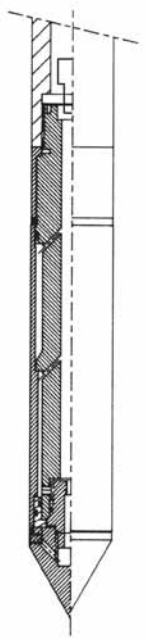
Cone Penetrometer Technology (CPT)

Hogentogler & Co. offers a wide range of advanced digital and analog electronic cone penetrometers with capacities ranging from 2.5 tons to 15 tons (tip load). All Hogentogler electronic cones have internal electronic power amplification and regulation mounted directly behind the transducer, eliminating the effect of cable resistance on the measurements. In addition, all Hogentogler digital electronic cones are temperature compensated to reduce errors due to temperature shift. Available channels include: (1) Tip Resistance; (2) Skin Friction; (3) U1/U2/U3 Pore Pressure; (4) X and Y Inclination; (5) X, Y and Z axis Seismic; and (6) Temperature. Additional measurements, such as Resistivity and Optical Soil Imaging can be achieved with add-on modules. In addition to our standard line of 10 cm2 and 15 cm2 cones, we have constructed many custom probes, such as miniature penetrometers, pH probes and water level indicators. We also manufacture mechanical cone penetrometers with automated readouts. Please contact us with your commercial or research requirements.

Standard Cone Channels

The following channels come standard on all cones:

- Tip Resistance
- Local Friction
- Inclination



Optional Cone Channels

The following channels are optional on all of our standard cones:

- U1/U2/ U3 Pore Water Pressure
- Ground Temperature
- X/Y/Z Seismic Velocity*
- Electrical Conductivity**
- Video Cone

* Cone Seismic Option

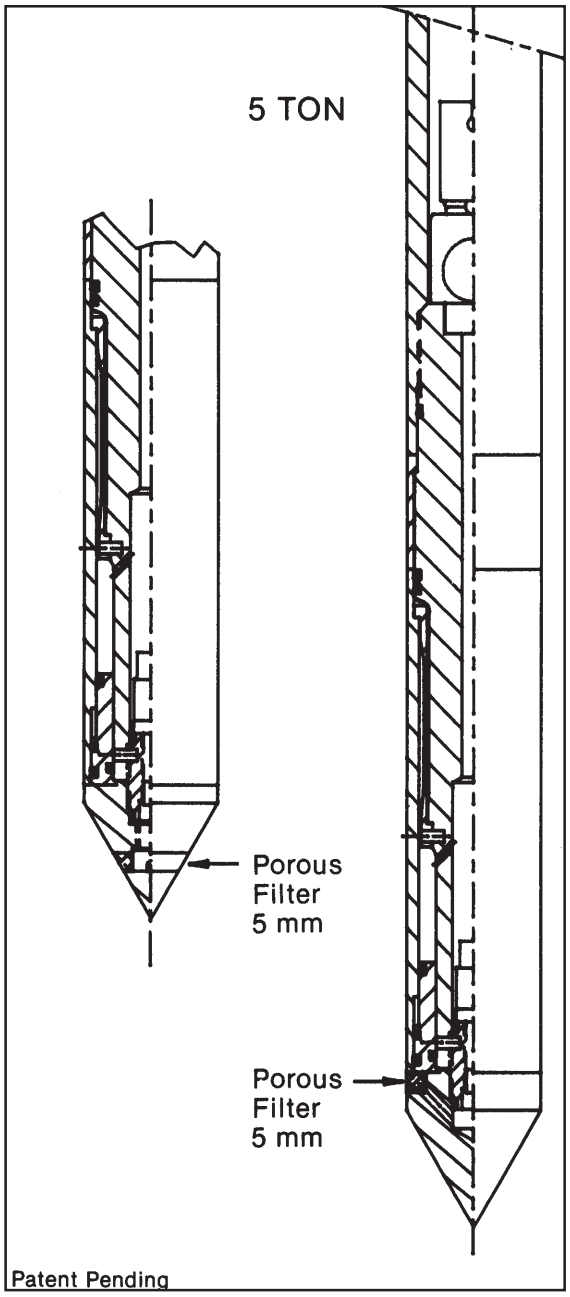
The cone seismic option makes it possible to use a cone penetrometer to measure downhole shear wave propagation velocity. The shear wave velocity can be used in conjunction with an estimate or measurement of the soil density to determine the dynamic shear modulus of the soil at low strain values. The data can be presented using the Hogentogler interpretation software.

* * Resistivity (Electrical Conductivity) Module

The Hogentogler electrical conductivity module provides electrical conductivity measurements of the soil. These measurements can be used to determine the location of potential ground water contamination and/or salt water intrusion. The module is designed to attach to the top of a standard 5 ton or 10 ton electronic cone penetrometer.

Cones: 5 Ton Digital Tension Cone

Full range of one through five channel capacity and six channels total



TEMPERATURE COMPENSATED

The digital electronic tension 5 ton cone has been developed to address the accuracy, sensitivity and durability problems inherent in other cone designs of the same or lower capacities. With a resolution of 3 Ibs., there no longer exists the need for cones of lower capacities plus their associated spare parts. The unit consists of a dual element strain gauge transducer, with cone support electronics packaged directly behind the transducers. The cone tip, local friction element and pore pressure element are field replaceable by the operator in approximately five minutes. The cone is configured with one through five channel capacity with six channels from which to choose.

CONE CHANNELS:

- **TIP**
- **LOCAL FRICTION**
- **PORE PRESSURE**
- **TEMPERATURE**
- **INCLINATION**
- **SEISMIC**
- **RESISTIVITY MODULE CAN BE ADDED**

There are two possible locations for pore pressure; one on the tip or one directly behind the tip.

The electronics have precision power supplies for the strain gauges, which eliminate the effects of cable resistance on the measurements. Calibration data for tip, local friction and pore pressure channels is stored in CPU non-volatile memory. Digital cone calibration is capable of correcting for non-linearity and hysterisis in a way that analog circuitry cannot. Digital cones conform to all

Cones: 5 Ton Digital Tension Cone

Electrical Specifications

- Power: +12 Volt at 200 mA (max).
- Connector: 10 pin LEMO waterproof connector.
- Operating temperature range: 0°C to 60°C
- Storage temperature: -40°C to 70°C
- 4 channel, 24 bit A/D converter for measurement of tip, friction, and pore pressure. Minimum noise-free resolution of 1 part in 65000.
- 10 channel, 12 bit A/D converter for measurement of inclination, seismic, temperature and spare channels.
- 8 bit microcontroller with 8kb flash memory for cone identification and calibration data storage.
- 32kb non-volatile ram for data storage.
- RS-485 serial communication. Cable lengths of 1000 ft possible. CRC error checking to prevent transmission of incorrect data.
- Cones are interchangeable in the field. Cones can be calibrated in the field. All calibration data is contained in the cone.
- Compatible with vision cone and fuel fluorescence detector.

Mechanical Specifications (10 Ton / 15 Ton)

TIP
- Tip angle: 60 degree.
- Tip area: 10 cm^2
- Net area ratio: .8
- Tip range: 50 Mpa (522 TSF)
- Tip mechanical overload capacity: 300 %.
- Accuracy: .2 %.
- Temperature compensated.

SLEEVE
- Sleeve area: 150 cm^2
- Sleeve capacity: 1 MPa
- Sleeve mechanical overload capacity: 200 %.
- Accuracy: .2 %.
- Temperature compensated.
- Equal end area eliminates pore pressure effects.

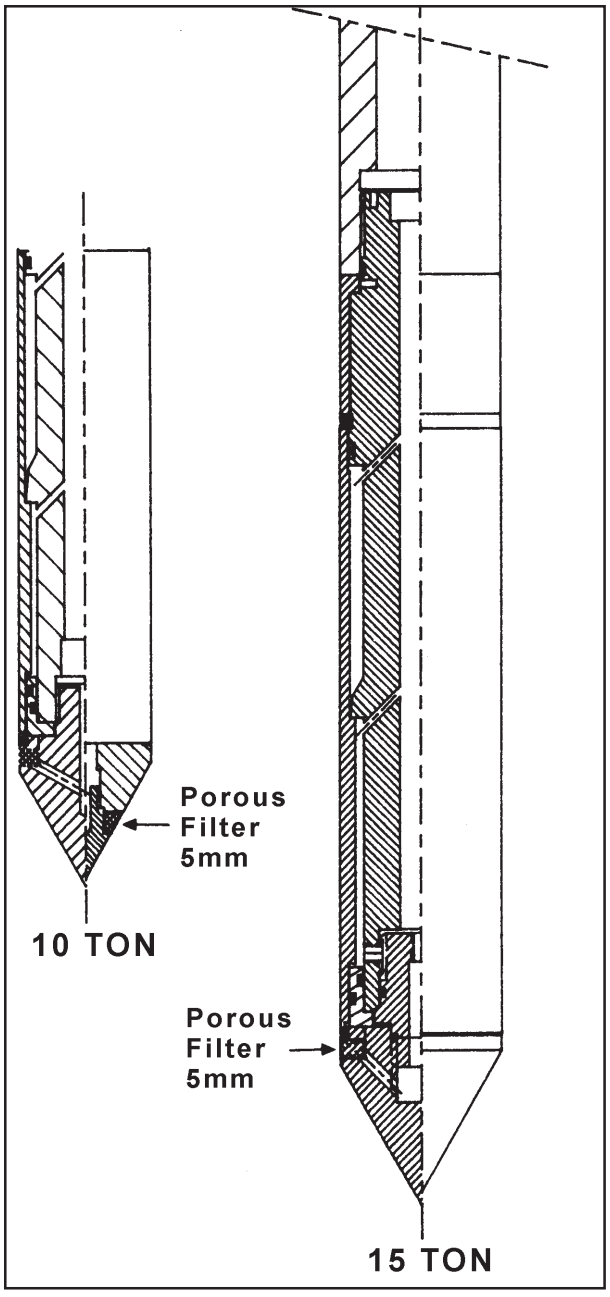
PORE PRESSURE TRANSDUCER
- Pore pressure range: 3500 kPa (500 psi).
- Pore pressure mechanical overload pressure: greater than 200 %.
- Accuracy: .5 %.
- Temperature compensated.
- Special cones available with three pressure transducers for simultaneous measurement of U1, U2, U3.

INCLINOMETER
- Two channel inclinometer. Pitch and roll measurement provides information on cone migration.
- Uses accelerometers to measure inclination. No moving parts.
- Range: 0 – 15 degrees
- Resolution: .1 degree.

SEISMIC
- Uni or Biaxial geophone.
- Capacity: +/- 2g.
- True DC response.
- Electronic offset eliminates effect of gravity.
- Digitized in cone and transmitted over serial port. No extra wires or analog measurement required.

Cones: 10 & 15 Ton Digital Subtraction Cone

Full range of one through five channel capacity and six channels total



TEMPERATURE COMPENSATED

The digital electronic subtraction 10 and 15 ton cones have been developed to address the accuracy, sensitivity and durability problems inherent in other cone designs, with a resolution of 6.5 and 10 Ibs. respectively. The unit consists of a single element strain gauge transducer, eliminating mechanical coupling effects, and with cone support electronics packaged directly behind the transducer. Both the cone tip, local friction element and pore pressure element are field replaceable by the operator in approximately five minutes. The cones are configured with one through five channel capacity with six channels from which to choose.

CONE CHANNELS:

- **TIP**
- **LOCAL FRICTION**
- **PORE PRESSURE**
- **TEMPERATURE**
- **INCLINATION**
- **SEISMIC**
- **RESISTIVITY MODULE CAN BE ADDED**

There are two possible locations for pore pressure; one on the tip or one directly behind the tip.

The electronics have precision power supplies for the strain gauges, which eliminate the effects of cable resistance on the measurements. Subtraction is performed digitally by the CPU and calibration data for tip, local friction and pore pressure channels is stored in CPU non-volatile memory. Digital cone calibration is capable of correcting for non-linearity and hysterisis in a way that analog circuitry cannot. Digital cones conform to all

Cones: 10 & 15 Ton Digital Subtraction Cone

Electrical Specifications

- Power: +12 Volt at 200 mA (max).
- Connector: 10 pin LEMO waterproof connector.
- Operating temperature range: 0°C to 60°C
- Storage temperature: -40°C to 70°C
- 4 channel, 24 bit A/D converter for measurement of tip, friction, and pore pressure. Minimum noise free resolution of 1 part in 65000.
- 10 channel, 12 bit A/D converter for measurement of inclination, seismic, temperature and spare channels.
- 8 bit microcontroller with 8kb flash memory for cone identification and calibration data storage.
- 32kb non-volatile ram for data storage.
- RS-485 serial communication. Cable lengths of 1000 ft possible. CRC error checking to prevent transmission of incorrect data.
- Cones are interchangeable in the field. Cones can be calibrated in the field. All calibration data is contained in the cone.
- Compatible with vision cone and fuel fluorescence detector.

Mechanical Specifications (10 Ton / 15 Ton)

TIP
- Tip angle: 60 degree.
- Tip area: 10 cm^2 / 15 cm^2.
- Net area ratio: .8
- Tip range: 100 Mpa (1044 TSF) / 150 Mpa (1566 TSF).
- Tip mechanical overload capacity: 300 %.
- Accuracy: .2 %.
- Temperature compensated.

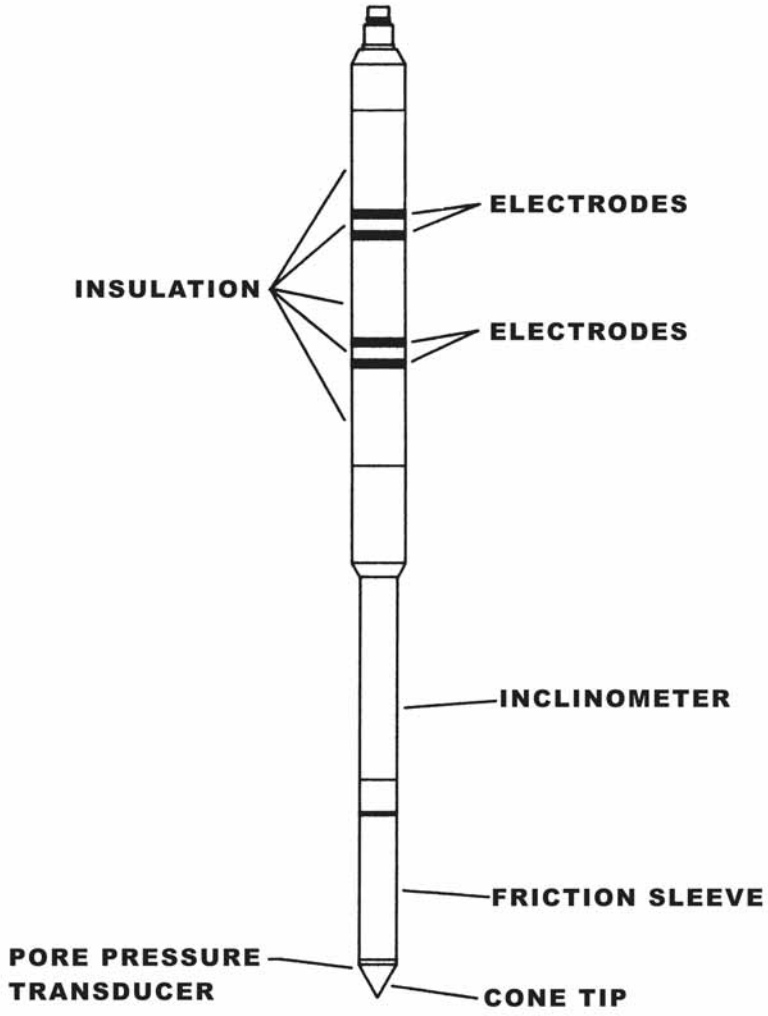
SLEEVE
- Sleeve area: 225 cm^2
- Sleeve capacity: 1 MPa
- Sleeve mechanical overload capacity: 200 %.
- Accuracy: .2 %.
- Temperature compensated.
- Equal end area eliminates pore pressure effects.

PORE PRESSURE TRANSDUCER
- Pore pressure range: 3500 kPa (500 psi).
- Pore pressure mechanical overload pressure: greater than 200 %.
- Accuracy: .5 %.
- Temperature compensated.
- Special cones available with three pressure transducers for simultaneous measurement of U1, U2, U3.

INCLINOMETER
- Two channel inclinometer. Pitch and roll measurement provides information on cone migration.
- Uses accelerometers to measure inclination. No moving parts.
- Range: 0 – 15 degrees
- Resolution: .1 degree.

SEISMIC
- Uni or Biaxial geophone.
- Capacity: +/- 2g.
- True DC response.
- Electronic offset eliminates effect of gravity.
- Digitized in cone and transmitted over serial port. No extra wires or analog measurement required.

Cones: Resistivity



ELECTRICAL CONDUCTIVITY (RESISTIVITY) MODULE

The Hogentogler Electrical Conductivity Module combines the standard CPT measurements: tip, local friction, inclination and pore water pressure with electrical conductivity measurements of the soil. The combination of these parameters provides comprehensive information useful in determining the stratigraphy of the soil and the location of potential ground water problems in one test. Groundwater problems could include corrosive soils, salt water intrusion or environmental contamination. Any soil contaminate that has a typical electrical conductivity higher than that of water can be detected.

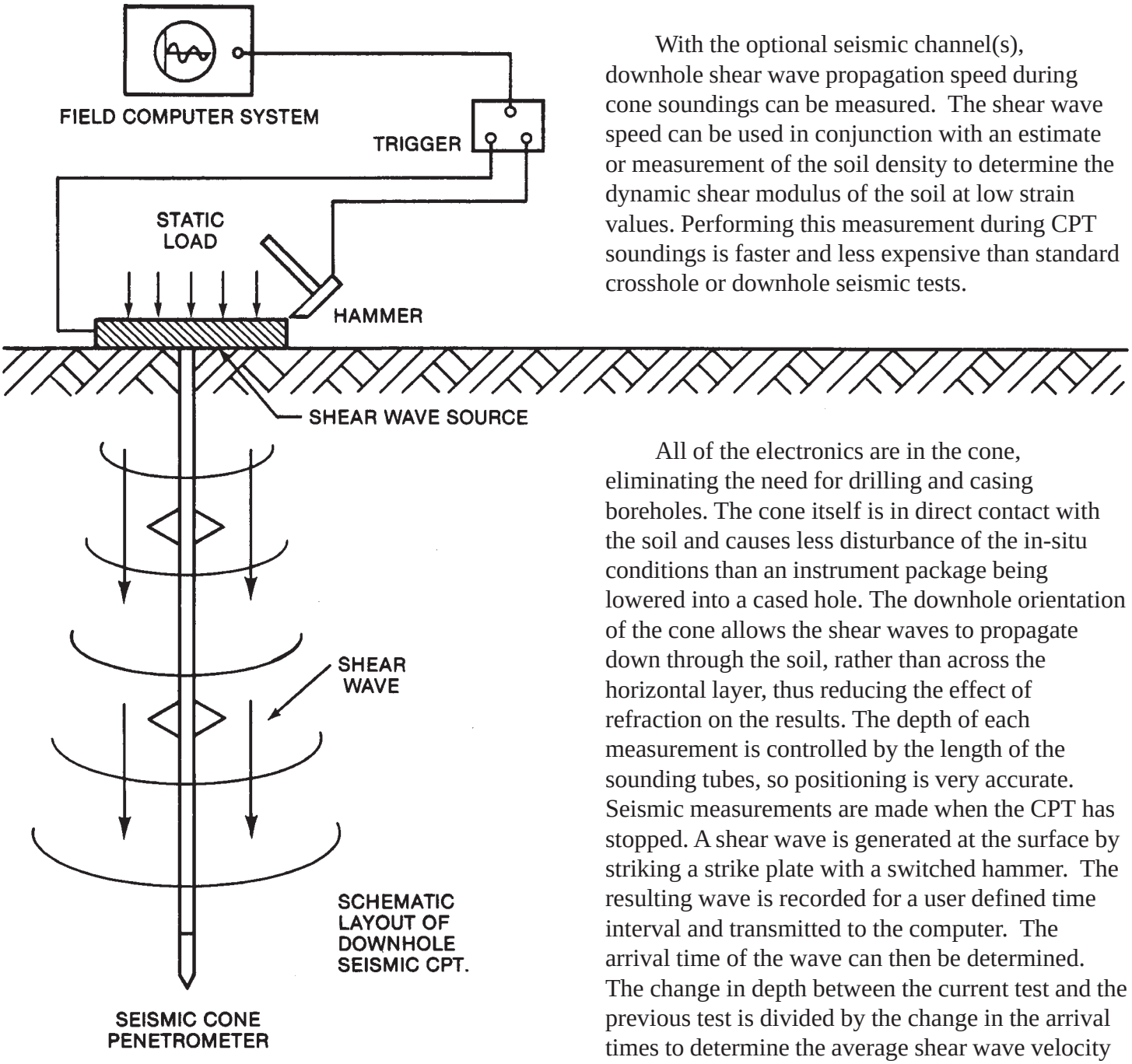
FEATURES

The Hogentogler Electrical Conductivity Module utilizes the standard four electrode array required to eliminate errors due to gas generation and plating. The device has a custom electronic servo system and auto-ranging technique to ensure accuracy over the entire 0-10,000 *mS/m* ground water conditions. The module also includes a secondary technique to eliminate the effects of the extraneous electrical path through the steel body of the device.

SOFTWARE

The module comes complete with software adaptable to standard Hogentogler E4FCS Data Acquisition System. The software provides tabular listings and digital plots of conductivity in *rnS/m* (or resistivity in ohm-m). It also interfaces with the module to auto-range the optimum data accuracy.

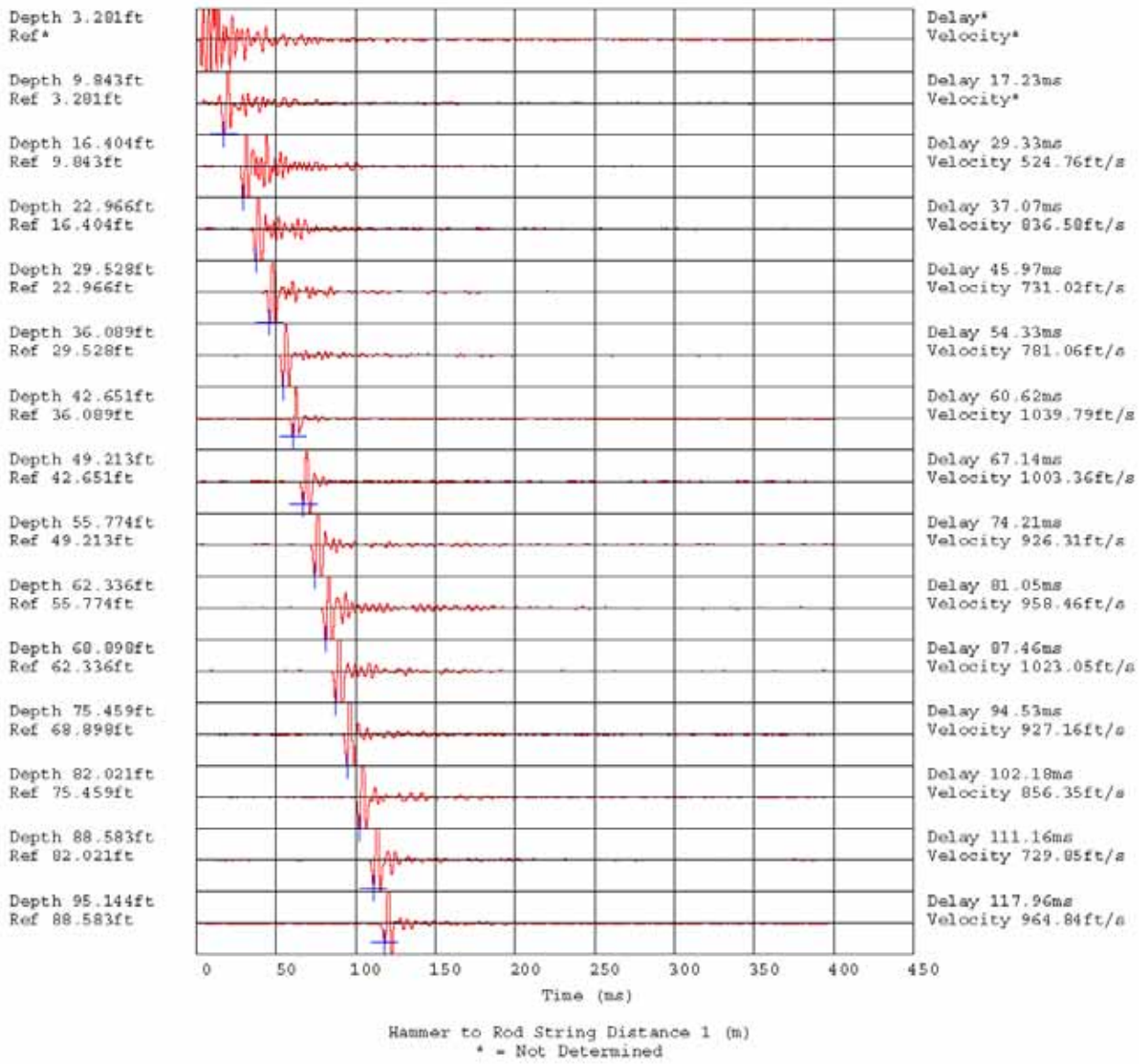
Cones: Seismic



With the optional seismic channel(s), downhole shear wave propagation speed during cone soundings can be measured. The shear wave speed can be used in conjunction with an estimate or measurement of the soil density to determine the dynamic shear modulus of the soil at low strain values. Performing this measurement during CPT soundings is faster and less expensive than standard crosshole or downhole seismic tests.

All of the electronics are in the cone, eliminating the need for drilling and casing boreholes. The cone itself is in direct contact with the soil and causes less disturbance of the in-situ conditions than an instrument package being lowered into a cased hole. The downhole orientation of the cone allows the shear waves to propagate down through the soil, rather than across the horizontal layer, thus reducing the effect of refraction on the results. The depth of each measurement is controlled by the length of the sounding tubes, so positioning is very accurate. Seismic measurements are made when the CPT has stopped. A shear wave is generated at the surface by striking a strike plate with a switched hammer. The resulting wave is recorded for a user defined time interval and transmitted to the computer. The arrival time of the wave can then be determined. The change in depth between the current test and the previous test is divided by the change in the arrival times to determine the average shear wave velocity for that depth interval.

Shear Wave Velocity



Vision Cone

The VisionCone or VisCPT was developed to address the fact that no sample is recovered during a CPT test. Because no sample is obtained SPT tests must be performed along with CPT for visual inspection, index testing and classification. The VisionCone addresses this problem by using a high speed CCD camera that records a continuous video onto a DVD recorder and is stamped with a depth marker to correlate the depth to the video. Now the engineer has a continuous visual profile of the material that is being tested. From this data the engineer can establish correlations using post processing software (see next page) that uses an algorithm to determine the grain size distribution.This not only allows the VisionCone to confirm the CPT results but also identifies small thin layers that aren't recognized by the CPT probe. These layers can be classified as different soil types (i.e. sand, silty sand, clay) based upon the results of the video post processing.

Video Cone: Data Sheet