Operations Technology Development

Modification of Soil-Compaction Measuring Devices for Utility Implementation

Throughout the natural gas industry, utilities use a variety of tools to measure soil compaction to ensure that adequate pavement restorations are provided following repairs or rehabilitations. In efforts to improve the overall effectiveness and lower the cost of pavement restorations, modifications were made on several soil-compaction measurement devices.

Project Description

One way utilities are improving pavement restorations is through the use of soil-compaction measurement equipment. The soil-compaction control technologies and quantified testing are among the major factors that impact utility cuts and the performance of the restored excavations.

For compaction control, regulators commonly require the use of the nuclear density gauge, a device of considerable concern throughout the natural gas industry because of its high cost, complexity, training needs, and licensing requirement. A number of devices have been developed over the years to replace the nuclear density gauge in measuring soil compaction. However, these devices have not gained the acceptance of regulators and required enhancements with regard to their consistency, effectiveness, and data-storage capabilities.

In response, researchers at Gas Technology Institute (GTI) have modified and demonstrated several devices to improve the speed, accuracy, and overall effectiveness of measuring soil compaction.

Deliverables

For this project, researchers modified three commonly used soil-compaction devices: the Clegg Hammer, the Soil Compaction Supervisor, and the Utility Dynamic Cone Penetrometer. The modifications were aimed at making the tools easier to use, enhancing their reliability, and adding electronic capabilities for data storage and display.

Benefits

The American Gas Association estimates that the natural gas industry alone could be spending $1.5 billion annually on pavement restorations due to increasing fees and permit costs, more rigorous construction requirements (including repaving curb-to-curb), and special cutting and grinding procedures.

Proper quality control for soil compaction will reduce failures significantly and help influence government bodies regarding appropriate methods, tools, and procedures for gas utility street cuts. In addition, improved soil-compaction technologies provide benefits by avoiding call-backs from failed pavement restorations. Experts estimate that if 20% of failed pavements are prevented through the use of improved soil-compaction measurement devices, the estimated industry savings would be $3.3 million a year.

Technical Concept & Approach

In a previous project, investigators conducted a comprehensive testing program with existing instruments and processes to determine the limitations of these soil-compaction measurement devices. Researchers identified and demonstrated three soil-compaction devices that have the highest potential for economical use in utility applications and acceptance by the regulators.

This project involved the following tasks:

- Identifying the specific features of the devices to be improved, based on previous research, input from utilities, and interactions with manufacturers

Soil-compaction measurement devices were tested at GTI's Pipe Farm and at several utility sites.

- Modifying the devices and testing their performance
- Providing the modified devices to investor utilities for testing under field conditions.

Results

Comprehensive testing and evaluation has been conducted on three of the industry's most commonly used soil-compaction instruments and alternatives to the nuclear desnity gauge.

Clegg Hammer

Modifications were made to Lafayette Instrument's Clegg Hammer to improve its mobility and use in the field. Electronic modifications were added to provide data storage, and downloading capabilities. Modifications enhanced the ability of the tool to correlate to soil compaction parameters (e.g., soil density and moisture contents) in the field. The device also incorporates a soil-moisture sensor and stores the moisture content readings in the data file.

The basic principle behind the Clegg Hammer is to obtain a measurement from a free-falling mass (hammer) from a set height onto a surface under test. The impact of the hammer produces an electrical pulse, which is converted and displayed as a soil-impact value.

The modifications also included: a redesign of the guide tube for easier transport (also eliminating the possibility of the hammer being removed from the guide tube), improved cable connections, a handle extension for use in small keyhole excavations, and the addition of a carrying case and cart to facilitate field transport. An American Society for Testing and Materials (ASTM) procedure exists for this device.

Soil Compaction Supervisor

Modifications were made to the MBW Inc.'s Soil Compaction Supervisor, a system that combines the use of disposable buried electric sensors and an above-ground measurement instrument to determine proper soil compaction. The Soil Compaction Supervisor monitors the compaction progress, signals when compaction is optimized, and features download capabilities for a fast, easy transfer of compaction data.

Researchers were able to provide several product enhancements, including:

- Increased sensor reliability provided through an improved logarithm of data analysis
- Improved sensor sensitivity (achieving satisfactory sensor output to soil depths of 36 inches)
- A modified data-processing algorithm to improve the filtered signal from background noise and ground echoes
- Modified electronics to simplify the recording of readings in new lifts and improve data output and storage management.

Utility Dynamic Cone Penetrometer

The GTI team developed a prototype of a modified Dynamic Cone Penetrometer (DCP) with an added data-recording system. Modifications were made to SGS Manufacturing's DCP to provide data-collection and storage capabilities.

The DCP uses a five-pound drop-weight to drive a small cone into the soil, counting the number of drops required to penetrate the soil a fixed distance of 3-¼ inches. The number of drops is determined by calibrating the device to the relative soil compaction of various soil types. Researchers report that the device proved to be a practical replacement for the nuclear density gauge by providing layer-by-layer compaction verification.

For the development of the new data-management prototype, a low-cost Palm OS™ handheld was used. A DCP Data-Collecting Unit was added to automatically read and log results and wirelessly transmit information to a hand-held device. The data can then be downloaded to a computer or printer for a computerized output.

Status

Modifications of the devices are complete. The commercial versions of the three devices are available from their manufacturers. A Final Report describing modifications is available.

For more information:

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