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Geogauge
SL186

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User Guide
User Guide
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Model H-4140

Soil Stiffness / Modulus Gauge

(patent pending)

GeoGauge™

User Guide

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Table of Content

Description

The Humboldt Stiffness Gauge (GeoGauge) is a hand-portable instrument that provides a simple, rapid and precise means of directly measuring layer stiffness and Young's modulus of compacted soils (Figure 1).

Figure 1

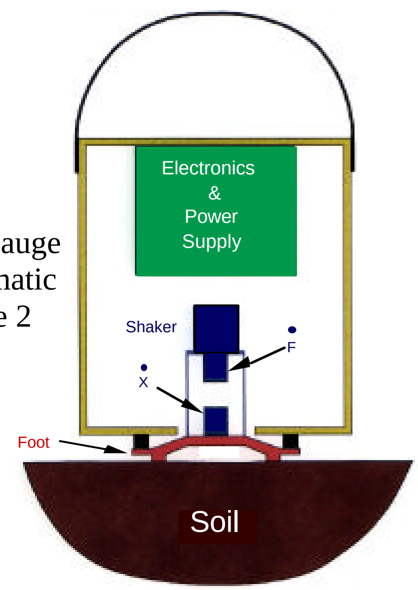
The GeoGauge is intended to meet a need that has existed since quality has been important to earthworks construction. This is the control of the construction process via the same mechanistic or performance specifications that earthworks are designed with. For example in highways:

- Stiffness, an engineering property of structures is used to determine its resistance to bending or deflection. It is used to ensure the uniform & effective transfer of loads from the pavement to the base & subgrade below and
- Young's modulus, an engineering property of materials is used to determine its resistance to change in shape when load is applied. It is used to assure that each soil component allows the highway system to perform as needed.

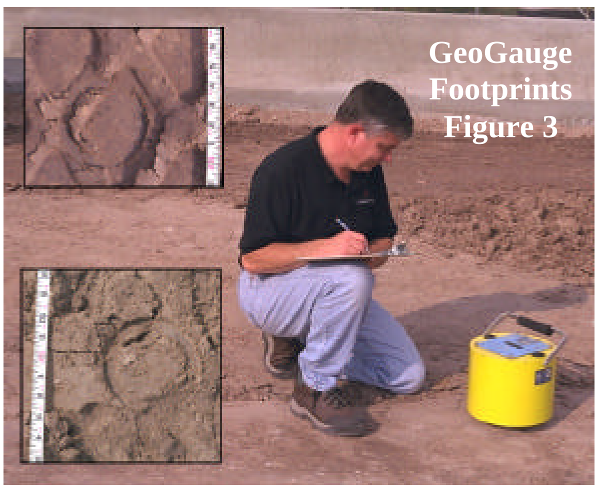
The GeoGauge measures the impedance at the surface of the soil. In other words, it measures the stress imparted to the surface and the resulting surface velocity as a function of time. Stiffness, the ratio of force over deflection, follows directly from the impedance. The GeoGauge imparts very small displacements to the soil (< 1.27×10^{-6} m or <.00005") at 25 steady state frequencies between 100 and 196 Hz. The stiffness is determined at each frequency and the average is displayed. The entire process takes about one and one-half minute. At these low frequencies, the impedance at the surface is stiffness controlled and is proportional to the shear modulus of the soil. With a Poisson's ratio and the GeoGauge's foot dimensions, shear and Young's modulus can be derived.

The GeoGauge weighs about 10 kg (~ 22 lb), is 28 cm (~ 11") in diameter, 25.4 cm (~ 10") tall and rests on the soil surface via a ring–shaped foot (Fig. 2). The foot bears directly on the soil and supports the weight of the GeoGauge via several rubber isolators. Also attached to the foot are the shaker that drives the foot and sensors that measure the force and displacement-time history of the foot. The connection between the shaker and force sensor is made via a rigid column.

GeoGauge Schematic
Figure 2



The GeoGauge is placed on the soil to make a measurement with little or no preparation of the soil surface. Typically, a slight push on or rotation of the GeoGauge is needed obtain the required 60% minimum contact area between foot and soil (Fig. 3). On particularly hard or rough surfaces, seating of the foot can be assisted by the use of less than 1/4" of moist sand or local fines. Common field practice is as applicable to the GeoGauge as it is to most current field measurement of soil performance. The detailed procedure for using the GeoGauge and preparing the soil is described later in this guide.



GeoGauge Footprints Figure 3

The current version of the GeoGauge displays and logs the data in memory with sufficient capacity for a full day of data gathering (100s of measurements). The data may be downloaded to a PC for archiving and further analysis with a separate and optional infrared interface cable. It is powered by 6 disposable D-cell batteries. Measurements can be performed as close to operating construction equipment, as safety will allow.

Many current methods of measuring soil modulus or stiffness in the field require large forces to produce a measurable deflection. The GeoGauge uses technology first used in the military to measure very small deflections, allowing much smaller loads. The GeoGauge does not measure the deflection resulting from the GeoGauge weight. Rather, the GeoGauge vibrates, producing small cyclical forces to the soil's surface. It then accurately measures the resultant very small deflections. The soil deflects an amount δ, which is proportional to the outside radius of the ring foot (R), the Young's modulus (E), the shear modulus (G) and Poisson's ratio (υ) of the soil.[1] The stiffness is the ratio of the force to displacement: K=P/δ. The GeoGauge produces soil stress and strain levels common for pavement, bedding and foundation applications (192 Pa or ~ 4 psi). As shown below, Young's and shear modulus can be determined from GeoGauge measurements if a Poisson's ration is assumed.

$$P \sim \frac{1.77RE}{\left(1-u^2\right)}d \sim \frac{3.54RG}{\left(1-u\right)}d$$

$$K = \frac{P}{d} \sim \frac{1.77RE}{\left(1-u^2\right)}$$

1 Poulos, H.G., and Davis, E.H., *Elastic Solutions For Soil & Rock Mechanics*, 1974, page 167-168.

Button (Keypad) Functions

"ON"	Turns on the gauge. When pushed, the GeoGauge goes through an electronics check, displays the present battery voltage and finally displays the value of the previous or last measurement. The gauge is then ready to perform a measurement.
"OFF"	Turns off the gauge.
"SHIFT"	To execute any of the four buttons with a blue background ("ERASE", "PRINT", "TEST", "UNIT"), you must first press the "SHIFT" button. After pressing "SHIFT", do not press the blue keys until "SHIFT" is displayed in the STIFFNESS window. Note: the "STOP" button does not require using "SHIFT".
"ERASE"	Erases all saved data. Starts measurement ID at "1".
"SAVE"	Saves the current measurement. This button must be pushed to save each measurement. If it is not pushed, the data for the last measurement will be discarded. Note: When the GeoGauge memory is empty, the first 20 measurements saved will contain the measurement ID, frequencies and the real and imaginary parts of the force and displacement (Research Format). There after, only the measurement ID, the displayed stiffness in SI units, and the time and date will be saved for the next 480 measurements. At this point the GeoGauge's memory is full and "db full" is displayed.
"PRINT"	Begins the downloading of data, via the IR COM port.
"MODE"	Shows the target stiffness value, in SI units, in the ID/TARGET window and ratio of the measured stiffness to the target stiffness in the STIFFNESS window. The target value can be incrementally changed in graduations of 0.5 MN/m by scrolling up or down using the "INCR" or "DECR" buttons respectively. Press "MODE" again to return to the previous display.
"MEAS"	Starts the actual stiffness measurement. Press the button and then take one step back to prevent any influence of your body weight on the measurement. The measurement will be completed in about 70 seconds. Pressing "SHIFT" and then "MEAS" will enter the Poisson's Ratio value display. Each successive pressing of the "SHIFT" and then "MEAS" buttons will enter the time/date display.
"START"	Begins the viewing or scrolling through the saved measurement data. You need to press the "INCR" or "DECR" button to scroll up or down the measurement values along with the measurement ID. You cannot take a measurement while viewing memory. Exit this mode status by pressing the "STOP" button.
"STOP"	Exits the viewing of the saved measurement data. Pressing it returns the gauge to normal status. The "SHIFT" button does not need to be pressed for this action.
"TEST"	System runs a self-test. Displays the electronic circuit board serial number, battery voltage, "batt", runs an internal electronic circuitry check,"SELF" "TEST" and then displays the results, "no" "ErrorS". The system runs the same test when the gauge is first turned on.
"UNITS"	Alternates between SI and English measurement units. The saved measurement data is in SI units only. Saved data can only be viewed in SI units.

Technical Specification

Soil Stiffness	**From**	**To**
Measurement Range	MN/m (lb/in)	MN/m (lb/in)
Stiffness	3 (17k)	70 (399k)
	MPa (kpsi)	MPa (kpsi)
Young's Modulus	26.2 (3.8)	610 (89)
Measurement Accuracy (typ., % of absolute)	< ± 5 %	

Depth of Measurement (from surface) 220 to 310 mm (9 to 12 in.)

Calibration Laboratory
Accuracy (% of actual mass) < ± 1%

Electrical

Power Source	(6) D size disposable cells
Battery Life	Sufficient for 500 to 1,500 measurements

Mechanical

External Materials	Aluminum case & foot, rubber isolators & seal
Vibration	<0.001 in. @ 125 Hz
Level re Vertical	± 5 °
Operating Temperature	0°C to 38°C (ambient)
Storage Temperature	-20°C to 50°C
Humidity	98%, without condensation
Gauge Dimension	28 cm (11") Diameter, 25.4 cm (10") Height (without handle)
Weight	Net 10 kg (22 lb), Shipping (with case) 17.7 kg (39 lb)

Country of Manufacture
U.S.A.

Standard Accessories
Transit / Carry Case, Batteries, and User Guide

Optional Accessories
* Infrared (IR) com serial interface adapter cable with software template (3.5” floppy, PC)
* Verifier Mass (to validate correct operation)

ALL TECHNICAL, PERFORMANCE AND OTHER SPECIFICATIONS ARE SUBJECT TO CHANGE.

Display Messages

StiF	Announces the measured value of stiffness (MN/m), (displayed in ID window). The measured value of stiffness is displayed simultaneously in the STIFFNESS window.
SENS OvLOAD	Indicates that the current measurement was aborted due to the sensors being overloaded. The word "SENS" is displayed in the ID/TARGET window and the word "OvLOAD" displayed in STIFFNESS window. This can be caused by too soft soil, too stiff soil, too a proximity to construction equipment or the foot being seated improperly The current measurement must be repeated.
5d	Announces the standard deviation of all 25 frequency dependent stiffness measurements relative to the measured (average) value of stiffness (displayed in ID/TARGET window). The standard deviation is displayed simultaneously in the STIFFNESS window.
vALuEd	Indicates how many of the 25 data points where used to determine stiffness for the current measurement. stiffness (displayed in STIFFNESS window). The number of data points is displayed simultaneously in the ID/TARGET window.
noiS	Indicates that the GeoGauge is measuring ambient noise (displayed in ID/TARGET window). The noise measurement takes about 11 seconds after depressing the MEAS button. Nothing is displayed simultaneously in the STIFFNESS window.
dAtA	Indicates that the GeoGauge is taking stiffness data over 25 frequencies between 100 and 200 Hz (displayed in ID/TARGET window). This follows the noise measurement and takes ~55 seconds. Nothing is displayed simultaneously in the STIFFNESS window.
Snr	Announces the display of the Signal Noise Ratio for the current measurement (displayed in ID/TARGET window). The Signal Noise Ratio, in dB, is displayed simultaneously in the STIFFNESS window.
5I or Eng	This message indicates the ready mode and the stiffness units (displayed in ID/TARGET window). The GeoGauge is ready to take the next measurement. The Stiffness window shows the value of the last or previous measurement, in SI units (MN/n) or English (Eng) units (klbf/in).
ALrE StorEd	Indicates that the current measurement value has already been stored in the memory. The word "AlrE"" is displayed in the ID/TARGET window and the word "StorEd" displayed in STIFFNESS window. If you don't know if the last measurement has been stored, the GeoGauge will tell you.

db - on	Indicates that the View Memory database mode has been entered. It is displayed momentarily in the STIFFNESS window. After this appears, pressing the INCR or DECR buttons will scroll through the stored data. Ordered pairs of measurement ID numbers and the measured values of stiffness will be displayed sequentially, in the order they were measured, in the ID/TARGET and STIFFNESS windows respectively.
db - off	Indicated that the View Memory database mode has been exited. It is displayed momentarily in the STIFFNESS window.
StorEd	Announces that the current measurement has been stored and displayed in STIFFNESS window. The assigned measurement ID number is displayed simultaneously in the ID/TARGET window.
bAtt	Announces the value of the combined voltage of the six (6) D-batteries (displayed in ID/TARGET window). he voltage is displayed simultaneously in the STIFFNESS window.
SELF TEST	Indicates that the GeoGauge is going through a self test of its electronics. The word "SELF" is displayed in the ID/TARGET window and the word "TEST" is displayed in the STIFFNESS window.
nO ErrOrS	Indicates that the results of the self test is within specified limits (displayed in ID/TARGET window).

Planning

What follows is more than a recommended method. It is the essence of has been learned during GeoGauge development about soil variability and how to best perform a non-destructive test on soil in the field.

Select a site where stiffness is probably within the range of the current version of the GeoGauge (~3 to 70 MN/m). Typically don't select very wet soils; they are typically below 4 MN/m. Bases with high aggregate contents should be avoided for awhile until the technician gains the experience using wet/moist sand in high aggregate locations.

Layout measurement locations in a line, not a two dimensional pattern, with the increment between locations being about 2 ft. or less. The GeoGauge is a non-destructive test (NDT). Walking over measurement locations will disturb the surface and affect this or any other NDT. Lines of locations can be easily traversed without stepping on them. The physical properties of soil are extremely variable. They are much more variable than people would expect or readily believe. Over a 2 ft. increment, it is not uncommon for soil stiffness to vary more than 1 MN/m! So, the over-sampling of soil is very desirable to develop accurate profiles. Ideally, the measurement increment should be no more that the lift thickness, but 2 ft. is practical place to start.

The layout of measurement locations should allow for repeated measurements in a few hours. Thirty six (36) locations is a good number. Site conditions change continuously. Moisture content is the good example. Sandy soils dry out rapidly. Clays take days to dry. Making a comprehensive set of measurements rapidly assures soil characterization under one set of conditions. Knowing site conditions is critical to characterizing the soil. Almost daily soil characterization is necessary to control construction and assure the near and long term performance of a soil structure. Making measurements quickly, before conditions change, is therefore important.

Repeat measurements at each location at least twice. It is important to lift and remove the GeoGauge from the soil between measurements. As accurate we believe the GeoGauge to be, the repeatability of measurements can vary with how the GeoGauge is used and site conditions. So, multiple measurements at a location are a good idea to gauge repeatability and determine a mean. The number of repeated measurements depends on the site. Don't judge the repeatability of the measurements by location to location variability. This will almost always be the soil and not the GeoGauge.

Perform GeoGauge measurements first, before other companion measurements. Just as with stepping on a location, performing measurements with other devices most likely will disturb the soil and affect any subsequent measurements. The GeoGauge is sensitive to minute changes in and of the soil.

Practice making measurements before performing measurements that matter. Site conditions and soil will affect how you will want to place the GeoGauge on the soil and how long it remains in contact with the soil. Knowing how to properly seat the GeoGauge's foot on the soil, as described below, and when to remove it from the soil are critical to a good measurement.

Remember, we have found that most people believe that compacted soil is more uniform than it really is. Stiffness and modulus are sensitive enough measurements of soil to reveal this variability. So be prepared to question and understand what you are doing with all the measurements you make, not just the GeoGauge. Process control for soil structures is new and will take different thinking to effectively implement it.

Soil Preparation

Seating

Good measurement arises from good seating, the foot to soil contact. It cannot be emphasized enough that preparing the soil surface is key to good seating. Merely having a level soil surface is not enough; the foot must have sufficient direct contact with the soil. Experience shows that at least 60% of the foot's surface, from 3 locations, approximately 120 degrees apart, is needed. The contact does not have to be continuous along the ring circumference nor along the full width of the ring.

Minimum Soil Contact

The contact area can be visually estimated. Precision is not necessary. However, estimating 60% direct contact can be challenging. The following guideline is offered. Sixty percent (60%) of the foot's circumference is 8 1/2 inches. 8 1/2 inches is the width of a standard sheet of paper. If you can guess that about 8 1/2 inches along the full width of the foot is making direct contact with the soil, then you are making the minimum recommended contact.

The only time to ascertain minimum direct contact is, of course, after the measurement by lifting the gauge from the measured spot and observing the imprint made. Occasionally, the soil is stiff enough that the imprint made by the foot cannot be seen. This is where experience will be the judge.

The soil surface most likely will contain pebbles or stones. These stones will not allow the 60% direct contact required. Loose pebbles and stones should be brushed away with a gloved hand or brush. If the pebbles or stones can not be easily brushed away lightly without disturbing the soil, the simple solution is to apply a thin patted layer of clean moist or wet sand, about 5 to 10 mm thick (1/8 to 1/4 inches), on the spot to be measured. Level and pat down firmly with your gloved hand. Place the GeoGauge on the packed wet sand and with a little downward force twist the GeoGauge about 45 degrees. Now you can take the measurement.

It is essential to be consistent in using wet sand and in the seating of the GeoGauge every measurement as it is more imperative that the site, as it is being constructed, be constructed to uniform values than a specific value.

Wet Sand?

The simplest method to assure good seating and filling the voids between the protruding pebbles and the actual soil is to use moist or wet, clean, medium and uniform sand. A small handful scooped from a bucket and patted down firmly (like a pancake) on the spot to be measured will more than suffice for good seating and good measurement. An alternate material is moist or wet, clean and uniform local fines. The key is wet and uniform. The moist or wet (near saturation) is for the cohesiveness. The placing and light twisting of the GeoGauge on the wet sand (pancake) squeezes the wet sand into a thinner layer such that the influence of the wet sand in the measurement is negligible.

Use just enough that when the GeoGauge is placed on it the sand or other material does not bunch up and touch the bottom of the internal or exterior flanges. It is important that no soil or any other material come into contact with the foot flanges or the underside and sides of the GeoGauge body. Only the ring foot surface should contact the soil. A small area on the sides of the ring foot may touch the soil if the soil there is loose.

Dry sand or other cohesionless materials do not help the contact, as it will flow away from the ring foot during measurements from vibrations.

Sequence Of Operations
For A Soil Stiffness Measurement

(Quick Sheet)

- **Inspect The Condition Of The GeoGauge Prior To Testing**
  1) Is the foot clean and free of soil and other debris?
  2) Is the rubber seal in good condition?

- **Turn On The GeoGauge** (press “ON” button)
  1) The self-test will be run (electronics functionality)
  2) Ensure battery voltage is adequate (> 7.5 V)

- **Prepare The Surface To Be Tested** (see Site Preparation)
  1) Is the surface smooth and level?
  2) Coarse aggregate or stiff clay may require moist sand to be sprinkled on the surface for good direct contact with the ring.
  3) Ensure the gauge has clearance on the side and bottom, does not come into contact with a trench wall, pipe, soil, etc.

- **Enter Data**
  Enter target stiffness from predefined, scrolled list via display.

- **Seating Of The Foot**
  How to properly seat the foot will be determined by on-site trial per the recommendations above (see Site Preparation). The following are recommendations for several site conditions.
  1) On fine-grained sand material, seat the ring by twisting the gauge 45 to 90 degrees once. No extra downward pressure is required.
  2) On a coarse aggregate, sprinkle some fine sand where the ring will contact the soil. Seat the gauge by twisting the gauge 90 degrees back and forth two or three times. Use a moderate amount of pressure (5 to 10 pounds of force).
  3) On soft clay, twist the gauge 90 degrees back and forth two or three times, and use a small amount of force (5 pounds).
  4) On firm clay, twist the gauge 90 degrees back and forth two or three times and use 10 to 15 pounds of force. It may be necessary to sprinkle some sand on the soil to get better contact.

  Do not apply so much force on the gauge that the ring foot sinks into the soil more than 1/4". Sinking the foot into the soil too far will cause the outer and inner flange or the underside of the foot to contact the soil. The GeoGauge should be removed for the soil and the foot reseated between measurements. Remember, these are typical guidelines for seating the foot. Specific site conditions and soils may require a slightly different procedure. It is essential that seating of the foot and making measurements be practiced for a time for each soil type or conditions change before making meaningful measurements.

♦ **Take The Measurement** (press “Meas” button)

1) GeoGauge will measure site noise as a function of frequency.
2) GeoGauge will measure site stiffness as a function of frequency.
3) GeoGauge will display, in sequence:
   - The Number of data points used to determine stiffness
   - Signal to Noise ratio (SNR) in dB
   - The standard deviation of all 25 frequency dependent stiffness measurements relative to the displayed (average) value of stiffness
   - Stiffness, MN/m or fraction of Target
   - Ready for next measurement (last stiffness value still displayed)

If construction noise (vibrations from compactors, heavy equipment or other equipment) is present and intermittent, try to make the measurement at a distance > 75’ from operating equipment. Intermittent noise will be measured by the Soil Stiffness Gauge during the noise sampling. In most cases, a minimum SNR of 15 dB is adequate for an acceptable measurement. It is not possible to establish one minimum SNR that is adequate for a "good test”. For example, on stiff clay (20 MN/m) with no noise, the SNR may be around 15 dB. On a loose sand or soft clay, a test with no noise will have an SNR around 30 dB. A minimum SNR of 10 on softer soils is adequate. In any case, a test yielding a negative stiffness or modulus value should be rejected and be repeated.

♦ **Remove The GeoGauge From The Test**

1) Examine the site and ensure good direct ring contact. While a full impression of the ring is ideal, it is not necessary. A contact area where the ring touches the soil in three points (with 60 percent or more of the ring being in contact with the soil) is better than having one half of the ring in contact, and the other half not touching. If contact is not adequate, redo the measurement; prepare the surface better with a straight edge shovel, or by sprinkling sand. Sprinkled sand should not exceed 1/4" in thickness.
2) Ensure that the ring was not pushed so far into the soil that the outer flange comes into contact with the soil, as this will result in an inaccurate measurement.
3) Clean any soil off of the foot that may have been caked on in the course of testing.

♦ **Store Data** (press “SAVE” button)

The measurement ID will be assigned to the stored data. The GeoGauge will store data for 500 measurements as displayed (Operational Mode). This first 20 measurements stored will also include the complex, frequency dependent components of displayed data (Research Mode).

♦ **Turn The GeoGauge Off** (press “OFF” button)

♦ **Transfer Data (if desired)**

1) Infrared (IR) link (optional accessory)
2) Transfer to IR reader in desktop PC.
3) Data stored on PC in ASCII format.
4) Data readily accessible via typical spreadsheet software (e.g., Microsoft Excel®).
5) Software template supplied.

Transit - Carrying Case

The transit case has both key lock and combination lock. The combination is set at factory "0-0-0". To re-set the combination number;

1. Open the case. Looking at the back of the lock inside the case you will see a change lever. Move this change lever from the normal position to the middle of the lock in the way that it hooks behind the change notch (figure 1). Move it sideways and then up.
2. Now you set your combination number by turning the dials to the desired three number combination. Record the numbers below.
3. Move back the change lever to the normal position (figure 2).
4. To lock, close the case securely and rotate one or more of the dials. To un-lock, set the dials to the proper numbers.
5. Record the numbers _______-________-________
6. The key lock/latch set requires the attached key to lock.

Replacing Batteries

Model H-4140 requires six (6) "D" size, 1.5 volts dry cell alkaline batteries. Three (3) batteries in each of the two battery compartments, accessible via two screw-on caps on the top of the GeoGauge. Replace all batteries with a fresh set. Attempting to mix fresh batteries with used batteries will cause the fresh batteries to deteriorate very quickly to the level of the used batteries, negating any advantage.

1. Turn off gauge. Remove the battery caps by unscrewing counter-clockwise. A suitable coin may be helpful to loosen them.
2. Carefully lift and remove the spring and the battery contact retainer.
3. Remove the batteries; tilting and turning the gauge upside down will facilitate removal.
4. Insert the fresh batteries with the positive (+) side up in both compartments.
5. Carefully insert the battery contact retainers, springs and then screw on clockwise the battery caps. There is an o-ring seal on the underside of the battery caps to seal out water and dirt. Hand tighten only. Occasionally insure that the battery caps are tight.
6. Loosen the four (4) corner captive screws with a Phillips screwdriver. Remove any static electricity in one-self by touching a metal earth grounded object such as the back of a computer housing.
7. Carefully lift up the display panel that also contains the electronic circuitry. On the left side are two toggle switches, #1 and #2.
8. Switch #1 to on as marked. Turn on the unit by pressing the "ON" button. The display will momentarily show reset and then revert to its normal display.
9. Turn the #1 switch to off. Turn off the unit by pressing the "OFF" button. Replace the display panel back onto the unit and lightly hand tighten the screws. The GeoGauge is ready for operation.

Note: The gauge exterior is not water (moisture) proof or dust proof. Attempts were made to make the gauge as tight as reasonable. Do not expose the gauge to precipitation. Should the gauge get wet, exposed to high humidity or suspected of containing moisture or condensation, immediately dry out the gauge by removing and gently setting aside upside down, without disconnecting the wires, the display panel and battery caps and batteries. Allow to air dry in a dry enough room overnight. Re-assemble before packing back in case.

Clock / Date Adjustment Guide

Purpose

The clock is used to stamp the time and date of each stiffness measurement. When saved the measurements can be downloaded into a PC onto a spreadsheet template to analyze the complex data from the first twenty measurements saved. Saved measurements number 21 to 500 show only the run #, stiffness value and time/date. Changing the batteries will not delete or lose the clock settings.

Operation

1. With the GeoGauge "ON" and in normal mode, press the "SHIFT" button and then the "MEAS" button to get into the user input mode. The Poisson's Ratio values will display. Press "SHIFT" and "MEAS" buttons again, the clock settings should display.

2. The "—" represents AM. The "+" represents PM. Pressing the "INCR" or "DECR" will scroll the values up or down.

3. With the first pressing of the "SHIFT" and "MEAS" buttons from step #1 and the clock displayed, both time and date, the hour will adjust. Scroll to the correct hour and AM or PM.

4. Pressing the "SHIFT" and then the "MEAS" buttons again will allow adjustment of the minute. Scroll to the correct minute.

5. Pressing the "SHIFT" and then the "MEAS" buttons again will allow adjustment of the month. Scroll to the correct month.

6. Repeat for day and then year. Continuing the adjustments will rotate back to hour, then minute, then month, then day, then year.

7. At anytime you are satisfied with the settings, press the "SAVE" button, and then press the "OFF" button to get out of the clock adjustment mode. Press "ON" to turn on unit for measurements.