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DEVELOPMENT OF COMPACTION QUALITY CONTROL GUIDELINES THAT ACCOUNT FOR VARIABILITY IN PAVEMENT EMBANKMENTS IN FLORIDA

PROBLEM STATEMENT

The Florida Department of Transportation (FDOT) is currently engaged in the implementation of a major quality management initiative (QC 2000). Much of this program is focused on re-engineering of the roles and responsibilities of construction project participants with regards to quality control and quality assurance. Additionally, however, FDOT has undertaken revisions to its construction sampling and testing specifications. The new acceptance sampling and testing formats vary somewhat depending on the particular material area, but most have included a transition to a statistical acceptance method (SAM) procedure. Recognizing the distribution of quality values in all populations, the statistical acceptance methods are considered one of the most efficient ways of managing quality.

Currently, soil density, primarily measured by the nuclear gauge, is the quality metric used to judge compaction acceptability. The desired engineering property is the soil stiffness (or soil modulus), when soil is compacted for pavements. The Soil Stiffness Gauge, or SSG, which directly provides a stiffness value, may provide a more direct measure of soil acceptability.

OBJECTIVES

The objective of this project is to begin the development of an improved testing and sampling methodology for the compaction of highway embankments. Researchers will assess the SSG under controlled conditions, analyze the resulting data, design a surface preparation tool to assure consistent SSG test conditions, and then produce a set of tentative operating procedures for SSG operations. A second phase of study will ensue to assess the preliminary findings, make necessary modifications, and provide recommendations.

FINDINGS AND CONCLUSIONS

Initial activities were directed at understanding the relationship between soil density and soil stiffness. Initial field-testing of the SSG focused on defining the relationship between measured densities and stiffness values produced by the SSG. Soil densities were measured by nuclear density and stiffness values were obtained using the SSG. The results of numerous tests (68) were representative of the field test results obtained from various field locations. From the analysis of the initial test data, it is obvious that the SSG values and the densities were poorly correlated. That is to say, the SSG did not provide a reliable estimate of the density on the initial tests.

As moisture is a very important factor in highway design, researchers attempted to correlate stiffness to moisture content, but test pit efforts produced no effective relationship. Plate Load Tests (PLT) were conducted in FDOT's Test Pit facility and the results were compared to the corresponding SSG stiffness values. No definitive correlation could be drawn between the various factors (i.e., percent fines, dry density, average SSG stiffness, moisture content, and average resilient modulus).

Since the variability of the nuclear density measurements is reasonably well-established from a long history of field testing, the precision of SSG test results was suspected to be a cause of the weak correlation. Therefore, the research team exerted considerable effort to design testing enhancements.

The primary tests indicated that repeatability and precision of the SSG device appeared to be largely dependent upon the condition existing at the soil – machine interface. The condition of the soil surface and the placement and operation of the device by the operator appeared to be the key factors. With these factors in mind, researchers initiated a series of tests to develop an improved testing procedure.

Researchers encountered several situations that skewed tests results, such as whether the instrument is in a vertical or an inclined position during testing and gaps that may exist between the soil and the ring foot. Ultimately, researchers developed portable calibrator devices that can be used on a regular basis for comparative purposes to achieve more reliable results.

The most important of the design enhancements to the SSG was the development of a new handle that would mitigate inconsistencies in the vertical force being applied. The objective is to produce a contact area between the foot ring and soil of at least 60% of the total foot ring area. The handle will be useful for providing a uniform seating of the SSG on the soil.

BENEFITS

Incorporation of statistical acceptance methods by FDOT would be the first step to optimize the construction of roadway embankments and to ensure that long-term pavement performance can be predicted by as-built constructions conditions. In order to accomplish this task, a performance-related field test that can be performed quickly, and for which the results can be related to pavement design parameters, is needed. The nuclear density test is the current field test used by FDOT for earthwork compaction control, but it only provides results that are an indirect measure of long-term pavement performance. In addition, the radiation safety program in association with the use of nuclear density testing equipment adds additional expenses to FDOT, which, if eliminated, could provide a significant cost savings. This project evaluated the use of a new test device as a replacement for the nuclear density test for earthwork compaction control, and it accomplished the initial steps of reducing the variability of the SSG device to within the same limits as the nuclear density test. The SSG test has the following advantages: it is a quick test to perform, it has the potential to be a direct performance-related field test, and it is a test with a non-nuclear source.

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