Depending on its mood, Louisiana’s Lake Pontchartrain can look like the North Sea, storm-tossed and volatile, or like an oasis of perfect-sunset tranquility. When you get out on it, you can see the curvature of the earth and nothing else, save a whole lot of water. (You can see pelicans, too, if you’re lucky.)

Lake Pontchartrain, about half the size of Rhode Island, is actually not a lake but a massive (630 sq mi) estuary that feeds into the Gulf of Mexico. For hundreds of years it has served as a hard boundary at the northern edge of New Orleans. In the 20th century, as New Orleans grew, small bridges were built over the lake’s narrow eastern edge. But it took innovations in concrete and construction methods to produce a bridge that would cut straight through the heart of the lake, which is nearly 24 mi north to south.

Opened in 1956, the original span of the Lake Pontchartrain Causeway runs 23.86 mi, gliding in most places just 16 ft above the surface of the water. At the time it was the longest bridge over water in the world, but in 1969 its sister, at 23.87 mi, took the title. The causeway was the first to utilize prestressed concrete and prefabricated modular components on a large scale. In 2013 it was formally recognized in ASCE’s Historic Civil Engineering Landmark Program.

Long before he became the general manager of the Greater New Orleans Expressway Commission, the agency that operates the causeway, Carlton Dufrechou studied engineering at Tulane University. One of his professors was Walter E. Blessey, P.E., L.S., M.ASCE, then head of Tulane’s civil engineering school and about to become ASCE’s president. “Little did I realize as a 21-year-old that this guy taking us on field trips to the prestressed factory on the north shore of Lake Pontchartrain was one of the original designers of the bridge,” says Dufrechou. Robert Bruce, Ph.D., now an emeritus professor of engineering at Tulane, conducted design calculations on the bridge. (A great deal of the research work on prestressed concrete was carried out at Tulane.)

In the 1930s and 1940s, Dufrechou explains, local businessmen and elected officials considered building a chain of islands in the lake with dredged material, like miniature Florida Keys. If the land could be developed, that would cover the cost of linking the islands to New Orleans with a bridge. Gradually, though, officials turned toward finding the quickest and smartest way to cross the lake. In 1954 the state created the Greater New Orleans Expressway Commission to construct, operate, and maintain a causeway.

The original causeway was built by the Louisiana Bridge Company, a consortium of three contractors: New York–based Raymond Concrete Pile Company, one of the country’s leading concrete contractors; Brown & Root, of Houston; and T.L. James, of Ruston, Louisiana.

Many prominent figures put their stamp on the bridge, including Blessey, who led a good portion of the research efforts at Tulane; Henry Lemieux, a district manager for Raymond Concrete Pile; and Wayne Palmer, the principal engineer for Palmer & Baker, the engineering firm that designed the original bridge. (Blessey worked with Palmer & Baker.)

But the most significant innovations on the bridge were led by Raymond Concrete Pile’s chairman at the time, Maxwell Upson, Ph.D., whom Bruce
worked for. A leader in the development of pile construction, Upson had been interested in the idea of prestressed concrete as early as 1937, when “he visited France to confer with Eugène Freyssinet, one of the early pioneers in prestressed concrete,” explained Bruce in an email.

(Years later at a dinner at the restaurant Brennan’s, in New Orleans’s French Quarter, Upson sketched on a napkin the basic design for the causeway: two piles, a pile cap, and a precast, prestressed slab. Bruce, who was at the dinner, stated, “You can bet that I wish that I had saved that napkin!”)

In a 1953 article in Civil Engineering, Upson wrote about the dream of “a homogeneous concrete with real tensile strength.” He noted that shrinkage of long members of concrete during setting may “place the steel under a compression amounting to well over 12,000 psi. Since this compression in the steel must be removed before its normal tension function can become effective, it is natural that the concrete, with its low elasticity, will not only lose its tensile strength but also develop cracks. If later overloading occurs, these cracks naturally become serious and result in steel oxidation and concrete disruption.”

The answer, of course, was prestressed concrete. Years of research led Upson to two key conclusions: for prestressed concrete to work well there would have to be “adequate bonding between steel and concrete,” he wrote in that 1953 article, and the concrete itself would have to be highly compressed.

To meet the first requirement, Raymond Concrete Pile developed a cable system that enclosed a group of wires in an “even and uniform position so that all surfaces are exposed to the grout,” Upson explained. The second requirement was met by a new concrete creation process dubbed cenviro. “Cenviro” was a portmanteau of three words that described how the concrete was formed: “centrifugal,” “violence,” and “rollers.” A History Channel documentary on the bridge noted that a centrifuge spun concrete to the outside wall of a cylindrical piling form, the concrete was compacted using heavy (violent) vibration, and then rollers pressed the concrete hard against the outside form. The piles were fabricated in 16 ft sections that were tied together using high-strength steel wire threaded through longitudinal holes in the pile walls.

As Miles Bingham, P.E., M.ASCE, wrote in a 2013 article in Louisiana Civil Engineer, published by ASCE’s Louisiana Section, “Prior to this bridge, the standard practice was to use solid square or circular concrete piles with dimensions equal to or less than 24 in.” The hollow piles Upson developed were 54 in. in diameter. This type of prestressed concrete would prove invaluable to bridge construction, especially as the interstate highway system was getting under way in the mid-1950s.

No one had ever attempted a project with these techniques on such a large scale. Even Gustav Mangel, a world expert on prestressed concrete who taught in Belgium at Universiteit Gent (Ghent University), apparently urged his American colleagues to not deploy prestressed concrete on such a large project. The warning, Bingham wrote, “would have swayed most engineers to abandon their pursuit. To their credit, Mr. Blessey, Mr. Lemieux, and Dr. Upson forged ahead.”

But prestressed concrete was not the only breakthrough the causeway achieved. The other major innovation was the method of construction. Up to that point large bridges usually featured a cast-in-place deck with concrete piles 24 in. square in cross section. But Upson and company created a process akin to an assembly line to mass-produce bridge components that the American industrialist Henry Ford, the founder of the Ford Motor Company, would have admired.

The Louisiana Bridge Company built a $6-million assembly plant on 40 acres of land on the northern shore of Lake Pontchartrain that employed 750 people to construct the causeway. The piles, caps, and decks were all manufactured there. A canal 1,200 ft long,

THE CAUSEWAY was the first to utilize prestressed concrete and prefabricated modular components on a large scale.
15 ft wide, and 12 ft deep was dredged so that barges could systematically transport the components to the lake.

According to a 2011 Historic American Engineering Record report written by the historian Kelly Sellers Wittie, “Plant workers manufactured pilings on the east side of the plant and constructed spans on the western portion. Concrete mixing machines and spouts separated the two.”

The pile sections were joined together to form piles of approximately 90 ft. Driving piles in Louisiana soils requires that the pile be driven deep until sufficient resistance, or skin friction, is developed in the sediments to support the load. “A pile is repeatedly struck, driving it into the ground,” Bingham wrote. Tensile stresses created by driving the pile in can damage an unstressed pile. “In contrast, prestressing introduces compression into the pile section, which resists tensile cracking,” allowing the piles to be driven deeper. Furthermore, the 54 in. diameter piles had a larger area from which to create stabilizing friction, and the hollowness meant that the piles were relatively light and easy to handle.

The rest was like building with a giant Erector Set. Once the piles were in place, the pile caps, each with wire basket inserts to fit inside the piles, were placed atop the piles. “The caps were then shimmed to assure the proper elevation and grouted into place,” Bingham wrote.

Bingham also describes the placement of the decks in his *Louisiana Civil Engineer* article: “Finally, the precast decks were set on top of the bents. Steel bolts anchored in the bent caps were threaded through slotted holes in steel angles affixed to the side of the outside girders on each slab. These bolts helped position the slabs properly while also providing some resistance to uplift and lateral movement.”

The 1956 bridge used a total of 2,243 precast panels, each 33 ft wide and 56 ft long. (The roadway itself is 28 ft wide.) From the time the first pile went into the lake, the entire bridge was built in a mere 14 months. The process was so radically efficient that bridge construction concluded four months ahead of schedule.

On August 30, 1956, the two-lane Lake Pontchartrain Causeway finally opened. Bruce wrote that George Ferris, the president of Raymond Concrete Pile, asked him to entertain guests on opening day, including the editors of *Civil Engineering* (Walter E. Jessup) and *Engineering News-Record*. Bruce rented a Cadillac convertible and planned to drive Upson and the editors across the causeway, part of a procession to celebrate the opening. Two photographers were perched on the trunk, their legs in the back seat.

Bruce’s convertible, top down, was the first car in the left lane; the Cadillac limo carrying Mayor Chep Morrison was the first vehicle in the right lane. The idea was that Morrison would
be the first to cross the bridge. “About halfway across, Mr. Upson decided that our car should be the first to cross the bridge,” Bruce wrote, “resulting in the convertible being driven at high speed, with the two photographers clinging to the trunk. At the reception following the arrival of the motorcade, the passengers in the mayor’s car were not overjoyed with us.”

For years after, the bridge was a tourist attraction. Dufrechou recalls visiting when he was a kid with his father, an architect who appreciated the structure’s clean lines. “Literally, it was like a wonder of the world,” he recalls. It also caused communities to the north of the lake to boom. “The magnitude of it was phenomenal.”

The bridge was built at a cost of $31 million. The traffic count for the first year was 200,000. It wasn’t long, however, before the annual figure rose to 1 million. By the mid-1960s, more than 2 million cars were driving on this one thin bridge each year. So the expressway commission decided to build a second one.

The new span was designed by David Volkert & Associates. Work on that bridge began in the summer of 1967 using the same prefabricated construction strategy. This bridge cost less than the original, coming in at just under $30 million. The only real difference was that the length of the decks was extended from 56 ft to 84 ft. The second bridge also used slightly thicker concrete piles (5 in. walls).

Because of greater experience with prestressed concrete, the second bridge has less of a camber than the original, and coupled with its longer deck spans, it offers a noticeably smoother ride.

The bridges have aged well. Since the mid-1980s about 3,000 piles have been encapsulated with epoxy-filled jackets to combat spalling. The causeway is on a five-year inspection cycle, so 20 percent of the piles and bridge decks are inspected every year. Each pile, pile cap, and deck section has a log much like that of an airplane or ship. Structurally, the bridge, Dufrechou says, “is not going anywhere. It’s robust and maintenance has been continual.”

**Wide and hollow prestressed columns 90 ft long were used to anchor the causeway in the sandy sediment beneath the lake.**

What has been a continuing challenge through the years, though, is safety. Barges hit the causeway 15 times between 1960 and 1990. The original designers even placed “spare parts” on piers adjacent to the bridge in case an accident damaged the causeway. A radar system installed on the bridges during the 1990s now detects off-course vessels so that they can be alerted to prevent collisions.

The barrier railings of the 1956 bridge, at 25 in. (not counting aluminum rails on top, which were not designed for impact), are low for today’s pickups and SUVs, with their high centers of gravity. Since the mid-1990s, 16 vehicles have driven off the bridge, 15 of them on the southbound bridge, which is the original.

The commission is planning two major projects to improve safety. With help from the Texas A&M Transportation Institute, new, 46 in. railings have been designed for retrofitting to the original bridge.

The other project will address the lack of shoulders on the bridges. Even with seven crossovers (each 84 by 84 ft), one every 4 mi, which join the bridges and allow emergency personnel to more easily respond to problems, there are frequent accidents. Last year there were 200 crashes. Many are caused by cars rear-ending those that have broken down but cannot be removed. On average, causeway police respond to at least 300 breakdowns each month. So the commission is planning to build a series of outboard segmented shoulders that would more than double the emergency stopping areas.

All told, overhauling the bridge railings and adding segmented shoulders is expected to cost $100 million. The commission sent out requests for qualifications to designers in early April, and it plans to invite five firms to compete for the work. Dufrechou is looking for innovative ideas. “Like the original bridge, we want to do it fast and efficiently.” A firm will be chosen in the fall, and construction should begin next year.

Although some 12 million vehicles per year traverse the bridges, the commission anticipates that population and traffic counts will stabilize over the coming years, so no third bridge is planned. Even so, the causeway’s legacy is secure. It has inspired numerous interstate highway bridges in the region, including structures over Mobile Bay, Pensacola Bay, Bay St. Louis, and Lake Charles and near Lafayette and Baton Rouge. “It was one of the most successful designs in the history of bridge construction on the Gulf Coast, and it’s still the longest [continuous] bridge over water in the world,” Dufrechou says. —T.R. Witcher

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