

Request for Research Funding for FY 2023-2024

Project Number (Research Center Use Only): STR-24-01

Requesting Office	CO Structures Design	Priority	1 of 5
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Proposed Title Experimental Evaluation of Strengthening Methods for Bridge Piers Against Vehicular Collision

Justification

In the AASHTO LRFD Bridge Design Specifications, the equivalent static force for consideration of lateral impact force caused by vehicular Collision to bridge piers increased from the previous 400-kip to 600-kip. However, many bridges were built prior to that change. FDOT is increasingly encountering projects with existing piers that were not designed to resist the AASHTO LRFD 600-kip equivalent static design force. In addition, a pier protection barrier is often not viable due to maintenance of traffic or geometric constraints, or conflicts with utilities or other features. Pier protection barriers are also expensive due to the significant length of barrier required and the maintenance of traffic needed during their construction. In these situations, designers must consider strengthening the existing piers.

FDOT is currently funding an analytical research project to evaluate the performance of different strengthening methods for piers against vehicle collision using dynamic finite element (FE) analysis. In order to validate the dynamic FE model developed in the current project, and to increase the confidence of FDOT in the proposed strengthening methods for bridge piers, a second experimental phase of the project is needed.

The experimental scale will be determined based on the capacity of the FDOT pendulum impact testing facility in discussion and coordination with the PM and the researchers at FDOT Structures Research Center. The impact testing data will be used to validate the developed FE model, which will be used to further evaluate the performance of the strengthened piers and the effectiveness of the strengthening methods.

Impact

This research could help FDOT understand how to retrofit existing piers to have adequate capacity to resist the LRFD 600-kip equivalent static design force without a pier protection barrier. If this research is not completed and current FE analysis research cannot be verified, 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 Maintenance Offices

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 Bridge Piers Against Vehicular Collision, FRP column impact, UHPC vehicular impact

Related Contracts (Give contract numbers)	BC355-6, BDV31-977-17, BD224, BED70		
Funding Request	\$540,000	Anticipated Duration	3 years
Project Manager	Christina Freeman	Contracting Method	Direct to FSU
Equipment	none		
Urgency	1	This project scored first in a rating of 25 research ideas by FDOT's Central and District Structures Design Offices.	
Implementability	1	This research has a high likelihood of implementation in the FDOT Structures Manual because the topic is already addressed there. Physical research is 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
<input type="checkbox"/> Materials Enhancement		More efficient and cost-effective details.
<input type="checkbox"/> Materials Savings		Possibly less material.
<input type="checkbox"/> Time Savings		FRP strengthening requires less time than traditional strengthening methods with concrete.
<input type="checkbox"/> Lives Saved/Injuries Prevented		Faster strengthening methods will require less MOT and therefore safety is enhanced.
<input type="checkbox"/> Other (Explain)		

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