Crosshole/Downhole Seismic » ASTM D4428/D4428M/D7400(DS)

Crosshole/Downhole Seismic (CS/DS) investigations provide information on dynamic soil and rock properties.

The Crosshole Seismic (CS) system and method determine shear and compressional wave velocity versus depth profiles. From these measurements, parameters, such as Poisson's ratios and moduli, can be easily determined. In addition, the material damping can be determined from CS tests. These dynamic soil and rock properties are often utilized for earthquake design analyses necessary for certain structures, liquefaction potential studies, site development, and dynamic machine foundation design. The most complete version of this downhole system, as manufactured by Olson Instruments, includes a borehole source capable of generating shear and compressional waves and a pair of matching three component triaxial geophone receivers. These instruments are lowered to the same depth in boreholes set at ~ 10 ft (3 m) apart in a line. The instruments are coupled to the side of the grouted borehole inclinometer casing, allowing for the detection of shear and compressional waves as they pass between the receivers.

The Downhole Seismic (DS) investigations are similar to CS investigations, but require only one borehole to provide shear and compressional velocity wave profiles. The DS method uses a hammer source at the surface to impact a wood plank and generate shear and compressional waves. This is typically accomplished by coupling a plank to the ground near the borehole and then impacting the plank in the vertical and horizontal directions. The energy from these impacts is then received by a pair of matching three component geophone receivers, which have been lowered downhole and are spaced 5 to 10 ft (1.5 to 3 m) apart.

Features:

- Real-time waveform display while testing
- Thin layers, which are often invisible to surface methods, can be detected with CS/DS investigations
- Acquisition and processing software are easy to use, yielding fast and accurate results
- CS method is the most accurate method for determining material properties of rock and soil sites
- Accuracy and resolution for the CS test method are constant for all test depths, whereas the accuracy and resolution for the DS surface method decreases with depth
- Sources and receivers can be oriented with inclinometer casing dummy probes
- P-SV source used in CS tests can impact in the up, down, and radial directions
- Correlation between CS and Spectral Analysis of Surface Waves (SASW) tests on soil sites showed that the values from both tests typically compare within a 10-15% difference

» Applicable On:
Soil and Rock
» Test For:
Seismic Shear and Compressional Wave Velocities
Locate Faults, Fractures
Image Voids, Solution Caverns, Washouts with Tomography

Model	Advantages
CS-1 Model	This system includes one triaxial geophone for CS testing and is only sold in combination with a P-SV source.
CS/DS-2 Model	This system includes two triaxial geophones and an accelerometer for CS or DS testing.
P-SV Source	This component allows for accurate and rapid triggering in CS testing by directly impacting the borehole casing. The source is configured for use with the above mentioned systems.
Options	**Advantages**
Tomo-1 Software	Allows the user to perform and display tomographic inversions of CS/DS seismic velocity data which provides 2-D or 3-D shear or compressional wave velocity images of soil and rock

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Method

The CS investigation requires drilling of two or more (ideally three) boreholes cased with PVC or slope inclinometer casing for deeper borings up to 328 ft (100 m), and grouted in accordance with ASTM standards to ensure good transmission of wave energy. The boreholes are typically 4-6 inches in diameter cased with 2.32 to 3 inch (59 to 76 mm) I.D. casing. The testing is simplified if inclinometer casing is used rather than normal PVC pipe. Typical distances between adjacent in-line boreholes are on the order of 10 ft (3 m). The testing is performed by lowering both the source and receiver(s) to an investigation depth, firing the source, and recording the energy with the receivers.

The DS investigation requires drilling a single borehole with similar specifications as listed above, except that only a single grouted 2 inch (50 mm) to 3 inch (76 mm) I.D. PVC casing is needed. The testing is performed by lowering the receiver(s) to an investigation depth, impacting the coupled surface plank, and recording the energy with the receivers.

Data Collection

The user friendly WinGEO-T software is written and tested at Olson Instruments' corporate office in Colorado. We do not outsource any tech support questions and, should you require software support, we welcome your questions and comments.

Available Models

The Crosshole/Downhole Seismic system can be configured from three different models with an optional P-SV Source. All systems require the Olson Instruments Freedom Data PC platform for testing:

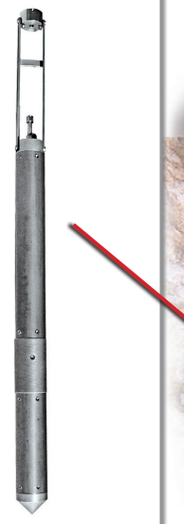
1. Crosshole Seismic - 1 (CS-1)
2. Crosshole/Downhole Seismic - 2 (CS/DS-2)
3. P-SV Source (P-SV)

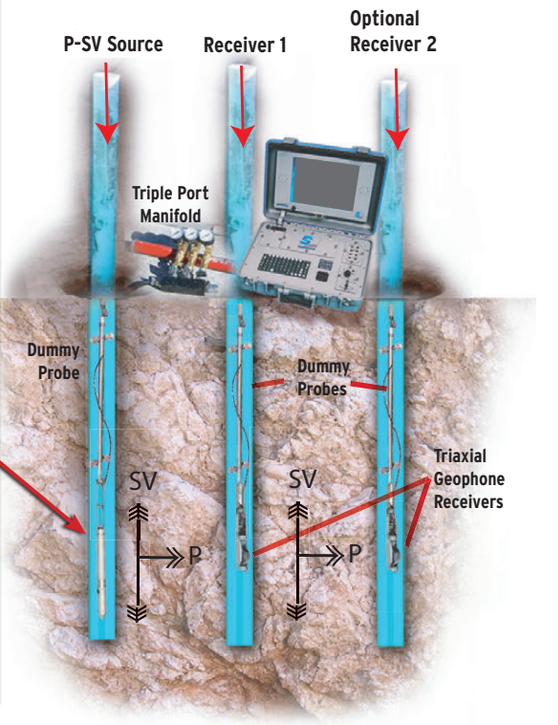
The **CS-1 Model** is the base model for Crosshole Seismic testing and is only offered with the P-SV source. This system includes one triaxial geophone allowing for direct path measurements associated with each set of impacts in the borehole. Specifically, this system can be used to test the material between the impact and the receiver's location in the borehole.

The **CS/DS-2 Model** includes two geophones and an accelerometer allowing for dual path measurements with paths that are either horizontal (CS) from borehole to borehole or vertical (DS) from surface to borehole. Specifically, this system can be used to test the material between the impact and the receivers' location in the borehole(s).

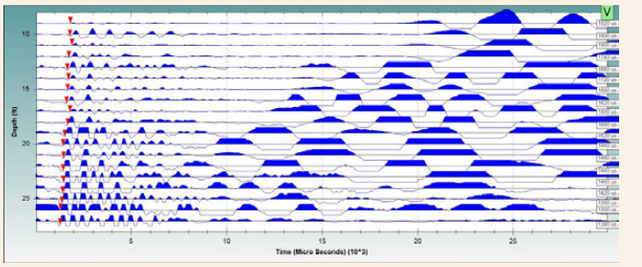
The **P-SV Model** includes a downhole source which can impact in the up, down and radial directions. The source is locked in place with an air-operated piston. Multiple interchangeable piston lengths are provided for operation in different diameter borehole casings.

All of the CS/DS Models are compatible with Olson Instrument's **P-SV Source**. This component provides the user with the most accurate and rapid method of generating impacts.

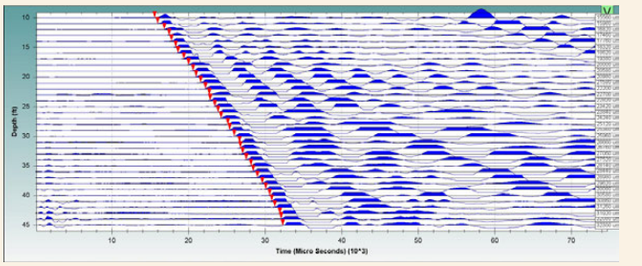




Data Example » 1



Crosshole Seismic stacked Data Plot



Downhole Seismic stacked Data Plot showing arrival move-out.

Freedom Data PC Required, Sold Separately