LeJeune Road Flyover

By Clyde Ellis

This was not a typical repair project. The repair and strengthening of the LeJeune Road Flyover pier caps and columns called for a quick, innovative solution. Built to ease traffic congestion leaving the Miami Airport going westbound to the city of Hialeah, the LeJeune Flyover connects LeJeune Road northbound to Okeechobee Road westbound. Approximately 33 ft (10 m) wide and 262 ft (80 m) long, the Flyover is designed to carry two lanes of vehicular traffic. The superstructure is supported on two piers and consists of a twin, steel-box girder bridge with an 8 in. (20 cm) cast-in-place composite deck. Pier Two has a cantilevered arm that gives the pier an L-shape and is set on a footing that is below grade. Pier Three is a hammerhead, T-shaped pier (Fig. 1). Construction began in March 2003, and the bridge began to experience cracking from the construction loads, prompting officials to be concerned that the problem would only worsen after it opened to traffic.

Problems that Prompted Repair

A few months after the bridge deck was constructed, an inspector discovered cracks in the pier resulting from construction loads. Improper detailing of the reinforcing steel at the top of the pier cap caused horizontal cracks in Pier Two, while insufficient top reinforcing steel caused the "V"-shaped cracks found in the pier caps of Piers Two and Three. Expecting a service life of 75 years, the Florida Department of Transportation (FDOT) knew that these cracks would continue to worsen over the years and cause long-term maintenance issues. It was necessary to immediately repair the cracks.

The backside of Pier Two had a series of horizontal cracks that were uniformly spaced 12 to 18 in. (30 to 46 cm) apart that started at the pier cap and went down the pier to the footing. Additional cracks that formed a V-shape were found at the pier cap. Although these cracks were barely within the criteria set forth by the FDOT guidelines, officials believed it was too close for comfort and that horizontal strengthening was necessary. It appeared now that some form of post-tension strengthening in a vertical and horizontal direction would be required on the pier and the pier cap.

Only minimal repairs were necessary for Pier Three, which had cracks at the pier cap. In the middle of the T-shape, hammerhead pier cap, the same V-shaped crack pattern was discovered. As such, the pier cap needed strengthening horizontally (Fig. 2).

Based on the need to combine constructibility and engineering, the repair contractor was contacted by the engineer-of-record to help develop a solution for the repair of Piers Two and Three in a manner that would have the least amount of impact on traffic. The initial repair strategy required excavating and

Fig. 1: Looking at Pier Three from scaffolding at Pier Two

Fig. 2: Enlarged horizontal pier cap section at Pier Three

dewatering at Pier Two. This solution was cost prohibitive, time-consuming and would have dramatically impacted the traffic pattern. As such, the repair contractor was contacted to help develop an innovative solution to this perplexing problem.

Inspection and Evaluation

Hairline cracks that propagated were visible at both piers. The contractors and engineers were able to determine that the cracks were growing in size by tracing the original crack and evaluating it over a period of a few weeks. Investigation revealed that the cracks were still propagating on the structure because it was trying to relieve stress from the superstructure above.

Because the cracks were visibly evident and their root cause was known, additional testing was not required for this project. Site conditions were evaluated to determine if the suggested repair strategy could be accomplished within the limited workspace at the busy interchange.

Upon review of the details in the as-built construction documents, it was determined that the horizontal cracks on the backside of Pier Two were due to a reinforcing steel detailing error. The horizontal cracks occurred because the vertical reinforcing steel in the column was not properly lap-spliced with the top steel in the pier cap. Pier Two also experienced "V"-shaped cracks in the pier cap due to insufficient top reinforcing bars. This was also the case for Pier Three, which had insufficient reinforcing steel in the pier cap.

Repair System Selection

Because FDOT wanted to ensure that the structure would have a service life of at least 75 years, a solution to the cracks had to be durable, cost-effective, and aesthetically pleasing. Additionally, the bridge was located over a canal, which created an environment that was classified as moderately aggressive. Because of this corrosive environment, the repair solution also had to be extremely resistant to corrosion. Accordingly, the repair contractor worked with the owner and design team to select a repair solution with post-tensioning tendons that was fully encapsulated and would be encased in concrete. Having experience with post-tensioning systems for decades, FDOT had a comfort level with the method and supported the repair solution.

It was important that the repair method for the horizontal cracks did not require enlarging the pier, as this would have required the repair team to excavate around Pier Two and place concrete below the water table. Further, adding post-tensioning tendons in a secondary enlarged concrete section below the water table would cause the steel to become susceptible to a corrosive environment because of the cold joint between the new concrete and existing concrete. FDOT felt this option would have reduced the service life of the structure. Further, excavating at Pier Two would have dramatically added to the time needed to complete the repairs and would have significantly increased the cost. As such, all parties decided that if the post-tensioning tendons could be encased in and protected by the existing concrete, then it would be the optimal solution. It was decided that placing the tendons into drilled vertical holes would provide the necessary protection (Fig. 2).

Site Preparation

Because the site required working 20 ft (6 m) above the ground, scaffolding was erected at both piers. The repair solution also necessitated special access for core drilling equipment. As such, a 4 x 6 ft (1.2 x 1.8 m) work platform was created specifically for the core drilling machinery. Further, because Pier Two was over a canal, the repair contractor had to have a special platform for the scaffolding to set on as it bridged the canal below. This scaffolding was tested to ensure that it was properly designed for construction loads. To provide minimal impact to the existing landscape, protective tarps were installed around the work area so construction debris resulting from the concrete chipping process would not fall into the canal or onto surrounding traffic (Fig. 3).

One of the primary concerns for all parties involved in the project was to ensure the safety of the workers, the structure, and its surroundings. Therefore, the first day on the job consisted of safety training. The first half of the day was spent at the site doing hands-on training and the second half of the day was spent reviewing the repair procedures. Life rescue issues were put in place at the site in case they were needed in an emergency situation. Special considerations also were taken

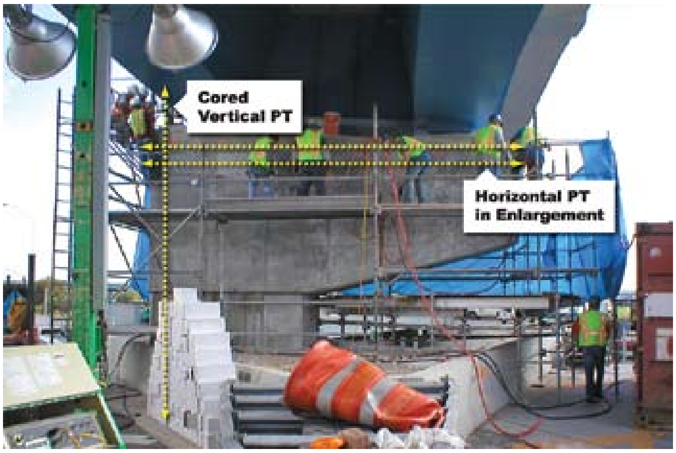

Fig. 3: Access via scaffolding and work platforms meeting OSHA standards

to ensure safety because work would be occurring over water. The extraordinarily tight schedule for the project required two 8-hour shifts, 6 days a week. To accommodate this schedule, light towers were erected onsite and security personnel patrolled the area at night. Ensuring the safety of the workers, the structure, and citizens was critical, so police maintained a presence at the job site to help direct traffic and to prevent vehicles from driving on the bridge until the repairs were complete.

Demolition and Surface Preparation

At both pier caps, bush hammers were used to prepare the concrete surface to a 1/4 in. (0.63 cm) amplitude. However, because of the nature of the aggregate often used in Florida ready mixed concrete, surface preparation also required the use of 15 lb pneumatic chipping guns to help achieve the desired 1/4 in. (0.63 cm) profile. This aggressive profile allowed for a good mechanical bond between the old and new concrete (Fig. 4).

To open the pores of the concrete, the structure was then water-blasted. This ensured that the pores of the old concrete were open and ready to receive the new concrete. Maximum compatibility was created by using the same concrete mixture proportions that was used in the original construction of the bridge piers (Fig. 5).

The Repair Process

To meet the latest FDOT post-tensioning specifications regarding the durability of structures, advanced technology was used to provide the most optimal, durable solution. This technology came in the form of a prepackaged grout with zero bleed characteristics and plastic corrugated

Fig. 4: Installing reinforcing steel cage and bursting steel around post-tensioned tendons on Pier Three

Fig. 6: Grouting post-tensioned tendons from colloidal mixing operation staged on top of bridge

Fig. 5: Pier Two formwork for enlarged concrete pier cap section

Fig. 7: Coring operation for vertical post-tensioning at Pier Two

duct sheathing for enhanced corrosion protection. Around the post-tensioning anchorage blockouts, an elastomeric coating was applied to ensure there was no penetration of water (Fig. 6).

To ensure a cost-effective, durable solution for repairing the horizontal cracks at Pier Two, the repair contractor selected post-tensioned concrete anchors. By using vertical post-tensioning tendons, compressive forces were introduced into the concrete to reduce cracking.

The repair team opted to core two holes, 5.5 in. (14.0 cm) in diameter and 40 ft (12.2 m) in depth, into the top of the pier cap, stopping only a few inches from the bottom of the footing. The core was extracted in 12 in. (30.5 cm) depths until the maximum depth was reached (Fig. 7). Made of high-strength prestressing steel, the post-tensioning tendon was lowered into the hole and grouted in two stages. The first grout stage was at 15 ft (4.6 m) from the bottom of the cored hole and created a "bond zone" for the anchorage (Fig. 8). The hydraulic jack stressing operation was then performed at the top of the hole and the second stage of grout was pumped into the remainder of the hole (Fig. 9). This stage created corrosion protection by enveloping the strands in a layer of cementitious grout.

The repair of the "V"-shaped cracks at the pier cap and column connection on both Piers Two and Three required casting an enlarged section of concrete on both sides of the pier cap. High-strength, horizontal post-tensioned bars were cast in the concrete section. Reinforcing bar dowels were used to connect the new concrete to the old concrete. The post-tensioned bars were then stressed using a hydraulic jack to compress the old section. The compressive force was then transferred from the new concrete to the old concrete through the reinforcing bar dowel bars and high-strength spin-lock anchors causing the pier cap to squeeze together and reduce the crack widths (Fig. 10).

Unforeseen Challenges

As with most concrete repair projects that require deep, precise holes to be cored, many unforeseen challenges arose. For example, the original design called for two 5.5 in. (14.0 cm) diameter holes to be cored simultaneously. However, the first hole began to experience problems at 10 ft (3 m). At this depth, the drill bit seized and stopped turning. When the core driller attempted to extract the core, it would not budge. As such, the decision was made to revise the original strategy and create a 5 in. (12.7 cm) hole instead of a 5.5 in. (14.0 cm) hole. Essentially, this adaptation resulted in a smaller hole being cored inside the original core barrel stuck in the hole. This necessary modification created

Fig. 8: Using crane to lower the post-tensioned assembly into the core hole

Fig. 9: Positioning of jack prior to stressing of post-tensioning tendon

Fig. 10: Bursting steel around spin-lock anchors, two horizontal post-tensioned tendons, reinforcing steel dowels, and reinforcing steel cage

significant challenges for the repair team because all designs had to be revised, including the post-tensioning anchor hardware, to fit the smaller hole. Even with this adaptation, the coring operation was complete in 10 days.

The LeJeune Road Flyover demonstrates the repair team's effectiveness for developing innovative solutions to complex problems. Before this project began, the road had been under construction for nearly 2 years, so it was critical that the project be completed in a timely fashion with minimal impact. By developing an open working relationship with the owner, innovative solutions were developed; and the contractor was able to provide a turnkey solution that included repair design services, labor resources, and shop drawings. The repairs were completed 2 weeks ahead of schedule and were delivered using the most cost-effective solution. The field portion of this extremely fast-track project was completed in a mere 4 weeks, allowing the flyover to be opened ahead of schedule and ensuring a long life for the structure.

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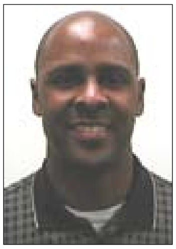
Owner
Florida Department of Transportation
Tallahassee, Florida

Project Engineer
Keith and Schnars
Fort Lauderdale, Florida

Repair Contractor
VSL
Pompano Beach, Florida

Material Suppliers
Williams Form Engineering Corp.
Grand Rapids, Michigan

Pilgram Permacoat, Inc.
Tampa, Florida



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