JOINT TRANSPORTATION RESEARCH PROGRAM

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Rumble Stripes and Pavement Marking Delineation

Motivation

Pavement markings serve an important role on the highway and must be visible in day, night, and wet conditions. In recent years, non-grooved paint, grooved multi-component, grooved preformed tape, and grooved thermoplastic have been the types of pavement markings applied on most state highways in Indiana. Pavement markings placed in grooved pavement are receiving considerable interest due to their potential for greater durability by providing protection from plow blades used during winter maintenance. Recessed durable pavement markings are hypothesized to require less maintenance, and there is a safety benefit in keeping workers off the road. Additionally, Indiana has installations of raised pavement markers (RPMs) in rumble stripes and between rumble stripes. This project also examined the failure rate of RPMs in and between rumble depressions.

Study

Although there are few studies related to pavement marking durability, anecdotal reports have indicated that grooved installations maintain higher retroreflectivity and are protected from damage by snowplows and traffic. This study evaluated white edge lines and yellow edge lines on roads in Indiana and other northern states. Data was collected by use of a hand-operated retroreflectometer as well as a mobile retroreflectometer. The data collected with a hand-operated retroreflectometer was collected on a 400' section of white edge line, with 16 measurements per section. Additionally, data shared by 3M was used in the evaluation of white and yellow edge lines. Most of the data collected was focused on dry road conditions, but limited data was obtained for markings with wet elements using the ASTM wet recovery test protocol. The RPM data collection consisted of driving three mile road segments and documenting the total number of RPMs, number of missing reflectors and castings.

As the study advisory team reached out to stakeholders during the study, the automotive lighting industry expressed interest in understanding the types of retroreflective materials used by INDOT (and other states) and how those materials respond to new wavelengths being introduced in headlights as well LiDAR sensors.

Results

Results showed that for both white and yellow edge lines, grooved preformed tape has the highest durability for greater than ten winter seasons (see figure). Based upon a small sample size and extrapolation, it is plausible that the grooved thermoplastic could last five winter seasons while grooved multi-component may have a slightly shorter life expectancy of three to four winter seasons. Non-grooved paint will last one or perhaps two winter seasons. Also, RPMs in rumble stripes have a higher failure rate than RPMs installed between rumble stripes.

Economic Analysis

A life cycle cost analysis was conducted to compare the performance of material types over a ten-year analysis period. Since there is still some uncertainty in the number of years the thermoplastic and multi-component markings will last, the economic analysis was completed with two different life expectancies. The assumed number of winter seasons are shown in white boxes on bar graphs and the legend is shown in lower left of graphs. From the expected durability and cost from the INDOT Unit Price Summaries, the total cost for each pavement marking in a ten-year analysis period was calculated.

Recommendation

Although grooved preformed tape has the longest life expectancy, the life cycle cost of this material is twice the cost of grooved thermoplastic, grooved multi-component, or non-grooved paint. However, since grooved multi-component, grooved thermoplastic, and non-grooved paint must be replaced more often than preformed tape, there may be significant (but hard to quantify) additional benefits associated with preformed tape due to reduced maintenance of traffic activities and reduced exposure of maintenance workers to traffic hazards.

Based upon data collected during this project, the following recommendations were made by the project team:

1. Grooved thermoplastic and multi-component have the lowest lifetime costs for durable markings. Additional performance data (particularly after 3, 4, and 5 winter seasons) should be collected to determine if either has a distinct economic advantage.
2. RPMs installed in rumble stripes appear to have a higher failure rate. It is recommended that RPM installation in rumble depressions be ended and that RPMs only be installed in between rumble millings on the pavement surface.
3. Characterizing how retroreflective roadway markings respond to emerging vehicle lighting technology and LiDAR is of strong interest to the automotive sector. INDOT has an opportunity to partner with Valeo (based in Seymour, Indiana) to help define new ways that state DOTs can prepare their infrastructure for the next generation of connected and autonomous vehicles.

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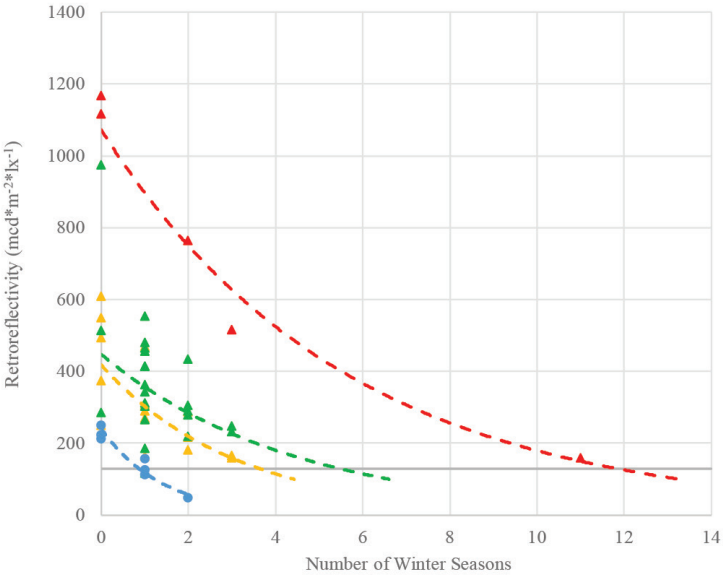
(a) White edge line



(b) Yellow edge line