Request for Research Funding for FY 2022-2023			
SPR Subpart B Project: TEO-23-14			
Requesting Office	State Traffic Engineering and Operations Office	**Priority**	14 of 23
Proposed Title	Assessment of Highway-Railroad Grade Crossing Strategies, Countermeasures, and Technologies to Improve Traffic Safety and Mobility in Florida		
Justification	**Describe the current situation, why the research is needed, and how the research affects your office's mission critical focus areas** Current Situation The 4,500 at-grade highway-rail grade crossings (HRGCs) in Florida are experiencing over 350 crashes and over a dozen fatal and serious injury crashes every year[1]. HRGCs are conflict areas for trains and railroad users and present a major safety concern in Florida. The at-grade HRGCs not only affect safety but have a significant impact on the traffic operations. Data from the Federal Railroad Administration (FRA) showed an increase in highway-rail HRGC crashes in Florida between 2015 and 2019. According to the FRA data, the average number of fatalities, injuries, and crashes without fatalities and injuries in 2018 and 2019 are 17, 35, and 65 per year, respectively. Specific to safety, vehicles stopping in Rail Dynamic Envelope (RDE) zones constituted 47% of train-vehicle crashes at HRGCs. These locations also cause increased delays, queue spillbacks at adjacent intersections, and adverse environmental impacts. The Florida Department of Transportation (FDOT) is committed to the safety and mobility of all roadway users. Several strategies were explored by FDOT to improve safety and mobility related to railroad grade crossings, including signage, pavement marking, quadrant gates, and traffic signal preemptions and pre-preemptions. Several of these have been implemented by various FDOT districts. To improve the safety performance of HRGCs and prevent train-vehicle fatalities and injuries at these locations, FDOT Central Office launched the Florida Operation STRIDE (Statewide Traffic and Railroad Initiative using Dynamic Envelopes) in 2019. This initiative is FDOT's commitment and action to improve the safety and mobility at HRGCs in Florida. As FDOT Secretary Kevin Thibault said, *"One fatality on our rail crossings is one too many"*[2], this program comprises the engineering treatment of RDE pavement markings and signs at State-owned highway-rail at-grade crossings in Florida to help keep motorists out of the danger zone near railroad crossings. Preliminary results showed an overall reduction of vehicles stopped at dangerous RDE zones. More deployments will be completed by FDOT districts in the coming year. Research Needed Despite the availability of potential strategies and associated countermeasures, safety and congestion issues related to HRGCs are still ongoing in Florida and across the nation. There are excellent opportunities for FDOT to improve safety and reduce congestion near and at HRGCs to save lives, reduce injuries, and lower vehicle delays in Florida. FDOT has invested significant resources and efforts via STRIDE to implement dynamic envelope pavement markings and associated signs at State-owned HRGCs. A detailed research project is needed to assess the implementation results from STRIDE, since more deployments will be completed in Florida in the coming year. The proposed research project can assist FDOT in identifying implementation issues, success stories, best practices, and lessons learned from the current deployments to improve and support future deployments. For example, an earlier study in FDOT District 7 recommended that avoiding right-turn channelization within dynamic envelope areas can reduce the chance of drivers stopping at an RDE zone. Improving nighttime visibility of dynamic envelope pavement markings to motorists can increase the chance of drivers stopping at a safe zone and reducing the chance of them stopping at dangerous zones. It is also necessary to conduct the proposed project to assess the effectiveness and benefits of other implemented strategies and countermeasures from FDOT districts and other state DOTs besides dynamic envelope pavement markings, and further explore new and promising active and passive technologies to mitigate fatalities and injuries at HRGCs. Proposed Research Project Objectives This proposed research project objectives and supporting tasks include: 1. Understand safety issues and contributing factors to crashes at HRGCs • Review police crash reports at HRGCs in Florida that occurred between 2017 and 2021 • Identify the factors contributing to the crashes at HRGCs		

[1] Based on data from Signal Four Analytics

[2] Rail News - Florida DOT launches crossing safety initiative. For Railroad Career Professionals (progressiverailroading.com)

	• Provide data visualization and spatial analysis in ArcGIS to better understand the contributing factors 2. Assess the implementation of dynamic envelope pavement markings and associated signs at State-owned HRGCs in Florida • Review and analyze deployment results obtained from each FDOT district • Prepare interview questions and schedule interviews with each FDOT district on their deployments • Conduct detailed interviews with district representatives to assess the effectiveness, success stories, and lessons learned from implementing dynamic envelope pavement markings and associated signs • Document and summarize the results and findings from FDOT district deployments and district representative interviews 3. Investigate the effectiveness of various strategies, countermeasures, transportation systems management and operations (TSM&O) strategies, and Intelligent Transportation Systems (ITS) technologies to improve safety and mobility at HRGCs • Perform a literature review to identify effective strategies, countermeasures, TSM&O strategies, and ITS technologies to improve safety and mobility • Prepare interview questions and schedule interviews with representatives of each FDOT district and selected railroad companies • Conduct detailed interviews with district representatives to assess the effectiveness, success stories, and lessons learned from implementing various strategies, countermeasures, TSM&O strategies, and ITS technologies • Conduct detailed interviews with selected railroad company representatives to assess the effectiveness, success stories, and lessons learned from implementing various strategies, countermeasures, TSM&O strategies, and ITS technologies • Summarize the results and findings from the literature review, district representative interviews, and railroad company representative interviews 4. Examine and provide a list of HRGCs needed for Special Treatments and Recommend the Treatments • Identify potential HRGCs needed for special treatments based on the crash data analysis and interview results • Review and examine existing treatments, geometrics, traffic conditions, nearby traffic signal preemptions of the identified HRGCs, and their issues to be addressed • Provide a list of HRGCs needed for special treatments to improve safety and mobility • Develop and recommend special treatments for each HRGC on the list 5. Provide best practices, analysis results, research findings, and recommendations to FDOT to effectively improve safety and mobility at HRGCs in Florida. • Integrate the results and findings from the literature review and interviews with FDOT districts and selected railroad companies on effectiveness, success stories, and lessons learned from implementing various strategies, countermeasures, TSM&O strategies, and ITS technologies. • Develop best practices for effectively improving safety and mobility at HRGCs in Florida • Provide best practices, analysis results, research findings, and recommendations to FDOT and document all of project accomplishments in the final report <u>Research Effects on FDOT Mission Critical Focus Areas</u> As HRGC related fatalities and injuries continue to be significant in Florida, effective strategies and countermeasures are needed to mitigate those crashes. FDOT's mission is to provide a safe transportation system that moves people and goods, improves economic prosperity, and preserves the quality of Florida's environment and communities. The mission of the FDOT Traffic Engineering and Operations office is to improve safety and mobility through the efficient application of traffic engineering principles and practices. This proposed project fully aligns with FDOT's safety and mobility mission critical focus areas. The project will identify effective and implementable strategies and countermeasures for mitigating HRGC related fatalities and injuries, which help improve safety and mobility at HRGCs and on Florida roadways.
Impact	**How shall the results impact practice? Consequences of not doing the research?** <u>How shall the results impact practice?</u> The proposed research will review crash reports to identify safety issues and contributing factors to crashes at HRGCs, assess the implementation of dynamic envelope pavement markings and associated signs at State-owned HRGCs in Florida, and identify effective strategies and countermeasures for improving safety and mobility at HRGCs. The proposed research will conduct a comprehensive literature review and obtain valuable inputs from FDOT districts and selected railroad companies on effective TSM&O strategies, countermeasures, and ITS technologies. Therefore, the results from

	this research could improve current practices. The research findings and outcome of the proposed project could lead to major safety and mobility improvements at HRGCs in Florida to save lives, prevent injuries, and improve mobility. <u>Consequences of not conducting the research include the following:</u> • FDOT and local transportation agencies cannot obtain the findings from review of crash reports to understand safety issues and contributing factors to crashes at HRGCs. • FDOT and local transportation agencies cannot obtain the results and findings from a comprehensive literature review of strategies, countermeasures, and technologies to improve safety and mobility at HRGCs. • FDOT and local transportation agencies cannot obtain a detailed assessment for the implementation of dynamic envelope pavement markings and associated signs at State-owned HRGCs in Florida. • FDOT and local transportation agencies cannot obtain the effectiveness of various strategies, countermeasures, TSM&O strategies, and ITS technologies to improve safety and mobility at HRGCs. • FDOT and local transportation agencies cannot obtain a list of HRGCs needed for special treatments, issues to be addressed at each HRGC, and recommended treatments to improve safety and mobility at each HRGC. • FDOT and local transportation agencies cannot obtain best practice, analysis results, research findings, and recommendations to effectively improve safety and mobility at HRGCs in Florida.
Affected Offices	Traffic Engineering and Operation Office, Safety Office, Roadway Design Office
Existing Work	Z. Wang, P. Lin, A. Vasili, R. Guo, R. Yang, "Evaluation of a Low-Cost Countermeasure to Prevent Incorrect Turns at Highway-Rail Grade Crossing", ITE Journal, March 2021. P. Lin, Z. Wang, A. Vasili, R. Yang, "Pilot Implementation for Preventing Incorrect Turns at Highway-Rail Grade Crossings", Final Report, FDOT Project Number BDV25 TWO 977-54, November 2019. P. Lin, A. Fabregas, A. Kourtellis, E. Bryant, S. Lall, "Planning and Design for Prevention of Incorrect Turns onto Highway-Rail Grade Crossings," Challenges and Advances in Sustainable Transportation Systems, 358-365, ISBN (print) 978-0-7844-1336-4, American Society of Civil Engineers (ASCE), May 2014. X. Chen, Y. Xiao, M. Hadi, M. Ackert, P. Lin, "Assessment of Pre-Preemption Strategy of Traffic Signals near Railroad Grade Crossing Utilizing Simulation Analysis," TRB 93rd Annual Meeting, Compendium of Papers, Transportation Research Board, Washington DC, January 12-16, 2014. S. N. R. Grade, Preemption of Traffic Signals Near Railroad Grade Crossings. T. Urbanik, A. Tanaka, Traffic Signal Preemption at Intersections Near Highway–Rail Grade Crossings. NCHRP Synthesis of Highway Practice, (Project 20-05, Topic 47-15) 2017. R. Campbell, D. Dokupil, & N. Jackson, Railroad Preemption Interconnect Circuits: How to Improve Operations and Safety. IMSA Journal, 53(6), 2015. B. Russo, Examination of factors affecting frequency and severity of crashes at rail-grade crossings (No. 13-0163), 2013. S. Gabree, S. Chase, M. daSilva. (2014, April). Effect of dynamic envelope pavement markings on vehicle driver behavior at a highway-rail grade crossing. In ASME/IEEE Joint Rail Conference (Vol. 45356, p. V001T06A005). American Society of Mechanical Engineers.
Keywords Used in Existing Work Search **(Cannot leave blank)**	Highway-rail grade crossings; State of the practice; Dynamic envelope pavement marking, signal preemption, Railroad crashes; Traffic safety, Mobility
Related Contracts (Give contract numbers)	FDOT Contract BDV25-762-21, Rail Dynamic Envelope (RDE) Pavement Markings Before-After Study in FDOT District 7. FDOT Contract BDK85 977-54, Pilot Implementation for Preventing Incorrect Turns at Highway-Rail Grade Crossings. FDOT Contract BDK85 977-45, Improved Traffic Control Measures to Prevent Incorrect Turns at Highway-Rail Grade Crossings. FDOT Contract BDK85 977-44, Coordinated Pre-Preemption of Traffic Signals to Enhance Railroad Grade Crossing Safety in Urban Areas and Estimation of Train Impacts to Arterial Travel Time Delay. FDOT Contract BDV25-977-11, A Pilot Study for Preventing Incorrect Turns at Highway-Rail Grade Crossings.

	FHWA Contract Number: Project 20-05, Synthesis of Information Related to Highway Problems. Topic 47-13. State of the Practice for Traffic Signal Preemption at Intersections Near Highway-Railway Grade Crossings. FHWA Contract Numbers: SPR-PL-1(63)557; JPA 02-209/R0557 15P, Congestion Mitigation at Railroad-Highway At-Grade Crossings. FHWA Contract Number: State Project Number: DOTLT1000149, Evaluating the Effectiveness of Regulatory and Warning Signs on Driver Behavior near Highway/ Rail Crossings.		
Funding Request	$230,000	**Anticipated Duration**	18 months
Project Manager	Raj Ponnaluri, Ph.D., P.E., PTOE, PMP	**Contracting Method**	Direct contract with FIU (Dr. Alluri) and USF (Dr. Lin)
Equipment	N/A	Comments* N/A	
Urgency	1	Conflicts at HRGCs still create considerable safety and mobility issues in Florida. Injuries and fatalities related to highway-rail grade crossings are rising in the state. There is an urgent need to conduct a comprehensive assessment of strategies, countermeasures, and technologies for effectively preventing crashes at HRGCs. This proposed research project could assist FDOT in understanding safety issues and contributing factors to crashes at HRGCs, assessing the effectiveness and benefit of FDOT's implementation of dynamic envelope pavement markings under Florida Operation STRIDE, identifying effective TSM&O strategies, countermeasures, and new technologies to improve safety and mobility at HRGCs in Florida, and providing best practices, research findings, and recommendations to FDOT to effectively improve safety and mobility at HRGCs in Florida.	
Implementability	1	The findings from the proposed research will be useful and valuable to FDOT. They can provide the effective strategies, countermeasures, and technologies FDOT needs to effectively improve safety and mobility at HRGCs in Florida. The results will help FDOT implement successful TSM&O strategies, countermeasures, and technologies to prevent fatalities and injuries, and improve safety and mobility at HRGCs in Florida. The likelihood of implementing research results is highest.	

Project Benefits (Succinct, complete explanation)

- Provide FDOT and local transportation agencies with the findings from review of crash reports to understand safety issues and contributing factors to crashes at HRGCs.
- Provide FDOT and local transportation agencies with the results and findings from a comprehensive literature review of strategies, countermeasures, and technologies to improve safety and mobility at HRGCs.
- Provide FDOT and local transportation agencies with a detailed assessment for the implementation of dynamic envelope pavement markings and associated signs at State-owned HRGCs in Florida to support and improve future implementations.
- Provide FDOT and local transportation agencies with the effectiveness of various strategies, countermeasures, TSM&O strategies, and ITS technologies to improve safety and mobility at HRGCs.
- Provide FDOT and local transportation agencies with a list of HRGCs needed for special treatments, issues to be addressed at each HRGC, and recommended treatments to improve safety and mobility at each HRGC.
- Provide FDOT and local transportation agencies with best practice, analysis results, research findings, and recommendations to effectively improve safety and mobility at HRGCs in Florida.

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	N/A	N/A
○ Materials Savings	N/A	N/A

○ Time Savings	Reduced vehicle delay near and at HRGCs in Florida	The project can identify effective TSM&O strategies, countermeasures, and technologies to implement to reduce crashes and delays at HRGCs in Florida. According to the FRA data in 2018 and 2019, there was an average of 117 crashes per year at HRGCs in Florida. The effective implementation of these can save a significant amount of time from the reduction of non-recurring congestion caused by HRCG-related crashes, and recurring congestion caused by inefficient traffic signal operations near HRGCs during train crossings.
○ Lives Saved/Injuries Prevented	Up to 4 lives saved and 7 injuries prevented per year Up to $38M of total cost saving per year for saving lives and preventing injuries	The project will identify successful strategies, countermeasures, and technologies for reducing fatalities and injuries at HRGCs in Florida. According to the FRA data in 2018 and 2019, there was an average of 17 fatalities and 35 injuries per year at HRGCs in Florida. Avoiding 20% of deaths at HRGCs in Florida could save lives and lead to an estimated yearly savings of $34.34M (=17*$10,100,000*20/100=$34,340,000). The prevention of 20% of railroad crossing injuries can lead to an estimated yearly saving of $3.44M [=35*$(163,254+818,636)/2*20/100=$3,436,615]. The estimated total savings in social costs, in terms of loss of productivity, would reach $37.78M (=34.34M + 3.44M) or $38M.
○ Other (Explain)		The reduction on the number of fatalities, injuries, and crashes at HRGCs will enhance FDOT's reputation and the public's trust. It will also show the outcomes of FDOT's determination and actions to reduce crashes at HRGCs and to enhance safety and mobility.

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