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**RESEARCH PROJECT TITLE**

Evaluation of Rumble Stripes on Low-Volume Rural Roads in Iowa—Phase II

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# Evaluation of Rumble Stripes on Low-Volume Rural Roads in Iowa—Phase II

tech transfer summary

The results of this project indicate narrow-width rumble stripes may have positive applications as mitigation for run-off-road crashes on lower-volume rural paved roads.

## Problem Statement

Single-vehicle run-off-road (SVROR) crashes are the most common crash type on rural two-lane Iowa roads. Rumble strips have proven effective in mitigating these crashes, but the strips are commonly installed in paved shoulders on higher-volume roads in Iowa.

Lower-volume paved rural roads owned by local agencies do not commonly feature paved shoulders, but frequently experience run-off-road (ROR) crashes.

## Objectives

This project involved installing rumble stripes, which are a combination of conventional rumble strips with a painted edge line placed on the surface of the milled area, along the edge of the travel lanes, but at a narrow width to avoid possible intrusion into the normal vehicle travel paths.

The project evaluated the effectiveness of rumble stripes in reducing ROR crashes and in improving the longevity and wet-weather visibility of edge-line markings.



*Milling work for edge-line rumble stripes on a rural highway in Iowa*

## Research Description and Methods

The project consisted of two phases.

In Phase I, candidate locations were selected from a list of paved local rural roads that were most recently listed in the top five percent of roads for ROR crashes in Iowa. Horizontal curves were the most favored locations for rumble stripe installation because they commonly experience roadway departure crashes.

Rumble stripes were installed at five tests sites in 2008. In addition, rumble stripes were installed independently at one site by a county during the installation period and it was included as an evaluation site.

A preliminary assessment of the rumble stripes' performance was conducted and lessons learned during installation were summarized. This information was included the Phase I report ([http://www.intrans.iastate.edu/reports/HallmarkTR-577\\_report.pdf](http://www.intrans.iastate.edu/reports/HallmarkTR-577_report.pdf)).

The purpose of the second phase was to provide a more long-term assessment of the performance of the pavement markings, conduct preliminary crash assessments, and evaluate lane keeping.

## Summary of Key Findings

The first evaluation was pavement marking wear. One of the advantages attributed to rumble stripes is additional visibility of the pavement marking. It is thought that the shape of the rumble stripe itself provides a raised (vertical) surface so that the markings are more visible at night and particularly when some amount of precipitation is on the pavement surface.



*Completed PCC rumble stripe installation in Buchanan County (image: Hawkins, CTRE)*

In addition, the depression protects part of the pavement marking which can lead to improved wear. Consequently, part of the evaluation was to monitor wear over time.

Iowa receives a significant amount of snow from December through March. Winter road maintenance in Iowa is aggressive and includes scraping and the use of salt and sand. As a result, winter maintenance is harsh on pavement markings.

Several sites were visited two years after application of the rumble stripes and a qualitative assessment of pavement marking wear was conducted. At all of the sites, a significant portion of the regular pavement markings, which were flush with the pavement surface, had been worn away by the snowplows, while much of the marking within the rumble stripe remained.

As a result, the rumble stripe was successful in preserving the pavement marking, which will lead to improved visibility. One problem that was noted with the rumble stripes is that material (sand, gravel, and dirt) tends to accumulate within the stripe.

A before and after crash analysis was also conducted. A set of control sites were included. Results of the analysis were inconclusive. However, only seven treatment sites were tested and only a short after-period (two years) was available.

In addition, even though the locations were considered to be "high-crash," given the majority of the sections were less than two miles long and volumes were less than 1,500 vehicles per day (vpd), the actual number of crashes was low. Due to the low sample size and number of crashes, it was difficult to conduct a statistically-valid crash analysis.



*Completed edge-line rumble stripe on a rural HMA highway in Iowa*

Lane position was evaluated before and after installation of edge-line rumble stripes as a surrogate measure of safety given only a short after-period was available for a crash analysis. Lateral position data were collected using a Z-configuration setup with road tubes at six locations.

Data were collected over several days before and, then, approximately one month after installation of the edge-line rumble stripes. Lateral position from the right roadway edge was measured using the road tubes. Distance from the lane center was calculated using lateral position and lane width. Data were evaluated for day and nighttime periods separately.

Average offset from the lane center decreased by more than 1 ft for two locations during the daytime period. Average offset decreased by 0.2 to 0.6 ft for three sites and increased at one site by 0.4 ft.

As indicated, the vehicle wheel path moved closer to the lane center for all six sites for the nighttime period but was not statistically significant at the 95 percent level of confidence for two of the locations. The change was around 1.5 ft for three of the sites. On average, improvement in offset from the lane center was higher for nighttime than for daytime.

Average and 85th percentile speeds were also compared from the before to after period. In general, both mean and 85th percentile speeds increased after installation of the treatments. Average speed increases ranged from 0.1 to 6.5 mph and changes in 85th percentile speeds increased from -2.5 to 6.9 mph.

It is not known if speed changes were due to better delineation of the roadway or if the speed increase was unrelated to the treatment.



*Road tube layout to measure lateral displacement in the field (Z configuration)*

Results indicate that, in most cases, average vehicle position moved closer to the lane center after application of the rumble stripes for both daytime and nighttime.

## Recommendations

Based on information gained in both Phases I and II, the research team offers the following recommendations for consideration.

- Based on preliminary evaluation results, local agencies could consider installation of narrow-width rumble stripes along paved rural roads (with or without paved shoulders) when they have a high potential for or actual number of ROR crashes.



*Sample wear on HMA after two winters*



*Edge lines still visible in rumble stripe depressions after wear*

- More definitive specification requirements for milling equipment should be considered, including alignment controls and minimum downward pressure for the milling head, especially on PCC pavements.
- Close inspection of the installation process should be applied. Of particular importance is the application of painted edge lines to ascertain sufficient paint and glass beads are applied. Specifications should describe minimum rates and initial retroreflectivity requirements for both.
- More investigation of propensity of the milled areas for filling with deleterious material should be undertaken. This project indicated significant variation in this occurrence between roadway sections, and that reason should be identified if possible.
- Continue to monitor the reaction to rumble stripes from special road users, such as bicyclists, horse-drawn vehicle users, and agricultural equipment operators.

- On roadway sections with an unusually high number or rate of left-side lane departure, narrow-width rumble stripes should be considered for centerline installation.
- A cost-effective measure of nighttime, wet-condition visibility should be developed for assessing performance of pavement markings, whether rumble stripes or standard applications.

## Implementation Benefits and Readiness

Even though the most significant potential benefit (crash reduction) of narrow-width rumble stripes will not be known for several years, the results of this project indicate that narrow-width rumble stripes may have positive applications as mitigation for ROR crashes on lower-volume rural paved roads.



*Sample wear on PCC after two winters*



*The Amish group in Davis County indicated the wider rumble stripes were a problem for them (image: Hawkins, CTRE)*