Use of Smart Work Zone Technology to Improve Work Space Access Point Safety

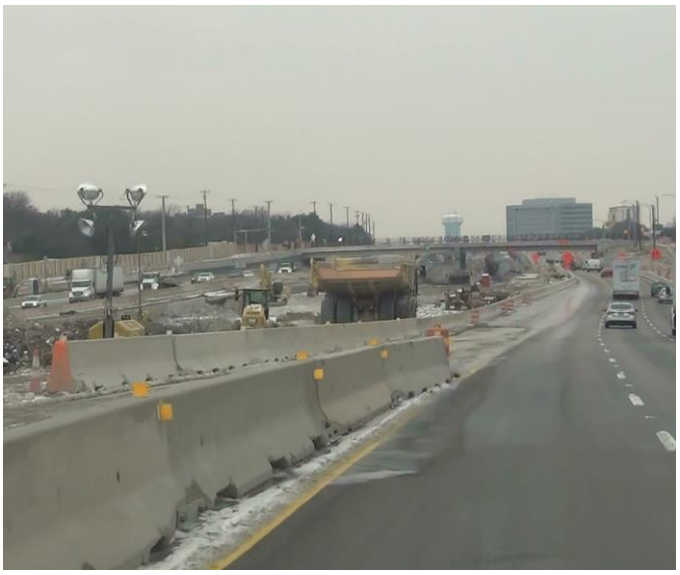
U.S. Department of Transportation
Federal Highway Administration

American Road & Transportation Builders Association

The Problem

Large trucks have been significantly over-represented in fatal work crashes nationally for the past several years, and are believed to be over-represented in injury and property-damage-only work zone crashes as well. Many of these crashes involve rear-end collisions. In fact, between 2012 and 2017, over 58 percent of large truck-involved fatal work zone crashes on interstate and freeway facilities involved rear-end collisions (*1*). Approximately one-half of those collisions involved a passenger vehicle running into the back of a large truck.

Although many of those types of crashes happen at the upstream end of traffic queues created by lane closures and other work activities, others occur when semi-tractor trailer trucks or dump trucks pull out of a construction work space at very slow speeds directly into high-speed travel lanes and are struck from behind by a vehicle in that lane. Similarly, other rear-end collisions occur when large work vehicles must slow down dramatically in a high-speed travel lane to turn into a construction work space access point and are struck from behind.



Source: TTI

A Solution – Smart Work Zone Technology to Warn Approaching Motorists

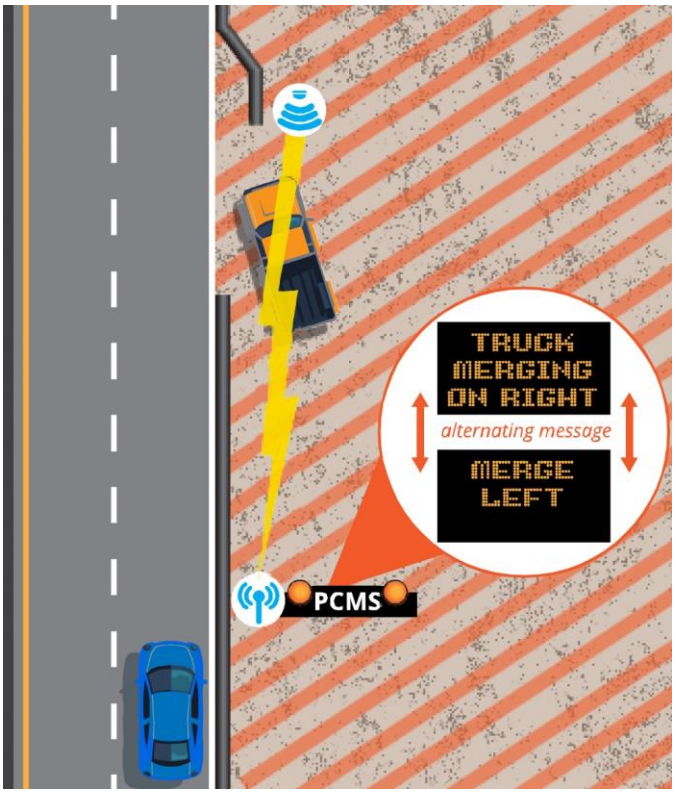
One way to reduce crashes between slow-moving construction vehicles entering and exiting work spaces and high-speed traffic is to warn approaching drivers of the presence of the slow-moving vehicle. Most agencies specify the use of static warning signs indicating that trucks may enter the roadway from the work space. Unfortunately, because motorists often pass these signs repeatedly without encountering construction vehicles entering or exiting the work space, they eventually learn to disregard the sign and fail to remain vigilant to the possibility of a slow-moving vehicle in the vicinity.

The lack of credibility of static signs can be mitigated by using technology to detect when construction vehicles are about to enter or exit a work space (*2*, *3*, *4*). With such detection, the warning message becomes dynamic and indicates to motorists that a slow-moving vehicle is indeed likely to be encountered downstream. Approaching motorists are then better prepared to slow down or change lanes as desired.

Warning Systems for Vehicles Exiting the Work Space

Description

Smart work zone (SWZ) systems exist that can detect a construction vehicle as it approaches the access point to exit the work space and automatically activate a warning to motorists upstream. Radar, microwave, and video detection can all be used for this purpose, although radar-based detection is likely to be the lowest cost. Both static warning signs with activated flashing lights and portable changeable message signs (PCMSs) with messages that are activated when a truck is detected can be used. Certain work space access point configurations will allow the sensor to be mounted directly on the sign and aimed where the construction vehicles will approach the exit.



Source: TTI

Other access point designs will require the sensor to be mounted separately from the sign and wireless communications used to activate the sign.

** Source: Street Smart Rentals*

** Source: Solar Advanced Warning Systems (SAWS)*

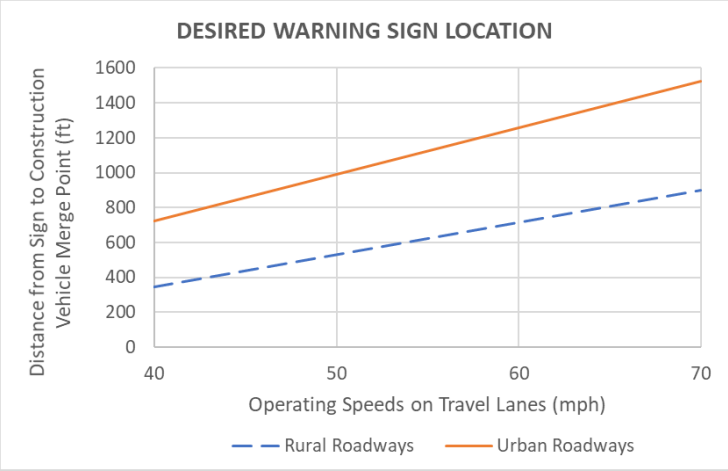
Key Considerations

- It is essential that the system reacts almost instantaneously when detecting a construction vehicle about to enter the travel lanes. This implies that sensors need to be wired directly into the processor that activates the flashing lights or message displays, or that direct point-to-point wireless communication (e.g., radio) exist between the sensor and the sign display.
- It is important that the sensor itself be positioned and oriented such that it only detects construction vehicles that are about to exit the work space and enter the travel lanes. Sensor location should be tested to ensure that the sensor does not detect other construction vehicles in the work space that are not about to exit, or main lane traffic approaching in the adjacent travel lanes. This can be a bigger issue for radar-based systems, due the spread of the radar signal itself. Microwave and video detection systems can be aimed more precisely, but are more susceptible to vibrations or slight bumps by other equipment passing by that can push the sensor out of alignment and cause the system to discontinue operations. These sensors also require recalibration each time it is deliberately moved because of work activities.
- The warning sign, regardless of whether it is a static warning sign with flashers or a PCMS message, should be located far enough upstream of the access point to allow motorists to detect, perceive, and react to the warning message. Applying principles of positive guidance (*5*), this distance ranges from approximately 400 to nearly 1600 feet depending on the operating speed of the travel lanes and the adjacent land use of the facility.
- Drivers will adjust their speed and perhaps change lanes if they perceive a need to do so. Therefore, it will be helpful to have the location of the warning sign within sight of the construction vehicle merge point into the travel lanes. When the sign is activated, approaching motorists will be able to look downstream and see the construction vehicle about to merge, adding credibility to the warning sign.

Warning Systems for Vehicles Entering the Work Space

Description

SWZ technology can also be used to warn of construction vehicles slowing in the travel lane as they prepare to enter a work space. However, it is difficult to detect an approaching construction vehicle within the overall traffic stream using traditional sensor technologies. As a result, other detection methods are needed. For instance, one option is to instrument the construction vehicles themselves with radio-frequency identification (RFID) or other type of transmitters and install a sensor upstream of the construction access point that can detect the transmitters and activate the warning message. If it is not possible to instrument the construction vehicles, then it may be necessary to utilize a non-smart work zone option, such a flagger or spotter positioned upstream and assigned to communicate with the drivers of the approaching construction vehicles, activate the warning sign when the vehicles are appropriately close, and then terminate the message once each construction vehicle has entered the work space.

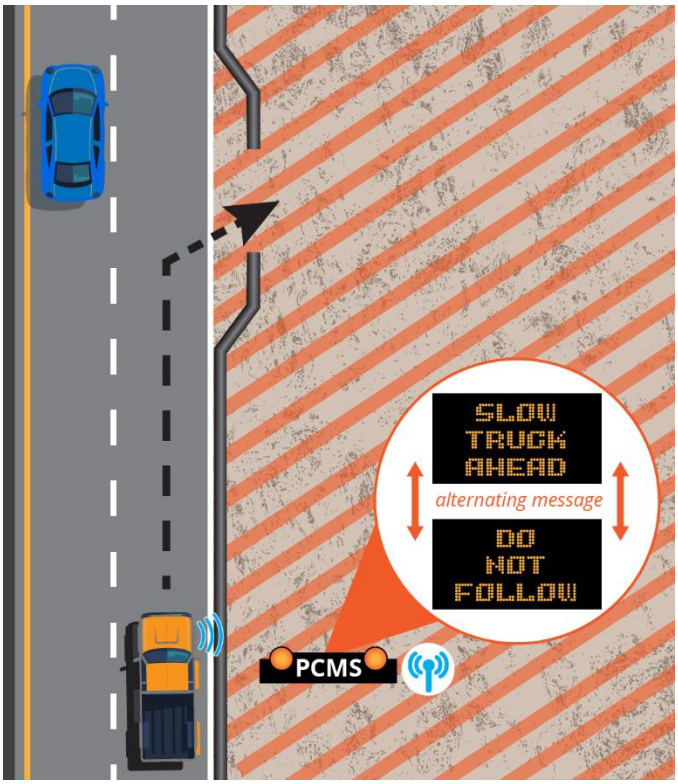


Source: Adapted from (5)

Key Considerations

- As with systems that warn of construction vehicles entering travel lanes, this system requires nearly instantaneous reaction to a detection of an approaching construction vehicle.
- The location of the advance warning sign relative to where construction vehicles are expected to begin slowing in the travel lane should still be based on positive guidance principles. The graph above is therefore also appropriate for this type of application.

Additional information on how to improve large truck safety in work zones can be found elsewhere (*6*, *7*).



Source: TTI

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