

Request for Research Funding for FY 2022-2023

SPR Subpart B Project: STR-23-04

Requesting Office	Central Office Structures	Priority	4 of 4
Proposed Title	UHPC Pile Splice		
Justification	<p>Precast, prestressed concrete piles are one of the most common foundation types used in Florida. Conventional prestressed concrete piles with carbon steel strands commonly experience corrosion, especially in marine environments. Ultra-high performance concrete (UHPC) is a high performance cementitious material with high compression and tensile strengths, sustained post-cracking tensile strength, low permeability, and good long-term durability. One application being explored for UHPC material is in prestressed piles. The use of UHPC in piles will improve long-term durability for bridges and performance of the piles and has been shown from previous testing to also improve the drivability of the piles. One of the limiting factors for the use of UHPC piles in Florida is the availability of a viable option to splice UHPC piles together. There has been little previous research on UHPC pile splices, and previous research was only on a welded splice option for 10-in. H-piles. This proposed project would evaluate the performance of several UHPC pile splice alternatives and develop proposed details for their use in FDOT projects.</p> <p>To improve the corrosion resistance of prestressed concrete piles used in Florida’s marine environment, FDOT currently requires certain pile sizes in extremely aggressive environments (due to chlorides) to be constructed with corrosion-resistant prestressing products. Two corrosion resistant prestressing products are currently allowed: carbon fiber polymer and stainless steel. Both are a form of prestressing strand used in conjunction with conventional concrete. A potential alternative corrosion-resistant pile option is UHPC piles reinforced with conventional carbon-steel prestressing strand. Precast concrete producers in Florida are enthusiastic about the use of UHPC for precast, prestressed piles, as evidenced by their investing their own funds to construct samples to give to FDOT SRC for testing.</p> <p>There is already a team of engineers in the Structures Design Office developing standard UHPC pile shapes. Although a standard section has not been established and so cost comparisons cannot be made, the support of precast product producers indicates UHPC piles will probably be cost-competitive, compared to other corrosion resistant alternatives. This requested research is needed to develop construction details, specifications and the driving limits for splicing those standardized UHPC piles. The lack of a research for splicing UHPC piles remains a barrier to their implementation.</p>		
Impact	<p>This requested research is at the intersection of two construction practices currently being pushed by industry: pile splices and UHPC piles. The general direction observed by FDOT SDO for design-build projects is towards longer piles with uplift forces and/or planned splices. That process seems to be preferred over alternative designs with more or larger piles. FDOT SDO anticipates that instances of projects with spliced piles will remain the same or increase in the future. At the same time, industry is showing support for the development of UHPC piles through research and development by precast concrete producers and drivability demonstrations by contractors. But, since designs with pile splices are common in Florida, UHPC piles cannot be used extensively until details for a pile splice are developed.</p> <p>If the use of UHPC piles is allowed in Florida without established details for splicing, and actual driving conditions aren’t well-predicted before the start of the project, an unforeseen pile splice might be required. There could be disagreement between the contractor and FDOT as to how the pile splice should be performed. The lack of research means solutions may not be sufficiently supported by proven performance. That could result in construction delays and claims, which would impact the traveling public and increase the cost of construction projects.</p>		
Affected Offices	CO Structures Design, Construction		
Existing Work	<p>Garder, J., Aaleti, S., Zhong, L., & Sritharan, S. (2019). Connection Details and Field Implementation of UHPC Piles – Phase II. Iowa Highway Research Board. https://intrans.iastate.edu/app/uploads/2019/10/UHPC_pile_connection_details_and_field_implementation_phase_II_w_cvr.pdf</p> <p>Leonhardt, S., Lowke, D., Stengel, T., & Gehlen, C. (2011). Impact Tests on Ultra-High Performance Concrete— Characterization of Strains and Ultrasonic Velocities. <i>Materials Testing</i>, 53(11–12), 736–740.</p> <p>Suleiman, M. T., Vande Voort, T., & Sritharan, S. (2010). Behavior of Driven Ultrahigh-Performance Concrete H-Piles Subjected to Vertical and Lateral Loadings. <i>Journal of Geotechnical and Geoenvironmental Engineering</i>, 136(10), 1403–1413. https://doi.org/10.1061/(ASCE)GT.1943-5606.0000350</p>		

	Voort, T. V., Suleiman, M., & Sritharan, S. (2008). Design and Performance Verification of UHPC Piles for Deep Foundations (Final IHRB Project TR-558). Center for Transportation Research and Education.		
Keywords Used In Existing Work Search (Cannot leave blank)	UHPC pile, UHPC pile splice		
Related Contracts (Give contract numbers)	BC354-48, Design Guidelines and Specifications for Engineered Grouts Used in Anchorage and Pile Splice Applications BC354-80, Alternatives for Precast Pile Splices BDV29-977-52, Epoxy Dowel Pile Splice Evaluation BDU79, Investigation and Development of an Effective, Economical, and Efficient Prestressed Concrete Pile Splice BDV29 977-28 and BDV29 977-65, Florida Slab Beam with UHPC Joint Connections BDV31-977-105, Ultra-High-Performance Concrete (UHPC) Use in Florida Structural Applications		
Funding Request	\$350,000	Anticipated Duration	3 years
Project Manager	Christina Freeman	Contracting Method	direct contract with university (FIU)
Equipment	None		
Urgency	4	This project scored fourth in a rating of research ideas by FDOT's Central and District Structures Design Offices.	
Implementability	1	This research has a very high likelihood of implementation without additional research. Information regarding pile splices for conventional piles is already readily available from multiple previous research projects. In addition, FDOT has funded several research projects related to UHPC and through those, has gained knowledge for implementation of UHPC in Florida.	
Project Benefits (Succinct, complete explanation)			
The primary objectives for this project are to:			
<ol style="list-style-type: none"> 1. Collect and summarize previous research and currently used details for pile splices and connections between UHPC members. 2. Develop options for possible UHPC pile splices and evaluate constructability through discussions with FDOT, contractors, and precast plants. 3. Experimentally evaluate the bond performance of reinforcing bar embedded in UHPC both preformed and cored dowel holes. Both grout and epoxy will be examined as bonding materials. 4. Experimentally evaluate the performance of selected UHPC pile splices through full-scale structural testing. 5. Develop design recommendations for UHPC pile splices. 			
Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc...if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits	
<input type="radio"/> Materials Enhancement		This research could enhance the current methods and materials by enabling the use of more durable UHPC for full-scale prestressed members.	
<input type="radio"/> Materials Savings		Fewer bridge replacements means less material used.	
<input type="radio"/> Time Savings		Construction time savings will be realized by the use of UHPC in piles because UHPC has much higher tensile and compressive strength than conventional concrete, so piles can be driven more quickly.	

○ Lives Saved/Injuries Prevented		Improved safety is associated with faster construction.
○ Other (Explain)		

*Comments should explain and support urgency, financial benefit, and implementability scores