Summary of Final Report, BD545-27
June 2006

ST. GEORGE ISLAND BRIDGE PILE TESTING

PROBLEM STATEMENT

The Bryant Patton Bridge (also known as the St. George Island Bridge) was constructed in 1965 to link mainland Florida panhandle to St. George Island. In 2004, the Bridge was replaced to improve traffic flow and because many of piles on the existing bridge had been badly damaged by corrosion. Some piles, however, were severely corroded in spite of relatively recent extensive repairs.

OBJECTIVES

The objective of this project was to study the effect of long-term exposure of prestressed concrete piles to the severe coastal environment. Twelve prestressed concrete piles with varying levels of corrosion damage were recovered and structurally tested after being inspected visually. Two of the selected piles were equipped with cathodic protection, which had been installed as part of the 1994 repairs. Three additional piles from the Escambia Bay Bridge were also tested during the study.

FINDINGS AND CONCLUSIONS

Bryant Patton Bridge

- Flexural test results indicated that some of the piles had severe reduction in capacity while others had no loss of capacity when compared to the calculated capacity. For example, in the most extreme case, the pile was able to carry only 31% of its calculated capacity. Other piles, however, were able to sustain loads higher than the rated capacity. Reduction in flexural capacity was due primarily to the section loss sustained as a result of corrosion damage to the prestressing strand. There was no apparent reduction in concrete strength.
- Visual ratings were assigned to each pile by the researchers based on photographs and notes taken by FDOT District 2 field personnel. The ratings were normalized to allow comparison with the tested flexural capacities of the piles. In 7 of the 12 piles, the normalized visual rating was within 10% of the normalized moment capacity. The capacity was overestimated in one pile and underestimated in the rest, according to the normalized visual ratings.
- The flexural capacities of the two cathodically protected piles were 53% and 79% of the calculated flexural capacity. It was not clear, however, from the post-test excavation how much of the corrosion had occurred since the CP system had been installed. There appeared to have been some protection provided by the cathodic protection system based on limited visual observations, but the duration and extent is not known.
- Severe corrosion was also noted in the strand that appeared to have been used for pick up points during pile construction and handling. Corrosion at these locations likely was initiated by chloride intrusion along the pick-up point strand where it exited the pile.
- Corrosion potentials measured on selected piles were related to the flexural capacity. When the average corrosion potential was less than -350 mV_{CSE} over an approximate height of 1 ft. above the mean high water (MHW), 100% of the pile capacity remained; when 3 ft. above the MHW,

approximately 68% of the pile capacity remained; when 5 ft. above the MHW, approximately 32% of the pile capacity remained.

- Strand samples from piles with and without CP were tested for dissolved hydrogen, which can be generated from cathodic protection systems. The dissolved hydrogen content averaged 2.0 ppm for the outer wires and 1.4 ppm for the inner wires of prestressing strands from a cathodically protected pile. The hydrogen content of the outer wires of a strand from an unprotected pile averaged 0.92 ppm. It is expected that as-drawn prestressing wire would have a background dissolved hydrogen content ranging from 0.2 ppm to as high as 1.0 ppm, typically averaging around 0.6 to 0.7 ppm. This compares well with the average background value of 0.92 measured in the unprotected pile and indicates some charging of the protected pile. These results also indicate that the outer wires tend to shield the inner wires but do not completely protect them from charging.
- The ductility factor of each pile was calculated by taking the ratio of the curvature at peak capacity to the curvature at 90% of capacity based on deflection data gathered during the flexural testing. These factors were used to compare the ductility of the cathodically protected piles with the unprotected piles to determine if the strands appeared to be susceptible to hydrogen embrittlement. One of the cathodically protected piles had a ductility factor greater than all but two unprotected piles, while the other had a ductility factor greater than only two of the unprotected piles. This same pile also had a comparable reduction in flexural capacity, which may have been due to severe corrosion occurring prior to the installation of cathodic protection. There was no clear trend to indicate that hydrogen embrittlement had affected the capacity or ductility of the CP piles.

Escambia Bay Bridge

- All three piles retained at least their calculated flexural capacity.
- No significant corrosion was noted on the prestressing wire during post-test excavation.

BENEFITS

This research is a unique combination of materials and structural testing that provides previously unavailable information on the performance of precast, pretensioned concrete piles located in severely corrosive environments. FDOT District 2 is currently evaluating and improving its pile inspection and evaluation protocol and is utilizing the findings of this research.

The strong relationship between the corrosion potentials and flexural capacity noted in this research appears to offer a promising addition to the current inspection techniques (i.e., it potentially provides a better technique for more accurate bridge pile inspection than the current visual inspection methods). Corrosion surveys are currently a routine inspection technique that includes measurement of corrosion potentials.

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