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16. Abstract

This publication catalogs several devices that were found to be effective at improving driver and worker safety at short-term work zones. The devices included are: fluorescent yellow-green worker vests and hard hat covers, portable variable message signs, speed display trailers, fluorescent orange roll-up signs, radar drones, and retroreflective magnetic strips for work vehicles. The catalog provides a brief description of each treatment, along with a summary of the treatment's effectiveness, and recommendations for its use at short-term work zones.

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CATALOG OF EFFECTIVE TREATMENTS TO IMPROVE DRIVER AND WORKER SAFETY AT SHORT-TERM WORK ZONES

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INTRODUCTION

Short-term, rural work zones have a number of characteristics that make safety a concern. These work zones are typically in place for a single day, making effective enforcement of these work zones impractical. Often, regulatory speeds cannot be lowered in these short-term work zones.

Countermeasures that can be quickly and easily set up in the work zones are needed in order to improve the safety of both workers and motorists. This document summarizes the results of a two-year evaluation of innovative work zone safety treatments in short-term rural work zones in Texas and catalogs the treatments that were determined to be effective. The detailed results of this evaluation can be found in the two yearly reports produced for the project (*1*,*2*).

DEVICE EFFECTIVENESS

The following devices produce positive impacts in temporary maintenance work zones:

- fluorescent yellow-green worker vests and hard hat covers,
- portable variable message signs, and
- speed display trailers.

Several additional devices showed some promise. These devices produced modest benefits, need to be further refined, or need to be studied in greater detail. These devices include:

- fluorescent orange signs,
- radar-activated flagger paddle,
- radar drone, and
- retroreflective magnetic strips for work vehicles.

Some of the devices evaluated were not appropriate and/or effective for use in short-term work zones. While these devices may not have been useful at these sites, they may have some application at other types of work zones. These countermeasures included:

- portable rumble strips,
- Safe-T-Spins™, and
- worker strobe lights.

Safe-T-Spin is a trademark of Safe-T-Spin, Inc.

This document summarizes the performance of the devices that may have some application to short-term work zones. Devices that were not determined to be effective are not included. Readers that wish to learn more about these devices are urged to consult the research reports associated with this project (*1*,*2*).

ORGANIZATION

These devices were evaluated based on their impacts on traffic speeds, conflicts, and a variety of other measures. This document provides a one-page summary of the effectiveness of each device and a recommendation as to whether the device should be used in rural maintenance work zones.

Each device summary has several key components. They are:

- **Description:** A brief description of the device.
- **Application:** The type of work zone where the device was evaluated.
- **Usability:** An assessment of how quickly and easily the device can be installed and removed.
- **Evaluation:** The effectiveness of the device based on relevant measures of effectiveness. The measures of effectiveness vary from device to device. The impact of the device on these measures of effectiveness is rated as positive, negative, marginal, or inconclusive.
- **Recommendation:** A final evaluation as to whether the device should be used for rural maintenance activities and a description of the conditions under which the device should be used.

FLUORESCENT ORANGE SIGNS

Description: This project evaluated fluorescent orange signs with a variety of common work zone legends. All of the roll-up signs evaluated were composed of microprismatic sheeting.

Application: Fluorescent orange signs were tested at both two-lane and four-lane rural work zones.

Usability: Fluorescent orange signs can be installed in the same amount of time as standard high intensity signs. Fluorescent orange signs do cost more than high intensity signs, however.

Fluorescent Orange Sign.

Evaluation:

Fluorescent Orange Signs Evaluation

Speeds		% Speeding		Conflicts	Worker Comments	Driver Comments	Traffic Control Visibility
Before Taper	Work Zone	Before Taper	Work Zone				
?	?	?	?	?	✔	✔	✔

✔ - Positive Impact/Comments
? - Inconclusive Impact

Recommendation: Fluorescent orange signs offer two potential benefits over the standard Texas Department of Transportation (TxDOT) high intensity work zone signs. The main advantage of fluorescent signing occurs during periods of low light. The advantages of fluorescence are especially noticeable on cloudy days, in the morning, in the evening, or in shady areas. A secondary advantage to fluorescent orange signing is that most are made of prismatic retroreflective sheeting. Consequently, if the signs were used during nighttime conditions, they would appear brighter than the beaded retroreflective material normally used. This device was very well received by the workers and motorists surveyed. These signs are ready for implementation, and workers could use them in rural maintenance operations without increasing the time for traffic control setup. Although a number of positive comments were received on the signs, limited data exist to determine if they actually improve safety at work zones. Additional data should be collected before fluorescent signs are used on a widespread basis.

FLUORESCENT YELLOW-GREEN WORKER VESTS AND HARD HAT COVERS

Description: Five separate worker garments and three hard hat styles were evaluated. Most of the styles evaluated involved using fluorescent yellow-green fabric or mesh in order to improve the contrast between the worker and work zone traffic control.

Application: The fluorescent yellow-green worker clothing was field tested at both two-lane and four-lane work zones. A closed course test was also performed to quantify if there was any difference in the vests.

Usability: The yellow-green vests and hard hat covers can be easily implemented and require no additional worker effort.

Evaluation: The evaluation was based on both the closed course testing and the field testing of the garments.

Fluorescent Yellow-Green Vests and Hard Hat Covers.

Fluorescent Yellow-Green Worker Vests and Hard Hat Cover Evaluation

Speeds		% Speeding		Conflicts	Worker Comments	Driver Comments	Worker Visibility
Before Taper	Work Zone	Before Taper	Work Zone				
?	?	?	?	?	✔	✔	✔

✔ - Positive Impact/Comments
? - Inconclusive Impact

Recommendations:

Worker Vests: The best options appear to be either non-mesh alternative or the TxDOT fluorescent yellow-green vest. However, based on the warm summer months typically associated with Texas, a non-mesh garment does not seem appropriate. Consequently, the best photometrically performing and comfortable worker garment option is the fluorescent yellow-green mesh vest.

Hard Hats: The photometric data do not support a conclusive recommendation for a hard hat color. However, with the considerable amount of visibility research demonstrating that fluorescent colors are more visible in terms of detection and color recognition, it would seem appropriate to consider further research and consideration of the move from a white hard hat to a fluorescent yellow-green hard hat. In addition, the hard hat donated for evaluation purposes included retroreflective elements. Although nighttime evaluations were not performed as part of this project, the research team feels that TxDOT should adopt a state-wide policy requiring retroreflective elements on all hard hats.

PORTABLE VARIABLE MESSAGE SIGNS

Description: This project utilized a trailer-mounted solar variable message sign (VMS). The VMS could display up to three lines of text with eight characters on each line. Light emitting diodes (LEDs) were used to display the characters. The message board met the TxDOT specification, which requires that the sign meet the *Manual on Uniform Traffic Control Devices* (*MUTCD*) visibility and legibility requirements

Portable Variable Message Sign.

Application: The portable variable message sign was evaluated on a four-lane divided highway.

Usability: The device was set up in under 10 minutes. The VMS was solar assisted, so little maintenance was required.

Evaluation:

Portable Variable Message Sign Evaluation

Speeds		% Speeding		Percent in Closed Lane	Conflicts	Worker Comments
Before Taper	Work Zone	Before Taper	Work Zone			
-0.5 mph	-1 mph	No Change	-3%	-20%	✔	✔

✔ - Positive Impact/Comments

Recommendation: The portable VMS is a versatile device that can be used in a variety of applications. The VMS results in minimal speed reductions within the work zone. The primary benefit of the VMS was in reducing the number of vehicles in the closed lane approaching the work zone taper. On average, there were 20 percent fewer vehicles in the closed lane when the VMS was operational. This reduction resulted in fewer conflicts created by late merges at the work zone taper. A supplemental VMS appears to have positive benefits in creating earlier lane changes at work zones, and the use of the VMS should be considered when a lane closure exists.

RADAR-ACTIVATED FLAGGER PADDLE

Description: The radar-activated flagger paddle is a prototype device that was developed by the Texas Transportation Institute during this project. It consists of a flashing flagger paddle that has been modified so that vehicles traveling over a preset speed threshold activate the LEDs in the sign face.

Application: This device was developed at the end of the project, and no suitable data collection sites were identified to test the device prior to project termination.

Usability: The device is a prototype and has several obvious usability issues. First, the battery for the unit is located within the face of the sign. This makes the unit rather top-heavy. Also, the wiring for the radar is exposed to the elements and is very fragile. Users of the prototype must be very careful in order to ensure that the radar is not damaged. Should a commercial version of this device be made available, it is quite likely that these issues could be resolved.

Radar-Activated Flagger Paddle.

Evaluation: The evaluation of this device is based solely on subjective observations of the device. Some field testing should be performed to determine if the device holds promise in the field.

Radar-Activated Flagger Paddle

Speeds		% Speeding		Conflicts	Worker Comments	Worker Visibility
Before Taper	Work Zone	Before Taper	Work Zone			
?	?	?	?	?	?	✔

✔ - Positive Impact/Comments
? - Inconclusive/Unknown Impacts

Recommendations: This device may provide a benefit at flagger controlled work zones. More detailed testing is needed to determine the effectiveness of the device. The unit would also need to be made substantially more rugged in order to withstand extended use in the field.

RADAR DRONE

Description: This evaluation utilized a commercially available radar drone. The radar drone emits a K-band radar signal that can be detected up to a mile away. The radar signal will activate radar detectors, potentially decreasing vehicle speeds as they approach the drone site.

Radar Drone.

Application: The radar drone was tested at both two-lane and four-lane work zones.

Usability: The drone is simply plugged into the cigarette lighter. It then continuously emits a radar signal until turned off.

Evaluation:

Radar Drone Evaluation

Speeds		% Speeding		Conflicts	Worker Comments	Driver Comments
Before Taper	Work Zone	Before Taper	Work Zone			
-2 mph	-1 mph	-1%	+0.5%	—	—	✔

✔ - Positive Impact/Comments
— - Marginal Impact/Comments

Recommendations: The radar drone provides small reductions in average speeds of vehicles approaching and traveling through the work zone. It has a marginal impact on the percent of vehicles exceeding the speed limit. Limited data indicate that it may have a positive impact in reducing conflicts at the work zone taper, but there is insufficient data to make a conclusion. The radar drone may be an appropriate device for use in rural work zones. It provides limited benefits in terms of speed reductions, but little effort is required to use the drone.

RETROREFLECTIVE MAGNETIC STRIPS ON WORK VEHICLES

Description: The vehicle visibility treatment tested consisted of an eight-inch wide strip sheeting on a magnetic backing. The strips were produced in lengths of 3 feet. Square blocks with four-inch sides were alternated along the strip to produce a checkerboard pattern. The square blocks consisted of microprismatic sheeting in orange and fluorescent orange colors. The magnetic strips were manufactured specifically for this project.

Vehicle Visibility Improvements.

Application: The strips were evaluated on both two-lane and four-lane roads.

Usability: The magnetic strips were simply placed around the perimeter of the flagger vehicle. These strips could easily be made a permanent part of the vehicle.

Evaluation:

Retroreflective Magnetic Strips on Work Vehicles Evaluation

Speeds		% Speeding		Conflicts	Worker Comments	Driver Comments	Vehicle Visibility
Before Taper	Work Zone	Before Taper	Work Zone				
?	?	?	?	?	✔	?	✔

✔ - Positive Impact/Comments
? - Inconclusive Impact

Recommendations: Since the focus of this study was on daytime work zones, the retroreflective strips did not have much of an impact on worker safety. However, the strips could significantly improve the visibility of the vehicle during nighttime operations. TxDOT should consider adding the retroreflective strips to its flagger vehicles. The strips improved vehicle visibility and could be made a permanent part of maintenance vehicles. One potential drawback of adding the retroreflective strips is that it may lower any potential resale value of TxDOT vehicles once the department has finished using them.

SPEED DISPLAY

Description: This evaluation utilized a trailer-mounted speed display provided by TxDOT. The unit features a 24-inch LED display and uses Ka-band radar to detect oncoming vehicles. The display has a strobe lamp that flashes when a vehicle is detected traveling over a preset speed threshold. This feature is intended to simulate the operation of photo radar, possibly decreasing speeds through the threat of automated enforcement. During this evaluation, the speed threshold for the strobe light was set at 75 mph. The display also has a 130 dB siren that can be activated by vehicles traveling over a preset speed. This option is intended to warn workers when an extremely high-speed vehicle is approaching.

Speed Display Trailer.

Application: The speed display was tested at both two-lane and four-lane roads.

Usability: The display could be set up in under 10 minutes. The controls were easy to operate, and TxDOT crews that have used the device have reported no maintenance problems.

Evaluation:

Speed Display Trailer Evaluation

Speeds		% Speeding		Conflicts	Worker Comments
Before Taper	Work Zone	Before Taper	Work Zone		
-5 mph	-3.5 mph	-13%	-6%	?	✔

✔ - Positive Impact/Comments
? - Inconclusive Impact

Recommendation: Of the devices evaluated in this project, the speed display trailer had the largest impact on traffic speeds. The display can be quickly set up and removed from the site. The speed display appears to be an appropriate device to improve work zone safety in rural maintenance work zones.

REFERENCES

1. Carlson, P.J., M.D. Fontaine, and H.G. Hawkins. Evaluation of Traffic Control Devices for Rural High-Speed Maintenance Work Zones. *DRAFT Research Report 1879-1*, Texas Transportation Institute, College Station, Texas, March 2000.
2. Fontaine, M.D., P.J. Carlson, and H.G. Hawkins. Evaluation of Traffic Control Devices for Rural High-Speed Maintenance Work Zones: Second Year Activities and Final Recommendations. *DRAFT Research Report 1879-2*, Texas Transportation Institute, College Station, Texas, September 2000.