



Project Summary Report 0-4028-S

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Project 0-4028: Statistical Analysis of Highway Work Zone Hazards
and Their Associated Risks

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Work Zone Crash Influences on Texas Roadways

As the caption for [Figure 1](#) indicates, protecting both workers and the traveling public in work zones is a high priority for the Texas Department of Transportation (TxDOT). TxDOT continuously searches for answers concerning what can be done to help reduce the frequency of fatal work zone crashes in Texas. To find such answers, officials need a better understanding of the work zone features and conditions that are associated with fatal work zone crashes.

Unfortunately, traditional police crash report forms do not capture work zone features with the level of detail and consistency needed for a meaningful analysis. Therefore, TxDOT contracted with the Texas Transportation Institute (TTI) to develop a method to obtain detailed work zone information from fatal crash locations, collect and analyze the information, and provide countermeasure recommendations to reduce fatal work zone crashes statewide.



Figure 1. Protecting Both Workers and the Traveling Public in Work Zones Is a High TxDOT Priority.

What We Did...

Five TTI researchers from College Station, Arlington, Houston, and San Antonio joined forces to serve as work zone crash site investigators for the duration of the project. Upon notification that a fatal crash had occurred in a work zone, one or more of the researchers would travel to that location and conduct a focused inventory and assessment of the features and conditions at the work zone at the time of the crash. The data were then analyzed to determine relevant

trends and identify potential countermeasures that could help reduce the fatal work zone crashes that occur.

Researchers first met with TxDOT officials and with representatives of the Texas Office of the Attorney General to formulate appropriate data collection and analysis protocols. Researchers then contacted safety coordinators and others in each of the TxDOT districts and requested that they contact the TTI researchers whenever a fatal work zone crash occurred in their jurisdiction. The data



collection protocol was pilot-tested, and each of the researchers was trained in the protocol to ensure consistent inventories and assessments over time and among the research team members.

The inventory and assessment protocol required researchers to document work type and location, permanent and temporary roadway geometrics, sight distances, and permanent and temporary traffic control signing layout and condition present in the vicinity of the crash. After each investigation, these data were brought back to the office and compared to existing standards such as the *Manual on Uniform Traffic Control Devices (MUTCD)*. Researchers also utilized principles of positive guidance to assess the condition of the overall information system presented to drivers traversing the work zone.

For each work zone assessed, researchers strove to develop an understanding of the likely chain-of-events leading up to and through the crash. Researchers also attempted to assess what work zone features, if any, may have had any direct or indirect influences upon the chain-of-events. For purposes of this project, influence was defined as anything that — if removed — may have somehow altered the chain-of-events that led to the crash in the first place. Some examples are shown in [Table 1](#) of the types of direct and indirect work zone influences on the hypothesized chain-of-events assessed during the project.

It is important to note that influences as defined in this project do not necessarily imply crash causation. Generally speaking, though, direct work

Table 1. Examples of Direct and Indirect Work Zone Influences on Crash Chain-of-Events.

Types of Work Zone Influences	Specific Examples Identified
Direct	<ul style="list-style-type: none"> • Pavement edge drop-off is higher than currently allowed in standards • Signing and channelization are misaligned enough to potentially create travel path confusion for the driver • Horizontal alignment is designed for speeds significantly lower than upstream operating speed of traffic
Indirect	<ul style="list-style-type: none"> • Temporary two-lane, two-way operations on a previous four-lane divided facility create a more difficult crossing condition for a jaywalking pedestrian • Elimination of emergency shoulders requires stalled vehicle to remain in active travel lane until removal • Temporary lane closures create traffic queues that are not normally expected or likely on the facility at that time of day (or night) • Dust from construction activities temporarily reduces driver visibility • Loss of edge line delineation at night during repaving operations eliminates a source of control and guidance information otherwise available to drivers • Loss of continuous shoulder rumble strip protection (when previously present) during repaving operations eliminates a warning system otherwise available to drivers • Wrong-way vehicles intrude into a work area from the unexpected direction and surprise oncoming traffic and the work crew

zone influences tended to be conditions that may have not completely conformed to existing standards or guidelines. Conversely, indirect influences were those conditions that were compliant from the standpoint of current standards and guidelines, but which still could be seen as influencing either the likelihood or the consequences of the crash chain-of-events.

As the number of work zone assessments performed during the project grew, researchers began to consolidate them into similar chain-of-event “scenarios” as a way of uncovering useful trends.

These scenarios then served as the basis for identifying possible countermeasures to mitigate work zone crashes.

What We Found...

Over a 15-month period, researchers investigated 77 fatal work zone crash locations. As might be expected, many crashes that occur within a work zone do not appear to be in any way directly or indirectly influenced by the presence of the work zone itself. As shown in [Figure 2](#), nearly one-half of the crashes investigated (45 percent) fell into the “no-work-zone-influence”



category. In comparison, only 8 percent of the crashes in the crash chain-of-events were judged to have had a “direct work zone influence,” while another 4 percent of the crashes occurred during work zone traffic control set-up or removal. (Set-up and removal crashes were examined separately because it was not immediately apparent whether such crashes should be considered affected by direct or indirect work zone influences.)

Perhaps most important was the finding that 39 percent of the crashes were judged to have an “indirect work zone influence” associated with them. Obviously, from TxDOT’s perspective, countermeasures that address these various indirect work zone influences would be expected to have a significant impact on safety.

The Researchers Recommend...

Emphasizing the crashes where indirect work zone influences were identified in the chain-of-events, researchers brainstormed and critiqued numerous potential crash countermeasures. From the initial list, researchers have presented eight final countermeasures for TxDOT consideration and adoption. These recommendations are as follows:

- Encourage flaggers to have audible warning devices (i.e., horns) with them at flagger stations to warn the work crew of an out-of-control vehicle that they have been unable to stop which is about to encroach into the activity area.
- Encourage additional research into panic-button-type safety

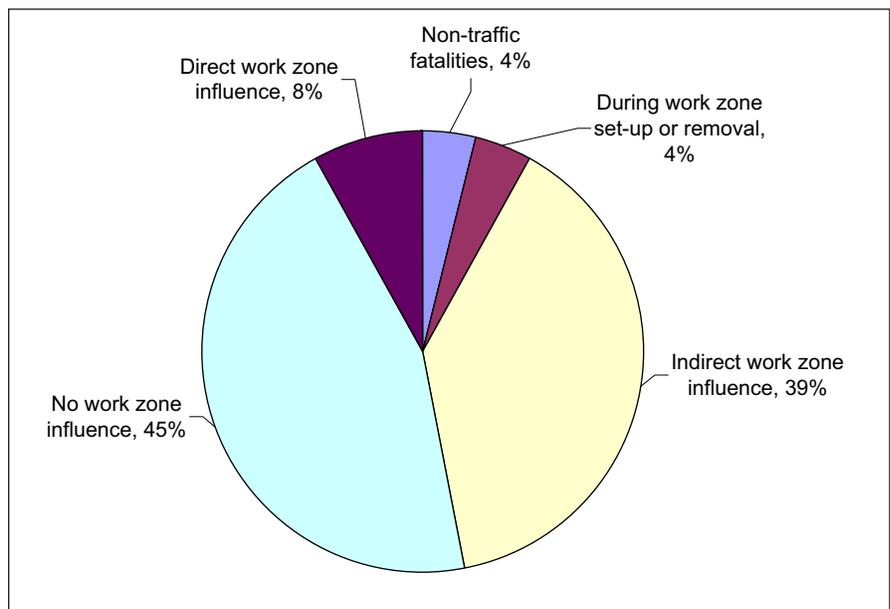


Figure 2. Work Zone Influence on Crash Chain-of-Events.

- clothing to be worn by all workers to warn each other of out-of-control vehicles that may encroach upon the activity area.
- Consider experimentation and eventual implementation of a highly mobile barrier system for short-term work zone activity areas, such as is currently under development in California.
- Consider requiring the use of channelizing devices to continuously delineate roadway edges at night when rumble strips and/or edge line pavement markings are removed or missing temporarily due to pavement resurfacing or replacement.
- Require that a mobile work operation being performed on a paved shoulder switch to the traffic control required for a mobile operation moving in an active travel lane whenever encroaching into the travel lane (such as at shoulder drops at bridges).
- Consider requiring exits or break-down refuge areas be made available at regular intervals (2 miles or less) in work zones where both shoulders are removed for construction.
- At work zones where the direction of travel is changed temporarily in one or more lanes (i.e., a four-lane facility that is converted to two-lane, two-way operation), encourage the use of opposing lane dividers or lane use arrow pavement markings to reinforce the fact that the travel direction for the lane has changed.
- Discourage traffic control plan designs that include transition areas for the work zone on an existing horizontal curve, and encourage that the transition be accomplished on a tangent section instead.



For More Details...

The research results, recommendations, and operating guidelines are documented in [Report 0-4028-1, *An Analysis of Fatal Work Zone Crashes in Texas*](#).

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The objective of this research project was to develop a better understanding of work zone conditions that are associated with fatal crashes in work zones. This was done through the development of detailed data collection techniques in work zones following a fatal crash. One product was required for this project: a list of typical hazards and risks found in work zones and recommended improvements to mitigate fatal work zone accidents. Currently, none of the findings developed in this project have been implemented; however, the Traffic Operations Division has referenced Research Report 0-4028-1, *An Analysis of Fatal Work Zone Crashes in Texas*, in TxDOT's annual Traffic Control Review Team report to the Federal Highway Administration. Some of the findings from this project may be incorporated into a work zone handbook or other standard manuals for distribution to TxDOT districts.

For more information, contact Mr. Wade Odell, P.E., RTI Research Engineer, at (512) 465-7403 or email wodell@dot.state.tx.us.

YOUR INVOLVEMENT IS WELCOME!

Disclaimer

This research was sponsored by the Texas Department of Transportation in cooperation with the Federal Highway Administration. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation or the Federal Highway Administration. This report is not intended to constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes.

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