TECHSUMMARY November 2013
SIO No. 30000153 / LTRC Project No. 09-5C

Evaluation of Non-Destructive Technologies for Construction Quality Control of HMA and PCC Pavements in Louisiana

INTRODUCTION

Current roadway quality control and quality acceptance (QC/QA) procedures for the Louisiana Department of Transportation and Development (LADOTD) include coring for thickness, density, and air voids in hot mix asphalt (HMA) pavements and thickness and compressive strength for Portland cement concrete (PCC) pavements. Mechanistic design is based on the moduli of pavement layers. As LADOTD pushes toward performance-based specifications, new parameters of the pavement must be considered for QC/QA. Non-destructive testing (NDT) devices, such as the light weight deflectometer (LWD) and the portable seismic pavement analyzer (PSPA), Figure 1, provide a non-destructive and portable means of quick in-place determination of pavement properties, resulting in an increase in sampling frequency to supplement coring. The LWD and PSPA are capable of measuring the in-situ modulus of a pavement layer. The measurements of these devices can either be used as a standalone measure or, in most cases, be correlated to other pavement properties. Many researchers have shown good trends between measurements of the NDTs and other pavement properties, though variability has shown to differ from report to report.

Figure 1
Left—Light weight deflectometer, right—Portable seismic pavement analyzer

This report details an evaluation of the LWD and PSPA. Data collected from multiple projects were used to determine if the devices show adequate repeatability for use as QC/QA tools in Louisiana. Various factors were tested to determine which ones potentially impacted measurements collected by these devices. Also, measurements from the devices were compared to laboratory measurements to confirm trends developed in other studies.

OBJECTIVE

The objectives of this research were to evaluate the repeatability of LWD with additional geophones and PSPA for pavement quality applications, determine factors of influence for LWD and PSPA through ruggedness testing, develop procedures for operating the LWD and PSPA for pavement quality applications in Louisiana, and compare laboratory properties obtained from cores and cylinders to field properties obtained from LWD and PSPA.

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SCOPE

To meet the objectives of this project, the LWD and PSPA were used to collect measurements on multiple field sites of different mix designs and pavement structures. A section sampling plan was established for collections. Also, minor modifications and additional data points were included to represent various ruggedness scenarios. Due to the abundance of literature showing good correlations between the laboratory and field for the portable seismic pavement analyzer on hot mix asphalt pavement, this objective was only performed for Portland cement concrete pavements.

METHODOLOGY

Data from four concrete projects and eight asphalt projects were used to evaluate the NDT devices. The typical sampling pattern was similar from project to project; however, the frequency and spacing were dependent upon the available pavement and timing of traffic control. The typical pattern consisted of nine to fifteen points, three to five stations, respectively, spaced evenly apart with one point in each wheel path and in the center of the lane. The coefficients of variation of the NDT devices were compared to those of test methods typically used for QC/QA. Analysis of variance (ANOVA) and F-test and T-test statistical methods were used to determine factor of influence within the data sets. The compression strength and modulus of elasticity of concrete cores or cylinders cast in the field were compared to NDT measurements collected at the same location.

CONCLUSIONS

The PSPA exhibited seismic modulus values of the surface layer with an average coefficient of variation (CoV) of 2 to 15 percent for repeat collections without moving the apparatus. The PSPA variability increased to a range of 6 to 28 percent if the apparatus changed orientation or moved within a close proximity. The LWD exhibited deflection values of the pavement structure with an average CoV of 4 to 12 percent for repeat collections without moving the apparatus. Variability increased when the surface layer moduli were back calculated using LWD data. The majority of the data sets fell within the specified limits of variability of the laboratory tests currently used for quality control.

NDT operators need to be trained to identify when a device is reading incorrectly. Deterioration of the feet pads, the presence of vibrations, or placement of a foot into a groove can cause incorrect measurements. Such measurements should be identified and recollected. Changing the orientation of the sensors increased the variability of the PSPA measurements; however, the variability increase is no different than moving the apparatus within a close proximity. Orientation of the sensors did not show to have a bias to measuring parallel or perpendicular to paving. Testing close to the joints showed an impact on measurements of the PSPA. The literature has shown the PSPA measurements correlate very well with laboratory testing of HMA samples. The relationship does not hold as well for PCC samples. The strength gain measured by the PSPA correlated well with the strength gain of laboratory testing for only one of the PCC data sets for this study.

A preliminary sampling procedure was developed for the PSPA as a quality control tool in Louisiana.

RECOMMENDATIONS

Proper implementation of the NDT devices into QC/QA would require additional laboratory testing prior to production to develop lab to field relationships and target values. Such testing will be required as Louisiana pushes toward performance based specifications, and the need for NDT moduli measurements will increase as well.

The PSPA has been recommended to begin a trial evaluation as a QC/QA tool for Louisiana using the sampling procedure described in this report. When Louisiana begins performance-based specifications, the trial data can be used to determine limits for QC/QA by pavement type or function.