Florida Department of Transportation
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APPLICATION OF NON-CONTACTING PROXIMITY SENSORS FOR MEASURING SOIL RESILIENT CHARACTERISTICS

PROBLEM STATEMENT

The resilient modulus is an index that describes the nonlinear stress-strain behavior of soils under repeated loads. Recently, the measurement of resilient modulus has become more common because of its importance in determining properties of roadbed soils and pavement components. In 1986, the *AASHTO Guide for Design of Pavement Structures* (AASHTO 1986) replaced the "soil support value" of roadbed soil with resilient modulus. The *Design Guide* recommends that the laboratory resilient modulus test procedure, AASHTO *T 274-82* (AASHTO 1986), be used to determine the basic engineering properties of roadbed soils and pavement components.

Since its introduction, the original AASHTO *T 274-82* has been widely criticized. A number of nationwide studies have been undertaken to search for solutions and alternate test methods, such as the National Cooperative Highway Research Program (NCHRP) 1-28 project. Researchers and agencies have also proposed several variations of the resilient modulus test procedure. AASHTO *T 294-92* (the Strategic Highway Research Program's Protocol P46) and AASHTO *T 292-911* (AASHTO 1991 & 1992) are the most commonly used in recent years.

Most often, resilient modulus measurements are conducted using linear variable differential transducers (LVDT) measurements, as specified by the AASHTO *T 292-911* and *T 294-92* test procedures. However, there are some notorious problems incurred by the current LVDT measurements. Thus, the possibility of finding an alternative method has become a major concern of many researchers.

OBJECTIVES

The primary objective of this study was to evaluate the possibility of alternating LVDTs with non-contact proximity sensors to measure axial deformation in resilient modulus testing. The goals of this study are (1) to develop an apparatus by applying the non-contact proximity probes as well as LVDT in a single chamber, and (2) to critically assess the strengths and weaknesses of utilizing non-contact proximity probes in triaxial tests.

FINDINGS AND CONCLUSIONS

The laboratory resilient modulus testing program was successfully conducted using specimens of selected granular materials and Florida limerock, utilizing the measurements of both LVDTs and non-contacting proximity probes simultaneously on a single sample. The resilient modulus test was repeatable and the test results were believed to be representative.

The resilient modulus values measured from the middle-positioned LVDTs (gauge length ratio of 0.5) were higher than those from the proximity probe measurement for the limerock and granular materials. The difference may be caused by frictions between the LVDT sensors and the noises induced to the proximity probes. The resilient modulus values measured from the full-length positioned LVDT measurement were lower than those from the proximity probe measurement and the middle-positioned (gauge length ratio of 0.5) LVDT measurement. The main reason for this difference could be due to the end effect.

The application of a non-contacting proximity probe with a gauge length ratio of one half gave accurate and reliable results in the measurement of axial deformation of resilient modulus tests. Typically, the results from the proximity probe measurements were about 5-10% lower than those from the middle-positioned LVDT measurements but about 15% higher than those from the full-length-positioned LVDT measurements for granular materials.

The proximity probes appeared to be a good alternative to the LVDTs. The major advantage of the proximity probes was a lower chance of test failure. However, they require that metallic targets be mounted, which move rigidly with the specimen.

One of the major concerns in resilient modulus testing is the positioning and mounting of the deformation measurement device. An improved mounting method of the devices on the specimen will possibly increase the reliability of noncontact measurement as well as the LVDT measurements.

For granular materials, vibratory or gyratory compaction may be a better choice for preparation of test specimens in the laboratory.

Further studies should be made on the improvement of LVDT measurement and the evaluation of other noncontact measurement, such as the electro-optical system.

This research project was conducted by Virgil Ping, Ph.D, P.E., at the FAMU-FSU College of Engineering. For more information on this project, contact Emmanuel Uwaibi, P.E., at (850) 414-4372, emmanuel.uwaibi@dot.state.fl.us