Request for Research Funding for FY 2021-2022			
Requesting Office	CO Structures Office	**Priority**	1 of 5
Proposed Title	Strengthening Piers to Resist Vehicular Collision		
Justification	The Department is increasingly encountering projects with existing piers that were not designed to resist the LRFD 600-kip equivalent static design force. A pier protection barrier is often not viable due to MOT or geometric constraints, or conflicts with utilities or other features. In these situations, designers must consider strengthening the existing piers. Of the options available for strengthening (see SDG 2.6.4.E) the most common method is to cast a reinforced concrete "collar" around the existing column to increase its diameter and achieve the required shear capacity. When strengthening piers with collars the Department requires certain details that, although logical, have not been evaluated (see SDG 7.3.6.C). Based on the observed failure mechanism of pier columns involved in large truck collisions, an acceptable method of calculating the column strength to resist the vehicular collision force is to assume failure along two shear planes inclined at 45-degree angles above and below the point of force application (Research Report No. FHWA/TX-10/9-4973-1). However, it is unknown if an existing column strengthened with a concrete collar will behave in a similar manner, or the significance of the details used for the collar. Other more efficient methods of strengthening should also be investigated, such as CFRP wrap which is currently prohibited by the Vol. 4, Section 4.1 of the Structures Manual. CFRP damage during the impact will also need to be evaluated to ensure integrity during the impact event. Optimizing the collar to minimize cost thru refinement or use of FRC or UHPC can also be considered. This project will be a synthesis study of previously completed research with some analysis to develop design details for strengthening with conventional concrete, UHPC and CFRP wrap.		
Impact	This research is necessary to ensure that retrofits to existing piers have adequate capacity to resist the LRFD 600-kip equivalent static design force. If this research is not completed and retrofit capacity is not well-understood, funding may be spent on inadequate retrofits and traffic crashes into those piers may result in significant structural damage, or the Department could be spending too much on overly conservative and complicated details.		
Affected Offices	Structures Design		
Existing Work	Alam, M. I., Fawzia, S., Zhao, X.-L., & Remennikov, A. M. (2020). Numerical Modeling and Performance Assessment of FRP-Strengthened Full-Scale Circular-Hollow-Section Steel Columns Subjected to Vehicle Collisions. Journal of Composites for Construction, 24(3). Buth, C. E., Williams, W. F., Brackin, M. S., Lord, D., Geedipally, S. R., & Abu-Odeh, A. Y. (2010). Analysis of Large Truck Collisions with Bridge Piers: Phase 1. Report of Guidelines for Designing Bridge Piers and Abutments for Vehicle Collisions. College Station: Texas Transportation Institute. Cao, R., El-Tawil, S., Xu, X., & Wong, W. (2019). Behavior and Design of Bridge Piers Subjected to Heavy Truck Collision. Journal of Bridge Engineering, 24(7). Chen, L., Wu, H., & Liu, T. (2020). Vehicle collision with bridge piers: A state-of-the-art review. Advances in Structural Engineering, 24(2), 385-400. Isaac, P., Silva, P., Darby, A. P., Ibell, T., & Evernden, M. (2010). Response of FRP wrapped RC columns to impact loads. ResearchGate. Retrieved January 15, 2021, from https://www.researchgate.net/publication/289079610_Response_of_FRP_wrapped_RC_columns_to_impact_loads Loudon, N., & Bell, B. (n.d.). FRP strengthening of concrete road and rail bridges in the UK. Magazine of Concrete Research, 62(4). Mohammed, T. A., & Parvin, A. (2020). Vehicle Collision Impact Response of Bridge Pier Strengthened with Composites. Practice Periodical on Structural Design and Construction, 25(4).		
Keywords Used In Existing Work Search	FRP column impact, bridge pier truck collision		

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Related Contracts (Give contract numbers)	BC355-6, BDV31-977-17, BD224		
Funding Request	$150k	**Anticipated Duration**	1.5 years
Project Manager	Will Potter, Christina Freeman	**Contracting Method**	RFP to all registered vendors
Urgency	1	This project scored first in a rating of research ideas by FDOT's Central and District Structures Design Offices.	
Implementability	2	This research has a high likelihood of implementation in the FDOT Structures Manual because the topic is already addressed there, but it is a synthesis and analytical project so further physical research may be needed prior to full implementation.	

Project Benefits (Succinct, complete explanation)

Pier protection barriers are expensive to add to bridges because of the significant length of barrier required and the maintenance of traffic needed during their construction. The need to strengthen or protect piers is being encountered frequently in multiple districts and strengthening methods with FRPs or other optimized methods would make those repairs more cost efficient.

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**
o Materials Enhancement		More efficient and cost-effective details
o Materials Savings		Possibly less material
o Time Savings		FRP strengthening requires less time than traditional strengthening methods with concrete.
o Lives Saved/Injuries Prevented		Faster strengthening methods will require less MOT and therefore safety is enhanced.
o Other (Explain)		

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