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.

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.
Very large defect found by Sonic Echo test.
Probably due to dirty hole.
No concrete.

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

Field Computer

Access Tubes

Electrical Impulse

Impulse Generator

Received Signal

Voltage Proportional to the Depth of the Test

Winch

Four Access Tubes In Shaft

LONGITUDINAL REBAR
ZONE TESTED
SHAPED WALL
Drilled Shaft Construction Inspector Training

Acceptance Testing
Performing the CSL Test

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

Anomaly (possible defect) at 59 feet
- Increase in arrival time (red)
- Decrease in velocity (green)
- Reduced energy blocks out stacked wave form plot

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
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

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

<table>
<thead>
<tr>
<th>Not Good</th>
<th>Acceptable</th>
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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 Caps (Construction & Placement):
- Check that the reinforcing caps are in place and not obstructed.
- Ensure that all caps are securely fastened in accordance with the approved plan.
- Confirm that all caps are properly aligned with the shaft alignment.
- Verify that the caps are properly filled with concrete or other material.

Concrete Operations:
- Check that the concrete is placed and compacted in accordance with ODOT specifications.
- Ensure that all forms are removed after the concrete has hardened.
- Confirm that the concrete is cured and meets the strength requirements.

Post Installation:
- Verify that all post-installation procedures have been completed as per ODOT guidelines.
- Ensure that all stress-relieving forms are removed.
- Confirm that all post-installation tests have been performed and recorded.

Acceptance Testing
**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.

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**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.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Unit of Measurement</th>
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<tbody>
<tr>
<td>(f) CSL Test Access Tubes</td>
<td>Foot</td>
</tr>
<tr>
<td>(g) CSL Tests</td>
<td>Each</td>
</tr>
</tbody>
</table>

- 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.