strand release and 7500 psi final. The main spans consist of a three-span continuous unit (with individual spans of 201 ft, 254 ft, and 201 ft) of spliced, post-tensioned, precast, prestressed concrete girders.

A precast concrete bent cap being set on precast concrete piles for the I-10 Twin Spans Bridges over Lake Pontchartrain.

Concrete Designs Vary

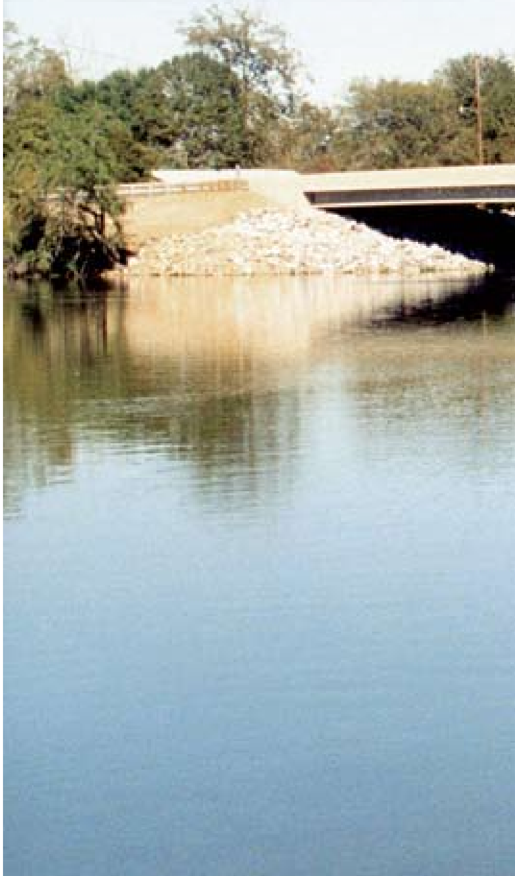
Designers use a combination of cast-in-place and precast concrete depending on the specific circumstances and the capabilities that each provide. Precast concrete provides efficient, fast construction while cast-in-place concrete provides added sturdiness and flexibility. Precast concrete panels require added attention to handle crossloads and camber, but those can be worked out to make the components quite efficient.

A recent example of concrete and steel construction is the $803-million I-10 Twin Spans structure crossing Lake Pontchartrain between Slidell and New Orleans. The crossing is approximately 5.5 miles long, with a total length of 11 miles of bridges on an offset alignment. The main channel provides 73 ft of vertical clearance and 200 ft of horizontal clearance, with the bridges offering three lanes in each direction and serving as one of the main evacuation routes for New Orleans.

In consideration of their location, size, and functional requirements, the bridges were designed to take advantage of precast concrete components for the bulk of the construction. The precast concrete elements include 36-in.-square precast, prestressed concrete piles, with 4-ft-deep by 5.5-ft-wide by 59.25-ft-long precast concrete bent caps and 135-ft-long, 78-in.-deep Florida bulb-tee girders. Stay-in-place precast concrete slabs were used to form the footings.

High-Performance Concrete Research Projects

One of the key reasons that Louisiana has turned to concrete for so many bridge designs comes from its long-standing research work in the field. Since the 1980s, LADOTD has



worked with the Louisiana Transportation Research Center (LTRC) in Baton Rouge and the Department of Civil Engineering at Tulane University in New Orleans, under the direction of Dr. Robert N. Bruce Jr., to evaluate HPC and create standards that can be used nationwide.

This work began in the 1970s, when the West Bank Expressway in New Orleans incorporated a HPC mixture with concrete compressive strength of about 6500 psi. That created interest in improving strength and durability capabilities, which led to a formal program that experimented with various methods, including variations with fly ash and silica fume. A variety of studies followed, such as examinations of fatigue endurance, curing temperatures, and concrete compressive strengths as high as 10,000 psi in combination with 0.6-in.-diameter prestressing strands.

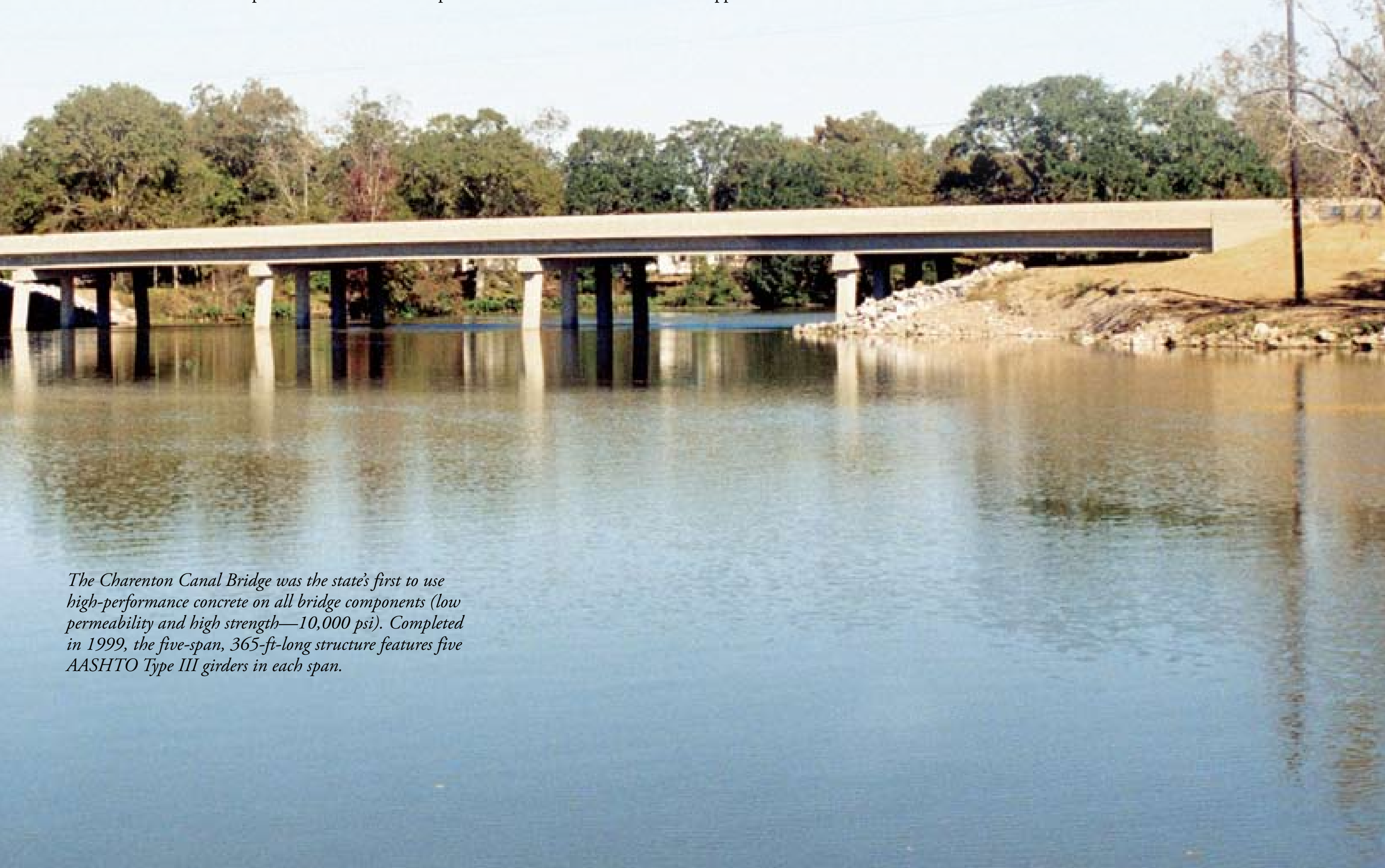
The continuing research led in 1999 to the opening of Louisiana's first bridge built with HPC, the Charenton Canal Bridge on LA 87 in St. Mary Parish. The project replaced a 55-year-old reinforced concrete bridge with a five-span, 365-ft-long continuous prestressed concrete structure using five Type III AASHTO girders. The girders on the 73-ft-long spans were spaced at 10-ft centers supporting an 8-in. cast-in-place concrete deck. The substructure of the bridge consisted of cast-in-place concrete bent caps supported on 24-in.- and 30-in.-square precast, prestressed concrete piles.

Specified concrete compressive strengths were 10,000 psi for the girders and piles and 4200 psi for the bridge deck and bent caps. All members had a chloride permeability of less than 2000 coulombs for durability. The use of HPC allowed the bridge to be designed with one fewer lines of girders than would have been required with normal strength concrete. The added pile strength also increased their ability to resist compressive- and tensile-driving stresses and allowed them to be cast to longer lengths. A 75-year to 100-year design life is expected compared to the 50-year limit that was more traditional at the time.

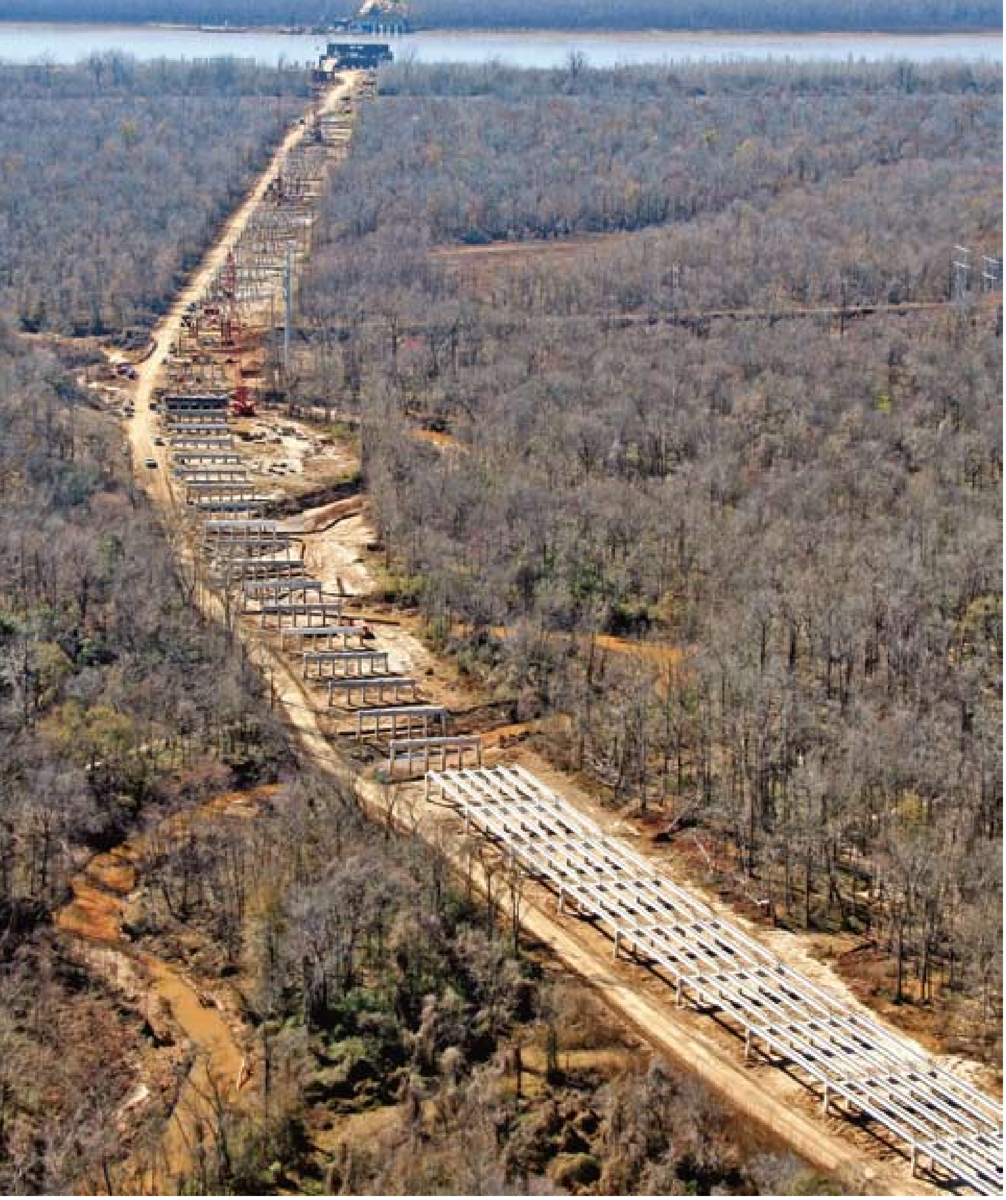
New Crossings Created

New crossings, although rare, continue to emerge. An example, which also shows how designs continue to improve, is the John James Audubon Bridge crossing the Mississippi River between Pointe Coupee and West Feliciana parishes in south central Louisiana. The project, to be completed in late 2010, will be the longest cable-stayed bridge in North America and replaces a ferry service. It will be the only structure across the Mississippi River between Natchez, Miss., and Baton Rouge, La. This will be the 10th bridge in Louisiana to cross the Mississippi River.

Twenty-four-inch- and 30-in.-square piles were cast with high-strength concrete permitting longer individual lengths.



The Charenton Canal Bridge was the state's first to use high-performance concrete on all bridge components (low permeability and high strength—10,000 psi). Completed in 1999, the five-span, 365-ft-long structure features five AASHTO Type III girders in each span.



The 2.44-mile-long John James Audubon Bridge crossing the Mississippi River, to be completed in late 2010, will be the longest cable-stayed bridge in North America. In addition to the precast concrete structure, the project involves seven other bridges featuring Type III AASHTO precast, prestressed concrete girders and 72-in.-deep bulb-tee girders with cast-in-place decks.

The project consists of approximately 12 miles of roadway with seven bridges in addition to the 2.44-mile-long main bridge. A key element unique to this design is the construction of the coffer-boxes used to create the tower foundations for the main cable-stayed spans. Instead of the traditional approach, in which cofferdams are driven into the river, the coffer-boxes are being constructed on top of the drilled shafts and then lowered into place prior to final concrete placement.

The coffer-boxes measure 160 ft long and 64 ft wide, weighing about 500 tons. The contractor used precast concrete side and bottom panels to form the coffer boxes. The panels will remain in place with the permanent concrete piers. The concrete main towers for the cable-stay span will be 500 ft tall to support the record 1583-ft-long main span.

The project's seven other conventional bridges and most of the approaches to the main span use AASHTO Type III precast, prestressed concrete girders typically about 70 ft to 75 ft long. Precast, prestressed concrete, 72-in.-deep bulb-tee girders are also used for the longer 140-ft spans.

Prestressed girders are made continuous using a new positive-moment continuity detail, which is being evaluated on a skewed span with instrumentation for a research project with the Department of Civil and Environmental Engineering at Louisiana State University. The program will test the value of positive-moment continuity, which is not used frequently. The bridge was designed and constructed as part of Louisiana's TIMED (Transportation Infrastructure Model for Economic Development) Program.

The monitoring work being performed on the bridge is not unique in the state. A number of current or under-design structures include monitoring and evaluation programs to aid in better understanding concrete applications. For instance, the Rigolets Pass Bridge features two 131-ft-long spans with HPC with a 56-day concrete compressive strength of 10,000 psi and release strength of 6800 psi to aid with LTRC studies. Girder spacing in these spans is 12.6 ft. Four of these girders were monitored from time of fabrication until the bridge was in service to evaluate their performance.

Tests also were performed on the I-10 Twin Spans to test lateral resistance. The footings were subjected to 2000 kips of lateral loading to simulate a ship collision and evaluate response. This is the first time such footing studies have been conducted in a full-scale test, which will allow designers to validate requirements for future designs. All of the precast concrete piles feature moment connections and studies will determine how they behave, while all columns, girders, and diaphragms are being continually monitored. In addition, corrosion meters in the footings and all spans will validate the ability of the HPC to protect the reinforcement.

New techniques continue to be tried, as well. The Caminada Bay Bridge Replacement on LA 1 in Grande Isle is the first bridge in the state to incorporate stainless steel reinforcement in the precast concrete components. It is being used in the substructure areas and spans in the transition area near water elevations, to provide additional protection against the marine environment.

Such efforts will continue as Louisiana studies alternatives and examines new concrete techniques to meet on-going challenges. The combination of new programs, Katrina-repair funding, the TIMED program, and funding from the American Recovery and Reinvestment Act of 2009, have created the largest amount of bridge construction in Louisiana's history. The goal is to use those programs to better serve citizens today and for the next 100 years, while incorporating monitoring equipment and research programs that will improve on today's designs to create even more efficient structures.

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For more information on Louisiana bridges, visit www.dotd.louisiana.gov