Extending the Service Life of Pavement Markings

Iowa Applies Innovation and Technology to Reduce Costs, Increase Safety

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Pavement markings guide motorists and delineate roadways for safe travel. Over the past decade, the Center for Transportation Research and Education (CTRE) at Iowa State University has conducted research to develop new technologies and innovative methods for agencies to manage pavement marking assets.

Problem

Pavement markings have a relatively short service life compared with that of many other roadway assets. The visibility characteristics of markings—their presence and retroreflectivity—deteriorate quickly. Maintaining the visibility of markings at acceptable levels is therefore a major task for agencies' roadway maintenance and safety programs.

U.S. transportation agencies face several issues related to the quality of pavement marking, including variability in the types and performance of marking materials, quality control during installation, damage from traffic and from winter operations, costs, and a lack of performance standards (*1*). The Iowa Department of Transportation (DOT) sought to address each of these issues.

Application of white line to a grooved surface, which can extend service life.

Winter operations contribute to the rapid deterioration of markings.

Solutions

CTRE first conducted pavement marking research to help Iowa DOT improve pavement marking practices. Expectations were that the outcomes also would improve roadway safety.

Before 2004, Iowa DOT had followed material and installation specifications for pavement markings but did not apply measures of performance. State district crews would paint as many miles as possible with waterborne paint, meeting the department's pavement marking specifications to ensure visibility (*2*). In 2004, the Iowa DOT Pavement Marking Task Force began collecting retroreflectivity measurements for pavement markings on all state-owned roads; measurements were taken before the paint season and again after the season.

New Tools

CTRE worked with Iowa DOT to develop tools to manage the pavement markings and improve marking performance. CTRE assessed the installation methods and equipment, the materials—notably, beads and binders—and the application on flat or grooved pavement surfaces.

The initial effort explored ways for the districts to use geographic information system (GIS) tools to

determine their paint programs based on the retroreflectivity values that were recorded in 2004. The district could use the GIS map to determine which lines needed repainting, in which direction of travel.

As more data became available, CTRE developed an interactive tool to allow the central office and field crews to query, analyze, and report data on paint and retroreflectivity. The Iowa DOT Pavement Marking Management Tool assembles reports on pavement marking performance by district or statewide in terms of retroreflectivity, paint data and initial retroreflectivity, materials used, and whether the marking was on a flat or grooved surface.

Figure 1 (below) offers a screen shot of the statewide retroreflectivity values for white edge lines in the fall of 2011. Green represents roads that do not need painting, red indicates roads with marking retroreflectivity below Iowa DOT's threshold of 150 millicandela (mcd), and yellow identifies roads that are in between the two conditions.

The map informs the field crews and district managers about the condition of the pavement markings and supports planning for the next year's paint season. A similar system for managing pavement marking assets was developed for Minnesota DOT using a web-based platform (3).

Operations and Installation

Iowa DOT also used the data to make decisions about operations and installation procedures. Districts lowered the vehicle speeds for painting to 8 to 10 mph from the previous 12 to 15 mph; this reduced bead roll and improved the distribution and embedment of beads, increasing the retroreflectivity of the markings. This practice boosted the average retroreflectivity values statewide for all yellow and white lines.

The next step was to determine and evaluate the performance of pavement marking materials to

Close-up view of yellow line deterioration.

expand the options available to Iowa DOT. CTRE designed a field study on 12 one-mile roadway sections to assess the performance of two binders and three bead packages applied to flat or grooved surfaces. The binders were waterborne and highbuild waterborne; the bead packages included standard Iowa DOT beads, 1.9 refractive index beads, and American Association of State Highway and Transportation Officials Type III beads.

CTRE developed the data collection protocol, collected and analyzed the data, and developed recommendations based on observations from two winters. Grooved surfaces showed a potential for extending the life of a marking more than 2 years. Iowa DOT now uses grooving to improve pavement marking retroreflectivity and the quality of service provided to the public.

Cost Savings

On average, the traditional method of painting costs Iowa DOT $210 for 2 lane miles—an expense recurring every year or every 2 years. Applying the paint to grooved surfaces costs the same but lasts for 3 years—a potential savings of $210 to $420 per 2 lane miles in a 3-year cycle.

The savings estimates compared the cost of highbuild paint with Type III beads with the cost of paint-

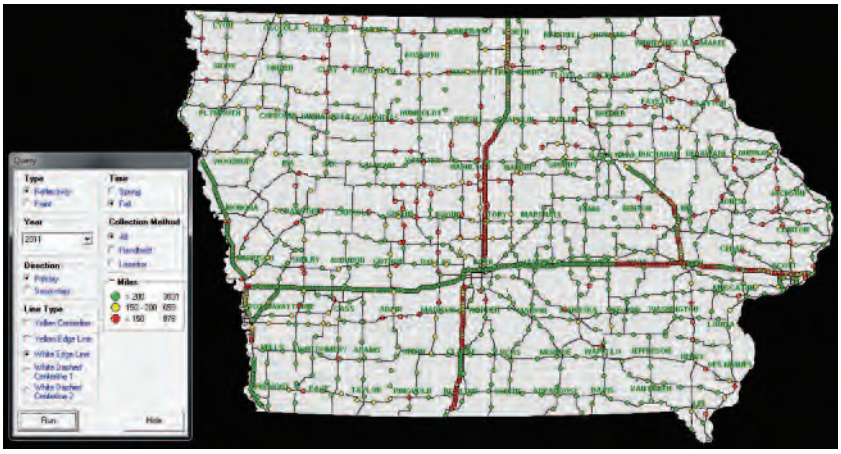

FIGURE 1 Iowa DOT Pavement Marking Management Tool, showing statewide retroflectivity.

Lowering vehicle speeds to 8 to 10 mph during application increased the retroflectivity of the markings.

ing with standard Iowa DOT materials. These savings will be significant when extended to the entire state road network. Iowa DOT therefore has implemented two statewide grooving projects; the results of the projects will be available in 2014.

Safety Findings

CTRE examined the impact of pavement marking on crashes in Iowa, using the retroreflectivity data collected from 2005 to 2010. The study explored the statistical relationship between the probability of a crash and the retroreflectivity of longitudinal pavement markings.

Pavement marking retroreflectivity deteriorates nonlinearly and varies greatly by location, environmental condition, and other unidentified factors. Nonetheless, analysis of the 5 years of marking retroreflectivity and crash data for Iowa DOT state roads yielded a statistically significant conclusion that crash occurrence increases as the retroreflectivity values decrease for both white and yellow longitudinal pavement markings (*4*).

Iowa DOT has established a minimum retroflectivity of 100 mcd for yellow lines.

Benefits

Iowa DOT central and district staff routinely use the tools developed by CTRE to monitor and manage pavement marking assets. Iowa DOT has established minimum retroreflectivity standards of 150 mcd for white lines and 100 mcd for yellow lines based on the effects of pavement marking quality in reducing vehicle crashes.

Both Iowa DOT and Minnesota DOT have changed their pavement marking installation practices as a result of the research findings. The research showed that pavement grooving protected the markings from the wear of traffic and from winter maintenance operations; as noted, the potential savings ranged from $210 to $420 per 2 lane miles in a 3-year cycle.

From a safety perspective, the researchers documented a decrease in crashes with increased retroreflectivity in longitudinal pavement marking. For example, on a two-lane rural road, the crash probability decreased by 2.5 percent when pavement marking retroreflectivity increased from 50 mcd to 200 mcd.

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Suggestions for Research Pays Off topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).