LOUISIANA TRANSPORTATION RESEARCH CENTER

TECHSUMMARY February 2020

State Project No. 30000610 / LTRC Project No. 12-11P

Field Validation of Equivalent Modulus for Stabilized Subgrade Layer

INTRODUCTION

In Louisiana, highway construction efforts often encounter field conditions that are so poor that conventional site development cannot proceed. In such cases, the structural capacity of the existing subgrade is not sufficient to support the introduction of construction equipment. When this occurs, it is often the practice to treat the existing soil matrix by introducing cement or lime to a depth of six or more inches. The additional strength that such a treatment brings to a pavement is in no way integrated into that pavement's design. Instead, the augmented strength is usually consigned to the margins of safety. Often the added strength that results from subgrade treatment is considerable and its utilization in design would improve project cost-benefit ratios significantly. The 12-11P research effort attempted to explore the viability of trying to exploit this lost strength to those ends.

OBJECTIVE

One objective of this research was to validate the newly developed Equivalent Modulus Analysis (EMA) spreadsheet that was created by the Louisiana Department of Transportation and Development (DOTD). This interactive spreadsheet, designed to predict layered design strengths, was to be validated by comparison of its predictions to field collected data. Where validation was possible, current pavement design strategies and policies were to be updated and modified so as to improve long-term performance and increase benefit-cost ratios on future pavement projects. It was also an objective of this research to develop guidelines wherein subgrade stabilization (lime and/or cement) could be used by DOTD, allowing the Department to take design advantage of the structural improvements that subgrade treatment applications might provide.

METHODOLOGY

An attempt was made to corroborate EMA spreadsheet predictions through a comprehensive series of before and after field evaluations. Falling Weight Deflectometer (FWD) and Dynamic Cone Penetrometer (DCP) testing served to model loading and were conducted between successive stages of construction and rehabilitation on existing and projected projects so that a dataset of actual performance could be compiled.

Correlations were arrived at by plotting projected performance against actual performance. FWD testing was conducted at prepared subgrade sites prior to lime or cement treatment so as to determine the site's "before" condition through direct measurement of subgrade properties. "Theoretical after" conditions were then arrived at by using the EMA spreadsheet to predict the modulus value that should appear once the project's subgrade layer had been treated. At such time as the subgrade layer is treated, FWD testing was again carried out in order to arrive at an "empirical after" condition. Correlations were arrived at by plotting the "theoretical after" data against the "empirical after" data.

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The compiled correlation plots were analyzed in order to isolate outliers and to parameterize how the theoretical figures deviated from the empirical. The reasons that may underlie why these deviations and outliers became manifest were explored and reported on in order to establish a usage adjustment for the EMA spreadsheet where possible.

CONCLUSIONS

Most findings were inconclusive. Compaction and shearing typically took place when FWD testing was conducted on raw subgrade and atop lime treated material. Such shearing and compaction violates back-calculation theory and drew into question the results derived from FWD tests conducted on these materials. Also, there were problems with populating the test grid. Only three projects underwent enough FWD and DCP testing for the effects of lime treatment to be assessed. These three projects showed mixed results. Two of these projects showed marginal strength improvements. The remaining project showed that lime treatment actually weakened the structure. As such, it was not possible to define a usage policy.

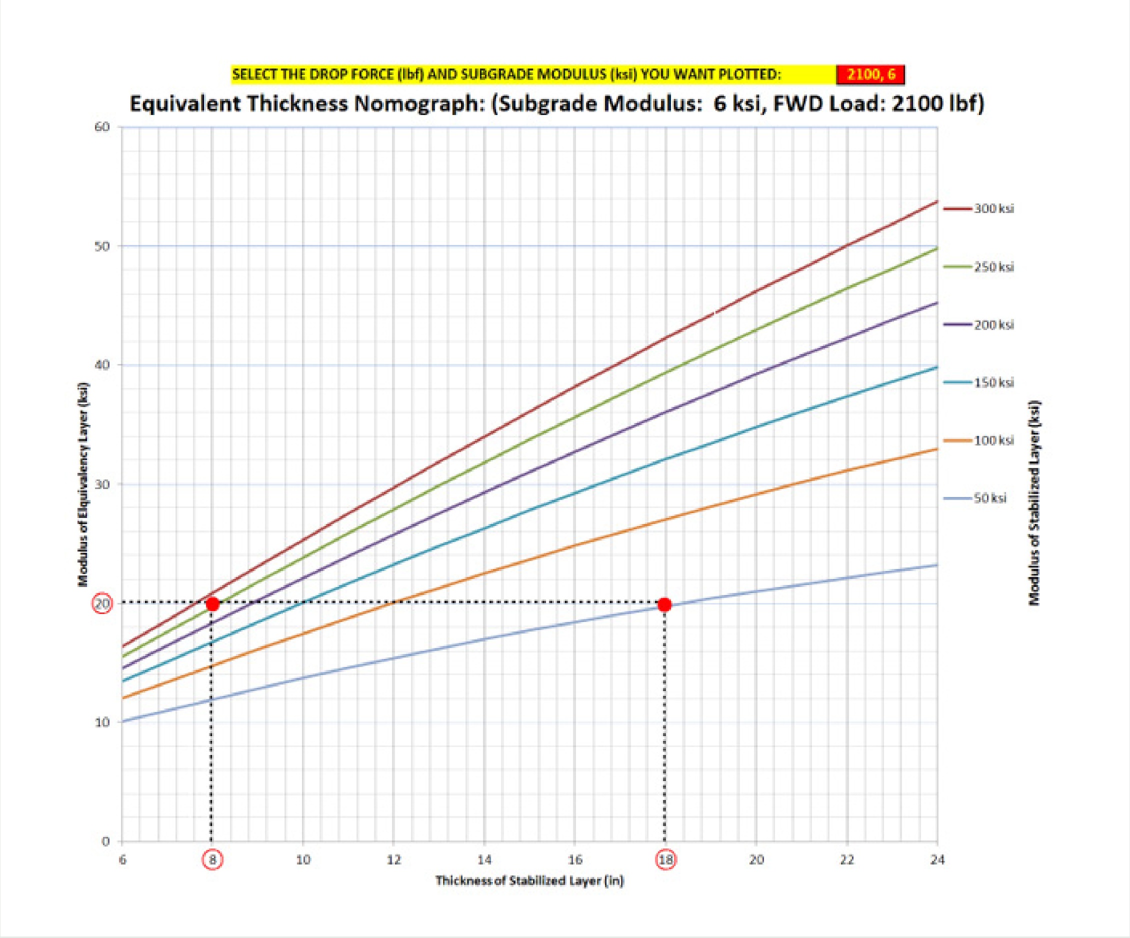

Figure 1
Output from DOTD's EMA spreadsheet