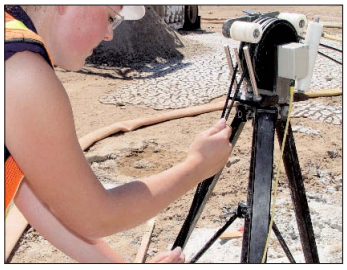
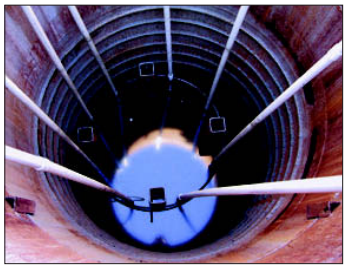
CROSSHOLE SONIC LOGGING



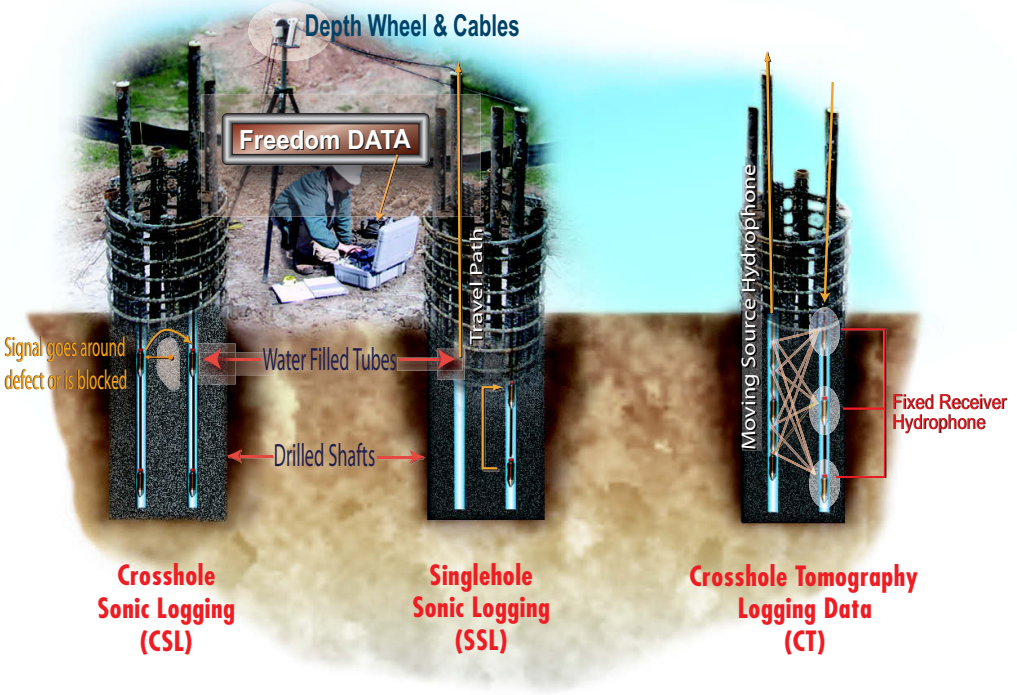


APPLICATION

Olson Engineering is a pioneer in the instrumentation and use of **CSL tests** for checking the integrity of newly placed drilled shafts, seal footings, and slurry or diaphragm walls. The CSL test relies on propagation of ultrasonic waves between two or more access tubes to measure the velocity and signal strength of the propagated waves. The testing can be performed on any concrete foundation provided two or more access tubes or coreholes capable of holding water are present in the foundation. CSL can also be used to check the integrity of underwater concrete piers and foundations by strapping access tubes to the sides. Crosshole Tomography can be performed to image critical anomalies found in CSL tests as discussed below.

A companion of the CSL test is the Singlehole Sonic Logging (SSL) test, which can be performed in one access tube or corehole to check the integrity of the concrete foundation around the tube in a fashion similar to Gamma-Gamma nuclear density tests.

CSL tests are typically performed on concrete, particularly concrete drilled shafts. Other materials, which support transmission of ultrasonic waves, can be tested, such as slurry, rock, grout, water-saturated media, and cemented radioactive wastes.



STANDARDS

Standards for the CSL method include ASTM D6760-02 for integrity testing of concrete deep foundations and ACI 228.2R for NDE applications, and FLH 521.830 for determining pulse velocity through concrete in drilled shafts.

- **See end of document for full references.**

ACCESS

Access tubes must be installed before the construction of the drilled shaft for quality assurance purposes, unless coreholes are to be drilled in a forensic case. PVC or black steel tubes (U.S. schedule 40) are typically used. The tubes are 1.5 (steel tubes only) to 2 inches (38 to 50 mm) in diameter, and are typically tied to the inside of the rebar cage to ensure close to vertical positions of the tubes. The tubes must extend about 3 feet (1 m) above the top of the shaft to compensate for the water displaced by the source, receiver, and cables and to allow for easy access. Tubes must be bonded to the concrete for good test results. In order to minimize debonding of tubes, water should be added immediately prior to or after concrete placement and the tubes should not be mechanically disturbed.

At least two tubes are needed to perform the CSL test. For good coverage of the test shaft, we recommend the following number of tubes be installed:

SHAFT DIAMETER	RECOMMENDED NUMBER OF TUBES	TUBE SPACING
D ≤ 2.5 ft (0.75m)	2 minimum	180 Degree
2.5 < D ≤ 3.5 ft (1.0 m)	3 minimum	120 Degrees
3.5 < D ≤ 5.0 ft (1.5 m)	4 minimum	90 Degrees
5.0 < D ≤ 8.0 ft (2.5 m)	6 minimum	60 Degrees
8.0 < D ≤	8 minimum	45 Degrees

The concrete in the shaft should normally be allowed at least 1-2 days to cure to hardened concrete prior to testing. If PVC tubes are used, testing should be done within 10 days after the placement of concrete due to possible tube-concrete debonding. If steel tubes are used, the testing can be done within 45 days after concrete placement as the steel tubes bond better than PVC tubes over a longer time.

COLLECTION OF DATA

In a CSL test, the source is lowered to the bottom of one of the tubes and the receiver is lowered to the bottom of another tube. The source and receiver are pulled simultaneously to allow the horizontal ultrasonic pulse velocity to be measured. A depth wheel controls the resolution of the collected data. Typically, the source is excited every 0.2 ft (6 cm) vertically and a measurement is taken. The source and receiver are pulled to the top of each shaft, thus giving a complete assessment of the concrete quality between the two tubes. CSL tests are typically performed between all the perimeter tubes to check the perimeter of the shaft. Additional opposing diagonal CSL tests are also performed to check the integrity of the inner core of the shaft. If there are more than 4 tubes and an anomaly is identified, CSL tests may be performed of subdiagonal tube pairs to further define an anomaly. A pair of tubes can be logged and the results displayed in less than approximately 5 minutes. Olson Engineering uses the Olson Instruments Freedom Data PC with the Crosshole and Singlehole Sonic Logging System (CSL-1 & CSL-2) for collection and analysis of CSL or SSL data.

CSL-1 SYSTEM: Includes components shown above.
CSL-2 SYSTEM: Includes components shown above with an additional hydrophone.