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GeoGauge™ Principle of Operation (ref. Fig. 1)

The force applied by the shaker and transferred to the ground is measured by differential displacement across the flexible plate.

$$F_{dr} = K_{flex} (X_2 - X_1)$$

where

F_{dr} = force applied by the shaker
K_{flex} = stiffness of the flexible plate
X_2 = displacement at the flexible plate
X_1 = displacement at the rigid foot

At the frequencies of operation, the ground-input impedance will be dominantly stiffness controlled.

$$K_{gr} = \frac{F_{dr}}{X_1}$$

where

K_{gr} = stiffness of the ground

Thus, the ground stiffness is:

$$\overline{K_{gr}} = K_{flex} \frac{\sum_1^n \frac{(X_2 - X_1)}{X_1}}{n} = K_{flex} \frac{\sum_1^n \frac{(V_2 - V_1)}{V_1}}{n}$$

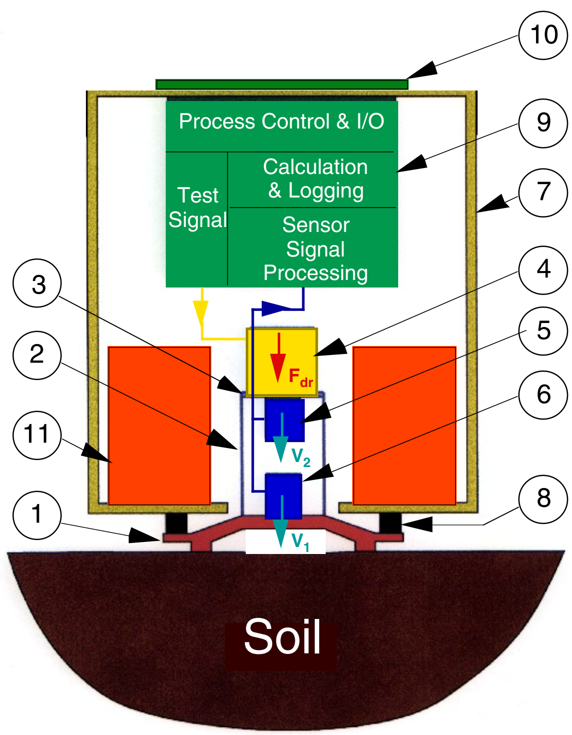
where

n = number of test frequencies
V_2 = velocity at the flexible plate
V_1 = velocity at the rigid foot

This dynamic approach avoids the need for a non-moving reference for ground displacement and permits the accurate measurement of small displacements. It also assumes the following conditions.

1) At least 20 discrete measurement frequencies above the typical operating frequencies of construction equipment and below the frequencies where ground impedance is no longer stiffness controlled.
2) A period of less than 1.5 minutes for a single measurement.
3) A depth of measurement of at least 4” and preferably greater that 6 “.
4) A measurement be unaffected by construction site noise.
5) An apparatus static weight to produce 4 psi on the ground.
6) The following selected such that displacements of ~ 0.00005” can easily be resolved.
   - Velocity sensor sensitivity (output per unit displacement)
   - Shaker transmitting response (force out per unit input)
   - Dynamic range of the electronics

Figure 1 GeoGauge™ Schematic



1	Rigid foot with annular ring
2	Rigid cylindrical sleeve
3	Clamped flexible plate
4	Electro-mechanical shaker
5	Upper velocity sensor
6	Lower velocity sensor
7	External case
8	Vibration isolation mounts
9	Electronics
10	Control & display
11	Power supply