

DOWNHOLE SEISMIC VELOCITY LOGGING METHOD



Overview

Downhole seismic velocity logging is a well known method of measuring seismic wave velocity profiles, and has been used for more than 50 years. This method relies on a surface source to generate P- and S-waves that travel down the soil or rock column where they are recorded by a sensor(s) locked in a borehole. Travel time is measured using a trigger at the surface, and a digital seismograph recording.

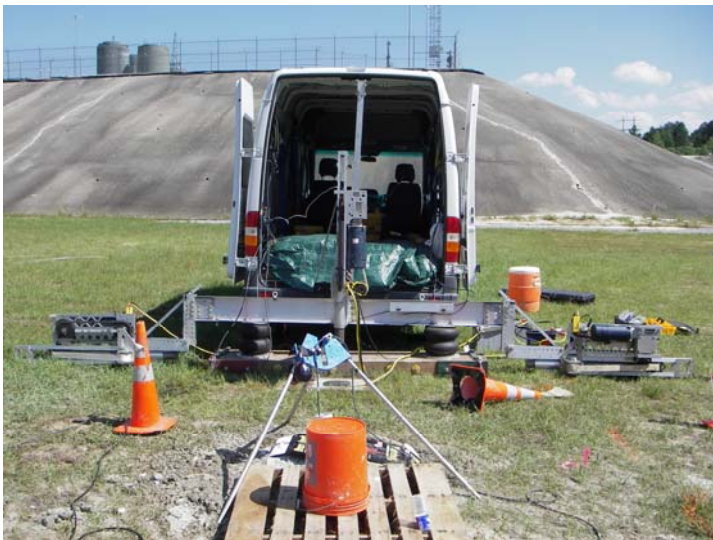
Procedure

The Downhole P-S Logging System uses a probe with a borehole wall-locking mechanism, containing an orientable geophone and fluxgate compass package, suspended by a cable. The compass/geophone assembly can be rotated from the surface control module to match the azimuth of the horizontal geophone axis with the azimuth of the surface shear wave source. The probe receives control signals from, and sends geophone signals to instrumentation on the surface via the cable. Cable travel is measured to provide probe depth data. The probe is locked into the borehole by a motor-driven clamp that runs the length of the probe.

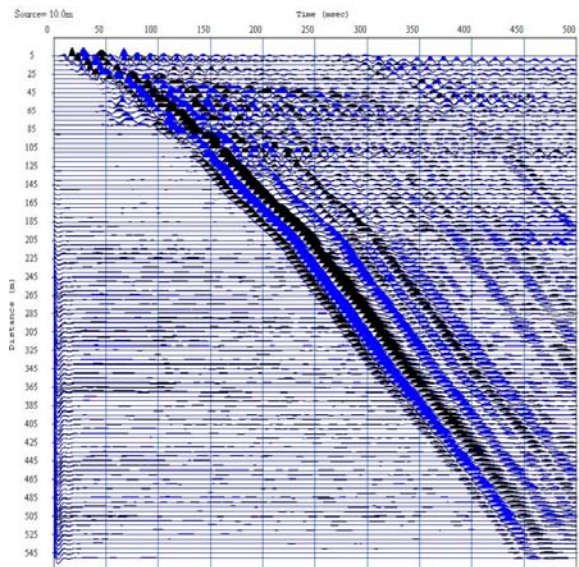
The elapsed time between the source strike at the surface and the arrivals of the waves at the downhole receiver is used to determine the average velocity. Incrementing the depth results in an incremental travel time and velocity.



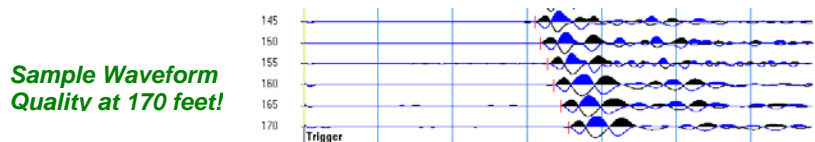
Standard source is a person with a sledge hammer, shown here making a P-wave (note heavy shear plank – 140Kg plus vehicle)



Triple Whammy High Energy Source



Waveform Data Down to 550 feet



Sample Waveform Quality at 170 feet!

Applications

Typical applications of Downhole P- and S-wave velocity logging include:

- Dam safety investigations
- Seismic site response studies for bridge abutments, dams, buildings, etc.
- Foundation studies
- Measurement of soil/rock properties (i.e. shear modulus, bulk modulus, compressibility, and Poisson's ratio)
- Characterization of strong motion sites
- Velocity control for seismic reflection surveys



Typical Downhole Probe

Key Benefits

Downhole P- and S-wave velocity profiling is a reliable choice for certain situations:

- Highly fragmented rock above water table is difficult to drill and maintain circulation using rotary mud method, resulting in cased boreholes with an unknown grout column. In this situation Downhole can be more reliable than the OYO P-S Suspension
- When validation is desired for OYO P-S Suspension results, and Downhole is a good choice because it measures velocities in the same orientation
- Can work in borehole diameters as small as 2 inches (cased)
- Can be a good choice when high resolution is not important, and borehole depth is shallow

Figure at right shows an example, comparing Downhole with OYO P-S Suspension travel time curves. Below is the resulting S-wave velocity profile for both methods.

