

## Crosshole Sonic Logging (CSL) and Crosshole Tomography (CT)



**Figure 1 – CSL with Freedom PC**

### Introduction

Crosshole Sonic Logging (CSL) is the most accurate and reliable technique for assessing the integrity of deep foundation elements such as newly placed concrete drilled shafts and slurry walls, particularly when drilling below groundwater level. Considering the number of issues which can threaten the integrity of deep foundation elements during construction, it is essential to adopt a high level of quality control and assurance. The CSL testing procedure can detect anomalies inside concrete within just minutes.

Crosshole Tomography (CT) is a higher resolution analysis which is used for further investigations after CSL has detected a flaw. CT delivers unmatched accuracy for defining the size, shape, severity and location of defects. CSL and CT analysis can eliminate the questions and concerns associated with problematic concrete pours.

### The Problem

The number of issues which threaten the integrity of drilled shafts and slurry walls are extensive. Necking and caving in of drilled shafts, reinforcing cage buckling, tremie 'burping' and excess water intrusion can all have serious effects on structural integrity. Being able to perform QA promptly after the concrete pour can save a substantial amount of time and money compared with late detection of flaws. Having the ability to assess the exact scope of defects will ensure efficient remedial measures.

### Applications

CSL and CT can be applied to any structure which supports the transmission of ultrasonic waves. This

includes concrete, slurry and grout placed either above or below the waterline. The tests can be applied to concrete drilled shafts, auger cast piles, slurry walls or any mass concrete pour where QA is a priority.

### Advantages

- Quick and safe – CSL tests performed in less than 5 minutes
- Can perform tests for above and below waterline structures
- Identify and locate the presence of multiple defects
- CT can deliver high-resolution images with unsurpassed accuracy and interpretation simplicity
- Perform QA regarding the presence of poor quality concrete, voids, honeycombing and soil intrusion
- Identify the size, shape, severity, nature and location of anomalies

### How it works

#### 1. Installing Access Tubes

Access tubes must be installed before construction and filled with water. These are typically 38 to 50mm diameter PVC or steel tubes tied to the inside of the rebar cage. The number of tubes required depends on the structure's size and the resolution required.

#### 2. Taking Readings

The source and receiver hydrophones are lowered to the bottom of separate tubes. As the hydrophones are simultaneously lifted, the horizontal ultrasonic pulse velocity is measured. The depth wheel controls the sample reading resolution which is typically taken at 6cm intervals.

#### 3. Interpreting Results

Uniform, good quality concrete will promote propagation of ultrasonic waves. Longer ultrasonic wave travel times and lower amplitudes correspond to poor quality or voided concrete. A complete loss in signal means a substantial void is hindering the transfer of the signal between the hydrophones. Refer to Figure 3 for an example results readout.

#### 4. Further Investigation

If multiple access tubes are installed, then the perimeter pairs and sub-diagonal tube pairs can be



**Melbourne Office**  
 Niddrie  
 (03) 9938 3830  
[r.barnes@pcte.com.au](mailto:r.barnes@pcte.com.au)

**Perth Office**  
 Nowergup  
 (08) 9407 5363

**Website**  
[www.pcte.com.au](http://www.pcte.com.au)

**Sydney Office**  
 Brookvale  
 (02) 9939 7177

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used to further define the 2D image of any anomalies. In addition CT uses differential height measurements to deliver a complete 3D internal image of the structure (see Figure 4).

### Platform

CSL and CT require the Freedom Data PC as shown on the previous page in Figure 1. It allows for mobility and onsite analysis. Please see the Freedom Data PC brochure for more in depth specifications on this platform. Other equipment supplied includes the hydrophones and depth wheel.

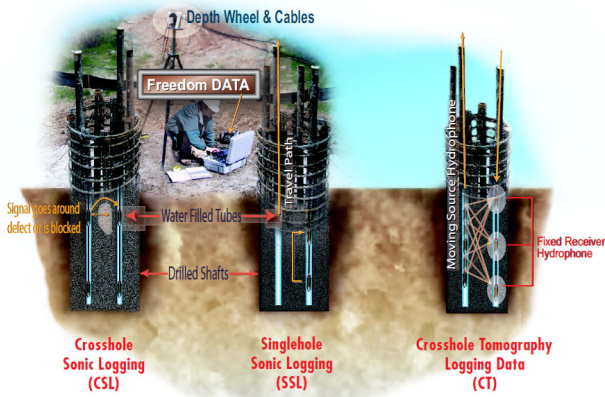


Figure 3 – CSL, SSL and CT

### Relevant Standards

- ASTM D6760-02
- ACI 228.2R
- FLH 521.830

### Versatility

By utilising the same set of water-filled access tubes, both CSL and CT can give invaluable information regarding the quality of concrete between these tubes. Singlehole Sonic Logging (SSL) as presented in Figure 2 provides additional information regarding concrete quality around the

vicinity of an individual tube. This allows QA analysis beyond the perimeter of the rebar cage giving a complete cross-sectional analysis.

### About PCTE

PCTE have over 30 years experience in the measurement and testing of concrete. With experience in research, consulting and construction they are able to assist you in reviewing issues and developing solutions. PCTE can provide more than just the equipment. They can provide leading technical support for your business.

### Other Equipment

The full Olson Instrument range includes the NDE360, CTG, Freedom Data PC and DAS as well as the resonance tester. The full Proceq range of equipment is available for insitu non-destructive concrete measurement, including Schmidt Hammers, Covermeters, Half Potentials, Resistivity and Permeability. We also supply Intelli-Rock maturity, temp and humidity logging systems, corrosion rate monitoring equipment and Ground Penetrating Radar.

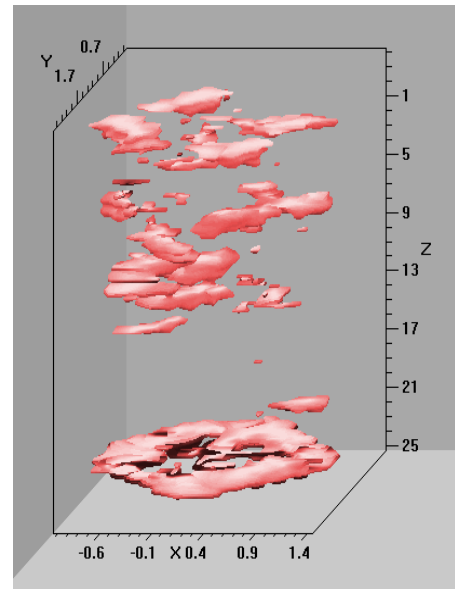


Figure 4 – Tomographic image of defects using CT

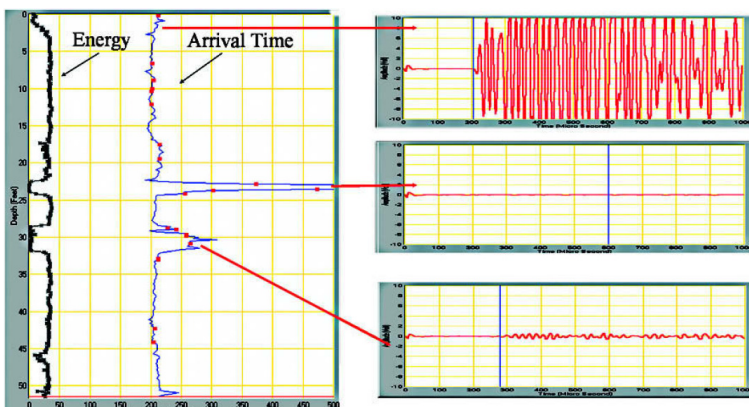


Figure 3 – Data Readout

Strong response = Good quality concrete

Complete signal loss = Significant void

Delayed, reduced signal = Poor quality concrete