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<tr><td colspan="4">Request for Research Funding for FY 2022-2023</td></tr>
<tr><td colspan="4">SPR Subpart B Project: STR-23-01</td></tr>
<tr><td>Requesting Office</td><td>Central Office Structures</td><td>Priority</td><td>1 of 4</td></tr>
<tr><td>Proposed Title</td><td colspan="3">FSBs with HSSS Strands and GFRP Shear Reinforcing</td></tr>
<tr><td>Justification</td><td colspan="3">Prestressed concrete beams, girders, piles are an essential part of most bridges built in the US. Half of the bridges located in Florida are prestressed concrete bridges (FHWA NBI 2021). Many of those are in coastal areas with extremely aggressive environments.

• The most common type of deterioration in coastal bridges is the corrosion of reinforcing steel.
• The durability of prestressed concrete bridges in a marine environment is of increasing concern.
• Federal Highway Administration’s goal is to extend the service life of bridges to 100+ years.
• Stainless steel strands are a viable alternative material to enhance the durability of bridges in marine environments.

Stainless steel strands are a corrosion-resistant solution for bridges in aggressive environments. They are likely to be used in beams with minimal clearance above saltwater. Shallow-depth beams such as the Florida Slab Beam (FSB) are commonly used in those conditions.

Barriers to the use of the High-Strength Stainless Steel (HSSS) are the relatively high cost of stainless-steel strands, a limited number of producers, and a lack of full-scale test results describing the behavior of the HSSS strands in real structural members. The latter was resolved by the research performed by M. Rambo-Roddenberry (FDOT BDV30-977-22). In the project, 10 full-scale AASHTO Type II girders were tested; prestress losses, mechanical and bond characteristics of HSSS were determined and design recommendations were formulated. The resultant design provisions were summarized in SDG 4.3.1.A.4. For shallow depth members, there is potential for current design methods to be optimized with a reduced resistance factor.

The proposed study will be conducted in two phases. The first phase will examine the following:
• Applicability of HSSS for Florida Slab Beam (FSB).
• Appropriateness of existing design provisions for shallow-depth beams.

The second phase will examine the following:
• Structural behavior of GFRP as shear reinforcement.
• Possibility of regular carbon steel reinforcement placed in a bridge deck along with GFRP (to avoid dissimilar metal corrosion).
• Suitability of GFRP as pocket reinforcing for transverse load distribution.

The objective of this project is to refine/update the existing design procedure for FSBs prestressed with HSSS strand and enables and increase the durability of new bridges in a corrosive environment.</td></tr>
<tr><td>Impact</td><td colspan="3">Design provisions using HSSS are already available in SDG 4.3.1.A.4 based on the results from the research Report FDOT BDV30-977-22. The proposed study is called to refine the design procedure and populate the usage of HSSS reinforcement in newly designed costal bridges.</td></tr>
<tr><td>Affected Offices</td><td colspan="3">CO Structures Design, Structures Maintenance</td></tr>
<tr><td>Existing Work</td><td colspan="3">1. Al-Kaimakchi, A. & Rambo-Roddenberry, M. Full-Scale AASHTO Type II Girders Prestressed with Stainless Steel Strands. ASCE Journal of Bridge Engineering 26, (2021).
2. Al-Kaimakchi, A. & Rambo-Roddenberry M.. Mechanical and bond properties of Grade 2205 duplex high-strength stainless steel strand. PCI Journal 66–81 (2021).
3. Al-Kaimakchi, A. & Rambo-Roddenberry M.. Structural behavior of concrete girders prestressed and reinforced with stainless steel materials. ACI Structural Journal 137–152 (2021).
4. Alvaro, P., Gleich, L. B. & Kahn, L. F. Transfer and development length of high-strength duplex stainless steel strand in prestressed concrete piles. PCI Journal 60–71 (2017).
5. Moser, R. D., Kahn, L. F., Singh, P. M. & Kurtis, K. E. Preliminary Studies of High-Strength Stainless Prestressing Steels. Transportation Research Record (2013).
There is an ongoing NCHRP project (number 12-120) examining the use of stainless steel strands for prestressed concrete bridge elements. The project has a completion date of March 1, 2023. FDOT has a representative serving as a member of</td></tr>
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	the review panel for the project. It is known that the number of shallow depth members to be constructed and tested in the scope of the NCHRP project is low and so this research by FDOT is warranted. In addition, FDOT research will examine beam shapes which are commonly used in Florida. FDOT will continue to monitor work completed in the NCHRP project to ensure there is no overlap of research efforts.		
Keywords Used In Existing Work Search **(Cannot leave blank)**	Full-scale girders, corrosion-resistant strands, stainless steel strands, prestressed concrete, flexural behavior.		
Related Contracts (Give contract numbers)	BDV30-977-22 Stainless Steel Strands and Lightweight Concrete for Pretensioned Concrete Girders		
Funding Request	Phase 1: $200,000 Phase 2: $200,000	**Anticipated Duration**	Phase 1: 2 years Phase 2: 2 years
Project Manager	Vickie Young	**Contracting Method**	Direct to researcher (FSU)
Equipment	N/A		
Urgency	1	This project scored first in a rating of research ideas by FDOT's Central and District Structures Design Offices.	
Implementability	1	This research has very high likelihood of being implemented in FDOT Structural Manual since general design provisions for HSSS are already included in SDG 4.3.1.A.4 based on the results from the research Report FDOT BDV30-977-22. The proposed study is needed to expand the existing procedure to shallow-depth beams such as FSBs.	

Project Benefits:

- Design recommendations for FSBs will provide clear guidance for bridge designers to replace traditional carbon prestressing steel or carbon fiber with HSSS strands. This will enhance HSSS applicability and the overall durability of new bridges.
- Proposed testing (shear test using GFRP, decked and undecked beam flexural tests) would resolve the questions and concerns, such as dissimilar metal deterioration and controlling shear failure. The results will also provide an additional justification for designers to consider the HSSS option.

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**
○ Materials Enhancement		HSSS strands have high durability due to corrosion resistance which makes them more efficient compared to the carbon steel strength.
○ Materials Savings		This research will consider the use of a higher jacking force to be allowed when using HSSS strands in FSBs. If acceptable, the depth of the section or number of strands can be reduced to achieve material efficiency. Corrosion resistance extends the service life of the structure without major repairs.
○ Time Savings		There are no direct time savings during the fabrication of FSBs with HSSS compared to the traditional carbon steel option. Nevertheless, HSSS is an efficient alternative to carbon fiber reinforced polymer strands (an alternative corrosion-resistant material) in terms of fabrication efforts and time.

		In the long term prospective, the avoidance of bridge rehabilitation or strengthening reduces human hours during bridge service life.
○ Lives Saved/Injuries Prevented		Corrosion of the reinforcing steel can compromise the structural integrity of the girder. This may lead to the bridge's premature failure. Usage of corrosion-resistant prestressing steel can prevent corrosion-related structural failure.
○ Other (Explain)		

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