CENTER FOR TRANSPORTATION RESEARCH

# PROJECT SUMMARY

Texas Department of Transportation

## 5-6995-01: Implementation of Retroreflective Pavement Markers (RPMs) in Rumble Strips as a Method to Enhance Driving Conditions After Snowplow Operations

### Background

The absence of retroreflective raised pavement markers (RRPMs) due to snowplow operations leads to reduced road safety from lower visibility of the centerline and monetary losses from reinstalling the markers before the end of their service life. RPMs have been shown to have better nighttime visibility when compared to other road delineation methods like pavement marking stripes, and this is especially true under low visibility conditions like rain or fog. This is of particular importance in the age of assisted driving features-enabled vehicles and autonomous vehicles, which rely extensively on road delineation devices for road awareness. Multifunctionalization of rumble strips to serve as both a sensory warning to roadway users who have drifted from their lane and an in-situ roadway casing to protect markers from snowplows is a novel solution to address the loss and damage to markers due to winter operations. This implementation project aimed to validate the results of a previous project (0-5665) by determining the rumble strip depth that can provide adequate protection to the markers while also still being visible to road users.

### What the Researchers Did

The research team identified additional sites to deploy embedded markers in rumble strips. Two marker types (low profile markers and regular profile markers) were evaluated in six highways sites around Texas and one test roadway site at the research's team institution (see Figure 1).

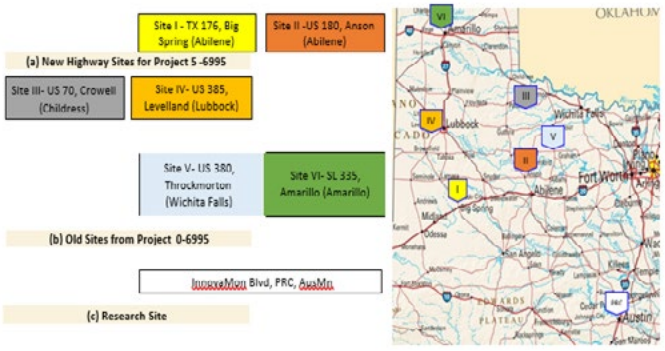


Figure 1: Locations of Sites Selected for the Research Project

Approximately 100 markers of each type were installed at each highway site and the damage to the markers from regular snowplow operations was observed over the project period. In addition, the research team received Institutional Review Board approval to conduct visibility assessment using human participants. The visibility studies were conducted at two of the seven sites, and the studies were conducted to confirm the night-time visibility of markers embedded in snowplow-resistant depth rumble strips. Two types of visibility assessments tests were used in this project: dynamic tests to determine the distance at which road users can perceive the markers while in motion, and static tests to determine the distance at which road users can distinguish the markers from a static point were conducted.

### What They Found

The results show that a critical rumble strip depth, which depends on the marker geometry, exists where the marker is safe from snowplows and visible. It was found that the minimum snowplow-resistant depth for a given marker can be predicted based on the marker height. Participants in general had positive feedback about the retroreflective pavement

**Research Performed by:**
Center for Transportation Research

**Research Supervisor:**
Dr. Raissa Ferron, CTR

**Researchers:**
Md Al Amin
Savitha Srinivasan
Michael Rung

**Project Completed:**
08-31-2023

markers embedded in the rumble strips (see Figure 2). The regular-profile marker exceeded minimum visibility requirements as per TxDOT standards under static and dynamic conditions at low and highway speeds. The low-profile marker exceeded minimum visibility requirements as per TxDOT standards under static and dynamic conditions at low speeds but did not meet minimum visibility requirements at highway speeds. This was attributed to the high amounts of visual distractions during the low-profile marker testing, as such, additional visibility studies should be conducted to confirm the low-profile marker data. The visibility of both marker types reduced drastically when placed in rumble strips deeper than the snowplow-resistant rumble strip depths.

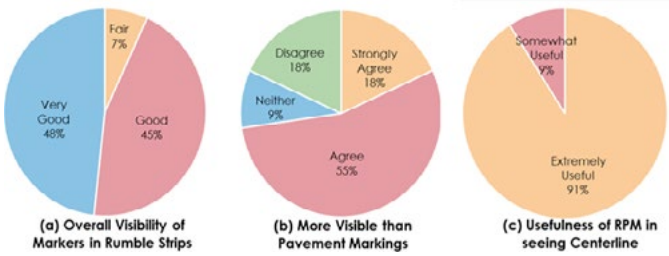


Figure 2: Participants Perception of Retroreflective Pavement Markers Embedded in Rumble Strips

## What This Means

Rumble strips can be multifunctionalized by embedding markers in them to provide snowplow resistance to the markers while also fulfilling their primary duty of alerting drivers of lane departures during driving. In order to adequately protect the markers, deeper rumble strips than what is currently specified by TxDOT is needed; specifically, the rumble strips depths will need to increase by two to five millimeter depending on whether a low profile marker or regular profile marker is embedded in the rumble strip. Tighter tolerances for the rumble strips depths are also recommended (changed from three millimeter to two millimeter mm), and reducing the spacing between markers should be explored as a way to further increase marker visibility when they are embedded in the rumble strips. The results show that controlling depth during the cutting of the rumble strips is crucial and stricter inspections during the cutting of the rumble strips and markers installation will still be necessary for the successful implementation of the embedded RPM technique. The estimated value of research for Project 5-6995-01 shows that implementation of the markers embedded in the rumble strips method of highway delineation can provide cost savings of $1.8 million annually and $8.9 million over five years to TxDOT using current RPM spacing guidelines. The savings will depend on the marker spacing, for example if marker spacing is reduced from 80 feet to 30 feet spacing the cost saving over five years is estimated to be $3.2 million.


**For More Information**

**Project Manager:**
Jade Adediwura, RTI (512) 486-5061

**Research Supervisor:**
Raissa Ferron, CTR (512) 232-2691

Technical reports when published are available at **https://library.ctr.utexas.edu.**

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research