Advanced Highway Maintenance and Construction Technology Research Center

Department of Mechanical and Aerospace Engineering
University of California at Davis

Evaluation of Methods to Reduce Speeds in Work Zones

Executive Summary

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16. Abstract.

This study involved an evaluation of the effectiveness of the California Highway Patrol (CHP) combination Radar Detection/Changeable Message Sign (CMS) (CHP-CMS) trailers to manage traffic speeds in highway work zones. The CHP-CMS trailer is a radar-equipped CMS trailer unit outfitted with revolving or flashing lights similar to those used on CHP vehicles. The main objective of this study was to test the following hypothesis: does the CHP-CMS trailer unit provide an effective deterrent to speeding, thereby slowing traffic in the work zones? The results of this study validated this hypothesis with the understanding that the validation was based on limited (a total of three) field tests due to the limited scope and time duration of this study as well as availability of actual work zones for testing. Further testing is recommended in the future. The research developed a repeatable test methodology based on the use of easily deployable speed sensors distributed throughout the work zone. Additional sensors were also used for validation and collection of other pertinent data. Data was also collected on the combined utilization of the CHP-CMS trailer and a CHP vehicle as in MAZEEP (Maintenance Zone Enhanced Enforcement Program) and its effect on traffic speed reduction at work zones. The overall conclusion of this study is that the use of the CHP-CMS system does result in a deterrent to speeding vehicles near work zones and its use can therefore improve work zone safety.

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ABSTRACT

This study involved an evaluation of the effectiveness of the California Highway Patrol (CHP) combination Radar Detection/Changeable Message Sign (CMS) (CHP-CMS) trailers to manage traffic speeds in highway work zones. The CHP-CMS trailer is a radar-equipped CMS trailer unit outfitted with revolving or flashing lights similar to those used on CHP vehicles. The main objective of this study was to test the following hypothesis: does the CHP-CMS trailer unit provide an effective deterrent to speeding, thereby slowing traffic in the work zones? The results of this study validated this hypothesis with the understanding that the validation was based on limited (a total of three) field tests due to the limited scope and time duration of this study as well as availability of actual work zones for testing. Further testing is recommended in the future. The research developed a repeatable test methodology based on the use of easily deployable speed sensors distributed throughout the work zone. Additional sensors were also used for validation and collection of other pertinent data. Data was also collected on the combined utilization of the CHP-CMS trailer and a CHP vehicle as in MAZEEP (Maintenance Zone Enhanced Enforcement Program) and its effect on traffic speed reduction at work zones. The overall conclusion of this study is that the use of the CHP-CMS system does result in a deterrent to speeding vehicles near work zones and its use can therefore improve work zone safety.

EXECUTIVE SUMMARY

Background

Cars and trucks have been observed to exceed the posted speed limits in construction and maintenance work zones, increasing risk of injury and death to workers and the traveling public as well as property damage to vehicles, equipment and the highway infrastructure. In order to influence driver behavior in reducing traffic speeds and therefore improving safety in highway work zones, the California Department of Transportation (Caltrans) uses COZEEP (Construction Zone Enhanced Enforcement Program) and MAZEEP (MAintenance Zone Enhanced Enforcement Program) which involve employing the California Highway Patrol (CHP) at some work zones to influence the traveling public to observe the speed limits. This study was aimed at developing a test methodology and field testing of a special Changeable Message Sign (CMS) and its effect in speed reduction in highway work zones. The CMS evaluated is a trailer based system that is acquired by CHP and is equipped with radar for speed measurement. It has a changeable message sign for display of messages to the drivers and revolving or flashing lights similar to those that are used in CHP vehicles for prompting or emulating police presence. The units also have a siren system onboard, but at the direction of CHP, the siren was neither activated nor tested during this research.

Two types of radar traffic sensing systems were evaluated and tested as part of this study and were incorporated into the test methodology. One was the iCone system developed and marketed by iCone Products LLC and the other was the Remote Traffic Microwave Sensor (RTMS), developed and marketed by Image Sensing System of Canada. Data from field testing performed in this study indicated that the iCone system was more accurate in estimating the average speed of traffic while the RTMS system provided data on per-lane vehicle count and vehicle headway information. The iCone system is installed by its equipment manufacturer into a traffic barrel and can therefore be directly used in a work zone. The RTMS system, however, required design of an additional structure for its field utilization that allowed elevating the system at least 17 feet above the roadway surface on the side of the roadway.

Field testing was performed to determine the actual performance of the two sensing systems and gain experience in this field utilization prior to conducting field tests with the CMS. A test methodology based on these two sensing systems was then developed with the expectation that it could be modified based on logistics and the directions of the Maintenance Supervisor in charge of the maintenance function or the Residence Engineer in charge of the construction work zone. The basic layout consists of a set of iCones for speed measurements and two RTMS systems for measurement of traffic counts. Two cameras were used to collect redundant information.

A total of three field tests were performed, all at highway work zones where maintenance functions were being performed. All three tests were performed at the same location in the Stockton area - one in March 2011 and two on the same day in April 2011 (One in the morning hours and one in the afternoon hours).

Conclusions, Limitations and Recommendations

Conclusions

The significant findings from analyzing the data from these three tests are summarized below:
(It should be noted that speeds are rounded to 0.5 MPH)

1. The lane closure alone without the CMS trailer resulted in a reduction of average traffic speed by approximately 5 to 5.5 MPH.

2. The use of the CHP-CMS trailer by itself resulted in approximately 3 to 7 MPH further reduction of the average traffic speed in the work zone beyond what was observed with the closure alone.

3. Use of a CHP officer in a police vehicle in addition to the CHP-CMS trailer resulted in approximately 5 to 9 MPH further reduction of the average traffic speed in the work zone beyond what was observed with the closure alone.

4. Use of the CHP-CMS trailer by itself reduced car density (number of cars) in the lane being closed at the beginning of taper (location of the Arrow Board) by 0.7 to 2.4 percentage points.

5. Use of a CHP officer in a police vehicle in combination with the CHP-CMS trailer resulted in a further reduction between 0 to 6.3 percentage points in car density in the lane being closed at the arrow board location.

6. Data indicates a trade-off between speed reduction and headway (time between vehicles) in the lane adjacent to the lane being closed. Data from other lanes did not provide for a consistent conclusion.

The main result is that the use of the CHP-CMS as configured in this study in combination with a CHP officer unit provides for traffic speed reductions in work zones. In the absence of a CHP officer unit, the CHP-CMS trailer alone still improves the safety in terms of reducing traffic speeds, at least for short duration work zones. This indicates that both methods are effective in improving work zone safety. It should be pointed out however that the testing performed in this study was only done in short duration work zones. Since repeated exposure to the CHP-CMS can allow drivers to become aware of the fact that the system is not used for speed enforcement and is only advisory may reduce its effectiveness due to this memory effect. Such memory effects were not evaluated in this study.

Limitations and Recommendations

1. The results obtained are based on very limited data and does not represent a statistically representative sample. They should, therefore, be used cautiously.

2. The testing was only performed in Maintenance Work Zones which are typically of short duration. More data that can extrapolate the results to long duration construction work zones would be desirable.

3. Testing was only performed in relatively low traffic density metropolitan areas. Additional testing in high traffic density metropolitan areas as well as in rural areas is recommended to supplement the test data provided here.

4. Long term driver response to the non-enforcement nature of the CHP-CMS was not tested. The results presented are more applicable to short time duration work zones.

Field Testing and Results

In this research a total of three field tests were performed, all in maintenance work zones at approximately the same location on southbound highway 99 in Stockton, California. One test was performed on March 22nd 2011, and two tests (one in the morning hours and one in the afternoon hours) were performed on April 15th, 2011. In these tests, the effect of the CHP-CMS unit on driver behavior in terms of speeds, headways, and traffic volume per lane was evaluated. The following four conditions were tested in each the three tests:

a. No CHP present.
b. CHP-CMS trailer without CHP vehicle presence.
c. CHP-CMS trailer with CHP vehicle upstream of the CHP-CMS unit
d. CHP-CMS trailer with CHP vehicle downstream of the CHP-CMS Unit.

The results are summarized in Figure 1-Figure 3. In these Figures, the horizontal axis plots the iCone location from the zero reference point in miles. The vertical axis is the average speed measured by each of the six iCones used along the roadway in MPH. The case with no CHP-CMS and no CHP vehicle is indicated in black, the case when the CHP-CMS unit was in place is indicated in red, the case when the CHP-CMS unit and the CHP vehicle were upstream is indicated with blue triangles, and finally the case when the CHP-CMS unit and the CHP vehicle were downstream is indicated with blue squares.

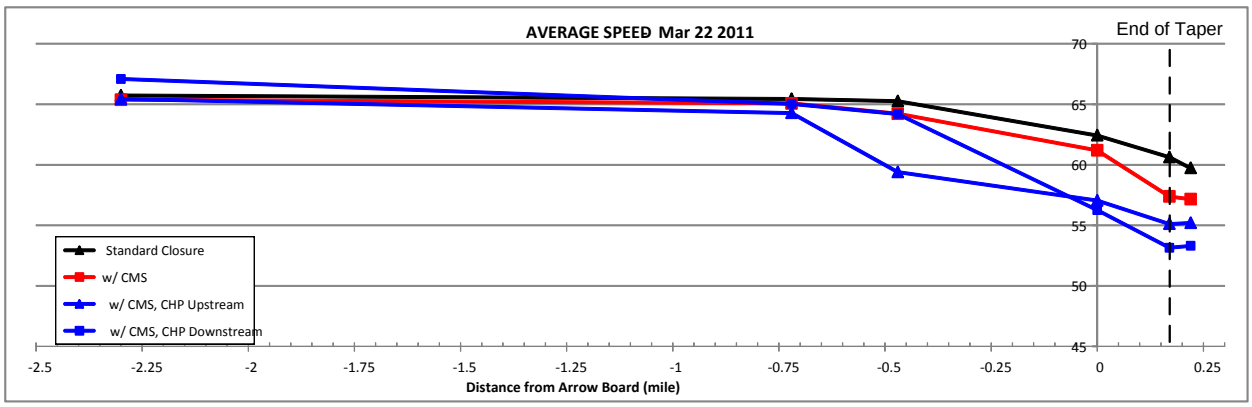

Figure 1: iCone data from Test 1 on March 22, 2011.

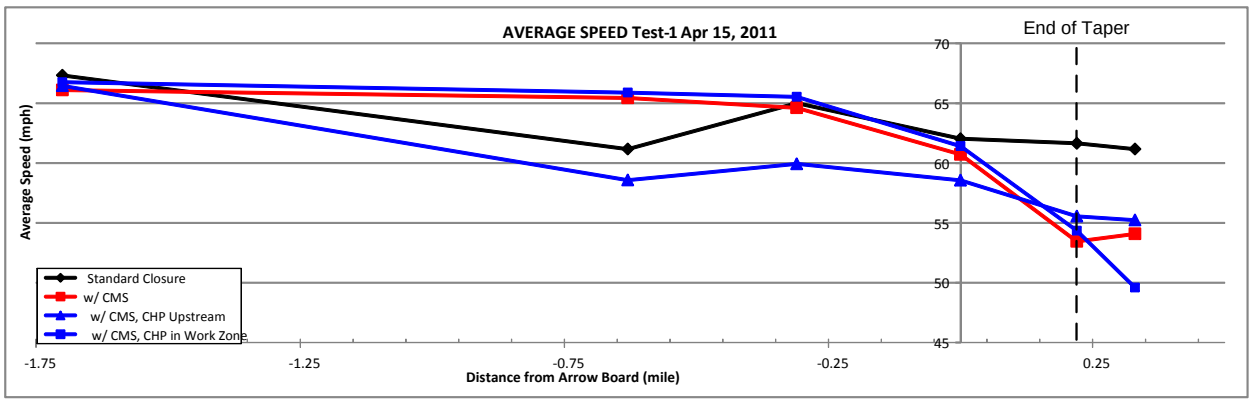

Figure 2: iCone Data from Test 2 on April 15, 2011 (Morning Hours).

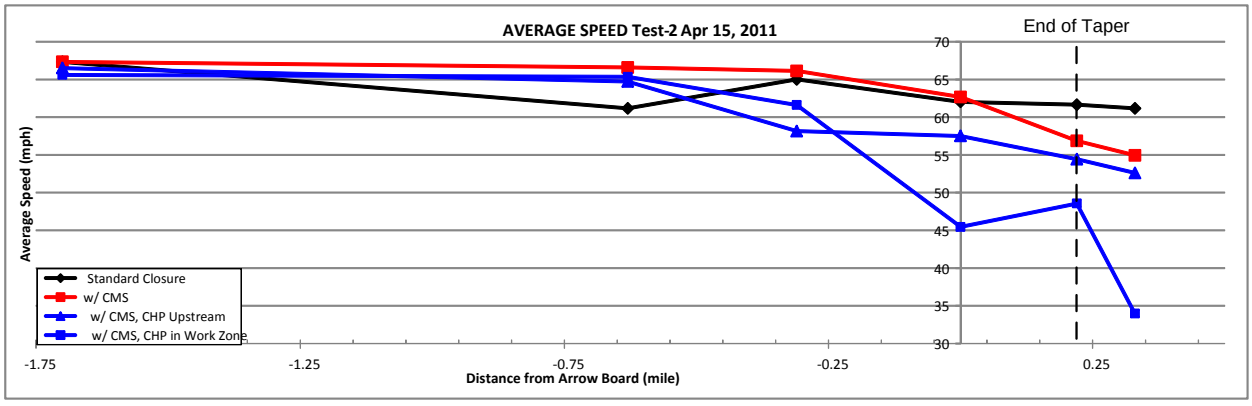

Figure 3: iCone Data from Test 3 on April 15, 2011 (Afternoon Hours).

The data in these plots clearly show that the CHP-CMS unit is effective (at least in the three tests) in positively influencing the driver behavior resulting in a reduction in average traffic speed from the upstream highway speed of approximately 8.0 to 12.6 MPH at the end of taper

(fifth iCone or the second to last mark from the right in the plots). Furthermore, the same data indicates that the closure alone may be responsible for approximately 5.1 to 5.7 MPH of this reduction. The data also indicates that when there is a CHP vehicle upstream of CHP-CMS there is a local reduction of speed near the CHP vehicles but such a presence of CHP vehicle upstream does not significantly affect the speed at the end of taper. The same local effect of the CHP vehicle in speed reduction was also observed in the test depicted in Figure 3. During this test, however, an unusual level of traffic congestion was developed; therefore, it was not clear how much of the reduction in speed shown in Figure 3 is from the local effect of the CHP vehicle and how much is from the intrinsic traffic congestion. ***The main conclusion is that the data clearly indicates that the CHP-CMS trailer can be an effective deterrent for reduction of average traffic speed in a work zone.***