Field Investigation of Dowel and Tie Bar Placement

Objectives

- Investigate and quantify dowel and tie bar placement in Wisconsin roadways
- Recommend tolerance limits for dowel and tie bar alignments to achieve long-term performance
- Document the relationship between misalignment and joint performance
- Develop field inspection procedures for proper bar installation

Benefits

- Evaluates any potential relationship between dowel and/or tie bar misalignment and pavement distresses
- Helps better understand the impact of misalignment on pavement performance

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Background

This report presents the results of dowel and tie bar alignment data collected using the MIT-DOWEL-SCAN and MIT-SCAN-T2 from various counties in Wisconsin. Considering the potential negative impact of dowel and tie bar misalignment on pavement performance, it is important to investigate any dowel and/or tie bar misalignment and determine if the alignment is within tolerance limits. In addition, an investigation is needed to inspect joint and pavement condition and establish any potential relationship with dowel and/or tie bar misalignment, which may help better understand the impact of misalignment on pavement performance.

Methodology

The data was analyzed using the latest version of the MagnoProof® software to calculate the various dowel alignment parameters including horizontal skew, vertical tilt, longitudinal translation, and vertical translation. These measured parameters were used to compute joint score (JS) and equivalent dowel diameter (EDD). Chi-squared tests were performed to determine any relationship between JS and spalling, slab cracking, and longitudinal translation. AASHTOWare® Pavement ME Design (PMED) was used to evaluate the impact of dowel misalignment on pavement performance.

MIT-DOWEL-SCAN testing in Chippewa County

Results

In total, 1,293 joints were evaluated by the research team across twelve sites in six counties which included 12,862 dowel bars after the data was passed through the initial filtering process. The data set also included additional MIT-DOWEL-SCAN data provided by WisDOT, which included 386 joints consisting of 3,954 dowel bars.

The data showed moderate to good dowel alignment for both basket and dowel bar inserter sections with over 95 percent of dowel bars

"Achieving long-lasting and well-performing rigid pavements requires an understanding of factors affecting their long-term performance. The results of this research on the effects of dowel and tie bar alignment on Wisconsin's pavement performance will help advance the department's efforts in constructing and maintaining quality concrete pavements."

– Peter Kemp, WisDOT

having horizontal skew and vertical tilt values between 0 and ± 1.0 inches, longitudinal translation between 0 and ± 3.0 inches, and vertical translation between 0 and ± 1.5 inches.

Results did not indicate any relationship between JS and spalling or cracking for any of the sections, suggesting that other factors may have a stronger effect on spalling and transverse cracking than JS. In two counties, the results indicated a relationship between JS and longitudinal translation. Although JS and longitudinal translation are independent metrics, the relationship between the two in these two counties suggests the contractor experienced challenges with dowel bar placement during paving.

The chi-squared results were also confirmed by performing a logistic regression analysis that included JS, pavement age, and slab thickness as the independent parameters with spalling and cracking as the dependent parameters. EDD ranged from 1.6 percent to 20.5 percent equivalent reduction in dowel diameter as compared with actual dowel diameter.

Results from the PMED runs using EDD as compared to actual dowel diameter showed increased roughness and faulting over the life of the pavement caused by the equivalent reduction in dowel diameter due to misalignment. However, slab cracking was not affected by change in dowel diameter.

Recommendations for Implementation

The research team proposes several recommendations for WisDOT's specifications and protocols including:

- Install tie bars parallel to the substrate surface and perpendicular to the longitudinal joint for 415.3.7.2 longitudinal joints
- Install dowel bars parallel to the substrate surface and parallel to the centerline of the pavement for 415.3.7.3 transverse joints. Before placing the concrete, mark the location on both sides of each transverse joint. Ensure the proposed saw cut is centered on the dowel bars and that the dowels remain parallel to the centerline. Transfer the markings on the top surface of the concrete immediately after completing the final finishing operations
- At least seven days before the beginning of concrete paving, provide a Quality Control Plan to the engineer for acceptance that provides a method for keeping the dowel basket assemblies anchored. The plan should include the type, location, number and length of the fasteners, proposed installation equipment, dowel basket assembly anchoring plan and action plan if misaligned baskets are identified during the pavement placement

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-22-02
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Wisconsin Highway Research Program