



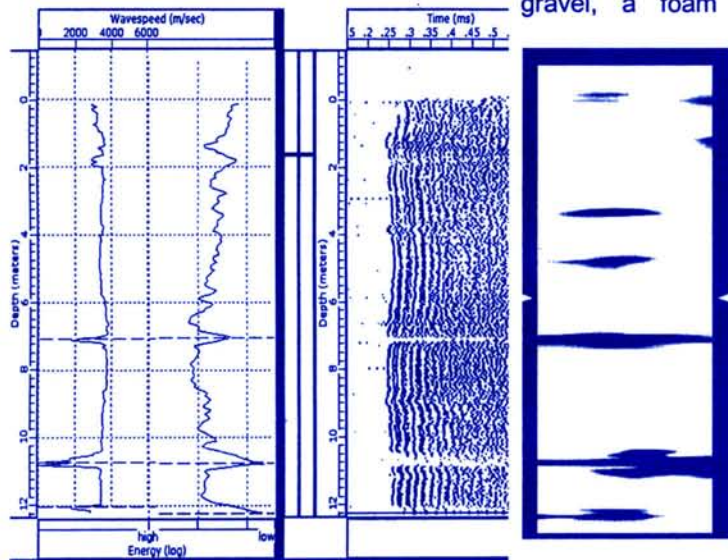
### Test Shaft Installation for CSL by Brent Robinson, GRL Engineers, Inc.



On March 3, 2003 (a cold, breezy day this winter at 10°F), McKinney Drilling Company installed the 40 foot long, 60 inch diameter shaft at Pile Dynamics' yard for PDI's research and training purposes. Four concrete mix designs were used (in 10 foot lifts) to evaluate ultrasonic signals in different mixes including nominal strengths of 3000, 4000 and 6000 psi and a self-consolidating concrete, or SCC, designed by Master Builders, Inc.

The shaft has planned defects. Eight CSL access tubes were attached to a full length reinforcing cage to allow cross hole sonic logging (CSL) using PDI's Cross-Hole Analyzer™ (CHA). Various manufactured defects were suspended on the cage.

The defects included buckets and cones filled with sand or gravel, a foam



Processed arrival and energy (left) and raw "waterfall" data (center)

2-D image

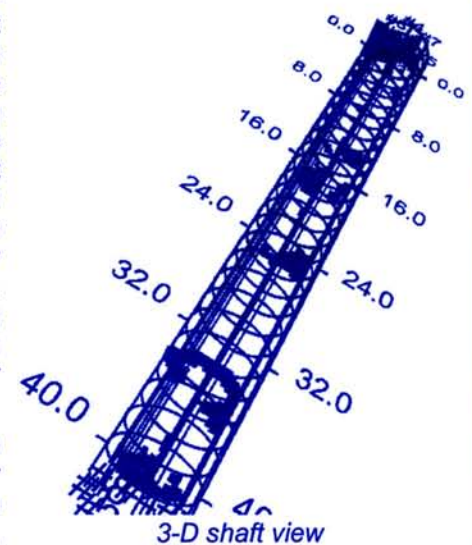
plate covering half the shaft diameter, and various localized defects around some tubes or outside the cage. Sand at the shaft bottom simulates a "soft bottom". Defects were chosen to investigate defect size and position that could be detected by non-destructive testing methods.

To avoid damaging the carefully placed defects, the concrete was installed using a pump truck. During pumping, PDI engineers monitored the concrete volume versus depth with magnetic flow meters typically used to record grout volume in augercast piles with a Pile Installation Recorder (PIR-A). EDP Consultants measured slump, entrained air, and concrete temperature and broke concrete cylinders for each 10 ft concrete layer at 7, 28 and 56 days.

Immediately after installation, the tubes were filled with water and anti-freeze. Soon afterward, testing with the CHA began. After taking limited data on the day of installation, cross hole data was taken twice a day for the first week. CHA and Pile Integrity Tester (PIT) tests continued daily for the next two weeks. Testing activities still continue at this time.

The testing has revealed interesting results about detecting various defects, as well as changes with wave speed and CSL data quality with time. A sample of CHA processing for one tube pair (at 3 days curing time) is shown at the lower left of this page with processed arrival time and energy, and the raw data "waterfall". The CHA's exclusive "Defect Analysis" found three major defects at the dashed line depths on the processed results plot in this particular scan.

Cross hole tomography, created using our TomoSonic software, shows both 2-D and 3-D images of the shaft. The black and white image to the right of the waterfall diagram is a 2-D slice of a 3-D analysis. It shows black holes (defects) in the shaft which corresponds to the planned defect locations. The 3-D image shows defects spatially along the shaft. The illustration would be even clearer had a color printer been used.



3-D shaft view

If you want to try out the CHA or PIT for yourself on our test shaft, contact Steve DeWitt or John Wargelin at PDI. Keep in mind, however, that Cleveland is warmest from May to October and, at least this year, feels coldest in March.