IOWA STATE UNIVERSITY

Department of Civil, Construction, and Environmental Engineering

Dowel Bar Retrofitting in Buena Vista County, Iowa

tech transfer summary

Pavement rehabilitation in Buena Vista County, Iowa involved the use of various retrofitting options for better pavement preservation.

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RESEARCH PROJECT TITLE
Evaluation of Dowel Bar Retrofits for Local Road Pavements

SPONSORS
Iowa Highway Research Board (TR-520)
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Objective

This project's objective was to evaluate the use of various types of dowels for the preservation of local road pavements, as well as to study their impact on long-term pavement performance in Buena Vista County, Iowa. A secondary objective was to determine the costs of this method of pavement preservation.

Problem Statement

An increase in truck traffic on Iowa's secondary roads poses a problem of preserving the pavement of these roads. Installing or retrofitting load transfer in pavement joints to preserve these roads requires that a number of questions be answered, ranging from what type of dowel material, spacing, placement method, construction techniques to use, to the number of dowel bars to use. Answering these questions will allow engineers to better respond to pavement preservation issues.

Research Description

The research team laid out a series of subsections in the one-mile test section that included the variables of dowel material type and number of bars per joint. Test segments consisted of conventional round steel dowels and elliptical steel and fiber-reinforced polymer (FRP) dowels. A total of 36 test sections in each direction of travel were used for this work. Selected bars in three of the test segments were instrumented for strain evaluation.

The Buena Vista County staff developed a construction project to retrofit dowels in the joints and grind the surface of the test pavement. The research team provided a dowel bar plan that included bars of each type, which they instrumented to provide strain information after construction.

Surface grinder used in pavement rehabilitation

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The joint fault testing was conducted by ISU faculty and research assistants. The fault meters were produced by the Federal Highway Administration and have an accuracy of 0.04 inches. Faulting measurements were taken 18 inches from each edge of the pavement in the northbound and southbound lanes. Faulting data were acquired at every joint along the retrofit pavement. The data were then broken down by bar material type, as well as the number of bars used in each joint.

The falling weight deflectometer testing was conducted by Braun Intertec Inc. Data were collected in both the northbound and southbound lanes, once before project construction and three times after the retrofit was complete. Deflection data were collected at three joints in each of the 36 test sections along the retrofit pavement.

The profile testing was conducted by Ames Engineering. The data were collected in both wheel paths and both directions on the one mile section of roadway at four different time periods. International roughness index values were extracted from ProVAL 2.7 computer software to analyze the effects of diamond grinding—used to remove excess grout and joint faulting—and dowel bar retrofits on pavement profile.

With the assistance of Buena Vista County, the research team conducted load transfer strain measurements in each of the dowel types during summer and winter conditions in the first year after construction and again at the end of years two and four.

Key Findings

The research team discovered the following key findings with regard to its questions to be answered.

- The international roughness index was reduced to 80 in/mi because of diamond grinding.
- Faulting was reduced to approximately 0.019 inches because of diamond grinding.
- Two, three, and four dowels all performed equally for faulting and load transfer across joints.
- All bar material types performed equally in load transfer development.
- The FRP dowels attained higher performance in terms of pavement international roughness index vs. steel dowels.
- Using more dowels increased international roughness index performance.
- The FRP strain values were higher than steel strain values, but all combinations performed in an acceptable range.
- Increasing the number of dowels increases the performance of the pavement.

Recommendations

The research team concluded that FRP bars maintain a better international roughness index. However, these bars carry a higher cost. Decisions about which retrofit would best suit the needs of a particular project should be made on a case-by-case basis. The life extension displayed below does not account for any extension due to the reduced corrosion benefits of FRP dowels. If corrosion is considered to be an issue, the team recommends the consideration of FRP dowels.

Summary of life extension to cost for one-mile pavement

Bar type / #	Cost/mile	Pavement life extention (years)
Heavy elliptical 4	$136,000	26–33
FRP 2	$101,700	25–32*
FRP 4	$156,100	23–29
FRP 3	$128,900	17–22
Steel round 4	$136,000	13–17
Heavy elliptical 3	$114,300	13–17
Medium elliptical 4	$135,600	13–16
Medium elliptical 3	$113,500	11–13
Steel round 2	$91,700	9–12
Steel round 3	$113,800	9–12
Medium elliptical 2	$91,500	8–11
Heavy elliptical 2	$92,000	7–8

NOTE: * indicates a number that has intuitively inconsistent data