Joint Transportation Research Program

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Developing Statistical Limits for Using the Light Weight Deflectometer (LWD) in Construction Quality Assurance

Introduction

Quality control/quality assurance (QC/QA) during the compaction of a roadway's subbase and subgrade helps ensure the load-carrying capacity of the pavement system. The traditional in-situ compaction evaluation methods for unbound pavement layers are predominately based on density and moisture measurements requiring excessive time and resources, and in some cases, equipment that can be harmful to the health of the operator.

The Light Weight Deflectometer (LWD) measures the deflection and stiffness of unbound pavement layers under a given load, producing a safe, reliable, rapid, and cost-effective field measurement of compaction. Currently, INDOT determines the maximum allowable deflections for each project individually, by constructing an on-site test section and measuring the deflection values. The engineering properties of the compacted construction materials dictate how the unbound pavement layers react to different loadings.

This research investigated the feasibility of developing statistical limits for the compaction of specified combinations of subbase and subgrade materials in terms of their maximum allowable LWD deflections. The intention was to eliminate the need for establishing project site-specific test sections for purposes of compaction quality control during pavement construction.

The number of test sections with LWD deflection readings was limited to only two to five projects per combination of subgrade and subbase material. As such, the LWD acceptance test sections were identified as a second source of data. Acceptance tests are the measured deflections collected during compaction QC/QA after a project site-specific maximum allowable deflection is established.

Statistical limits were developed for six of the most common subgrade and subbase combinations used for highway pavement construction in Indiana: lime-modified, cement-modified, and natural subgrade, as well as #53 crushed stone (53CS) subbase overlaying these subgrades. Due to variability in the data and data limitations, any effort to generalize the findings published in this report must proceed with due caution.

Findings

The outcomes of this research suggest that there is consistency in LWD deflection measurements across a limited number of test sections for certain material types. Test section data yielded maximum allowable deflections that did not vary significantly between projects involving cement-modified and lime-modified subgrades, non-modified subgrade, and six inches of #53 crushed stone over lime-modified subgrade.

The research determined that the location of the LWD test, in terms of proximity to the edge of the placed material, did not vary significantly at a given test station. However, the research findings suggest that the number of acceptance tests completed at each station should be increased from three to seven. The

average acceptance test deflection measured by the LWD was determined to be unequal across different projects with similar subbase and subgrade materials. Therefore, it is recommended that the acceptance test data should not be used as a basis to develop statewide statistical limits.

Implementation

The statistical limits developed from test section LWD data can be used by INDOT as a baseline for further developing statewide maximum allowable deflections for use with the LWD. The limits developed for the subbase layer are for the first six inches of placed subbase over subgrade and are not applicable to thicker subbase lifts, nor are they applicable to the second or third subbase lift.

Stiffness modulus values were developed as part of this study, and can be used by INDOT to assess the relative strength afforded by the developed statistical limits. However, without an accurate record of the nominal force applied at each LWD test, exact stiffness values cannot be calculated. Ultimately, the modulus is the parameter of concern. Therefore, it is suggested that subsequent research focus on the reliability of the modulus values provided in the LWD output. It is suggested that, as part of implementation, data be collected to confirm whether the modulus values, rather tha deflections, can serve as a better basis for establishing target values for QC/QA in unbound materials used in pavement construction.

Implementing the results of the study is expected to assist INDOT to decide if and how to eliminate the use of project site-specific test sections. At the current time, it is suggested that INDOT should not abandon the use of these test sections; the agency should continue the use of the project site-specific test sections as part of the LWD tests for pavement construction QC/QA. The minimum compaction requirements currently in use, in terms of the minimum number of passes of the vibratory roller, should be kept in place until further tests and additional data analysis suggest otherwise.

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