



Project Summary Report O-4728-S

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Project O-4728: Evaluation of New RRPM and Marking Applications

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An Assessment of Various Pavement Marking Applications and Rumble Strip Designs

Traffic control devices applied to the pavement can provide a significant amount of information for drivers. Over the years, various pavement marking materials, devices, and treatments have been developed that have the potential to increase driver awareness and safety. As part of this project, researchers assessed the effectiveness of yellow-green (YG) crosswalk material, in-roadway warning lights (IRWLs), fluorescent orange retroreflective raised pavement markers (RRPMs), “removable” pavement marking paint, and various designs of rumble strips.

What We Did...

Over a two-year period, researchers completed the following tasks.

- A crosswalk design survey of the 25 Texas Department of Transportation (TxDOT) districts gathered information about crosswalk designs used in each district and solicited input with respect to the types of new pavement marking devices that should be evaluated as part of the research project.
- Researchers conducted a survey of the agencies that have received approval from the Federal Highway Administration (FHWA) to experiment with yellow-green crosswalk markings to summarize the results of recently completed or ongoing evaluations, determine whether additional driver behavior studies were needed, and if possible make recommendations concerning the use of yellow-green markings at crosswalks in school zones.
- Researchers compiled a synthesis of previous research conducted on in-roadway warning lights in order to determine their effectiveness and develop application guidelines.
- A color recognition study evaluated the daytime and nighttime perceptions of two types of newly developed fluorescent orange RRPMs in a simulated work zone environment.
- Researchers evaluated the durability, ease of installation, and ease of removal of a new “removable” pavement marking paint product.



- Researchers measured the sound (inside and outside a vehicle) and vibration (inside a vehicle) caused by running over various types and designs of rumble strips. Tests evaluated three different vehicles at two speeds in order to quantify the stimulation received by the driver and the impact on the surrounding environment.

What We Found...

This research project yielded many findings with respect to the various pavement marking devices examined; however, only a few key findings are provided in this report. Additional results can be found in Report 0-4728-2.

In-roadway warning lights (Figure 1) have been installed by numerous agencies in the United States, and various research projects on the effectiveness of these devices have been completed. For most installations, in-roadway warning lights have increased the frequency that drivers yield to pedestrians into the 50 to 98 percent range. In addition, in-roadway warning lights typically increase the distance at which drivers first brake for a pedestrian, reduce pedestrian wait time prior to crossing, and



Figure 1. In-Roadway Warning Lights in Austin, Texas.

reduce the percent of hurried pedestrian crossings. Driver reaction results tend to be more dramatic at night than during the day. Many of the previous research projects and a few agencies have developed criteria for determining when and where in-roadway warning lights should be considered as a potential crosswalk enhancement.

“Removable” pavement marking paint showed promise, as it can be applied and removed with existing equipment. The patented remover does eliminate the markings without scarring the pavement like some other eradication methods. However, as shown in Figure 2,

the durability of the white “removable” paint at the field locations was less than ideal (retroreflectivity values less than 100 mcd/m²/lux after one month).

Milled rumble strips 8 inches or greater in width generated adequate sound to alert drivers in passenger vehicles (increase of 4 dB or more). However, only milled rumble strips 12 inches or greater in width produced enough sound increase to alert drivers of commercial vehicles. The increase in sound inside the vehicle was adequate for all of the spacings evaluated under all conditions with the exception of the 36-inch spacing for the commercial vehicle. The



change in the sound outside a vehicle increases as the width of milled rumble strips increases, and decreases as the spacing of milled rumble strips increases. The increase in sound (inside and outside the vehicle) was higher for milled rumble strips placed on hot-mix asphalt versus chipseal.

The Researchers Recommend...

Based on the review of previous research and existing agency policies, researchers recommend that TxDOT use the criteria in [Table 1](#) to determine if in-roadway warning lights should be considered as a potential crosswalk enhancement. Considering the need for drivers to be alerted and the impact on the general public living and working near roadways with rumble strips, researchers developed the milled rumble strip application recommendations in [Table 2](#). Further research is needed on the yellow-green crosswalk material, fluorescent orange RRPMS, and the “removable” pavement marking paint before application guidelines can be developed.

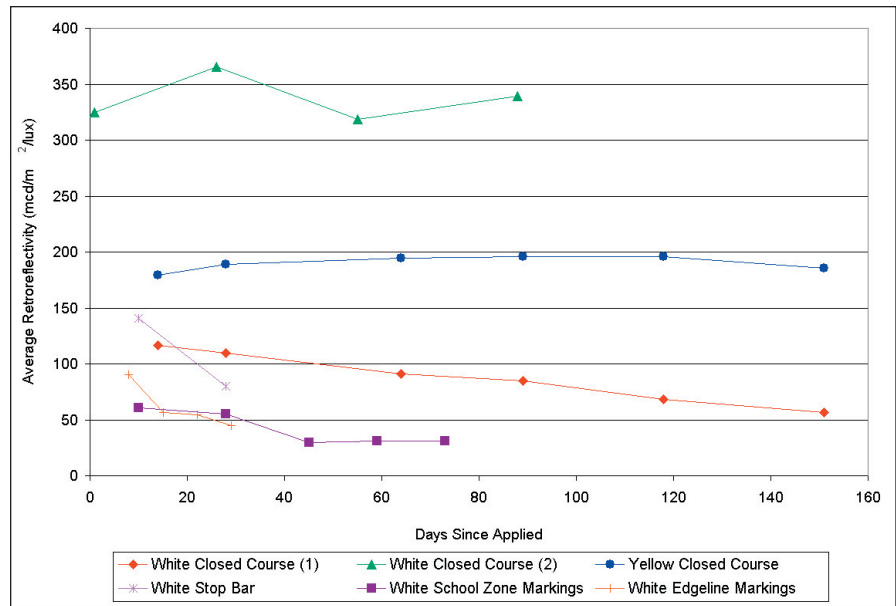


Figure 2. Retroreflectivity of “Removable” Pavement Marking Paint at Various Locations.

Table 1. In-Roadway Warning Light Criteria.

<ul style="list-style-type: none"> • An engineering study should be conducted to determine if there is a pedestrian safety problem. • The location must have a marked crosswalk with applicable warning signs. • Alternative measures to mitigate the pedestrian safety problem should have been tried and proven unsuccessful, or engineering judgment should have determined that other alternative measures are not feasible. • The 85th percentile speed of vehicles approaching the crosswalk from either direction should not be more than 45 mph. • The average daily traffic on the street being crossed should be between 5000 and 30,000 vpd, or vehicular volume through the crossing should exceed 200 vph in urban areas or 140 vph in rural areas during peak-hour pedestrian usage. • The daily pedestrian crossing volume should be at least 100 ppd, or at least 40 pedestrians should regularly use the crossing during each of any two hours (not necessarily consecutive) during a 24-hour period. • The existing stopping sight distance from both directions should not be less than the stopping sight distance criteria in the current version of the <i>TxDOT Roadway Design Manual</i>.
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Table 2. Milled Rumble Strip Application Recommendations.

Vehicle	Width	Spacing
Passenger	≥ 8 inches	≤ 36 inches
Commercial	≥ 12 inches	≤ 24 inches



For More Details...

The research is documented in Report 0-4728-2, *An Assessment of Various Rumble Strip Designs and Pavement Marking Applications for Crosswalks and Work Zones*.

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Disclaimer

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the project was Melisa D. Finley, P.E. (TX-90937).

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