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Speeding in highway work zone: An Evaluation of methods of speed control

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ABSTRACT

Highway workers frequently work in close proximity of live traffic in highway work zones, traffic accidents therefore have devastating effects on worker safety. In order to reduce the potential for such accidents, methods involving use of advisory signs and police presence have been used to mitigate accident risks and improve safety for highway workers. This research evaluates the magnitude of the speeding problem in highway work zones and the effects of four levels of police presence on improving work zone safety. Speed data were collected in six different work zone locations in northern and southern California and used to determine the magnitude and nature of speeding problem in highway work zones. In addition data were collected over 11 test-days in four work zones with four levels of police presence: radar speed display with police decal and lighting, passive use of a police vehicle with radar speed display, passive use of a police vehicle without radar speed display, and active police speed enforcement near work zones. This paper analyzes this data using statistical methods to evaluate the effectiveness of these different methods of speed control on the safety of the work zone. Four Measures of Effectiveness (MOE) were used in this evaluation consisting of average speed reduction, speed variance, 85th percentile speed, and proportion of high speed vehicles. The results indicate that all levels of police presence provided statistically significant improvements in one or more of the MOEs.

1. Introduction

Improving work zone safety has always been an important task for the agencies dealing with roadway operations. Temporary traffic control methods have been shown to reduce the probability of fatal and severe crashes (Li and Bai, 2009). In addition, the use of police presence in work zones is also often utilized to provide additional protection to the work crew and improve the conspicuity of work zones to the traveling public. Deployment of a police vehicle making circulating trips near a work zone, while actively issuing speeding citations, was shown to decrease the average speed of cars and trucks by approximately 4.4 mph and 5.0 mph, respectively (Benekohal et al., 1992). Stationary police vehicle deployed near the end of taper was also shown to reduce traffic speeds by approximately 3.0–6.0 mph and standard deviation of vehicle speeds by 25% (Zech et al., 2005). Police presence near work zones can also provide reductions in accident rate by 41.5% (Chen and Tarko, 2012), regardless of whether citations were issued. Previous studies have not performed a comparative assessment of different levels of police presence and their effects on speed reduction in highway work zones.

In California, the Department of Transportation (Caltrans) has routinely employed California Highway Patrol (CHP) to protect the work crew by placing police vehicles near or at the work zones. This paper investigates the impact of four different levels of police presence using four different Measures of Effectiveness (MOE).

While it is difficult to define quantitative measures of safety, certain attributes of traffic can be used to study the effect of speed control methods. Speed and speed variance are usually considered as causal factors for work zone accidents (Daniel et al., 2000). It is generally accepted that excessive speed is usually associated with increases in accident severity while speed variance is usually associated with accident rate (Quddus, 2013; Hauer, 2009). Higher speeds also results in longer braking distance, as well as less time for the driver to react to hazards on the road (Elvik et al., 2004) which creates elevated risks for the road work crew.

This paper illustrates the severity of the speeding problem near work zones in California highways followed by studying the effects of different levels of police presence using traffic data collected during road work activities. Four levels of police presence are evaluated consisting of: (1) changeable message sign trailer with police decal and lighting, (2) changeable message sign trailer with police decal and lighting plus passive use of a police vehicle, (3) passive use police vehicle only, and (4) active use of police vehicle.

Four MOEs of safety are used for the comparative evaluation of the four different levels of police presence. These are: average speed reduction, speed variance, 85th percentile speeds and proportion of high

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speed vehicles. Similar MOEs have been used in pervious literature which evaluated speed control devices (Mattox et al., 2007; Brewer et al., 2005). In this paper, speed data were collected in intervals of aggregated speed distribution in 5 mph bins using a commercially available radar sensor system to monitor highway speeds at strategic locations. Traffic data for speeding were collected from 6 work zone locations and traffic data for the effect of traffic control methods were collected over 11 test-days in 4 different work zone locations. Additional details of the traffic sensor used and the data collection method and the data is reported earlier (Ravani et al., 2013) and is not repeated here. A method of combining the aggregated data is also presented in this paper to facilitate hypothesis testing. This paper presents the statistical analysis of the data (which has not been presented before) to evaluate the effect of traffic control methods involving four different levels of police presence using the four MOEs of safety.

2. Speeding in work zones

In 2015, there were approximately 642 work zone related fatal crashes in the United States, out of which 181 (approximately 28%) involved speeding. In the state of California, there were 65 work zone related fatal crashes and 32 (approximately 49%) involved speeding (U.S. Department of Transportation, 2017). A study performed in the state of Illinois observed 10% of cars traveling at least 10 mph above the speed limit upstream of the work zone, 45% near the active work area (where the speed limit was reduced to 45 mph) and 92% towards the end of the work zone. When a police vehicle was deployed to actively patrol the segment of highway near the work zone, the proportions were reduced to 7%, 17% and 74% (Benekohal et al., 1992).

Traffic speed measurements made next to work zones on California highways in this study revealed significant speeding in both urban and rural environments. In urban environments, the average proportion of speeding vehicles ranged from 32% to 91%. In more populated areas such as Los Angeles there could be as much as 96% of vehicles traveling above the speed limit. In addition, the proportion of traffic traveling at least 10 mph above the speed limit in urban areas ranged from 2% to 59%, indicating serious speeding problems at higher speeds. In rural areas, the speeding problem also exists but was less severe. The average proportion of speeding vehicles ranged from 8% to 51%. The proportion of vehicles traveling at least 10 mph above the speed limit in rural areas was up to 6%. The breakdown of the data on measured proportion of speeding vehicles is shown in Table 1.

To improve safety of the worker as well as the traveling public near work zones, Caltrans currently works with the California Highway Patrol (CHP) to include police vehicles in work zones during hours of active maintenance or construction work. The typical scenario of police deployment involves placing a single CHP vehicle near the end of the lane closure taper to increase the conspicuity of the work zone and discourage speeding. This paper investigates the effect of four different levels of police presence ranging from a changeable message sign with police decal to passive and active speed enforcement.

3. Speed control methods

Lane closures for maintenance activities are often temporary which must be set up and removed at the beginning and end of each shift. Light weight traffic cones are typically used as delineation devices to separate live traffic from the work area. A standard configuration for such lane closure is defined in Chapter 8 of the Caltrans Maintenance Manual. In the California, the police is often used to provide additional support and protection to the work crew during road construction or maintenance activities.

Four levels of police presence were studied in this paper. The first level was the deployment of a Changeable Message Sign (CMS) equipped with police lighting and radar trailer owned and operated by the California Highway Patrol (CHP) (CHP-CMS). The CHP-CMS was placed inside the work zone with the intention of encouraging drivers to slow down by informing drivers if they are speeding and indicating their speeds. The second level combined the CHP-CMS with a passive police vehicle in the work zone for added presence of authority. The third level involved the passive use of a single police vehicle in the work zone. In the case of the second and the third levels, the police vehicle did not leave the work zone to stop a speeding vehicle except in extreme situations at the officer's discretion. The fourth level of speed control involved staging multiple police vehicles near the work zone and the officers were instructed to actively stop speeding drivers as they see fit. Fig. 1 illustrates a typical work zone with a lane closure and the second level of police presence.

Baseline speed reductions due to the existence of the standard taper were established for each speed control method by taking speed measurement inside of the work zone without the deployment of the either CHP-CMS trailer or police vehicles.

3.1. Police changeable message sign

The CHP-CMS trailer used in this study is a CMS trailer with additional blue and amber flashing lights (standard color lights used on CHP vehicles) as well as police decal. It detected the speed of approaching traffic. If the detected speed was higher than a preset threshold, a warning message "SLOW DOWN" was displayed as shown in Fig. 2 and the flashing blue and amber lighters were activated. Details of the CHP-CMS can be found in (Ravani et al., 2012). Fig. 3 shows the location of a police vehicle at the end of taper used to protect the work crew.

Similar radar-equipped CMS devices without the police lights and decal were studied in the existing literature and was shown to be effective in terms of improving one or more of the metrics discussed above (Mattox et al., 2007). The speed feedback to the driver was also observed to improve speed limit compliance (Brewer et al., 2006) in highway work zones. This paper studies the effectiveness of the CMS trailer with additional police lighting.

3.2. Passive and active use of police vehicle(s)

The next level of police presence involved deployment of a police

Table 1
Proportion of speeding vehicles near work zones in California.

Standard Closure (No Police)	City	Speed Limit (mph)	Proportion of Vehicles with speed > speed limit			Proportion of Vehicles with speed ≥ 10 mph + speed limit		
			Average	Max	Min	Average	Max	Min
Urban	Stockton #1	55 (reduced from 65)	81%	89%	76%	34%	45%	26%
	Stockton #2	65	32%	37%	27%	2%	2%	2%
	Los Angeles	65	91%	96%	81%	59%	70%	44%
	San Diego	65	40%	57%	26%	5%	11%	0%
Rural	Redding	70	8%	8%	8%	0%	0%	0%
	Weed	55 (reduced from 70)	51%	61%	45%	6%	9%	4%