MIDWEST SMART WORK ZONE DEPLOYMENT INITIATIVE

MwSWZDI

FHWA POOLED FUND STUDY

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FYG Backing for Work Zone Signs

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Abstract

MIDWEST STATES SMART WORK ZONE DEPLOYMENT INITIATIVE (MWSWZDI) YEAR 3

FLUORESCENT YELLOW-GREEN BACKGROUND FOR VEHICLE-MOUNTED WORK ZONE SIGNS

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INTRODUCTION

Moving work zones have fewer traffic control devices than stationary work zones and provide no buffer space for vehicles that encroach on a work zone. Figure 1 shows the standard traffic control for a mobile work zone on a multilane road according to the current *Manual on Uniform Traffic Control Devices* (MUTCD). Figure 2 shows the position of the fluorescent orange RIGHT LANE CLOSED AHEAD sign attached to the back of the maintenance vehicle on the shoulder.

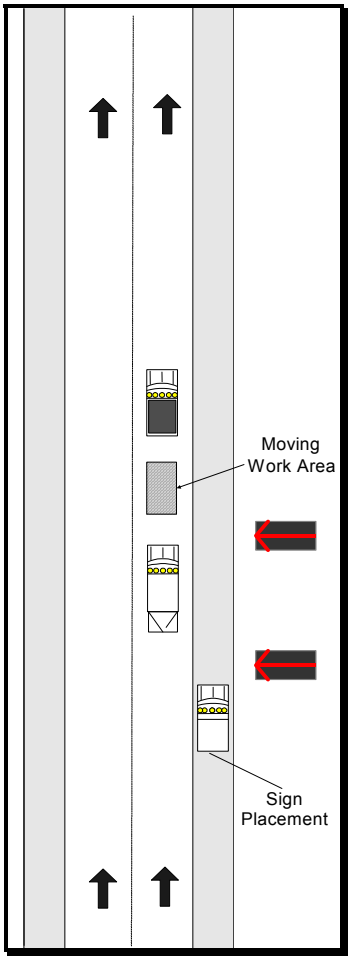

Figure 1. Moving Work Zone on a Multilane Roadway

Figure 2. Orange RIGHT LANE CLOSED AHEAD Sign

To improve the safety of moving operations, the Iowa Department of Transportation (Iowa DOT) created a six-inch fluorescent yellow-green (FYG) background for the work zone signs that are mounted on the back of work zone vehicles (see Figure 3). As shown in Figure 4, the background provides a highly visible contrast between the orange work zone vehicle and the orange work zone sign.

Figure 3. Fluorescent Yellow-Green Background

Figure 4. Orange RIGHT LANE CLOSED AHEAD Sign With FYG Background

As a part of the Midwest States Smart Work Zone Deployment Initiative (MwSWZDI) Year 3, the impact of the FYG background on improving drivers' lane-changing behavior in advance of a work zone was evaluated. Furthermore, a motorists survey was conducted at interstate rest areas. The Center for Transportation Research and Education (CTRE) deployed the background during a simulated moving work zone operation on multilane divided highways. The purpose of the study was to examine the effects of the FYG background in encouraging approaching motorists to merge to the open lane sooner. This report presents the evaluation strategies and results.

The University of Kansas is also evaluating the FYG background as part of the MwSWZDI. They are conducting a human factor assessment of the background's visibility in collaboration with the university's Psychology Department.

EVALUATION METHODOLOGY

The difficulty of conducting an on-site study of upstream traffic behavior of a moving work zone led to the development of a more manageable data collection strategy. In this evaluation, a stationary Iowa DOT truck, augmented with a RIGHT LANE CLOSED AHEAD sign, was placed on the outside shoulder near a crest vertical curve to depict a moving work zone on the downstream side of the curve (see Figure 5). No arrow display was used on this vehicle so that approaching motorists were required to gain information only from the static signing.

As shown in Figure 6, a video detection trailer with one video camera was placed downstream of the stationary truck to record the lane occupancy with and without the FYG background. A few cones were placed on the shoulder to simulate a real work zone

rather than having a totally “imaginary” one. Figure 7 shows a schematic of the data collection setup. With this setup, the video records traffic movements 100 feet upstream of the stationary truck.

Figure 5. Stationary Iowa DOT Truck on the Shoulder at a Crest Vertical Curve

Figure 6. Data Collection Trailer Downstream of the Iowa DOT Truck

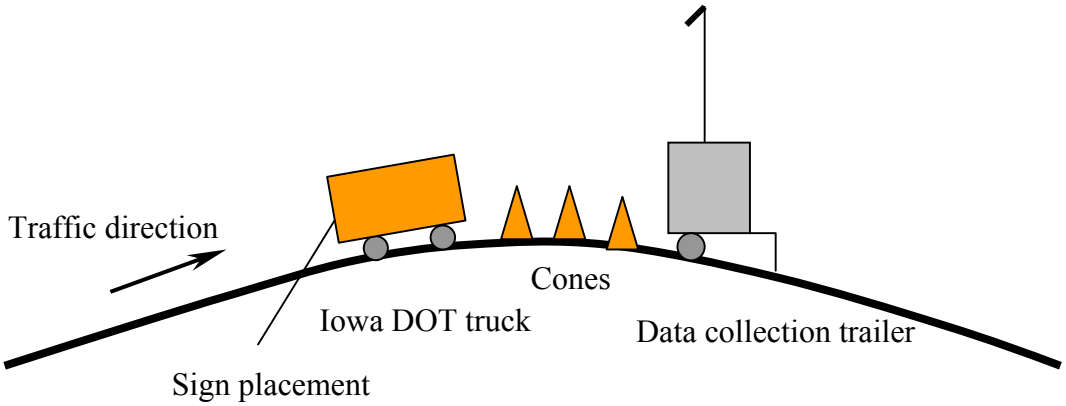

Figure 7. Data Collection Setup

Traffic Performance Measurement

Data were collected for a total of seven days using the data collection trailer. The trailer includes a pneumatic mast to hoist a video camera 30 feet above the pavement's surface, where the camera collects video of traffic operations. Using the Autoscope image processing technology, the recorded videotapes were analyzed to determine traffic flow performance data (vehicle speed, headways, volume, etc.) of approaching vehicles. Because the lane occupancy changes with and without the FYG background were desired, only traffic volume was used.

The geographical location of the work zone research was moved to a new location daily to minimize repeat drivers. To fairly evaluate the effectiveness of the FYG background, the "before" and "after" condition data were collected at the same location. For example, a scheduled six-hour data collection period at a location consisted of three hours "without" and three hours "with" the FYG background in place.

Driver Survey

A brief survey was conducted to assess drivers' opinion on the visibility of the sign augmented with the FYG background. The survey was performed at an interstate rest stop downstream of the work zone during the "after" condition, when the FYG background was in place. Side-by-side pictures of the sign with and without the background (see Figure 8) were shown to the drivers who were asked whether they noticed either sign while passing the work zone. They were also asked whether they reacted to the sign's message and merged to the left lane.

Figure 8. Survey Picture

RESULTS

Data collections were conducted from July 9 through July 19, 2001, for a total of 42 hours over seven days. The six hours of data collection each day were divided into two, three hours of before (without) and three hours of after (with) the background in place. Data were collected at the sites and dates listed in Table 1. As presented in Table 1, except for the US 30 near Boone location, data were collected for two nonconsecutive days at the remaining locations.

Table 1. Data Collection Sites

Site			Date
Route	Direction	Mile Marker	
US highway 30	West	161	July 9, 2001
Interstate 35	North	118	July 11, 2001
Interstate 35	South	101	July 12, 2001
US highway 30	East	Near Boone	July 16, 2001
Interstate 35	North	118	July 17, 2001
US highway 30	West	161	July 18, 2001
Interstate 35	South	101	July 19, 2001

Table 2 presents the total traffic volumes and right-lane traffic proportions observed at each site before and after the background installation. As shown in Table 2, at the US 30 mile marker 161 site the right-lane traffic was reduced during both days of data collection in the “after” condition. On the two interstate sites, however, the “after” right-lane traffic was somewhat higher than the traffic volumes observed in the “before” condition on the first day and became lower on the second day of data collection. The US 30 near Boone data indicate slightly higher right-lane traffic in the "after" condition.

Table 2. Collected Traffic Volume

Site	Total Traffic Volume		Right Lane Proportion (%)	
	Before	After	Before	After
US 30 - 161	767	827	18	14
I-35 - 118	1,883	2,418	13	15
I-35 -101	3,131	3,085	17	18
US 30 - Boone	668	753	7	8
I-35 - 118	1,096	2,148	21	20
US 30 - 161	911	879	18	12
I-35 - 101	3,243	2,413	26	21

Data samples collected at three of the locations during the two days of data collection were combined to determine the impact of the FYG background in reducing the right-lane traffic proportion at an individual site (see Table 3). The combined site data show that the right lane traffic volumes reduced at the US 30 - 161 and I-35 - 101 sites, whereas the other two sites observed slightly higher traffic on their right lanes. Provided that the right lane traffic proportions are not close to zero, the normal approximation to the binomial distribution[1] can be used to determine whether the changes in the right lane traffic were statistically significant.

Table 3. Combined Traffic Volume

Site	Total Traffic Volume		Right Lane Proportion (%)	
	Before	After	Before	After
US 30 - 161	1,678	1,706	18	13
I-35 - 118	2,979	4,566	16	17
I-35 -101	6,374	5,498	21	19
US 30 - Boone	668	753	7	8
Total	11,699	12,523	19	17

In this study, there are samples of n observations and percents of vehicles (p), which were detected on the right lane during the "before" and "after" conditions. At the US 30 - 161 site, for example, 18 percent (p) of 1,678 observed vehicles (n) were detected in the right lane during the six hours of data collection in the "before" condition. After mounting the background, 13 percent of 1,706 vehicles were observed on the right lane at the same location.

[1] A binomial distribution is commonly used to represent situations consisting of repeated trails, n, in which each trial is independent and has a probability of success, p.

By entering the total observed traffic volumes and right-lane traffic proportions listed in Table 3 into Equation (1), a *t*-statistic was determined for each study site (see Table 4). A *t*-statistic of ±1.96 or higher indicates statistical significance at the 95 percent confidence level.

$$t = \frac{p_b - p_a}{\sqrt{p_0 q_0 \left(\frac{1}{n_b} + \frac{1}{n_a} \right)}} \quad (1)$$

where

$$p_0 = \frac{p_b n_b + p_a n_a}{n_b + n_a}$$

$$q_0 = 1 - p_0$$

n_a and n_b = total number of vehicles observed after and before the background placement, respectively

p_a and p_b = percent of vehicles observed after and before the background placement, respectively

Table 4. *t*-statistics

Site	*t*-statistic	Significant (95%)
US 30 - 161	3.87	Yes
I-35 - 118	-1.03	No
I-35 -101	3.19	Yes
US 30 - Boone	-0.79	No
Total	3.86	Yes

As shown in Table 4, the calculated *t*-statistics of the US 30 - 161 and I-35 -101 are greater than 1.96. Thus, the five and two percents of right-lane traffic reductions at the two sites after the background was mounted were statistically significant at the 95 percent confidence level. Results also indicate that the right-lane traffic volumes were increased by one percent at the I-35 - 118 and US 30 - Boone sites in the "after" condition. These increments, however, were statistically insignificant. Furthermore, the analysis of the overall data observed during the seven days of data collection at all sites indicates a statistically significant right-lane traffic reduction (i.e., two percent) at the 95 percent confidence level in the "after" condition.

To assess drivers' opinion on the visibility of the sign augmented with the FYG background, the picture (Figure 8) was shown to the drivers who were asked whether they noticed either sign while passing the work zone. Over the course of two days when

the data were collected at the I-35 - 118 site during the "after" condition, drivers who stopped at the downstream rest area completed 100 surveys.

Of the drivers surveyed, 53 percent stated that they noticed the sign with the background, from which 41 percent merged to the left lane and 12 percent did not pay attention to the sign. More than one third of drivers (34 percent) mistakenly identified the sign (they pointed to the sign with no background). Twenty-seven percent of drivers in this group indicated that they did change lanes after they saw the sign, whereas the remaining seven percent continued their trips on the right lane. Eight percent of drivers who participated in the survey did not know which sign was up. All except one driver in this group merged to the open lane. Interestingly, five percent of drivers saw no sign and continued their trips as if there was no work zone. Figure 9 presents a summary of responses.

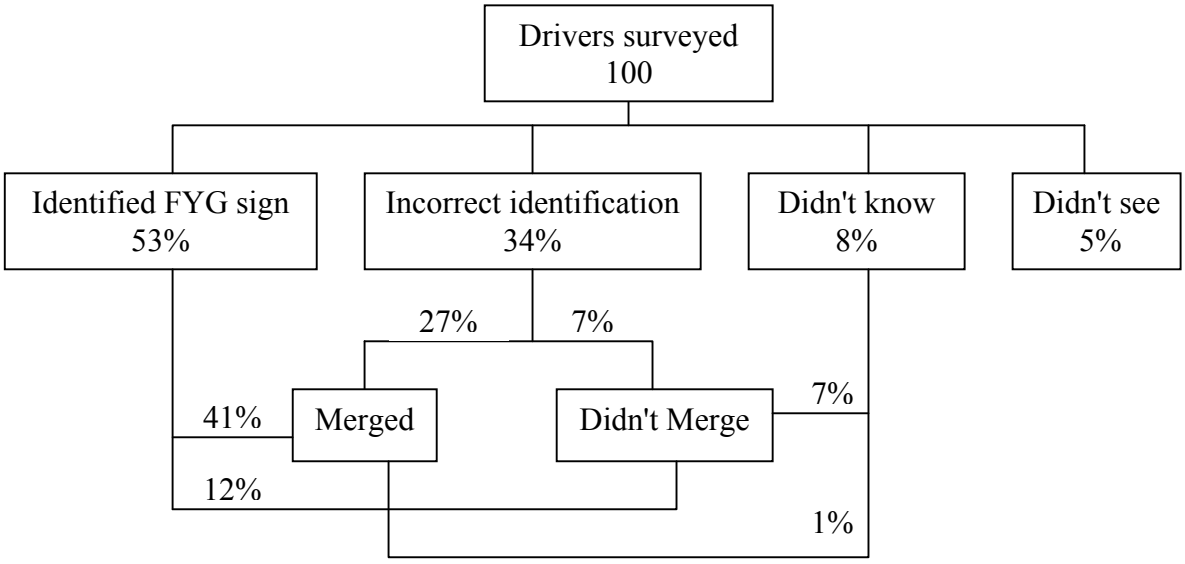

Figure 9. Survey Summary

CONCLUSIONS

Undoubtedly the FYG background creates a clear contrast between the orange sign and an orange Iowa DOT truck that follows a moving work area. This study examined the impact of the sign's improved visibility in encouraging drivers to make an early merge to the open lane prior to a lane closure.

The analysis of data indicates that overall right-lane traffic volumes, recorded during the seven days of data collection after the background placement, were two percent less than the traffic observed in the "after" condition. The study concludes that the difference between the right-lane traffic observed in the "before" and "after" conditions is indeed statistically significant at the 95 percent confidence level.

The resulting right-lane traffic counts are representative of lane distribution changes within 100 feet upstream of the truck. It is suggested that collecting data at locations, for example, at a distance 500 feet from the truck or where most approaching vehicles move to the open lane would be good information to collect if additional research is conducted. However, using the data collection trailer or individuals to count traffic at a different location may influence drivers' lane-changing behavior.

Another factor that could lead to different results is having a real lane closure. Due to the difficulties in developing an experimental design to collect traffic data in advance of an actual moving work zone, data were collected at an "imaginary" work zone. In a more realistic setup, where drivers actually face a real lane closure, a lower right-lane traffic volume is expected to be observed in the "after" condition.

Furthermore, a survey conducted at a rest area during the "after" condition indicates that more than 50 percent of drivers identified the enhanced orange sign as a sign seen on the back of the Iowa DOT truck before reaching the work zone. Human factor assessment of the FYG background's visibility is currently underway at the University of Kansas. The study is conducted in collaboration with the university's Psychology Department to evaluate human recognition of the sign augmented with the background.