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STUDY ON EVALUATION OF SAFETY EFFECT OF VARIABLE MESSAGE SIGN

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ABSTRACT

Speeding is generally one of the major causes of the death or serious injury occurred at road construction section. For such reason, road manager has the concern on improving the safety of the road workers and drivers at the road construction section under unfavorable environment. In this study, mobile variable road electronic display was developed as part of the measure to encourage the drivers to comply with the speed regulation and evaluation of safety effect was conducted on road. The criteria for safety effect applied to this study weremean speed and compliance of the speed limit by the drivers. To quantify the safety effect, linear regression and logic model were adopted. Consequently, mean speed was reduced significantlyfrom the statistical standpoint at the monitoring points after the variable message sign was installed comparing to the speed before installing the sign, that is, the overspeed ratio was reduced by 60% approximately. Thus variable message sign is expected to offer the safety benefit at road construction section and when applying the variable speed limit system.

Keywords*: variable speed limit sign, Road safety, Speed, Compliance.*

I. INTRODUCTION

Speeding is generally one of the major causes of the death or serious injury in traffic accident, which particularly brings about more dangerous result at increment weather such as foggy condition. One of the alternatives to control the speed is speed limit. According to the relevant studies, limiting the speed and controlling the speed to comply with the speed regulation appears to be the most effective way. However the manpower and equipment which the police which is responsible and authorized to control the speed owns are limited and thus it's difficult to some extent to control the speed over entire road construction section. Another alternative to control the speed is using the variable message sign, which is effective in maintaining the safe speed and has been widely used for intelligent traffic system worldwide. It's intended to provide the drivers with the static sign and informationon danger ahead through variable message sign. This study is aimed at evaluating the safety effect by applying variable message sign to road construction section.

This paper comprises of, first, review of the measures to improve the safety at road construction section as well as the method to evaluate the safety effect. Once the evaluation method is established, road construction section for evaluation of safety effect of variable message sign was selected and the relevant data was collected. Finally, safety efficiency of P variable message sign was proposed through statistical analysis.

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Figure 1 Variable message sign

II. REVIEW OF PREVIOUS STUDIES

Benekohalet.al (2009) conducted the test to evaluate the safety effect of unmanned speed camera at road construction section in the United States. As a result, safety on road construction section was improved by speed camera. That is, a free speed was reduced by 3 to 8mph and speed violation was reduced by up to 15 to 50%.

Kazunori Munehiro (2005) asserted saying that importance of traffic safety device on foggy road is very high and the performance of traffic safety device is significantly reduced in foggy or rainy weather, day or night.

Lee, Suk-ki (2008), as a result of the test to identify the visibility and readability by the driver depending on type of visual guidance device,claimed that internal lighting type is more effective comparing to retro-reflection type.

Santoago-Chaparro et al (2012) conducted the test to evaluate the spatial effect of Speed Feedback Sign (SFS) on speed in Wisconsin, USA and also proposed the method to determine the optimal position of SFS. The outcome of the study proved that SFS have had positive effect on road safety. Ivette Cruszado and Eric T Donnell (2009) evaluated the effect of dynamic message sign at transition section. According to this test, dynamic message sign proved to be the optimal alternative of speed control too.

Ali Hajbabaje et al (2011) compared the effect in a way of applying various measures to guide the speed reduction at road construction section. The approach adopted in this study is the combination of unmanned speed camera, dynamic speed feedback sign, police patrol car and police patrol car speed feedback sign. Among these measures, unmanned speed camera had more effect than others on reduction in mean speed and speed violation rate. The effect was greater in order of combination of police patrol car and speed feedback sign, speed feedback sign and police patrol car. Juan C Median et al (2009) also evaluated the speed reduction effect by various speed guidance measures at road constriction section. Unmanned speed camera proved to be most effective in reducing the speed in this evaluation as well.

III. SAFETY EFFECT EVALUATION METHOD

1. Determination Of Site Investigation Location

Evaluation of safety effect of variable message sign was conducted at road construction site on national highway #32 at Shinyang-myun, Chungcheongnam Province in Korea. The road construction was intended to expand a 2-lane to a 4-lane road, Fig 2 shows the view of road construction site. The upstream of the construction site is a 4-lane section with median strip while a 2-lane roadis provided temporarily in the downstream for constriction. Transition section from a 4-lane to a 2-lane is 200m-long. The roadlinked to the end of transition section was temporarily closed for construction. Speed limit on a 4-lane section was 80km/h, a 2-lane was 60km/h and the temporary 2-lane was set at 40km/h. Daily traffic on this section was 300 cars/day and a free speed was monitored at 87km/h. Static sign indicating “Lane is reduced and join to the right “ on road construction section was set up at 300m, 200m and 100m from the end of transition section at upstream of construction site. And speed limit sign 60km/h was set up additionally at 100m point. Speed limit to 60km/h was applied to the start point of temporary 2-lane section and

speed limit sign to 60km/h from temporary road to 100m in upstream was set up. Finally speed limit sign to 40km/h from the start point on temporary 2-lane section was set up.

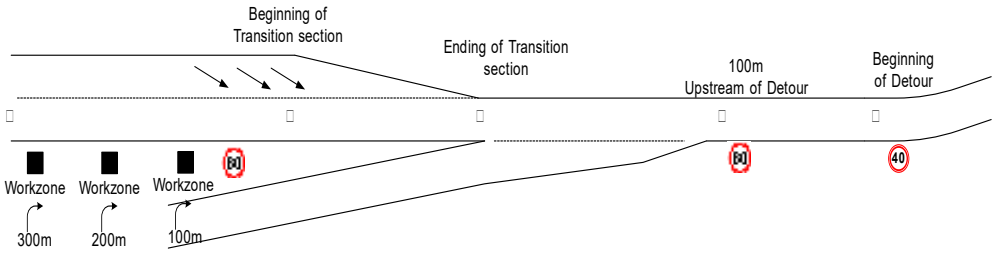


Figure 2Layout of constriction zone

Variable message sign developed in this study was set up at 500m and 200m, respectively, from the start point of temporary road in upstream of the road construction site. Existing temporary sign remained unchanged. Variable message sign at 500m point indicated "single lane" and "Closed" alternately. Variable message sign at 100m point indicated "speed limit 60km/h" and "reduce the speed" alternately. Fig 3 shows the variable message signs in operation.

Figure 3Variable message sign set up at 200m and 500m upstream of constriction section

2. Data Collection Method

In site investigation, the data on speed of individual car was collected using movable detector (NC-97).Detectors were set up at 5 locations in upstream from the start point of temporary 2-lane section. The locations were determined at the point where geometric structure or speed limit is changed. Based on such principle, speed measuring point for individual car was set at 500m in upstream section (1), start point of transition section (2), end point of transition section (3), 100m in upstream section (4) and start point of temporary detour. The detectors provide the information to trace the speed profile of the car approaching to the road construction section. Using the detectors at each point, the time when passing the point and speed was collected by PVMS, before and after installation, separately. Operation at nighttime was limited because of limited electric power of PVMS. Samples monitored at daytime totaled 5,987 and the data before and after installation was 4,108 and 1,879, respectively.

IV. RESULT OF EFFECT EVALUATION

Based on 0.05 statistical significance level, t-test and F-test were conducted at night and day to identify the difference in speed dispersion before and after installation. Fig 4 shows the comparison of speed dispersion before installation and after installation. <Table 1> shows the result of two-tailed F-test. According to the result, no statistical difference in speed dispersion before and after installation was monitored at 0.05 significance level, irrespective of day or night, but a slight difference in statistical significance was monitored and speed deviation before installation was reduced after installation.

Fig 5 shows the comparison of mean speed 50% and 85% before and after installation by monitoring point. According to Fig 5, mean speed after installed at the most of the points was reduced by 5 to 10km/h from the speed before installation. At 50% speed, speed was reduced by 2 to 10km/h and at 85% speed, it's reduced by 2 to 12km/h. Fig 6 compared the cars exceeding the speed limit by 10km/h before and after installation. Consequently, the speed appeared to have been reduced significantly at the points except 500m point and start point of construction section.

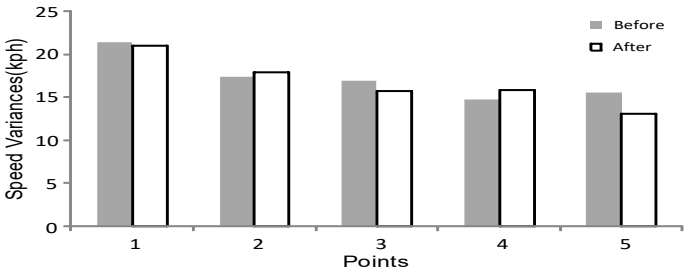
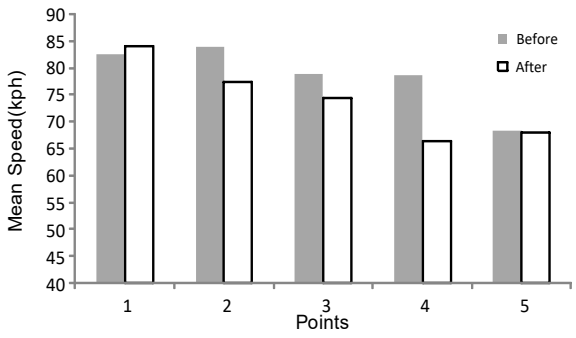


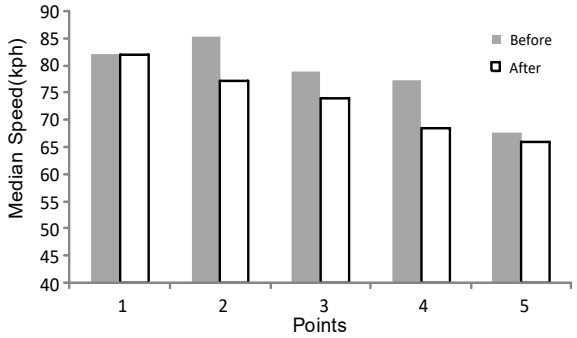
Figure 4 Speed variance between before and after

Table 1Result of F-test for variance

Points	Variance			p-value	Test Results
	Before	After	Difference1)		
①500m upstream of detour	21.43	20.95	-0.48	0.2453	Fail to reject
②Beginning of transition	17.37	17.92	0.55	0.1281	Fail to reject
③Ending of transition	16.95	15.67	-1.28	<0.0001	Reject
④100m upstream of Detour	14.75	15.85	1.10	0.0002	Reject
⑤Beginning of Detour	15.52	13.04	-2.49	0.0010	Reject



<Mean Speed>



<Median Speed>

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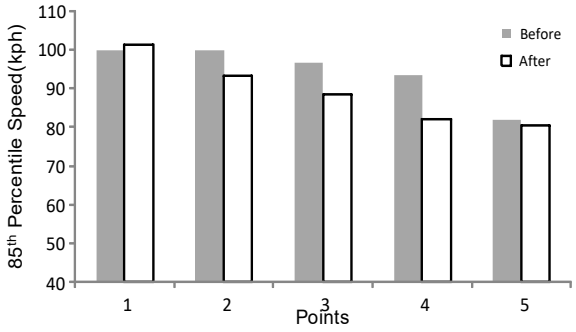

< 85th percentile speed>

Figure 5Mean/median/85th percentile speeds between 'before' and 'after'

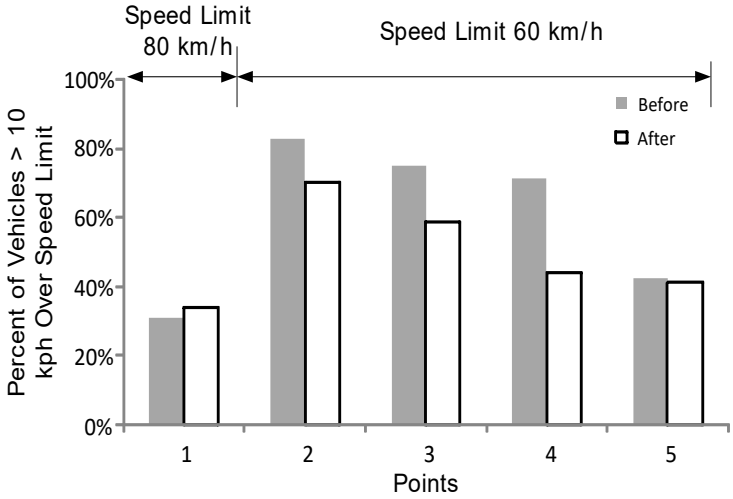

Figure 6Percentage of cars exceeding the speed limit by more than 10km/h between before and after

V. CONCLUSION

The drivers are obliged to comply with the speed limit on road. Driving within the range of speed limit is the matters of driver's compliance with the regulation. This study thus adopted the statistical approach to identify the driver's compliance with the speed rule. Consequently, the drivers tended to comply with the variable message sign, which indicated that the drivers are expected to comply with the speed limit by reducing the speed in inclement weather such as rain or snow.

Further study on methodology for operation of variable message sign on road needs to be continued based on study on luminance of variable message sign and visible distance on assumption of foggy road condition.

VI. ACKNOWLEDGEMENTS

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