National Concrete Pavement Technology Center

Field Evaluation of Elliptical Steel Dowels

tech transfer summary

Joints are always a concern in the construction and long-term performance of concrete pavements.

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RESEARCH PROJECT TITLE
Field Evaluation of Elliptical Steel Dowel Performance

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Objectives

The research for this project was conducted to answer the following questions:

- What is the relative performance over time of medium and large elliptical steel dowels as compared to that of the conventional steel dowels in terms of deflection, visual distress, joint faulting, and joint openings?
- What is the impact of dowel spacing on the relative performance of the elliptical and round dowels in field conditions?
- What is the impact on performance of the various dowel shapes when placed in cut or fill sections of the roadway?
- What constructability problems, if any, are associated with the installation of dowel shapes other than round?

Problem Statement

Research has shown that we need some type of positive load transfer across transverse joints. The same research has directed pavement designers to use round dowels spaced at regular intervals across the transverse joint to distribute the vehicle loads both longitudinally and transversely across the joint. The goals are to reduce bearing stresses on the dowels and the two pavement slab edges and to reduce erosion of the underlying surface, hence improving long-term joint and pavement structure performance.

Other considerations include road salts which cause metal corrosion in doweled joints, excessive bearing which stresses hollow dowel ends, and construction processes which are associated with cracked pavement at the end of dowels. Dowels are also a factor in the pavement costs when joint spacing is reduced to control curling and warping distress in pavements. Designers desire to place adequate numbers of dowels spaced at the proper locations to handle the anticipated loads and bearing stresses for the design life of the pavement.

Research Description

This summary is based on the final report of three reports on the evaluation of elliptical steel dowels. The report consists of results of the testing and performance analysis of the various shapes and sizes of dowels. It also documents the results of the first series of performance surveys and draws conclusions about the performance of various bar shapes, sizes, spacings, and basket configurations.

The project period extended from May 2002 to September 2007. The first year, summarized in the previously submitted Construction Report, involved the installation of the dowel bars according to the spacing con-

figurations outlined in the "Installation" section found in the report. Years two through five include various tests and evaluations such as the tests described in the "Data Collection" section of the report.

The construction project chosen for the field research—Iowa 330 in Iowa's Jasper, Story, and Marshall counties—provided all the variables needed for the research. Dowel test section length accounted for 3.5 mi (5.63 km) of the 11.47 mi (18.46 km) portland cement concrete (PCC) paving project that was used for this study. The construction project's contractor, Fred Carlson Company, Inc. of Decorah, Iowa, and materials suppliers, including American Highway Technology, provided the necessary support to implement the research.

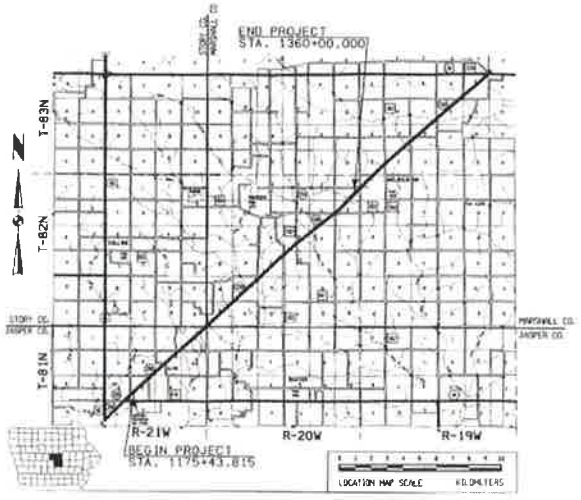

Figure 1. Site map

Key Findings

Load Transfer Findings

- All dowel types transferred 80%–90% of the load across the joints.
- Medium elliptical steel dowel bars were equally adequate, if not better than standard round dowel bars at transferring load across the transverse joints.
- Medium elliptical steel dowel bars performed equally to standard round dowel bars when wheel path baskets were used.
- Dowel spacing of 12 in. (304.8 mm) and 15 in. (381 mm) indicated equal performance for elliptical medium, large, and round dowels, while 18 in. (457.2 mm) spacing provided a lower level of load transfer.
- Load transfer values were essentially equal for all bar materials and sizes between cut, fill, and transition sections.
- Wheel path dowel baskets performed equal to full dowel baskets when the medium elliptical and standard rounds are compared.

General Findings

- The medium and large elliptical steel dowels performed equal to or better than the conventional steel dowels in terms of deflection, visual distress, and joint faulting. No conclusions could be reached on the relative performance in terms of joint openings.
- The medium-sized elliptical steel dowels can be spaced up to 15 in. (381 mm) center to center and perform equal to or better than the conventional round bar. The use of 18 in. (457.2 mm) spacings cannot be substantiated with only five years of data.
- The impact of subgrade location (cut, fill, and transition) provided offsetting results in terms of faulting, load transfer, and profile, but not in terms of the differences between the performance of the various dowel shapes.
- The elliptical steel dowels, when used in standard baskets, can be placed as easily as the standard round bars in basket assemblies. The weight differences can be mitigated with the increased spacing of the elliptical bars to 15 in. between round standard dowels and medium elliptical dowels.

Implementation Recommendations

- Make changes in the Iowa Department of Transportation specifications to allow for the use of elliptical-shaped steel dowels in the medium or large sizes (tested in this report) as an alternative to the standard round steel bars currently in use.
- Employ the medium elliptical bars shown in this report for future construction at the 12 in. (304.8 mm) or 15 in. (381 mm) spacings.
- Consider further testing or monitoring of medium elliptical wheel path dowel bars to evaluate the long-term performance.

Figure 2. Placed wheel path baskets