PILE RESTORATION OF THE LAKE PONTCHARTRAIN CAUSEWAY WORLD'S LONGEST BRIDGE

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ABSTRACT

Consisting of parallel, 24 mile long spans, the Lake Pontchartrain Causeway holds the distinction of being the world's longest bridge. The bridge carries traffic from New Orleans and Jefferson Parish on the South shore of Lake Pontchartrain to the popular residential communities of St. Tammany Parish on the North shore. The twin bridges are supported by more than 9,500 prestressed concrete cylinder piles. This paper describes the first phase of the Pile Restoration Program for the Lake Pontchartrain Causeway.

HISTORY OF THE CAUSEWAY

The twin bridges crossing Lake Pontchartrain are each 24 miles in length and are supported by more than 9,500 prestressed concrete Raymond cylinder piles. The piles are 54" diameter, centrifugaly cast cylinder piles with 8,500 psi concrete.

Completed in 1955, the first bridge is one of the oldest prestressed concrete bridges built in the United States. The second span was completed in 1965 and now carries the north bound traffic. The older bridge has spans of 56 feet and is supported on two pile bents, while the newer bridge has 84 foot spans supported by three pile bents.

Total cost for the first bridge, including land acquisition and approaches was $ 51 million. The second bridge cost $ 33 million. Estimated cost for a new bridge exceeds $ 600 million. Daily vehicle count is now in excess of 30,000. [1]

UNDERWATER INSPECTION / EVALUATION

Over the course of the bridge's impressive history, the condition of the piles has been carefully monitored as part of a continuing maintenance program. Inspections have followed the requirements of the "National Bridge Inspection Standards" (NBIS).

Inspections during 1987, revealed that a small number of the piles were exhibiting longitudinal cracks in the splash zone. The pattern of cracks corresponded with the location of the prestressing strands. The cracks appeared to extend to the depth of the strands, however, there was no visible evidence of corrosion staining. There was also some localized damage to the original epoxy compound used to seal the transverse joints between the pile sections.

The engineers examined several repair options, including patching with epoxy paste, crack injection, several wrap methods, and a relatively new, all-polymer encapsulation (A-P-E) process. They selected the all-polymer encapsulation process because it would not only seal the cracks, but would also provide a composite barrier that would completely surround the effected length of the piles and arrest further deterioration. In 1988, 21 piles were encapsulated for a length of ten feet in the splash zone.

Responsibility for the maintenance program changed hands over the next few years, but monitoring of the piles continued on a periodic basis. In 1994, new engineers were chosen and given the tasks of performing a more detailed Level II and Level III underwater inspection in accordance with NBIS.

In 1995, the engineers began their Level II and III underwater inspection, with the results showing that more piles were exhibiting defects similar to those found in 1987. Concurrent with this inspection, the engineers also conducted a study of methods which could be used to provide long term protection to the Raymond cylinder piles supporting the Causeway.

Their search revealed several repair products and systems, including wraps and numerous FRP "jacketing" systems, involving both polymer and Portland cement grouts. None, however, appeared to equal the all-polymer encapsulation system used in 1988. To confirm this, they ran extensive tests of the seven year old encapsulations. Several cores were taken through the encapsulations and these revealed a tightly bonded, composite barrier was still in place. There was no evidence that any further deterioration to the pile had occurred beneath the encapsulations during the seven year period.

In-situ direct bond tests, using a Modified Elcometer

Test Method, were also performed on a number of the 1988 encapsulations. These tests, performed by coring through the encapsulation materials and applying direct tensile load to an isolated specimen, further confirmed the sound condition of the encapsulations. When tested to failure, the test specimens (Photo 1) indicated that the bond of the encapsulation materials exceeded the tensile strength of the 8,500 psi concrete.

Photo 1

As a result of these tests and extensive research into other available systems, the engineers again selected the all-polymer encapsulation system which had been specified and installed in 1988.

PILE RESTORATION - PHASE I

Phase I of the Pile Restoration Program began in late October of 1996, and covered approximately four miles of the Causeway starting at the North shore. Nearly 500 piles were encapsulated, and in addition to the encapsulation work, over 9,000 linear feet of small cracks were surface sealed above and below water with a marine epoxy paste. The basic criteria was to encapsulate any pile with three or more cracks, and/or piles with deteriorated transverse joints near the splash zone.

The engineers developed a very detailed set of performance specifications for Phase I, as it was also considered a pilot program for future work. Basic features of the specifications included - translucent FRP jackets, the pumping of aggregate filled polymer grout into the jackets from the bottom up, properly designed grout handling equipment, and periodic in-situ bond testing. The specifications also required both contractors and manufacturers to have prior experience with pile encapsulation. Based on the long term success of the A-P-E Process, MADCON chose to use this system for the encapsulation materials.

Most of the encapsulation work was carried out near or below the waterline. All diving work was performed by properly trained commercial divers using surface supplied air and hard wired communications.

Jack-up vessels (Photo 2) and self-propelled barges were used for most of the work. This was due to both the strict navigation rules set forth in the contract, and also because of the volatile nature of the weather on Lake Pontchartrain. The Lake is a very large body of water with relatively shallow depths (avg. 16 ft.). Lake conditions become unworkable in a matter of minutes with any significant change in the wind.

Photo 2

Surface preparation is critical on any encapsulation project. For this work, a 10,000 psi water blaster was used with the required operating pressures of between 7,000 psi and 8,000 psi (Photo 3). All marine growth was removed and proper concrete surface profile was established. Surface preparation was performed within 48 to 72 hours of grout placement.

Photo 3

After surface preparation was complete, translucent, marine grade FRP jackets were placed around the piles. Patterns of polymer stand-offs, positioned inside the jacket, maintained the 3/8" minimum annulus between the pile and the jacket. An

aggregate filled, 100% solids epoxy grout was pumped into the jackets from the bottom up through strategically placed injection ports in the jacket.

The progression of grout was carefully monitored through the translucent jackets to ensure a continuos void free encapsulation. Rising inside the confined space between the pile and the jacket, the aggregate filled epoxy grout created a scouring effect that further enhanced the bond between the encapsulation components and the pile.

Batching, mixing, and pumping of the grout was accomplished with special plural component grout handling equipment. With this equipment, the reactive components of the grout are each pre-mixed with aggregate and kept separate until just before entering the jacket. This enabled longer work periods without the concern for epoxy reaction time. This plural component equipment also had the added advantage of clean-up with water only, which greatly reduced the use of solvents and their negative impact on the environment. During the winter months when water temperatures dropped to 40 degrees F, temperature control features of the grout handling unit were utilized to maintain proper grout consistency.

The encapsulations were toped-off with a fillet of marine grade, water insensitive, epoxy paste, forming a watershed at the top of each encapsulation. Once completed, the encapsulations were also aesthetically pleasing, as they only protrude _" from the pile surface and the color of the finished encapsulation closely matches that of the concrete piles (Photo 4).

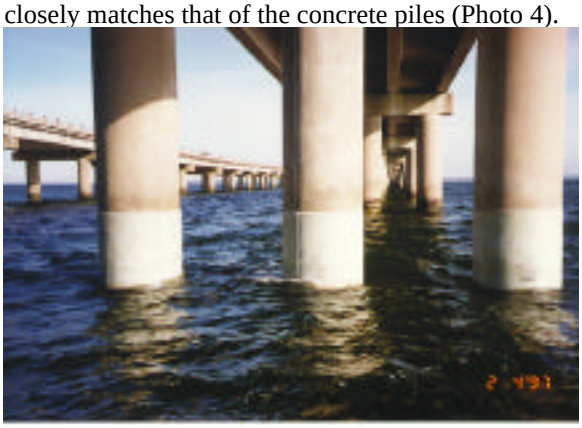

Photo 4

Phase I of the Lake Pontchartrain Causeway Pile Restoration Program was completed in late summer 1997. The Project was extremely successful, and came in on time, under budget, and with zero defects.

In October, 1998, this Project received the prestigious "Project of the Year Award" from the International Concrete Repair Institute for excellence in concrete repair projects.

PROJECT PARTICIPANTS

Owner: Greater New Orleans Expressway Commission
Engineer: GEC / Krebs, LaSalle, LeMieux Consultants, Inc.
Material Supplier: A-P-E Process by Master Builders, Inc.
Contractor: MADCON Corporation

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Photos number 1 and 2 are courtesy of Dee White, KLL Consultants.

REFERENCES:

[1]LeMieux, G. F., "Underwater Inspection of the World's Longest Overall Bridges, Part I", Feb. 1998 *Concrete International.*