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Soil-Stiffness Gauge for Soil Compaction Control

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SOIL-STIFFNESS GAUGE FOR SOIL COMPACTION CONTROL

THE NEED

Soil stiffness and modulus are the most meaningful engineering parameters for soil structures. Until now, there were no practical and reliable means to rapidly measure the in-situ soil stiffness and elastic modulus of soils. Soil density has always been a surrogate and empirical specification that has some shortcomings. The primary motivations are due to the need to find an alternative to nuclear density gauges, drastically reduce laboratory results time, and validate and implement mechanistic design models.

FIGURE 1 USING HUMBOLDT'S STIFFNESS GAUGE DEVICES

THE TECHNOLOGY

The Humboldt Stiffness Gauge (HSG) enables both the design and construction to be controlled by the same physical parameters, namely stiffness and modulus. Used as a compaction process control tool, it brings the contractor closer to the real purpose of compaction, which is to improve the stability of the soil over the life of the structure. The HSG's sensitivity and ability to rapidly take large amounts of data at a site enables site profiling for intelligent analysis. Lightweight and ease of use overcomes the inconvenience and impracticalities of density based measurements and in-situ plate load tests. The Humboldt Stiffness Gauge was developed from land-mine detection technology to improve the control of compaction. The gauge consists of four main parts: ring foot, shaker and sensors, microprocessor, and body. The ring foot couples the force into the soil and provides feedback to the sensors for accurate measurement of force

and displacement. The shaker drives the ring foot from 100 to 200 HZ and the sensors measure the impedance (force and resulting surface velocity vs. time).

FIGURE 2 THE SOIL STIFFNESS GAUGE

Lightweight and ease of use overcomes the inconvenience and impracticalities of density based measurements and in-situ plate load tests. The Humboldt Stiffness Gauge was developed from land-mine detection technology to improve the control of compaction.

FIGURE 3 SOIL STIFFNESS GAUGE PRINCIPLE

The gauge consists of four main parts: ring foot, shaker and sensors, microprocessor, and body. The ring foot couples the force into the soil and provides feedback to the sensors for accurate measurement of force and displacement. The shaker drives the ring foot from 100 to 200 HZ and the sensors measure the impedance (force and resulting surface velocity vs. time). The microprocessor computes the stiffness (force over displacement) at each of the 25 different frequencies and then displays the average of the 25 measurements. The body provides the protective housing as well as the reaction mass to couple the ring foot to the soil. The entire measurement process takes about one minute.

THE BENEFITS

- Validation of mechanistic design models.
- Compaction process control via modulus.
- Non-nuclear measurement of soil density.
- Directly connects design and construction via stiffness and modulus.
- Rapid soil characteristic.
- Basis for performance specification.
- Characterization and control of stabilized soil.
- Simple to use, minimum training, no license or special handling required.

STATUS

The Humboldt Stiffness Gauge has recently been evaluated in one of the largest broad-based evaluation program for a single soil measurement device. Over twelve separate groups consisting of state DOTs, academic researchers, and private laboratories have participated in the program. The gauge is in use worldwide.

[Construction Innovation Forum](#) honored the Humboldt as one of the winners of 1999 Nova Award.

BARRIERS

Density based measurements are so ingrained in the construction industry that the most powerful tool, education, is being used to create the awareness of the benefits of stiffness and modulus. Nearly all measurements require ASTM or AASHTO standards. The ASTM standard covering the use of Humboldt Stiffness Gauge is currently being developed.

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REVIEWERS

Peer reviewed as an emerging construction technology

DISCLAIMER

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