

## Executive Summary and Research Readiness Level Assessment

# Measuring Foundation Course Modulus Using Falling Weight Deflectometer, Light Weight Deflectometer, and Dynamic Cone Penetration

### Research Objectives

The purpose of this investigation was to determine the feasibility of measuring bituminous foundation course modulus under concrete roadways by comparing testing results derived before and after paving using Falling Weight Deflectometer (FWD), Light Weight Deflectometer (LWD), and Dynamic Cone Penetrometer (DCP).



### Research Benefits

This research

- Provided confidence to the Pavement Design Section that FWD, LWD, and DCP all provided valid results when used on an exposed bituminous foundation course.
- Indicated that using FWD testing after concrete is built does not provide an accurate modulus of the foundation course and cannot be used.

### Background

There have been attempts in the past to forensically evaluate subgrade and foundation course strength that underly concrete pavement by Falling Weight Deflectometer (FWD) testing on top of doweled concrete. The accuracy of these data is unknown.

The Falling Weight Deflectometer is a trailer mounted, non-destructive testing device that drops a weight onto the pavement and has sensors that measure the amount of resulting deflection. The slope of the load and resulting deflection is referred to as the modulus.

NDOT has years of experience testing strata beneath asphalt surfaces but because FWD testing of subgrades beneath rigid pavement are not well established, NDOT has not adopted testing of rigid pavements and underlying bases by FWD.

### Conclusion

Results showed that FWD, LWD, and DCP provided valid results and trended with each other at the stations all three tests were run. This gives confidence that any test method is reliable when used on an exposed bituminous foundation course.

The results indicate that using FWD testing after concrete is built does not provide an accurate modulus of the foundation course. As demonstrated through the statistical analysis, foundation course moduli cannot be reliably calculated by using FWD on top of doweled concrete pavements and back-calculated using Darwin software or ME Design. Additionally, the COV Phase I data reveals a significantly larger variance than Phase II across the test area proving that uniformity of the foundation course cannot be determined by FWD testing after the concrete pavement is placed.

DCP showed an approximate 50% reduction in the penetration of the foundation course when constrained by concrete in place. However, only a limited number of tests using DCP after the pavement was placed were conducted and therefore no conclusion can be drawn at this time.

### Principal Investigators

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NDOT Pavement Design

### TAC Member

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Interested in finding out more?  
Final report is available at:  
[NDOT Research Website](#)

## NDOT Recommendations Based on Research

This research provided the Pavement Design section information that confirms foundation course modulus cannot be reliably determined after a concrete pavement is built. As a result of this project, NDOT will not accept foundation course modulus measured on top of doweled concrete pavement as proof that a foundation course was stable and consistent throughout the project. No further research is necessary.

- *As provided by Bruce Barrett, Lead TAC Member*

## Research Readiness Level (RRL) Assessment

### Level 5: Standard Practice–

Research/Technology fully implemented and understood. No follow-up is necessary.

**RRL 5**

**This brief summarizes the In-House Research Project:  
“Measuring Foundation Course Modulus Using Falling Weight Deflectometer, Light Weight Deflectometer, and  
Dynamic Cone Penetration”  
Nebraska Department of Transportation Research Program**