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CASE STUDY ON CFRP PRESTRESSED CONCRETE SOLDIER PILE WALLS WITH GFRP REINFORCED PRECAST CONCRETE PANELS

Joseph Losaria, P.E.
Patel, Greene & Associates, LLC
12570 Telecom Drive, Temple Terrace, FL, USA
joseph.losaria@patelgreene.com

Steven Nolan, P.E.
Florida Department of Transportation
Advanced Materials for Structural Durability & Resiliency
605 Suwannee Street, Tallahassee, FL, USA
steven.nolan@dot.state.fl.us

Andra Diggs II, P.E.
Florida Department of Transportation
District Structures Design Engineer
801 N. Broadway Avenue, Bartow, FL, USA
andra.diggs@dot.state.fl.us

Dave Hartman
Owens Corning Composites, Science and Technology, LLC
2790 Columbus Rd, Granville, OH, USA
dave.hartman@owenscorning.com

ABSTRACT

OBJECTIVES:

This case study presents the use of Carbon-Fiber Reinforced Polymer (CFRP) prestressed concrete (PC) soldier-piles coupled with Glass-FRP reinforced concrete (RC) precast panels, for a combined bridge bearing abutment and retaining wall system. The application of FRP prestressing and reinforcing on the US 41 Highway Bridge over North Creek in Sarasota County was promoted by the Florida Department of Transportation under their Transportation Innovation Challenge initiative. Soldier-pile retaining walls are a commonly used system in southeastern US coastal states, but the incorporation of innovative materials such as CFRP-prestressing for piles and GFRP-reinforcing for concrete panels is not yet widespread. In addition to describing the preferred FRP-PC/RC solution adopted for this project, a comparison is provided to a recently completed adjacent bridge that utilized a traditional carbon-steel PC soldier-pile and RC precast panel wall system. A further comparison is presented for the design and cost of the wall system based on the project design criteria with the refinements and savings possible under the newer editions. Finally, the durability and environmental benefits from the use of the innovative CFRP and GFRP reinforcing systems in this type of traditional wall system, will be identified for typical urban coastal areas with extremely aggressive conditions, congested access, and challenging environmental constraints.

RELEVANT RESULTS:

The soldier-pile end bent system is a combined end bent abutment and retaining wall system. The end bent foundations serve dual functions, as a bridge foundation and as a wall support system. The system utilized for this project is composed of precast GFRP reinforced concrete panels that serve as the vertical wall panels that rest laterally on square, precast CFRP or HSSS prestressed concrete driven piles.

When the project was in the design phase, the AASHTO LRFD Bridge Design Guide Specifications for GFRP-reinforced Concrete Bridge Decks and Traffic Railings, 1st edition (AASHTO, 2009) was the design code applicable at that time. Since then, the 2nd edition of this design code was released (AASHTO, 2018a).

For the soldier-pile end bent system, there are several advantages to the use of GFRP reinforcement in the precast panels and CFRP in the prestressed soldier piles. Precast panels can be fabricated utilizing reduced concrete cover requirements resulting in an overall reduction in panel thickness. The use of GFRP reinforcing allow further concrete cover reduction and also promotes easier handling and placement given its lighter weight.

CONCLUSIONS:

The soldier-pile end bent system is economical when other abutment retaining wall systems such as sheet piles, CIP walls, and MSE walls are not practical. The use of GFRP on the precast panels allowed a reduction of concrete cover, and ease of handling/placement. Using the newer design code for the project would result in further efficiencies in the GFRP reinforcement design for the structure. Due to this exposure to wetting/drying cycles, corrosion is a common occurrence in the end bent vertical wall system located in extremely aggressive environments. Although, traditional concrete and carbon steel components can be enhanced by using admixtures, increasing concrete cover, coating exposed steel components, etc., the use of FRP components enables a more practical long-term solution.

Keywords: GFRP; Soldier Pile End Bent; Precast Panels; CFRP Piles; Walls