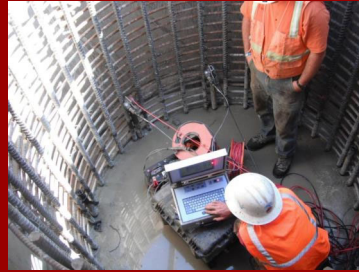


# Acceptance Testing

## Lesson 7



### Learning Objectives

- Discuss when the contractor may proceed with subsequent shaft construction (after completing the first shaft)
- Identify and describe nondestructive (Crosshole Sonic Log) and destructive (core drilling) integrity tests
- Discuss Shaft Repair Plans
- Discuss the Drilled Shaft Inspection Report
- Measurement and payment



## ODOT Standard Specifications 00512.49 Scheduling and Restrictions

Unless otherwise approved, do not proceed with construction of subsequent shafts until the CSL testing has been completed on the first drilled shaft and the results have been approved and accepted, in writing by the Engineer.



## ODOT Standard Specifications 00512.49 Scheduling and Restrictions

Approval to proceed with the construction of subsequent shafts, before receiving approval of the first shaft will be based on the Engineer's observations of the Contractor's workmanship during construction of the first shaft and the Engineer's review and assessment of the following:

- The Contractor's conformance with the approved shaft installation plan.
- The Contractor's daily reports and Inspector's daily logs of excavation, rebar, and concrete placement.
- The concrete placement logs and volume curves.



## **ODOT Standard Specifications 00512.49 Scheduling and Restrictions**

- Written notification will be provided to the Contractor on whether or not to proceed with subsequent shaft construction within 24 hours after completion of the first shaft.
- If the Engineer determines the first shaft to be of questionable quality, discontinue all shaft construction until the CSL test results of the first shaft are received and reviewed and the shaft accepted, in writing, by the Engineer.



## **ODOT Standard Specifications 00512.49 Scheduling and Restrictions**

- Do not proceed with the third drilled shaft until the final CSL test results from the first drilled shaft has been received and reviewed and the shaft accepted, in writing, by the Engineer.
- After the first drilled shaft on the Project has been accepted, make no significant changes in construction methods, equipment, or materials used to construct subsequent shafts, unless otherwise approved.



## Learning Objective

**Describe when the contractor may proceed with subsequent shaft construction**

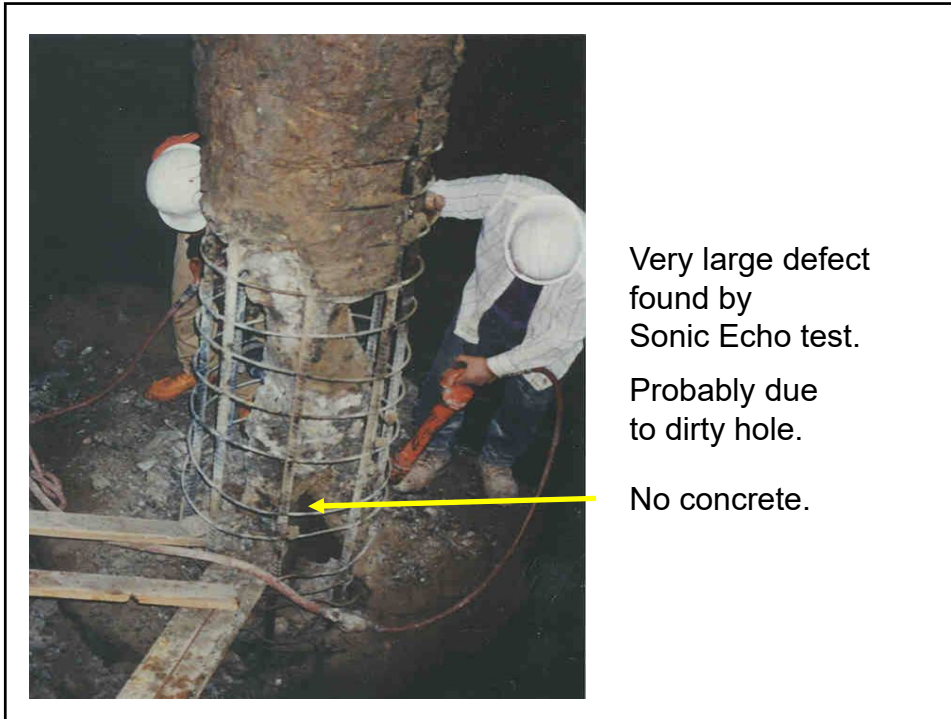
- No problems with the first shaft
- After review of:
  - The Contractor's conformance with the approved shaft installation plan.
  - The Contractor's daily reports and Inspector's daily logs of excavation, rebar, and concrete placement.
  - The concrete placement logs and volume curves.



## Potential Problems with Constructed Shafts

- Folded-in debris in concrete – excessive sand being carried by the slurry and sedimentation of cuttings from the slurry column.
- Soft shaft bottom – incomplete bottom cleaning.
- Caving of the sidewalls.
- Temporary casing that cannot be removed – In some cases, the crane or other equipment handling the casing doesn't have the power to pull the casing out.
- Horizontal separation or severe necking – This can occur if the concrete sets too early and temporary casing has concrete adhering to it when pulled.





### Post Construction Testing

- **Load Tests**  
To determine if the shaft, as constructed, will carry the required design loads.
- **Integrity Tests**  
To evaluate the soundness or “structural integrity” of the constructed shaft.



## Load Tests

Typically there are three types of load tests conducted on drilled shafts:

- Axial (downward) ASTM D 1143
- Lateral (sideways) ASTM D 3966
- Uplift (upwards) ASTM 3689

**These tests are usually done under a separate contract prior to the main bridge construction contract so the information obtained can be used in design.**



## Integrity Tests

- The purpose of post-construction integrity testing is quality assurance of concrete placement.
- Most tests used for this purpose have no permanent effect on a drilled shaft and are therefore referred to as “non-destructive tests”, or NDT.
- NDT results are used in “nondestructive evaluation”, or NDE, in combination with construction observations, inspection records and other quality control assurance measures to assess shaft acceptance.
- NDE provides a tool for ensuring the as-built foundation satisfies the construction specifications and will perform as assumed in the design.



## Integrity Tests Types

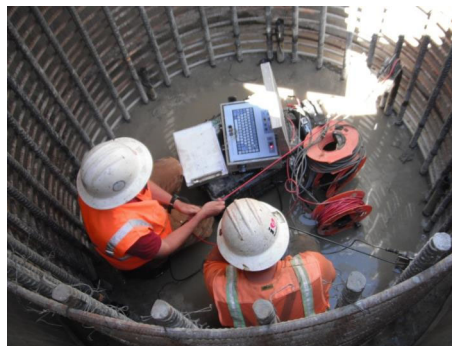
- Crosshole Sonic Log (CSL)
  - Currently the only test that is done by ODOT
  
- Other Tests in the industry
  - Sonic echo / impulse-response
  - Gamma-gamma
  - Thermal integrity

*Tests are run by trained and experienced personnel, using specialized equipment and software.*



## Crosshole Sonic Log (CSL) Test

- Primary integrity test method used in ODOT
- Conducted according to ASTM D6760
- Required on all drilled shaft jobs
- Contractor typically supplies personnel to perform the testing



### Crosshole Sonic Log (CSL) Test

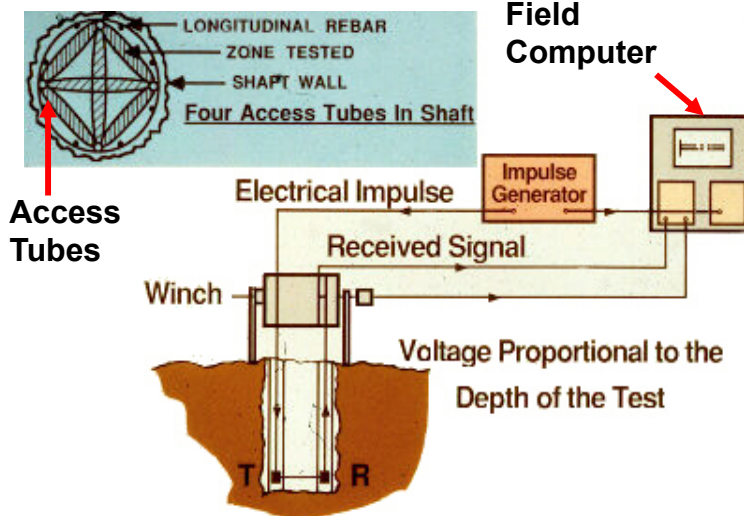
- Check that CSL tubes were installed as per the plans and filled with water and capped within 1 hour after the concrete pour is completed.
- Before testing, check to see that the water level in the tubes has not dropped.



CSL Tubes, straight and parallel



### Crosshole Sonic Logging









### Crosshole Sonic Log (CSL) Test

- CSL testing is not always a conclusive test and the results often require interpretation and further in-depth review by the geotechnical and structure engineers.
- The results can sometimes be misleading.
- The CSL test results are used along with the concrete volume graphs, excavation logs and other shaft construction records to determine shaft acceptance.



## Crosshole Sonic Log (CSL) Test

Procedures to use when conducting CSL testing for quality control of drilled shafts on ODOT projects.

- Contractor provides the CSL subcontractor to do the testing (00512). This is included in the contract with a bid item for the number of CSL tests per shaft.
- CSL testing performed according to ASTM D6760-02
- CSL testing is performed on the first shaft constructed and others as described in the Special Provisions.
- Additional shafts are tested if construction methods change or shaft construction results in questionable quality shafts. This is especially true for uncased shafts, excavated below the water level in soils.

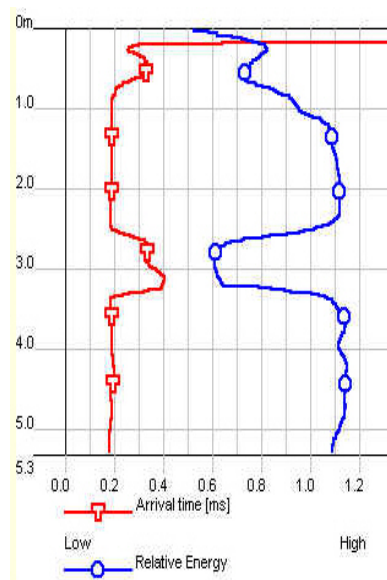


## Crosshole Sonic Log (CSL) Test Reports

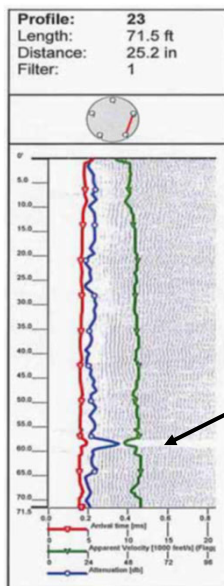
- Submit three copies of a final CSL Test Report for each shaft tested.
- Submit all reports to the Engineer within five calendar days of the performance of the tests.
- Provide electronic file copies of the raw CSL data measurements, if requested.



### Crosshole Sonic Log Test Results



### Crosshole Sonic Log Test Results



#### Sample CSL Profile

- Profile name designated by the tube number in each pair, tubes are numbered clockwise from the top
- Depth is from the top of concrete
- Distance is distance between tubes

Anomaly (possible defect) at 59 feet

- Increase in arrival time (red)
- Decrease in velocity (green)
- Reduced energy blocks out stacked wave form plot

## Integrity Test Results

“**Anomalies**” – unusual patterns, voids or soft spots in the concrete.

Anomalies may be structural defects that require repair if they are confirmed with other supporting data (including inspection records and documentation) and after evaluation by the Engineer of Record.



## Integrity Test Results

If an anomaly is detected, the Engineer will determine course of action which may include:

- Additional CSL testing or tomography
- Excavation around shaft to expose defect
- Core drilling
- Down-hole cameras



*Whatever the course of action is, the Engineer will want to review all of the shaft construction records to try and determine what caused the problem.*



### Concrete Coring

- Number of holes, locations and depths determined by Engineer
- Log the boring like a regular borehole
- Take photos
- Record any driller comments on concrete quality

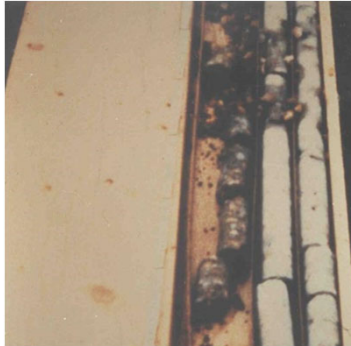


### Concrete Coring



## Concrete Coring

- Coring is not always definitive in ruling out defects.
- Defects can be missed by the coring tool.



**Not Good**



**Acceptable**



## Shaft Repairs

### Possible Solutions:

- Excavate upper portion of shaft and repair defect area.
- Clean out defect area with high pressure water jets and fill with non-shrink grout.
- Replace Shaft
- Add additional piling or other deep foundation elements around perimeter of shaft.



## Shaft Repairs

### Section 512.48(d) “Drilled Shaft Repair” and Section 512.40(b) “Drilled Shaft Repair Plans”

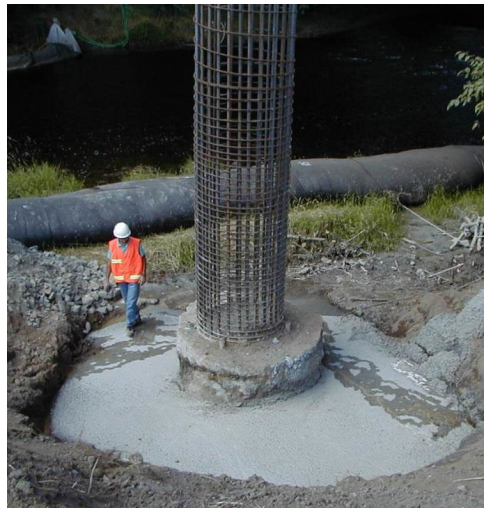
- Repair plan submitted by Contractor and approved by the Engineer
- Do not begin repair operations before remedial procedures or designs are approved.



## Shaft Repairs



*Excavate upper portion of shaft and repair defect area.*







**Question 07-1**

After installing the rebar cage and after the concrete is placed and prior to testing, the CSL tubes are filled with:

- A. Concrete
- B. Air
- C. Water
- D. Grout

### Question 07-2

How soon do CSL Tubes have to be filled with water?

- A. As soon as possible
- B. Directly after installing
- C. Not more than one hour after concrete is placed
- D. A & C



### Drilled Shaft Inspection Report

- Required to be filled out by the Contractor (512.40c)
- Available on ODOT Construction Section Web Page (Form 734-2598 )
- Submit the report within 21 calendar days after the completion and acceptance of each shaft



## Drilled Shaft Tolerance Criteria

- Horizontal Position  
(at the Plan Elevation of the Top of Shaft)
- Top Elevation of Shaft Concrete
- Vertical Alignment in Soil
- Vertical Alignment in Rock
- Top Elevation of Steel Reinforcement



## ODOT Drilled Shaft Inspection Checklist

Reinforcing Cage (Construction & Placement)	
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 25. Is the rebar the proper grade steel, correct size and correct configurations as shown in the project plans and shop drawings?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 26. Is the rebar properly tied in accordance with Section 05530.41(B)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 27. Are the proper number of Crosshole Sonic Log (CSL) tubes furnished and installed according to the project plans?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 28. Does the Contractor have the proper number and type of spacers for the steel cage in accordance with the approved Drilled Shaft Installation Plan and Section 05512.45(B)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 29. If the steel cage was spliced, was it done in accordance with the details shown on the contract plans?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 30. Is the steel cage adequately secured to maintain vertical tolerance during concrete placement operations (05512.45(A) and 05512.47(B))?
Concrete Operations	
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 31. Prior to concrete placement, has the slurry (both manufactured and natural) been tested in accordance with Section 05512.43(B)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 32. If required, was the casing removed in accordance with Section 05512.47(a)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 33. Does the Contractor's tremie meet the requirements of Section 05512.47(a)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 34. Was the discharge end of the tremie maintained in the concrete mass with proper concrete head above it at all times (05512.47(a))?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 35. For shafts with non-contact splices, have the cold joints been properly cleaned and roughened in accordance with Section 05512.47(a)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 36. For shafts without non-contact splices, did the Contractor overfill the shaft until good concrete flowed out of the top of the excavation (05512.47(a))?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 37. Were the Concrete Placement and Concrete Volume logs completed?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 38. Were the concrete acceptance tests performed as required?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 39. Were the Crosshole Sonic Log (CSL) Tubes filled with water and capped in accordance with Section 05512.46?
Post Installation	
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 40. Is all casing removed to the proper elevations in accordance with 05512.47(a)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 41. Is the concrete being cured in accordance with Section 05540.51?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 42. Has all Crosshole Sonic Log (CSL) Tiewing been completed in accordance with Section 05512.48?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 43. Is the shaft within the allowable construction tolerance (05512.42)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 44. Has the Contractor completed the Drilled Shaft Inspection Report (05512.45(C))?
<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> NA 45. Has the Inspector completed the Drilled Shaft Inspection Report (05512.45(C))?
NOTES / COMMENTS	



**Measurement**

**Standard Specifications**

**00512.80 Measurement**

- (f) Crosshole Sonic Log Test Access Tubes  
 CSL access tubes will be measured on the length basis of the number of tubes installed in the shafts. Grout used to fill the access tubes after the completion of CSL testing will not be measured
  
- (g) Crosshole Sonic Log Tests  
 CSL tests will be measured on the unit basis for each CSL test completed, reported, and accepted. No separate measurement will be made for CSL tests performed at the Contractor's option.



**Payment**

**Standard Specifications**

**00512.90 Payment**

The payment specifications address what the pay items are, the unit of measurement, and defines what work is included with each pay item.

<b>Pay Item</b>	<b>Unit of Measurement</b>
(f) CSL Test Access Tubes	Foot
(g) CSL Tests	Each

- Item (f) includes filling the tubes with grout after completion of CSL testing.
  
- Item (g) includes mobilization of all CSL testing equipment and personnel to and from the site, all CSL testing, interpretation, analysis, electronic data, and final report for each tested and accepted shaft.

