JOINT TRANSPORTATION RESEARCH PROGRAM

Principal Investigator: Rodrigo Salgado, Purdue University, salgado@purdue.edu, 765.494.5030

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

SPR-3635

2015

QA/QC of Subgrade and Embankment Construction: Technology Replacement and Updated Procedures

Introduction

The dynamic cone penetrometer (DCP) is a simple tool for assessing the quality of the compaction at a jobsite. Not only is the DCP light and easy to transport and use, its use is also not limited by the availability of power. Once proper correlations are established, quality assurance and quality control (QA/QC) procedures are fairly easy to administer.

QA/QC tests for compacted soils have in the past been limited to density tests, which have certain shortcomings. Performance-based tests, such as the DCP, are used to ensure that compaction quality is achieved and that the compacted soil satisfies a certain minimum level of performance. Research on the development of various correlations for the DCP has been carried out over the past decade. Correlations have been developed between the DCP blow count and quality control parameters, such as California bearing ratio (CBR), resilient modulus (M_R) and relative compaction. As a result, the DCP has gained more acceptance as a QA/QC testing device by the construction industry.

The DCP can be used in tandem with other means of quality control to ensure the construction of a well-built

subgrade or embankment. However, as in the case with other tests, the statistical variability associated with the test results needs to be accounted for in the process of development of QA/QC correlations.

In this research study, in order to develop suitable QA/QC correlations for the DCP blow count values and the compaction quality of the subgrade, soils were classified into two main categories: coarse-grained (or sand-dominated soils) and fine-grained (or clay-dominated soils). For soils with clay contents greater than about 20%, the behavior of the soil is similar to that of clay. To account for all the governing factors that control the mechanical behavior of soil and its response to DCP loading, the decision as to which category a soil belongs—sand-dominated soil or clay-dominated soil—was based on the compaction characteristics, plasticity index (PI) and fines content of the soils.

Findings

The DCP blow counts for coarse-grained soils had a good correlation with the optimum moisture content (OMC) obtained from standard Proctor compaction tests performed in the field or in the laboratory. The

Spatial arrangement of 10 DCP test sets and sand cone test sets

blow counts for penetration of 0 to 12 inches decreased when the OMC of the soils (compacted to at least 95% relative compaction) increased.

The demarcation between manufactured and natural coarse-grained soils was also clear. Correlations were developed for manufactured coarse-grained soils with respect to both the OMC and the coefficient of uniformity.

The DCP blow counts for fine-grained soils, with fabric dominated by clay-size particles, had a very good correlation with the plasticity index (PI) of the soil. The PI is indicative of the clay content of soils and its value depends on the clay mineral or proportions of the clay minerals in the clay phase of the soil mass. Equations were developed for 0- to 6-inch and 6- to 12-inch penetration of the DCP.

The soil classification criteria and the accompanying DCP correlations developed in this research for quality control of compaction were found to be suitable to establish QA/QC procedures for compacted soil and received positive feedback from INDOT engineers.

Based on the statistical analysis of the DCP test data, it was determined that the mean of seven DCP tests performed at a given location provides a reasonable

estimate of the actual mean of the compacted soil mass, assuming that the DCP test results follow a normal distribution. In addition to small-scale DCP testing, large-scale testing was also investigated, and a preliminary procedure for large-scale testing was proposed. Further work still needs to be carried out in the direction of establishment of the scale of fluctuation of compacted soils to further refine the preliminary large-scale testing procedure proposed in this research.

Recommended Citation for Report

Ganju, E., Prezzi, M., Salgado, R., Siddiki, N. Z., & Sommer, K. (2015). *QA/QC of subgrade and embankment construction: Technology replacement and updated procedures* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2015/01). West Lafayette, IN: Purdue University. <http://dx.doi.org/10.5703/1288284315521>

View the full text of this publication here:
<http://dx.doi.org/10.5703/1288284315521>

Published reports of the Joint Transportation Research Program are available at <http://docs.lib.purdue.edu/jtrp/>.

Spatial distribution of DCPTs and sand cone tests performed in one set in the field