SWZDI
Smart Work Zone Deployment Initiative

Development of a Low-Cost Work Zone Queue Warning System

tech transfer summary

A prototype low-cost and less complex queue warning system was developed, but crash testing and field tests will be required before full-scale implementation is possible.

Objectives

- Design a low-cost, mobile, and easy-to-deploy, queue warning system (QWS) for use on all types of highways
- Conduct a test of a prototype in the field

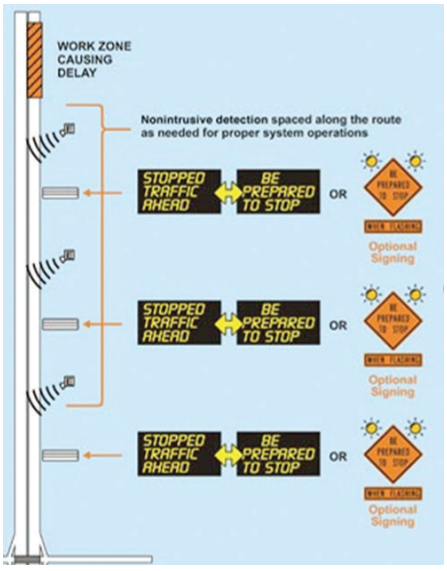
Problem Statement

Implementation of queue warning systems has been limited in work zones due to their cost and complexity. Because of the complexity and variable lengths of queues, it is also difficult to provide adequate coverage throughout the work zone.

Background

Back-of-queue crashes are a significant safety hazard in highway work zones—especially those with intermittent congestion. Work zone crashes most often involve a front-to-rear crash caused by a vehicle traveling at high speed approaching a line of stopped or slowed traffic. If the approaching vehicle fails to decelerate sufficiently, the result can be a severe collision at the back of the queue.

Safety benefits of queue warning systems in work zones are demonstrated from multiple QWS deployments in work zones. One study estimated a crash modification factor of 0.559, indicating a 44% decrease in crashes when a QWS was used.



MnDOT

Low-cost QWS using multiple detectors and signs

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RESEARCH PROJECT TITLE
Development of a Low-Cost Work Zone Queue Warning System

SPONSORS
Smart Work Zone Deployment Initiative (TPF-5(295))
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Iowa, Kansas, Missouri, and Nebraska created the Midwest States Smart Work Zone Deployment Initiative (SWZDI) in 1999 and Wisconsin joined in 2001. Through this pooled-fund study, researchers investigate better ways of controlling traffic through work zones. Their goal is to improve the safety and efficiency of traffic operations and highway work.

IOWA STATE UNIVERSITY
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TPF-5(295)

A number of intelligent transportation system (ITS) technologies have been developed and are available to provide queue warning. These systems typically use side-fire radar for speed detection and trailer-mounted portable changeable message signs (PCMS) to display the warning message to drivers.

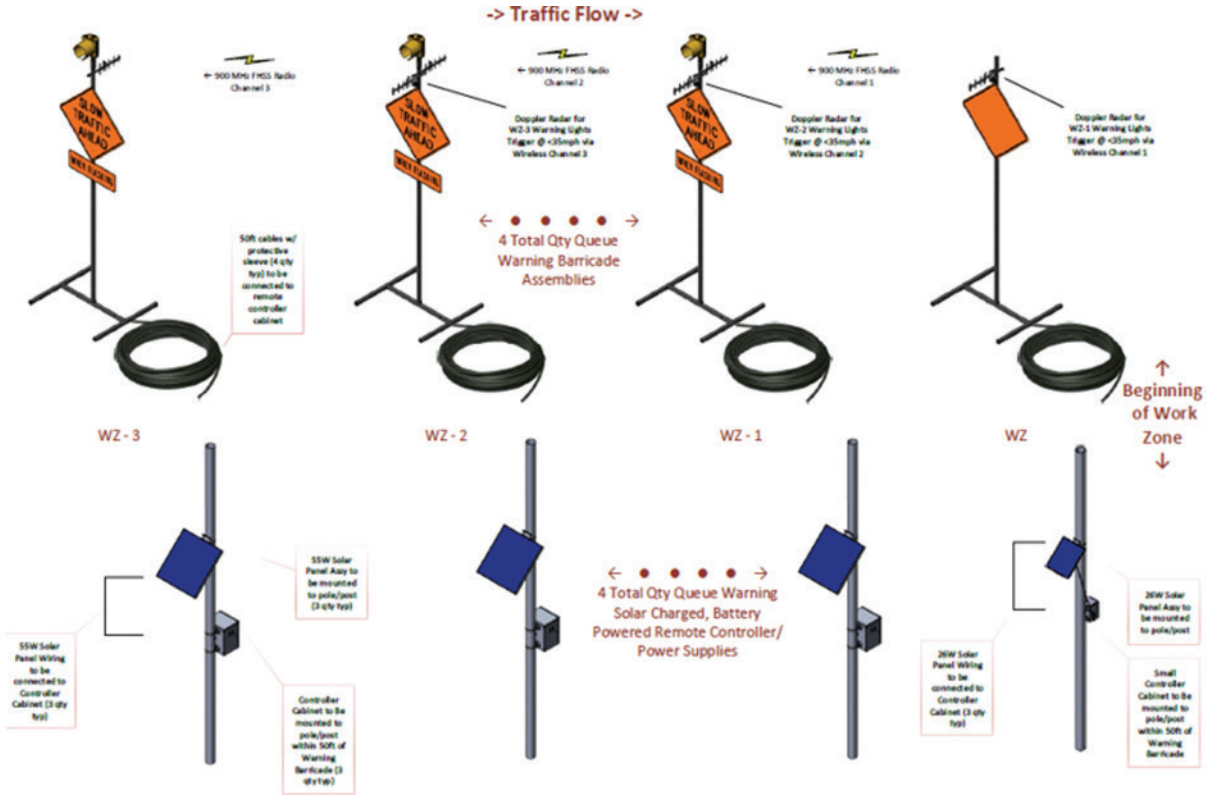
The PCMS use significant power requiring generators or solar power. These design characteristics increase weight, add complexity, and make the equipment relatively difficult to reposition as work progresses. Similarly, a number of designs require a telecommunications backhaul to a traffic operations center (TOC), rendering them unsuitable for remote sites or jurisdictions that do not have a TOC.

Project Description

- Conducted a national literature review on safety effectiveness of back-of-queue warning in work zones
- Designed a prototype low-cost back-of-queue warning system to collect and communicate traffic data between detectors, the system controller, and traffic signs using off-the-shelf commercial hardware
- Developed a sign legend warning message and warning light system to alert motorists when queue back-ups are identified
- Used an iterative design process to identify a sign support hardware system that would most likely, based on engineering judgement, satisfy current crashworthiness standards

Key Findings

- The sign warning message SLOW TRAFFIC AHEAD WHEN FLASHING offered the best warning message to alert motorists about potential back-ups.
- The research team identified a sign support system with a warning light that had been successfully crash tested to American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) standards with a 36 in. × 36 in. sign. However, the team did not identify a similar sign support system that also included additional lights and communication equipment (an antenna) mounted on the support.
- The final QWS prototype is based on the generic sign support system developed by the Texas A&M Transportation Institute for the Texas Department of Transportation (TxDOT), although its size limited the team's ability to test the equipment in the field.
- Based on engineering judgement, a prototype low-cost back of queue QWS was developed for use on all types of highways, including conventional highways, that is likely to comply with MASH standards, but the team was not able to verify this decision by conducting crash and field tests.



TAPCO

Prototype SWZDI low-cost queue warning system hardware components

Conclusions and Recommendations

The low-cost back of queue warning system is not ready for field testing or implementation on two-lane highways until crash testing of the 36 in.^{2} sign support system is conducted.

Before this low-cost QWS can be used on all highways, including freeways, further research is needed to develop the system with a 48 in.^{2} sign, to accommodate an acceptable larger message letter size, and conduct testing in accordance with MASH crash standards.

Implementation Readiness and Benefits

The proposed low-cost QWS design would cost a fraction of the conventional QWS based on PCMS standards. In addition, modular design of the low-cost QWS will allow the system to be extended as far upstream as necessary to provide ample driver notification in high-, medium-, and low-demand situations. However, further tests are needed before the proposed system can be implemented.