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REFLECTORIZED DEVICES FOR DRIVER INFORMATION

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INTRODUCTION

The TRB Committee on User Information Needs has established a Subcommittee on Reflectorized Driver Information. The Subcommittee has been assigned the task of assembling current information related to improved roadway delineation through reflectorization. Eight experienced professionals in the reflectorization field were asked to summarize problem areas requiring research effort. This Circular contains the eight summaries covering the following areas.

1. Snowplowable Raised Pavement Markers
2. Research Needs Related to Sign Luminance and Visual Complexity of Highway Signs
3. Night Work Zone Reflectorization
4. Reflectorized Information Needs: Wet Pavement
5. Reflectorized Guide Signs and Driver Response
6. Reflectorized Guide Signs: Human Factors
7. Reflectorization of Curves
8. Guiderail Delineation

The areas needing research are considered to be valuable to highway administrators, research managers, traffic engineers, and human factors specialists.

Drivers often find that driving at night is more difficult and believe it is more hazardous than driving in the daytime. Adverse weather conditions including snow, fog, dew, and rain produce special

burdens on the driving task in a way that often aggravates drivers' view of roadways, shoulders, roadsides, paths or locations of other vehicles, fixed roadside objects, and traffic control devices.

Using only the light energy emitted from automobile headlights, reflectorized devices have been developed and applied to enhance drivers' views on the highway where it has been believed to be necessary. Many of the decisions to use or not to use reflectorization have been limited by inadequate information on the priority, availability, and effectiveness of current reflective materials and devices. When decisions have been made to use reflectorized devices, the choice between practical, competitive devices for use under the great variety of conditions and purposes is not obvious. Often the need for more competition, lower costs, or new reflectorization systems is evident.

SNOWPLOWABLE RAISED PAVEMENT MARKERS

Helmut T. Zwahlen, Ohio University

A number of states in the northern part of the United States, including the State of Ohio, have regular annual programs to install and maintain large quantities of snowplowable raised pavement markers. These markers provide drivers with additional and effective visual delineation cues during night driving, especially in rain. In the past, the normal spacing for tangent sections and for curves was usually related to existing painted line segment-gap intervals rather than to scientifically established visual needs and capabilities of the driver.

The United States Department of Transportation (DOT), and the Federal Highway Administration (FHWA) have sponsored a number of roadway delineation studies in the past. In one study conducted by Systems Technology, Inc. (STI) (1), an empirical model for painted skip lines was developed on the basis of the results obtained in a driving simulator. This empirical model related lateral lane deviation to speed, delineation visibility, and configuration. Visual range was expressed in terms of delineation contrast and an empirical relationship was expressed between the average standard deviation of the lateral lane deviation and the contrast. In addition, the probability of lane exceedance was defined based on a Gaussian distribution of lane deviations.

The objective of a current study conducted at Ohio University sponsored by the Ohio Department of Transportation, FHWA, and DOT is to modify the empirical STI model for point sources and to determine the optimal spacings and placement for snowplowable raised pavement markers for tangent sections on Interstate highways and for entrance and exit ramps from a visibility and lateral lane deviation point of view. The spacing and placement recommendations obtained with this model will then be tested and validated in the field at night in rain using test drivers and an instrumented test vehicle. The lateral lane position, speed, and the driver's eye scanning behavior will be measured. On the basis of the analytical visibility and lane deviation calculations using the modified STI model, a spacing of 120 ft. for markers placed along skip lines is tentatively recommended for tangent sections on Interstate highways. For entrance and exit ramps with a 24-degree curvature it is tentatively recommended that the markers be placed on the outer edge line at a spacing of 25 ft.

Problems and Issues

Empirical Model

The empirical model developed by STI and modified by Ohio University for point sources is primarily based on driver performance results obtained from driver simulator studies. The degree to which the rather insensitive relationships between the number of markers and the lateral lane deviation apply to real world driving is questionable. It should be noted that the estimated average standard deviations for lateral lane deviation (based on real world night driving results obtained by STI) were about 0.85 ft. for a low-stripe contrast of 0.3 and about 0.60 ft. for a high-stripe contrast of 14. The standard deviation difference of 0.25 ft. between low contrast and high contrast represents only a 42 percent increase and would suggest that lateral lane deviation might not be the most sensitive driver performance measure. The effect of oncoming headlight glare (amplified by the wet pavement) from opposing traffic is not considered in the STI model or the modified STI model. The required point source intensities against wet and reflecting pavement surfaces need to be investigated, as well as the upper value of useful real world driving visibility distance from a lateral and guidance control point of view.

Performance Measures

The ultimate measure of performance would be the number of accidents that occurred at night in rain where delineation, or the lack thereof, was the major causative factor. It would be expected that the use of snowplowable raised pavement markers should result in a decrease of nighttime accidents in wet weather. Because accidents are low probability events and are usually caused by more than one single factor, an investigation of point source intensities against wet and reflecting pavement would require a large-scale experimental effort and large sample sizes to obtain statistically valid results.

Recording lateral lane deviations of regular traffic, or of test drivers in an instrumented vehicle, at night in rain might assist in evaluating the spacing and placement of snowplowable raised pavement markers. However, the average standard deviation of lane deviations might not be the most sensitive performance measure and might require large amounts of experimental data in order to demonstrate statistically significant differences between pavement marker spacings and/or placement schemes.

STI has proposed a measure called the probability of lane exceedance. This measure is based on a Gaussian distribution assumption and is quite sensitive to the average standard deviation of lateral lane deviations for z-values beyond +3 (low tail probabilities). It is, however, questionable whether the Gaussian assumption and the assumption that a driver always drives exactly in the center of the lane holds in the real world. Also, it is unknown how a driver's lateral lane deviation distribution changes as a function of different types of roads (narrow, two-lane rural roads versus Intertates roads; two-lane roads with wide shoulders versus two-lane roads with narrow shoulders; vertical and horizontal curves with different curvatures, etc.). The optimal spacings and placement of snowplowable raised pavement markers need to be determined for other types of roads such as rural two-lane roads.