Request for Research Funding for FY 2019-2020			
Requesting Office	FDOT District 7	**Priority** High	3 of 8
Proposed Title	Prioritized Safety Consideration by Work Zone Types and Pilot Implementations		
Justification	During the maintenance/reconstruction of existing infrastructure and the construction of new infrastructure, designated construction or work zones are important for the safety and efficient movement of road users and workers. These work zones are specially configured and managed by special traffic signs, standard channelizing devices, appropriate barriers, pavement markings, construction vehicles, and construction workers. The type of work zones and geometric configuration changes are based on the type of reconstruction or improvement work being done on a particular segment of the roadway in rural and urban settings. Based on the recommended temporary traffic control (TTC per MUTCD, Part 6, 2009) plan, the construction work continues with a specific target time to deliver the project by opening the corridor to normal traffic operation. A safe and efficient work zone operation and management is important to safety and mobility of all road users and construction workers. A major problem in freeway work zones is the safety of motorists and workers. If motorists are not provided with real-time or useful information, they don't know what delay, speed or travel time can be expected on the freeway. They are caught by surprise when vehicles ahead of them suddenly begin to brake, which often leads to rear-end accidents. Vehicles stray into the work area injuring construction workers. The result is a higher than normal crash rates in freeway work zones. There exists a necessity to provide accurate and reliable real-time information to motorists and apply smart work zone concept and associated countermeasures. Unfortunately, Florida moved to the 2nd highest number of work zone fatal crashes in 2015 and 2016 in the nation according to the National Work Zone Safety Information Clearinghouse. In 2017, there were 8,494 crashes in work zones, compared to 5,409 work zone crashes in 2014. This equates to approximately one work-zone crash per hour in 2017, as opposed to one crash every 1.6 hours in 2014. Considering the magnitude of the problem in terms of severity of work zone crashes, work zones are given significant emphasis in Strategic Highway Safety Plan (SHSP) defined by the American Association of State Highway and Transportation Officials (AASHTO). Appropriate traffic management is critical because it influences traffic delays, safety for motorists and workers, and completion of roadwork in a timely fashion, as well as the maintenance of access to businesses and residents in the area. Work zones can vary by duration and work zone types. There are four major work zone types including 1) lane closure, 2) lane shift/cross over, 3) work on shoulder or median, and 4) intermittent (i.e., mobile operations). The scope of this proposed research will focus on the investigation, innovative countermeasure development, testing, and evaluation on three stationary work zone types: lane closure, lane shift, and work on shoulder or median since an active national research focuses on mobile operation in work zone. Work zone are not encountered on a normal roadway system. With unexpected driving conditions of different work zone types and associated configurations, drivers should pay special attention on their driving. Speeding, careless driving, unfamiliarity with work zones, impaired driving, road curvature, and visibility issues at night are commonly known as major contributing factors to work zone related crashes. From previous crash data analysis, it has become clear that work zone types with their associated configurations play an important role on work zone safety. Besides a typical work zone setup, implementations of innovative countermeasures and technologies based on work zone types should be explored, tested and evaluated on their effectiveness to inform drivers, deter unsafe driving, and improve work zone visibility at night to protect drivers, pedestrians, and construction workers. During the period of construction with interruption of normal traffic flow, the frequency and severity of crashes vary by types of work zones. Importantly, the crash and severity risk associated with different work zone types is concerning for the safety professionals and construction agencies. The work zone related crash data (2011 - 2017) in Florida suggests that crashes areas where work is being performed on shoulders or medians are 1.1 to 1.5 times more likely to result in severe injury crashes (fatality or serious injury) compared to other work zone types. Moreover, the TTC plan is designed for different roadway functional classes with their geometric standards. The crash risk also varies for different functional classes of roadway for work zone types. Of major functional classes of roadways (freeway/ expressway, principal arterial, collector, and local), crashes in local and collector systems for work performed on shoulders or medians are 1.3 to 4 times and 1.2 to 1.6 times more likely to occur, respectively. As such, safety performance in terms of work zone types, needs to be clearly understood based on the data-driven approach. With the proper understanding of the safety performance by the work zone types, different strategies, countermeasures and technologies can be implemented to reduce the crash frequency by minimizing the risk associated with the severity of crashes. The work zone related crash data (CARS: 2011 – 2017) indicated that (1) disregarding traffic sign for lane closure, (2) exceeding posted speed limit for lane shift/cross over, (3) over-correcting in the driving for work on shoulder or median,		

	and (4) exceeding posted speed limit for intermittent work zones were the most risky driving maneuvers. They were identified from the crash investigations found in the Crash Analysis Reporting System (CARS) database in Florida. Recognizing the differences in the geometric configuration by work zone types and mitigating erroneous driving behavior can help frame different strategies from engineering, enforcement, education, and emergency services for work zone safety in Florida. Since the nation and Florida are predicted to grow economically, in terms of system preservation of road infrastructures with new constructions, work zones are likely to increase across the state with continued exposure to crash risks and injury severity. Given the importance of the work zone and its impacts, proper strategies and innovative countermeasures and technologies need to be developed by work zone types in Florida across the agencies and stakeholders. FDOT District 7 is currently experiencing serious problems on work zone safety with 45% fatal and injury crashes relative to other districts in Florida according to the crash data (CARS: 2011 – 2017). From the work zone safety statistics, Hillsborough ranks #1 worst, Pasco ranks #2 worst in counties above 200,000 population and Hernando ranks #2 worst in counties with population between 50000 and 200000 in Florida. The crash data (CARS: 2011 – 2017) also indicates that 93% of work zone crashes on urban areas in District 7, where work on shoulder/median is predominant work zone type (more than 50% of work zone crashes). It makes FDOT District 7 the best FDOT district as a testbed for pilot testing and evaluation of innovative countermeasures and technologies on reduction of work zone related fatalities, injuries and crashes. Given the need for research, the project objectives are as follows: 1. Perform a comprehensive literature review of proven countermeasures, innovative countermeasures, smart work zone initiative and system, as well as their applications and associated benefits. 2. Conduct detailed work zone related crash analysis focusing on the work zone types for time of day, month of year, land use, functional class, vehicle type involved, drivers' demographics and driving actions, driving speed, behavioral factors, and geometric consideration to understand the problem and causes thoroughly. The behavioral factors could include speeding, reckless driving, and impaired driving due to alcohol/drug. The geometric consideration should cover at least shoulder/median width, length of work zones, and number of lanes. 3. Develop and recommend innovative countermeasures for field implementation and evaluation, and establish safety performance matrices specific to three major work zone types: 1) lane closure, 2) lane shift/ lane cross-over, and 3) work on shoulder or median. 4. Conduct a pilot implementation of recommended/state-of-art practice innovative countermeasures (e.g., advanced work zone design, dynamic message sign with real-time information, dynamic lane merge, variable speed limit, and automated speed feedback sign etc.) and/or a series of countermeasures finalized by FDOT project manager in FDOT District 7, by work zone types, to evaluate their effectiveness. To provide a flexibility to account for a quick technological change, FDOT could add or remove a specific countermeasure for implementation if necessary.
Impact	Currently, Florida has no standardized strategies by work zone type, which means the same strategies/countermeasures are applied for all four types of work zones with limited effectiveness (e.g., reduction of crashes in work zones). This prevents Florida DOT from achieving a target reduction of crashes and resulting injuries in work zones. Considering Florida will continue to have more system preservation on aging infrastructure and new construction related to roadway infrastructure, the proposed research is expected to provide practical solutions to mitigate this issue by developing effective and smart countermeasures by work zone types, and applying smart work zone concepts.
Affected Offices	Construction, State Traffic Engineering and Operations, District Traffic Operations, Safety
Existing Work	There are limited studies on specific strategies in terms of implementation for different types of work zones. However, the existing literature provides some insights why implementation of specific countermeasures are important for agency like State Department of Highways: *Analysis of Passenger-Car Crash Injury Severity in Different Work Zone Configurations (Osman M., Paleti, R, and Mishra, S., Accident Analysis and Prevention 111, pg. 161-172, AAP, 2018)* This study analyzed 10-years for work zone crashes in Minnesota involving at least a passenger car and identified underlying factors contributing to injury severity levels for different work zone configurations. The analysis suggests that partial access control, on rural roads, time of day such as evening times, day of week such as weekends, and roadway alignment such as curved roadways are key factors that increase the likelihood of severe outcomes in work zones. This study highlighted the importance of implementation of specific safety measures based on the specific configuration of a work zone for FHWA, State DOTs, and public agencies. *Risk Factors Affecting Crash Injury Severity by Work Zone Area (Koilada, K., Pulugurtha S., and Mane, A., Transportation Research Board 97th Annual Meeting, Paper No. 18-05849, TRB 2018)*

<table>
<tr><td></td><td colspan="3">This study explored 5 years of data from North Carolina and identified the factors associated with different work zone locations, such as advance warning sign, transition and activity area inside work zone. The findings indicate the risk of getting involved in a work zone crash for –
▪ Advance warning area: is higher on roads with flexible post barrier medians but lower on roads with semi - rigid post barrier medians.
▪ Transition area: is higher on roads with rigid and flexible post barrier medians.
▪ Activity area: is higher in extreme weather conditions, on roads with rigid and flexible post barrier medians, on roads with speed limit between 26 mph - 45 mph, on interstates and on US routes.
Modeling Highway Performance under Various Short-Term Work Zone Configurations (Ramadan, O. and Sisiopiku, V., Journal of Transportation Engineering, Vol. 144 (9), ASCE 2018)
The performance-based planning and programming for work zones is important for Federal rules mandating the state departments of transportation (DOTs) and metropolitan planning organizations (MPOs). This study proposed three measures representative of level of service (LOS), travel delays, and environmental impacts with a case study on simulated work zones under various configurations. The results of the analysis provided clear evidence that work zone length does not affect facility performance significantly and late merge control as opposed to merge control holds great promise for implementation.
Guidance for Safe and Effective Temporary Traffic Control for Mobile Operations on Two-Lane Two-Way Roadways (LuAnn Theiss, NCHRP 03-132 [Active] project)
The objective of this research is to develop guidance to enhance safety and effectiveness of mobile operations on two-lane, two-way roadways under variable conditions. The guidance should address all aspects of mobile operations from planning (when to use mobile operations vs. other methods for lane closures) through implementation, and be useable by any entity involved in mobile operations.
Smart Work Zone (Raj Ponnaluri, Presentation, FDOT Transportation Systems Management & Operations (TSM&O), 2019)
This presentation describes how to leverage Intelligent Transportation System (ITS) and Connected and Automated Vehicle (CAV) applications and technologies to create the smart work zone (SWZ).</td></tr>
<tr><td>Keywords Used In Existing Work Search

(Cannot leave blank)</td><td colspan="3">Work Zone Safety, Construction, SHSP, Safety Performance, Work Zone Type, Countermeasures, Technologies</td></tr>
<tr><td>Related Contracts (Give contract numbers)</td><td colspan="3">BDK51, BB894, BDR74-977-01, BDV29-977-06, BD500-V2, and BDV29-977-33</td></tr>
<tr><td>Funding Request</td><td>$200,000</td><td>Anticipated Duration</td><td>21 months</td></tr>
<tr><td>Project Manager</td><td>Ms. Edith Wong
Co-PM: Raj Ponnaluri</td><td>Contracting Method</td><td>Direct contract with the Center for Urban Transportation Research (CUTR) at the University of South Florida</td></tr>
<tr><td>Urgency</td><td>1</td><td colspan="2">Nationally, fatal crashes and fatalities in work zone areas are increasing. Following that trend, work zone crashes have been increasing in Florida since 2014 when Florida experienced the 3rd highest number of fatal crashes, and moved up to the 2nd highest number of fatal crashes in the nation in 2015 and 2016 according to the National Work Zone Safety Information Clearinghouse.
FDOT District 7 is currently experiencing serious problems on work zone safety. From the work zone safety statistics, Hillsborough ranks #1 worst, Pasco ranks #2 worst in counties above 200,000 population and Hernando ranks #2 worst in counties with population between 50000 and 200000 in Florida.
There is an urgency to conduct the proposed research to improve work zone safety in Florida and FDOT District 7.</td></tr>
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Implementability	1	FDOT District 7 will be ready to support pilot implementations for recommended countermeasures. The recommended innovative strategies, countermeasures and technologies will be pilot-tested and implemented in FDOT District 7 via this proposed research project. The research findings from this proposed research project can directly support and benefit other FDOT districts on implementations of effective countermeasures based on work zone types and associated configurations to reduce work zone related fatalities, injuries and crashes. FDOT District 7 can serve as a testbed for pilot implementation of recommended innovative work zone countermeasures.

Project Benefits (Succinct, complete explanation)

- Understand the safety and mobility impacts of a road construction/maintenance/rehabilitation project from comprehensive literature review and work zone mobility and safety analysis.
- Help agency staff know how decisions made during planning, design, and construction are likely to affect road users, businesses, other transportation modes, and transportation system performance.
- Monitor the number of crashes, fatalities, and serious injuries by work zone types over the years for specific project length considering corridor specific parameters such traffic volume, mix of traffic, detour for local system.
- Estimate the crash risk by severity for work zone as opposed to non-work zone related crashes controlling for exposure (traffic volume) over the same corridor to understand relative risk of driving through the work zones.
- Compute the respective rates (per 100M VMT) for fatalities and serious injuries within the work zone limits as per FHWA safety performance measures.
- Understand the historical trend of crashes by severity for different work zone types and their correlation with other factors, such as weather, time of day, driving behavior (e.g., speeding, aggressive and distracted driving, driving under influence), presence of workers and/or enforcement, and diversion of traffic.
- Comprehensive review of proven and innovative countermeasures and their applications and benefits under different strategies considering the time frame of implementation of countermeasures (such as short, medium and long) (NCHRP Report 500: Vol. 17: A Guide for Reducing Work Zone Collisions, TRB 2005).
- Implement and evaluate a set of countermeasures with ITS deployment, particularly dynamic late lane merge, variable speed limit sign, and/or automated speed feedback sign as part of smarter work zone management based on the characteristics of crash severity and traffic condition for different work zone types. These countermeasures also include infrastructure improvements such as signage, pavement marking, and roadway lighting particularly at night where the motorists need safe and efficient delineation through different work zone configurations with Maintenance of Traffic (MOT) plan considering the constrained geometry, degraded surface condition, difference in vertical and horizontal alignment. (Note: Florida crash data via CARS suggest fatality risk at night is 3 times higher at night than during the day in work zones).

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		
o Materials Savings		
o Time Savings	Reduction on vehicle delay and person-hour delay	The project team will use the FHWA Traffic Analysis Toolbox: Work Zone Modeling and Simulation to conduct traffic operations analysis and assess the benefits of delay reduction from effective implementations of work zone countermeasure and technologies. Benefit-cost analysis will be performed based on benefit from the estimated delay reduction on vehicle-hours and person-hours, and the cost for the countermeasure implementations.

o Lives Saved/Injuries Prevented	Reduction on number of Fatalities and serious injuries. Fatality and serious injury rates per 100M VMT in work zone areas	Florida crash data via CARS and corridor specific parameters (e.g., length of work zone, duration, traffic volume, speed) will be linked together to compute these safety performance measures for work zones in Florida (preferably work zones on state roadway systems). Benefit-cost analysis will be performed based on benefit from the estimated reduction on number of fatalities and serious injuries, and the cost for the countermeasure implementations.
o Other (Explain)	Better understanding of safety and mobility impacts from different work zone types Better understanding of applications and benefits of recommended countermeasures and technologies	The project team will conduct a comprehensive literature review and survey, and detailed work zone related crash analysis to assess the safety and mobility impacts from different types of work zones. In addition to the literature review and survey, the project team will use the FHWA Traffic Analysis Toolbox: Work Zone Modeling and Simulation to quantify the benefits of key countermeasures and promising innovative countermeasures and technologies for different work zone types. A pilot testing of innovative countermeasures or a set of countermeasures on a smaller geographical scale by three major work zone types will be conducted to evaluate the effectiveness of existing or/and recommended ITS applications in the close proximity of work zones.

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