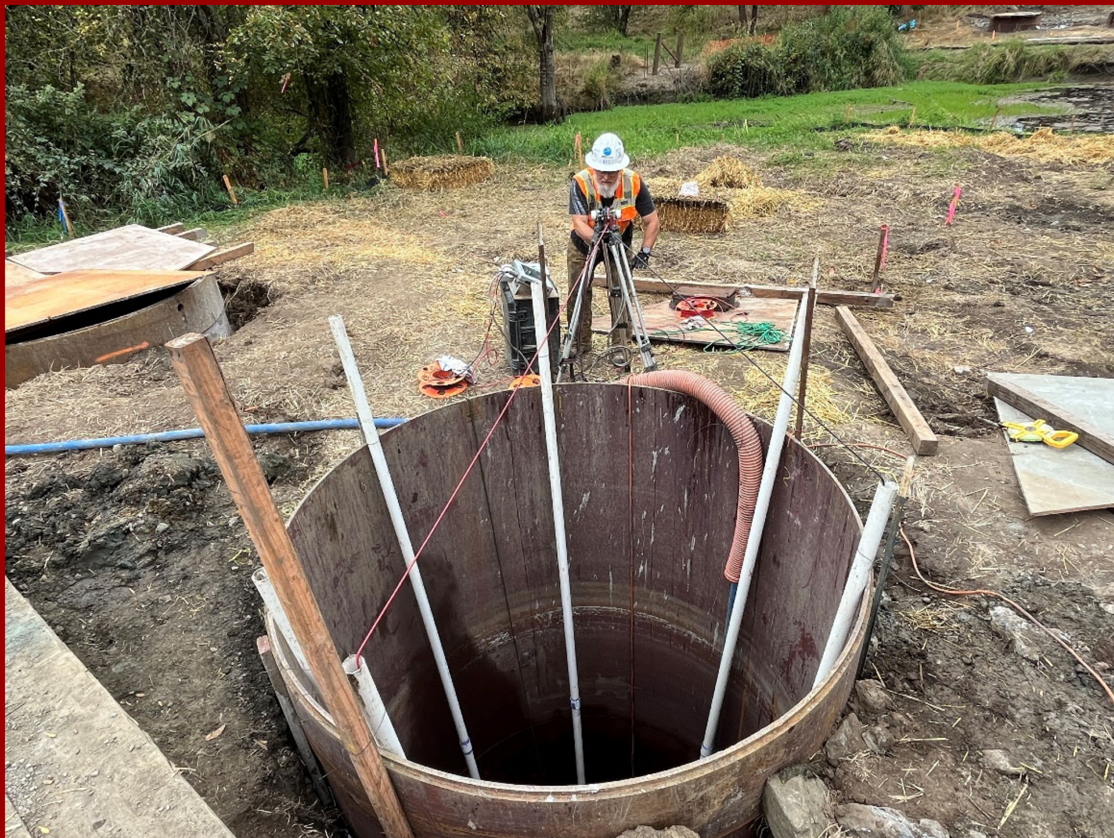

ODOT MATERIALS & INSPECTION

Drilled Shaft Inspector Training Manual

2023-2024

Drilled Shaft Construction Inspector

2023-24

Drilled Shaft Construction Inspector

2023-24

Drilled Shaft Construction Inspector

2023-24

Drilled Shaft Construction Inspector

2023-24

Drilled Shaft Construction Inspector

2023-24

INSERT TAB

Overview

1

Welcome and Introductions

- **James Gunter**
  ODOT Construction Quality Assurance Specialist
- **Rory "Tony" Robinson, B.S., M.S., Ph.D., P.E., G.E.**
  ODOT R2 Senior Geotechnical Design Engineer
- **Brian J. Cook, B.S., M.Eng., P.E.**
  ODOT R2 Geotechnical Design Engineer

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2

Housekeeping Items

- Restrooms
- Scheduled breaks
- Refreshments provided
- Lunch is on your own
- Turn cell phone ringers off
- Construction Training Hotline
  (503) 986-4336

ODOT MATERIALS & INSPECTION

3

Drilled Shafts Overview

Drilled Shaft Inspector Certification

ODOT MATERIALS & INSPECTION

4

Drilled Shaft Overview

Click on video to start

5

Inspection Certification Program

Who is required to be certified?

- All ODOT Inspectors
- Program makes allowances for non-certified personnel

6

Inspection Certification Program

Certification Process:

- Training available (but not required)
- Must pass an examination

- Link to ODOT Quality Assurance Program

https://www.oregon.gov/odot/Construction/Pages/Drilled-Shaft-Cert.aspx

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7

Getting to Know You

Where do you work?

1. Local Agency
2. Private Consultant
3. ODOT
4. Other

How many drilled shaft projects have you worked on?

1. 0
2. 1-5
3. 6-12
4. Too many to count

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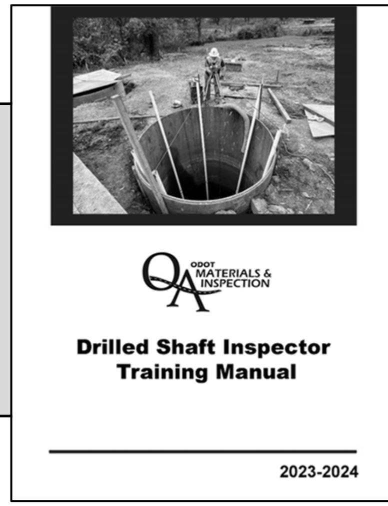
8

Training Documents



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Resources Used during Training

- 2021 Standard Specifications (Student)
- Calculator (Student)
- Drilled Shaft Inspector Training Manual (Student)
- 8.5 x 11 Resource Manual (Classroom)
- 11 x 17 Resource Manual (Classroom)

ODOT MATERIALS & INSPECTION

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8.5 x 11 Resource Manual (Classroom)

- Geotechnical Design Report
- Boring Logs
- Special Provision
- Installation Plan
- MFTP
- NTMAG
- QPL

ODOT MATERIALS & INSPECTION

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11 x 17 Resource Manual (Classroom)

- Project Plans
- Shop Drawings
- Geotechnical Design Report (Site Plan)
- Analysis Results

ODOT MATERIALS & INSPECTION

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Training Objectives

- Define inspectors' roles, responsibilities and authority.
- Identify contract documents and resources, learn how to use them.
- Overview of the Drilled Shaft Specification 00512
- Provide an overview of key inspection elements and materials.

ODOT MATERIALS & INSPECTION QA

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Drilled Shafts: Class Topics - Overview

- Welcome / Overview
- Design Elements
- Preconstruction
- Equipment
- Drilled Shaft Excavation
- Reinforcement
- Concrete Operations
- Post Installation Acceptance
- Work Safety
- Exam

ODOT MATERIALS & INSPECTION QA

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Certification Exam

- Exam on Thursday
- Open book
- Maximum 3 hours
- 80% passing
  Results in ~2 weeks
- Certification is good for 5 years

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Drilled Shafts

Roles and Responsibilities

16

Control of Work

State Engineer	Full authority over work
Resident Engineer (RE)	Authority to enforce the provisions of the Contract
Inspector	Authorized by RE to inspect, reject and temporarily suspend the work
Professional of Record (POR)	Responsible for project design and any design elements requiring modification

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The Inspector's Role, Duties & Responsibilities

Keep the POR and RE Informed

Notify the POR and/or RE soon enough to make a difference.

This reduces the impact to the project schedule, cost or quality.

18

When to Contact the Professional of Record

- If interpretation of specifications is required
- If work is performed outside of the plans or specifications
- Work or items requiring approval

ODOT MATERIALS & INSPECTION

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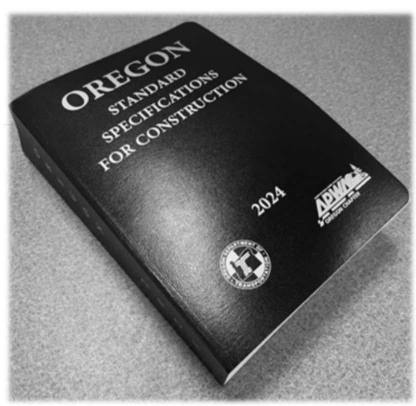
The Inspector's Role, Duties & Responsibilities

00150.20 – Inspection

- Right to inspect
- Facilities and access
- Acceptability of materials and work

Know the Standard Specifications



ODOT MATERIALS & INSPECTION

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00150.10(a) – Order of Precedence

1. Contract Change Orders
2. Special Provisions
3. Project Plans
4. Reviewed Stamped Working Drawings
5. 3D Engineered Models
6. Standard Drawings
7. Approved Unstamped Working Drawings
8. Supplemental Specifications
9. Standard Specifications
10. All other contract documents not listed above.

ODOT MATERIALS & INSPECTION

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The Inspector's Role, Duties & Responsibilities

Know the Specifications


CONTRACT AND BONDS
FOR HIGHWAY CONSTRUCTION

OREGON DEPARTMENT OF TRANSPORTATION
SALEM, OREGON

GRADING, DRAINAGE, STRUCTURES, PAVING, SIGNING, ILLUMINATION, SIGNALS, ROADSIDE DEVELOPMENT & INTELLIGENT TRANSPORTATION SYSTEM

OR217: OR10 – OR99W SEC.

BEAVERTON – TIGARD HIGHWAY

WASHINGTON COUNTY

CONTRACT NUMBER 15298

EXPENDITURE ACCOUNT NUMBER CON04430

CLASS OF PROJECT S144(026)

CONTRACTOR KERR CONTRACTORS OREGON LLC

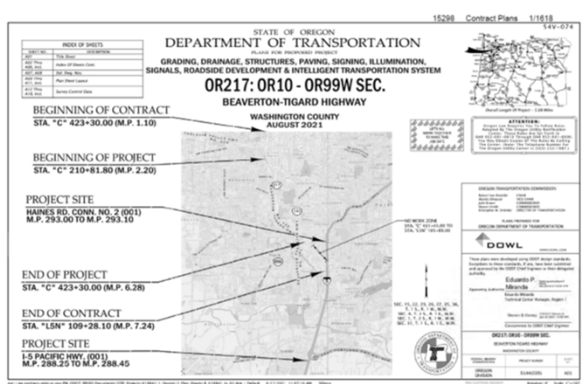
DATE OF AWARD

SPECIFIED COMPLETION SEE SUBSECTION 00180.50(h)

Key # 18841

Bid Date 08-26-21
Ad Date 07-08-21

Know the Plans



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Layout of the Drilled Shaft Specification 00512

- 00512.01 Definitions
- 00512.02 Subsurface Investigation
- 00512.10 Materials
- 00512.13 Steel Casing
- 00512.14 Drilling Slurry
  - (a) Mineral
  - (b) Synthetic
  - (c) Water
- 00512.15 Crosshole Sonic Log (CSL) Access Tubes
- 00512.30 Personnel Qualifications

ODOT MATERIALS & INSPECTION

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Layout of the Drilled Shaft Specification 00512

- 00512.40 Submittals
  - (a) Drilled Shaft Installation Plan
  - (c) Drilled Shaft Inspection Reports
  - (d) Concrete Placement Logs and Volume Curves
- 00512.41 Drilled Shaft Coordination Meeting
- 00512.42 Construction Tolerances
- 00512.43 Drilled Shaft Excavation
  - (c) Temporary Casing
  - (d) Unexpected Drilled Shaft Obstructions
  - (e) Lost Tools
  - (g) Drilling Slurry Inspection and Testing
  - (h) Clean Out

ODOT MATERIALS & INSPECTION

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Layout of the Drilled Shaft Specification 00512

- 00512.45 Reinforcing Steel
  - (a) Placement
  - (b) Bracing
  - (c) Splicing
  - (d) Concrete Cover
- 00512.46 Crosshole Sonic Log (CSL) Test Access Tubes
- 00512.47 Concrete
- 00512.48 Drilled Shaft Testing and Acceptance
- 00512.49 Scheduling and Restrictions
- 00512.80 Measurement
- 00512.90 Payment

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Forms

Description	Form No.	Eff. Date
Drilled Shaft Inspector's Checklist	734-2625	Feb. 2016
Drilled Shaft Excavation Log	734-2604	Nov. 2020
Drilled Shaft Concrete Placement Log	734-2597	Nov. 2020
Drilled Shaft Concrete Volumes	734-2603	Nov. 2020
Drilled Shaft Inspection Report	734-2598	Nov. 2020
Certificate of Materials Origin (CMO)	734-2126	Nov. 2020
General Daily Progress Report	734-3474	July 2019

Shaded forms are contractor responsibility.

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Checklist

- ODOT Form 734-2625
- Available on ODOT Construction Web page under Construction Forms:

https://www.oregon.gov/ODOT/Forms/2ODOT/7342625.pdf

***Included in Drilled Shaft Inspector Training Notebook* – Appendix B**

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Checklist

Pre-Construction

Oregon Department of Transportation

Print Form

Drilled Shaft Inspector's Checklist

The following is a general checklist to follow when constructing a drilled shaft. The answer to each of these questions should be "Yes" or "NA" unless plans, specifications or specific approval has been given otherwise. Any answer of "No" should be explained in the Notes/Comments.
CONSULT WITH PROJECT MANAGER FOR YOUR SPECIFIC PROJECT RESPONSIBILITIES.

Pre-Construction

☐ Yes ☐ No ☐ NA 1. Has the Drilled Shaft Installation Plan been submitted and approved (00512.40)?

☐ Yes ☐ No ☐ NA 2. Has a list of project personnel been submitted and approved (00512.30)?

☐ Yes ☐ No ☐ NA 3. Have the Contractor's quality control technicians been submitted and verified?

☐ Yes ☐ No ☐ NA 4. Does the Contractor have an approved concrete mix design according to 02001.35? The Inspector should have a copy on the project site.

☐ Yes ☐ No ☐ NA 5. Has the Contractor run the required plastic concrete tests (slump loss tests) for their concrete mix design (02001.35(h))?

☐ Yes ☐ No ☐ NA 6. If the Contractor proposed a polymer slurry, do you have a copy of the quality control plan for the slurry (00512.40 and 00512.43(f)) and the name and phone number of the slurry manufacturer's representative who will be providing technical assistance?

☐ Yes ☐ No ☐ NA 7. If the Contractor plans to use a manufactured slurry, do they have the proper equipment to mix it?

☐ Yes ☐ No ☐ NA 8. Have you reviewed the Foundation Data sheet and drill logs and understand the subsurface conditions?

☐ Yes ☐ No ☐ NA 9. Has the Contractor addressed the Protection of Existing Structures (00512.40)?

☐ Yes ☐ No ☐ NA 10. Does the Contractor have all the equipment and tools shown in the Drilled Shaft Installation Plan (00512.40)?

☐ Yes ☐ No ☐ NA 11. If permanent casing is required, is it the right size and material in accordance with the plans and Section 00512.13?

☐ Yes ☐ No ☐ NA 12. If temporary casing is to be used, is it in accordance with the Drilled Shaft Installation Plan (00512.40)?

☐ Yes ☐ No ☐ NA 13. If there are contaminated media (materials), hazardous materials, or contaminated groundwater present, are they being treated in accordance with 00290 and 00294?

☐ Yes ☐ No ☐ NA 14. Do you have all the required drilled shaft forms that need to be filled out during shaft construction?
a. Drilled Shaft Excavation Log (form 734-2604)
b. Drilled Shaft Concrete Volume Log (form 734-2603)
c. Drilled Shaft Concrete Placement Log (form 734-2597)
d. Drilled Shaft Inspection Report (form 734-2598)

☐ Yes ☐ No ☐ NA 15. Has the drilled shaft coordination meeting been held (Section 00512.41)?

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Checklist

Excavation

Shaft Excavation & Cleaning

☐ Yes ☐ No ☐ NA 16. Have the locations for the drilled shafts been accurately located and marked, and both the Contractor and Inspector understand the survey markings?

☐ Yes ☐ No ☐ NA 17. Is the shaft being constructed in the correct location and vertical alignment according to tolerances in Section (00512.42)?

☐ Yes ☐ No ☐ NA 18. Is the slurry level being properly maintained in accordance with 00512.43(f)?

☐ Yes ☐ No ☐ NA 19. Are the proper number and types of tests being performed on the slurry and reported in accordance with 00512.43(g)?

☐ Yes ☐ No ☐ NA 20. Are all excavated materials (spoils) properly contained and disposed of in accordance with 00512.43(a)?

☐ Yes ☐ No ☐ NA 21. If temporary casing is being used, does it meet the requirements of Section 00512.43(c)?

☐ Yes ☐ No ☐ NA 22. Is the shaft of proper depth?

☐ Yes ☐ No ☐ NA 23. Does the shaft bottom meet the clean-out requirements of Section 00512.43(h)?

☐ Yes ☐ No ☐ NA 24. Have the drilled shaft excavation forms been completed?

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Checklist

Post-Excavation – Steel Placement

Reinforcing Cage (Construction & Placement)

☐ Yes ☐ No ☐ NA 25. Is the rebar the proper grade steel, correct sizes and correct configurations as shown in the project plans and shop drawings?

☐ Yes ☐ No ☐ NA 26. Is the rebar properly tied in accordance with Section 00530.41(b)?

☐ Yes ☐ No ☐ NA 27. Are the proper number of Crosshole Sonic Log (CSL) tubes furnished and installed according to the project plans?

☐ Yes ☐ No ☐ 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 00512.45(d)?

☐ Yes ☐ No ☐ NA 29. If the steel cage was spliced, was it done in accordance with the details shown on the contract plans?

☐ Yes ☐ No ☐ NA 30. Is the steel cage adequately secured to maintain vertical tolerance during concrete placement operations (00512.45(a) and 00512.47(e))?

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Checklist

Concrete Placement

Concrete Operations

☐ Yes ☐ No ☐ NA 31. Prior to concrete placement, has the slurry (both manufactured and natural) been tested in accordance with Section 00512.43(g)??

☐ Yes ☐ No ☐ NA 32. If required, was the casing removed in accordance with Section 00512.47(e)?

☐ Yes ☐ No ☐ NA 33. Does the Contractor's tremie meet the requirements of Section 00512.47(a)?

☐ Yes ☐ No ☐ NA 34. Was the discharge end of the tremie maintained in the concrete mass with proper concrete head above it at all times (00512.47(c))?

☐ Yes ☐ No ☐ NA 35. For shafts with non-contact splices, have the cold joints been properly cleaned and roughened in accordance with Section 00512.47(a)?

☐ Yes ☐ No ☐ NA 36. For shafts without non-contact splices, did the Contractor overflow the shaft until good concrete flowed out of the top of the excavation (00512.47(a))?

☐ Yes ☐ No ☐ NA 37. Have the Concrete Placement and Concrete Volume logs been completed?

☐ Yes ☐ No ☐ NA 38. Were the concrete acceptance tests performed as required?

☐ Yes ☐ No ☐ NA 39. Were the Crosshole Sonic Log (CSL) tubes filled with water and capped in accordance to Section 00512.46?

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ODOT Drilled Shaft Inspection Checklist

Pile Acceptance

Post Installation

☐ Yes ☐ No ☐ NA 40. Is all casing removed to the proper elevations in accordance with 00512.47(e)?

☐ Yes ☐ No ☐ NA 41. Is the concrete being cured in accordance with Section 00540.51?

☐ Yes ☐ No ☐ NA 42. Has all Crosshole Sonic Log (CSL) Testing been completed in accordance with Section 00512.48?

☐ Yes ☐ No ☐ NA 43. Is the shaft within the allowable construction tolerances (00512.42)?

☐ Yes ☐ No ☐ NA 44. Has the Contractor completed the Drilled Shaft Inspection Report (00512.40(c))?

☐ Yes ☐ No ☐ NA 45. Has the Inspector completed the Drilled Shaft Inspection Report (00512.40(c))?

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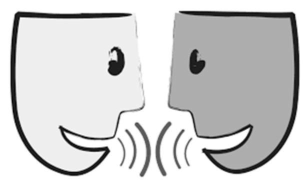
Coordination and Communication

- Remember that you are part of a team with the goal of constructing the drilled shaft.
- If you observe potential issues of non-conformance, immediately notify your Team and Contractor to avoid unnecessary details.
- Good and frequent communication is the key to success.



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AASHTOWare Project

odoteconstruction@odot.oregon.gov

AWPAdmin@odot.oregon.gov

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What type of data will Inspectors input?

Civil Rights & Labor

- Field Interviews
  - Employee Interviews

Construction & Materials

- Daily Work Report (DWR)
  - Formerly General Daily Progress Reports
  - Weigh memos attachments
- Pay notes generated from DWR
- Sample Tests

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What type of data will Externals input?

Civil Rights & Labor

- Certified Payrolls

Primes have ability to review data submitted by subs and technicians in AWP prior to ODOT's review.

Construction & Materials

- Subcontracts
- Daily Source Reports (DSR)
  - Updating production quantity
  - Identify how much material has been produced
- Submit mix designs
- Managing testing labs testers
- Sample Records - access to create records and enter test data
- View Sources and source material

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AASHTOWare Project

AASHTOWare Project for ODOT

odoteconstruction@odot.oregon.gov

Visit the APOST Website:

https://www.oregon.gov/odot/Construction/Pages/AW-Construction.aspx

Subscribe to The APOST Times:

https://public.govdelivery.com/accounts/ORDOT/subscriber/new?topic_id=ORDOT_863

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INSERT TAB

1. Design Elements

Design Elements

Lesson 1

ODOT MATERIALS & INSPECTION

1

Learning Objectives
Lesson 1

- Understand typical soil sampling procedures and understand Standard Penetration Test (SPT) values and Rock Quality Designation (RQD)
- Identify and describe the sections of a drill log and how this information is used
- Review how to prepare a field soil description for the Inspector's drilled shaft excavation log

ODOT MATERIALS & INSPECTION

2

Subsurface Exploration
Why is a Subsurface Exploration performed?

To determine the following for design:

- Subsurface materials composition and depth
- Measure engineering properties of subsurface materials
- Determine the capacity to support the design loads

To determine the following for construction:

- Appropriate equipment (rig and tooling)
- Construction method (wet / dry)
- Potential problems (caving / casing needs)

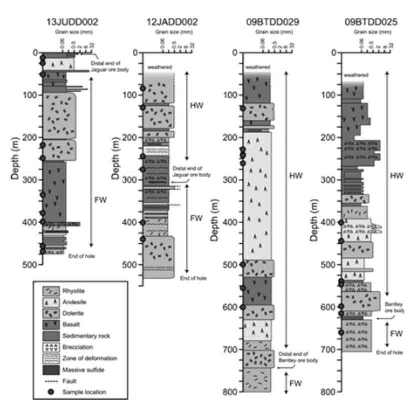
3

Subsurface Exploration
Goals

To gather data about the site:

- Geologic formations
- Soil and rock units
- Material engineering properties
- Groundwater conditions
- Ground surface elevation
- Localized conditions

The Drill Log



4

Soil and Rock Sampling

- Standard Penetration Tests (SPTs)
  - Measured in the Field
  - Number of Blows Recorded every Six Inches of Probe Penetration
  - Three Sets of Values - Only Use Last Two values
- Shelby tubes in soft soils
  - Used for Acquiring Samples
- HQ core in rock
  - Used for Acquiring Samples
  - RQD (Rock Quality Designation) is a Measurement of Rock Quality

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Soil and Rock Sampling
Standard Penetration Testing (SPT)

140 lb. Drive Hammer

- Probe placed in bottom of drill hole
- Driven into "virgin" soil by repeated blows with the 140 lb. hammer
- Number of blows counted for every six inches for a total of 18 inches of penetration
- **Final value is the sum of the last two increments**

SPT Probe

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Standard Penetration Test (SPT) and Compactness - Sands

Non-Cohesive Soils

Blows Per Foot	Density
0 to 4	Very Loose
4 to 10	Loose
10 to 30	Medium Dense
30 to 50	Dense
>50	Very Dense

7

Standard Penetration Test (SPT) and Consistency - Clays

Cohesive Soils

Blows Per Foot	Consistency
0 to 2	Very Soft
2 to 4	Soft
4 to 8	Medium
8 to 15	Stiff
15 to 30	Very Stiff
>30	Hard

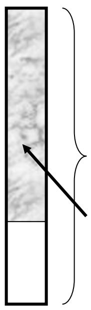
8

Soil and Rock Sampling
Rock Core Recovery

% Recovery is defined as the length of core recovered divided by the length of core run and is expressed and reported as a percentage.

$$\textbf{\% Recovery} = \frac{\text{Length of Core Recovered}}{\text{Length of Core Run}} \, (100)$$

<u>EXAMPLE PROBLEM</u>



Length of Run = 5.0'

Recovered 3.2'

$$\text{\% Recovery} = \frac{3.2'}{5.0'} \, (100) = 64\%$$

9

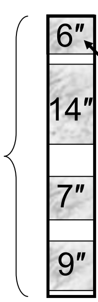
Soil and Rock Sampling
Rock Quality Designation (RQD)

RQD is defined as the sum of all recovered pieces of rock core 4 inches and greater in length divided by the length of core run and is expressed and reported as a percentage.

$$\textbf{\% RQD} = \frac{\text{Sum of Pieces 4"}}{\text{Length of Core Run}} \times (100)$$

<u>EXAMPLE PROBLEM</u>

Length of Run = 5.0'



Recovered pieces

$$\textbf{RQD} = \frac{36''}{60''} \, (100) = 60\%$$

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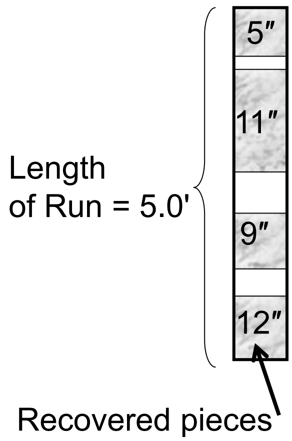
Soil and Rock Sampling

What is the RQD for the following core?



A. 50%
B. 60%
C. 62%
D. 65%

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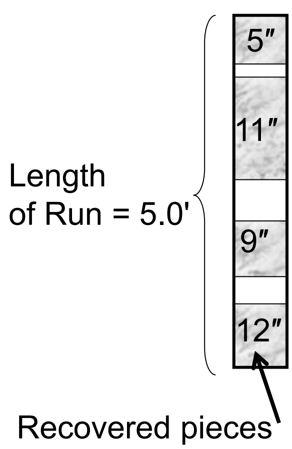
Soil and Rock Sampling

What is the RQD for the following core?



A. 50%
B. 60%
C. 62%
D. 65%

$$\textbf{RQD} = \frac{37''}{60''}(100) = 62\%$$

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Soil and Rock Sampling
Rock Quality Designation

RQD (%)	Description of Rock Quality
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

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Soil and Rock Identification
Why is it important?

In its natural (in situ) state may look like this.

Coming out of the shaft excavation, it may look like this.

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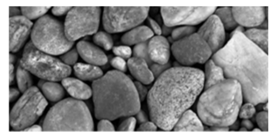
Soil and Rock Identification

What is Soil ?

Naturally occurring mineral particles which are readily separated into small pieces.

What is Rock ?

Naturally occurring material composed of mineral particles that are firmly bonded together.



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Soil and Rock Identification

Soil Types

- **Coarse Grained/Granular Soils:** Boulders, cobbles, gravels and sands
- **Fine-grained Soils:** Silts and clays
- **Organic Soils:** Peat, organic clays and silts

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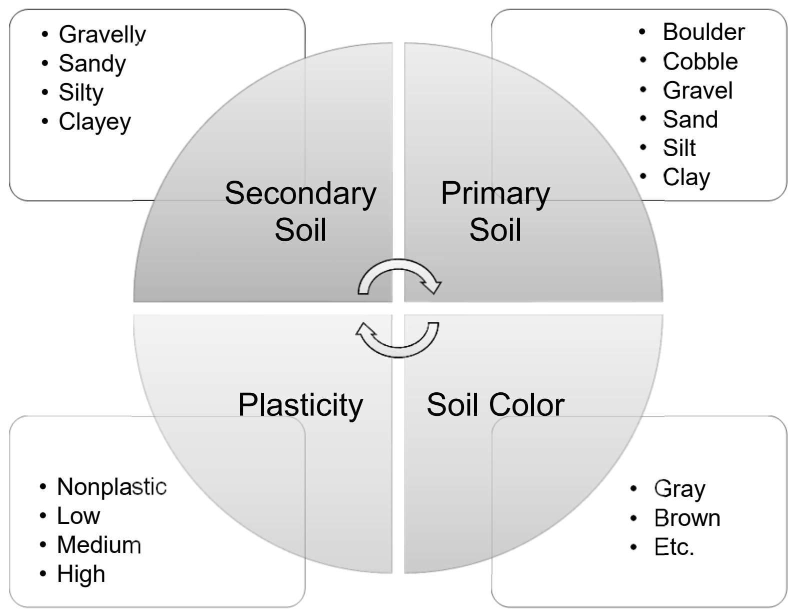

Naming Order: ***Secondary Soil, Primary Soil, Color, Plasticity***

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Unified Soil Classification System (USCS)

More than 50% Sand-Size (larger than 200 sieve)

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART		
COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures

LABORATORY CLASSIFICATION CRITERIA		
GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

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Unified Soil Classification System (USCS)

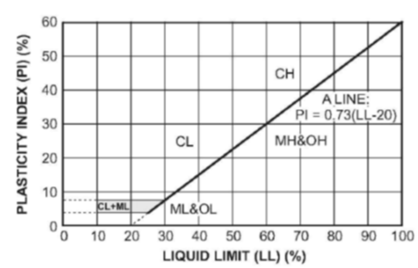
Less than 50% Sand-Size (smaller than 200 sieve)

FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



19

Soil and Rock Identification

Rock Types

- Igneous Rock: Granite, diorite, basalt
- Sedimentary Rock: Conglomerate, sandstone, mudstone
- Metamorphic Rock: Quartzite, schist, gneiss, greenstone

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Inspector's Drilled Shaft Excavation Log 1/2

Oregon Department of Transportation

DRILLED SHAFT EXCAVATION LOG

PROJECT		BRIDGE NO.	CONTRACT NO	
BENT	STATION	SHAFT NO.	SHAFT DIAMETER	
DRILLED SHAFT CONTRACTOR		INSPECTED BY	CERTIFICATION NO.	DATE

DATE/TIME EXCAVATED	TYPE OF CONSTRUCTION
START FINISH:	☐ DRY ☐ WET

ELEVATIONS

Reference Elev. ______
Grd. Surface Elev. ______
Water Table Elev. ______
Top Shaft Elev. ______
Msd Top Rock Elev. ______
Msd Avg. Shaft Bot Elev. ______

DIMENSIONS

Soil Auger Dia. ______
Soil Shaft Length ______
Rock Auger Dia. ______
Rock Socket Length ______
Construc. Shaft Length ______

CASING INFORMATION (if applicable)

Casing (Temp / Perm)	Casing (Temp / Perm)	Casing (Temp / Perm)
Type ______	Type ______	Type ______
OD (in.) ______	OD (in.) ______	OD (in.) ______
Thickness ______	Thickness ______	Thickness ______
Top Elev. ______	Top Elev. ______	Top Elev. ______
Length: ______	Length: ______	Length: ______

Record and describe all materials encountered during drilled shaft excavation, water table information, depths of seepage and seepage rates, obstructions encountered, equipment used and equip. breakdowns (use additional sheets if necessary)

DRILLING SLURRY

Slurry Type & Manufacturer : ______

Slurry Meets Specifications? Y N

CLEANOUT METHOD

Bucket ______ Airlift ______ Pump ______
Other: ______

BOTTOM INSPECTION

Visual ______ Tape/Probe ______
Record 5 depths to the bottom of finished shaft:

1 ______ 3 ______
4 ______
2 ______ 5 ______

Ave. Shaft Bottom Elev.: ______
Meet Cleanout Specification? Y N
Meet Alignment Specifications? Y N

21

Inspector's Drilled Shaft Excavation Log 2/2

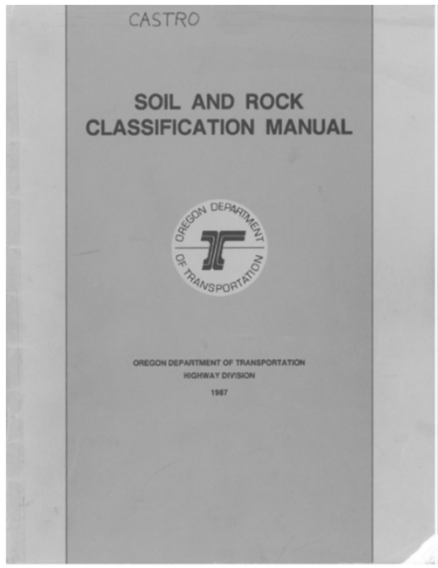
DEPTH	ELEVATION	START	FINISH	SOIL OR ROCK MATERIAL DESCRIPTION AND NOTES	LOG

INSPECTOR SIGNATURE ______ DATE ______

NOTES: ______

22

Soil and Rock Identification
ODOT Soil and Rock Classification Manual



23

Unit Review

- Subsurface Exploration
- Soil and Rock Sampling
- Soil and Rock Identification
- Filling out the Drilled Shaft Excavation Log

ODOT MATERIALS & INSPECTION

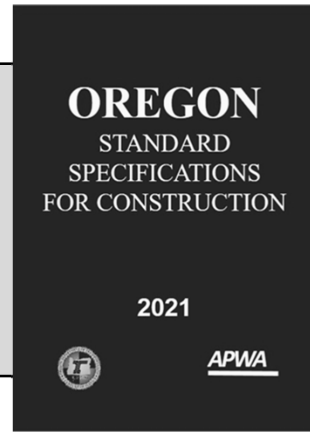
24

INSERT TAB

2. Preconstruction

Preconstruction

Lesson 2



ODOT MATERIALS & INSPECTION

1

Learning Objectives
Lesson 2

- Recognize the elements contained in a Geotechnical Report
- Identify the sections of a drill log and learn how this information is used
- Learn to Find and Review the Geotechnical Data Sheet
- Important Project Documents: Plans and Special Provisions

ODOT MATERIALS & INSPECTION

2

Learning Objectives

- Learning the Drilled Shaft Inspector's Checklist
- Understand key elements of the ODOT Standard Specifications and Special Provisions for Drilled Shafts
- Drilled Shaft Coordination Meeting
- Identify key elements of the Drilled Shaft Installation Plan

ODOT MATERIALS & INSPECTION

3

Geotechnical Report

- All bridge projects have a Geotechnical Report that should be on file with the Resident Engineer's office.
- Geotechnical Reports contain important information that is useful for the design and construction of drilled shaft projects.
- Project Inspectors should review the Geotechnical Report prior to the start of construction. Discuss any questions with either the Resident Engineer or the Geotechnical Engineer. Each ODOT Tech Center has at least one Geotechnical Engineer. Get to know them as they can be a great resource.

ODOT MATERIALS & INSPECTION

4

Geotechnical Report Components

Introduction	Defines the geotechnical scope of the project.
Office Study	Research documentation for existing site, bridge, foundation, performance.
Geologic Exploration (aka Subsurface Investigation)	Summarizes the subsurface conditions encountered including groundwater levels. This information is graphically summarized on the *Geotechnical Data Sheet*.

ODOT MATERIALS & INSPECTION

5

Geotechnical Report Components (continued)

Hydraulics Information	Summarizes scour information from the Hydraulics Report.
Seismicity Information	Summarizes seismic information, including liquefaction and lateral spread potential.

ODOT MATERIALS & INSPECTION

6

Geotechnical Report Components
Recommendations

- **Foundation Design Recommendations** – Provides the Structural Engineer with the geotechnically-related recommendations for the foundations of structures.
- **Geotechnical Design Recommendations** – Provides the Roadway Engineer with geotechnically-related recommendations for embankments, soil and rock cuts and landslide mitigation.
- **Construction Recommendations** – Identifies anticipated construction challenges such as caving soils, groundwater, obstructions, boulders, and utilities.

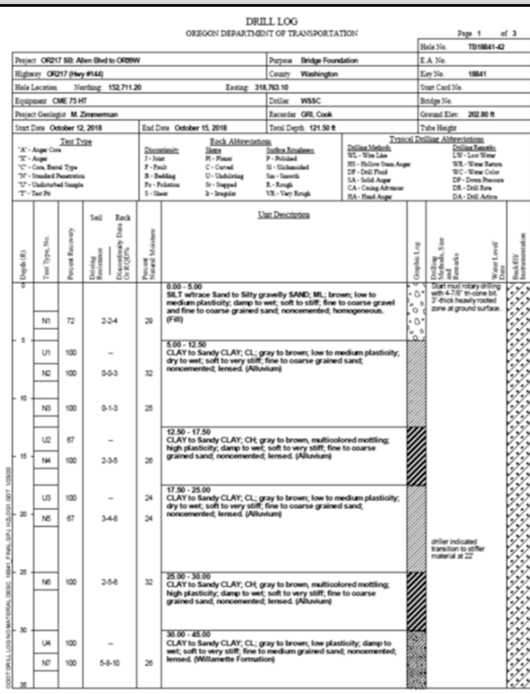
ODOT MATERIALS & INSPECTION

7

Soil and Rock Identification
The Drill Log

For full size copy, see Resource Manual Hole No. TB18841-42

ODOT MATERIALS & INSPECTION



DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION
Page 1 of 3

Project OR217 SB: Allen Blvd to OR99W	Purpose Bridge Foundation	Hole No. TB18841-42
Highway OR217 (Hwy #144)	County Washington	E.A. No.
Hole Location Northing 152,711.20 Easting 318,763.10		Key No. 18841
Equipment CME 75 HT	Driller WSSC	Start Card No.
Project Geologist M. Zimmerman	Recorder GRI, Cook	Bridge No.
Start Date October 12, 2018 / End Date October 15, 2018	Total Depth 121.50 ft	Ground Elev. 202.80 ft
		Tube Height

Test Type: "A" - Auger Core; "X" - Auger; "C" - Core, Barrel Type; "N" - Standard Penetration; "U" - Undisturbed Sample; "T" - Test Pit

Rock Abbreviations — Discontinuity: J - Joint; F - Fault; B - Bedding; Fo - Foliation; S - Shear. Shape: Pl - Planar; C - Curved; U - Undulating; St - Stepped; Ir - Irregular. Surface Roughness: P - Polished; Sl - Slickensided; Sm - Smooth; R - Rough; VR - Very Rough

Typical Drilling Abbreviations — Drilling Methods: WL - Wire Line; HS - Hollow Stem Auger; DF - Drill Fluid; SA - Solid Auger; CA - Casing Advancer; HA - Hand Auger. Drilling Remarks: LW - Lost Water; WR - Water Return; WC - Water Color; DP - Down Pressure; DR - Drill Rate; DA - Drill Action

Test Type, No.	Percent Recovery	Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Unit Description	Drilling Methods, Size and Remarks
N1	72	2-2-4	29	0.00 - 5.00 SILT w/trace Sand to Silty gravelly SAND; ML; brown; low to medium plasticity; damp to wet; soft to stiff; fine to coarse gravel and fine to coarse grained sand; noncemented; homogeneous. (Fill)	Start mud rotary drilling with 4-7/8" tri-cone bit. 3"-thick heavily rooted zone at ground surface.
U1	100	–		5.00 - 12.50 CLAY to Sandy CLAY; CL; gray to brown; low to medium plasticity; dry to wet; soft to very stiff; fine to coarse grained sand; noncemented; lensed. (Alluvium)	
N2	100	0-0-3	32		
N3	100	0-1-3	25		
U2	67	–		12.50 - 17.50 CLAY to Sandy CLAY; CH; gray to brown, multicolored mottling; high plasticity; damp to wet; soft to very stiff; fine to coarse grained sand; noncemented; lensed. (Alluvium)	
N4	100	2-3-5	26		
U3	100	–	24	17.50 - 25.00 CLAY to Sandy CLAY; CL; gray to brown; low to medium plasticity; dry to wet; soft to very stiff; fine to coarse grained sand; noncemented; lensed. (Alluvium)	
N5	67	3-4-8	24		driller indicated transition to stiffer material at 22'
N6	100	2-5-6	32	25.00 - 30.00 CLAY to Sandy CLAY; CH; gray to brown, multicolored mottling; high plasticity; damp to wet; soft to very stiff; fine to coarse grained sand; noncemented; lensed. (Alluvium)	
U4	100	–		30.00 - 45.00 CLAY to Sandy CLAY; CL; gray to brown; low plasticity; damp to wet; soft to very stiff; fine to medium grained sand; noncemented; lensed. (Willamette Formation)	
N7	100	5-8-10	26		

8

Geotechnical Report Review

What was the **blow count** and **percent moisture** for the SPT sample taken in hole **TB18841-42** at a depth of 75 feet?

A. 12 blows with 44% moisture

B. 7 blows with 29% moisture

C. 10 blows with 44% moisture

D. 44 blows with 29% moisture

ODOT MATERIALS & INSPECTION

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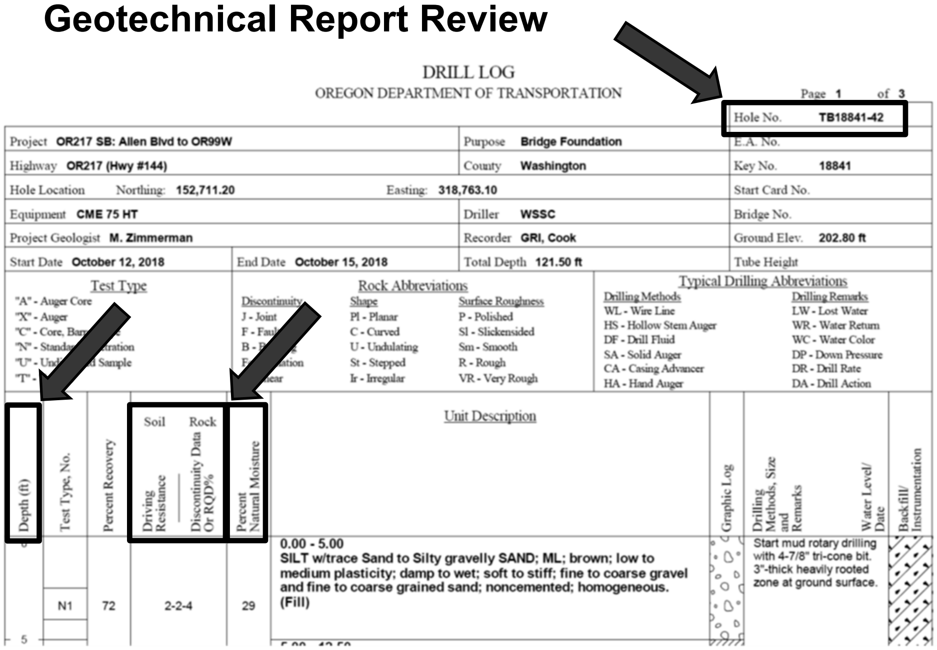
Geotechnical Report Review



DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION

Page 1 of 3

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Highway OR217 (Hwy #144)	County Washington	Key No. 18841
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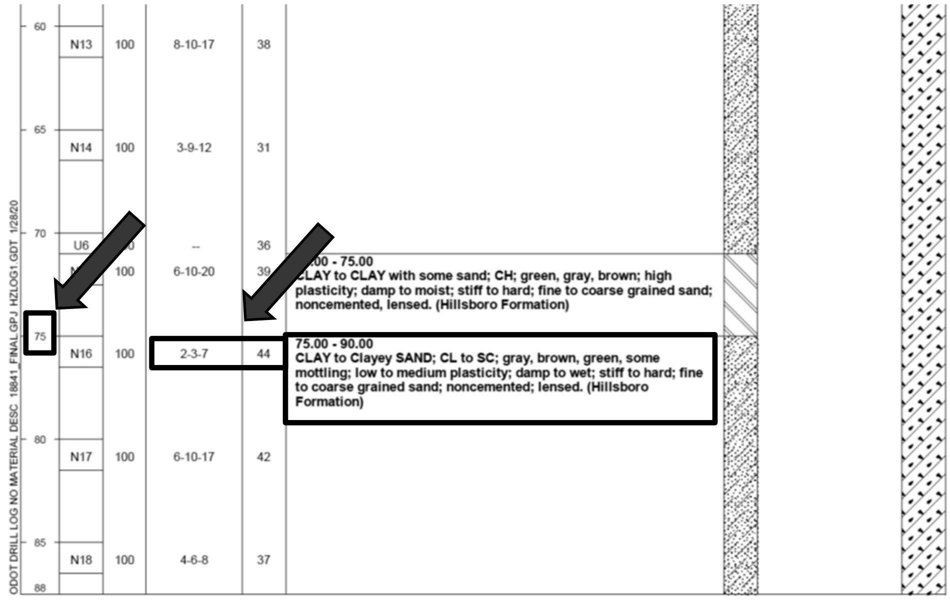
Depth (ft)	Test Type, No.	Percent Recovery	Soil: Driving Resistance / Rock: Discontinuity Data Or RQD%	Percent Natural Moisture	Unit Description	Graphic Log	Drilling Methods, Size and Remarks	Water Level/ Date	Backfill/ Instrumentation
0					0.00 - 5.00 SILT w/trace Sand to Silty gravelly SAND; ML; brown; low to medium plasticity; damp to wet; soft to stiff; fine to coarse gravel and fine to coarse grained sand; noncemented; homogeneous. (Fill)		Start mud rotary drilling with 4-7/8" tri-cone bit. 3"-thick heavily rooted zone at ground surface.		
	N1	72	2-2-4	29					
5									

10

Geotechnical Report Review



11

Geotechnical Report Review

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A. 12 blows with 44% moisture

B. 7 blows with 29% moisture

C. 10 blows with 44% moisture

D. 44 blows with 29% moisture

12

Geological Data Sheet

- Graphical compilation of the subsurface conditions encountered and information gathered from the subsurface investigation.
- Typically, the GDS is located after the Plan, Elevation and General Note sheets.
- Contract document that is the basis of the Contractor's bid relative to the subsurface conditions, in addition to any Special Provisions in SP00512 in applicable locations.

ODOT MATERIALS & INSPECTION

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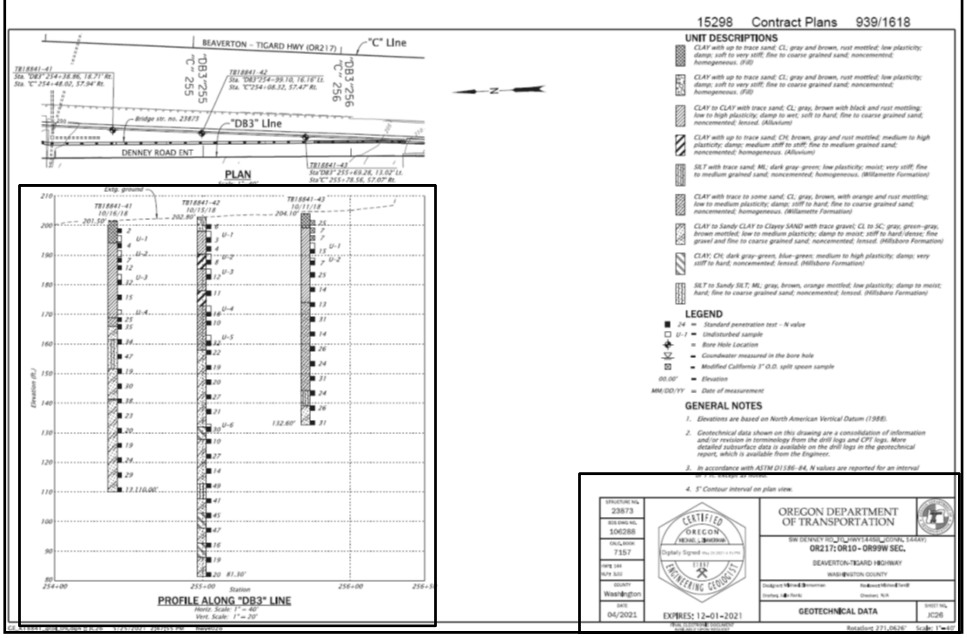
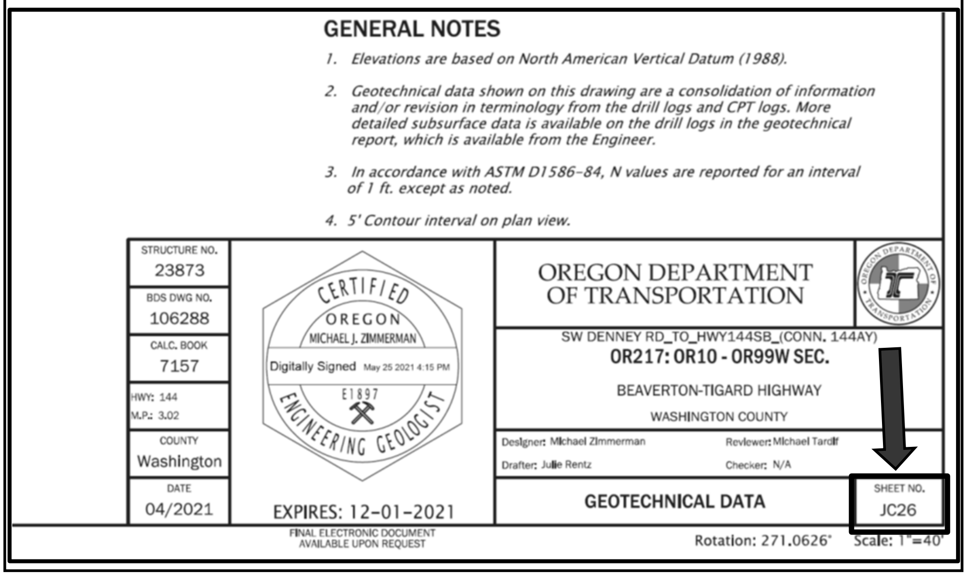
Geological Data Sheet Example

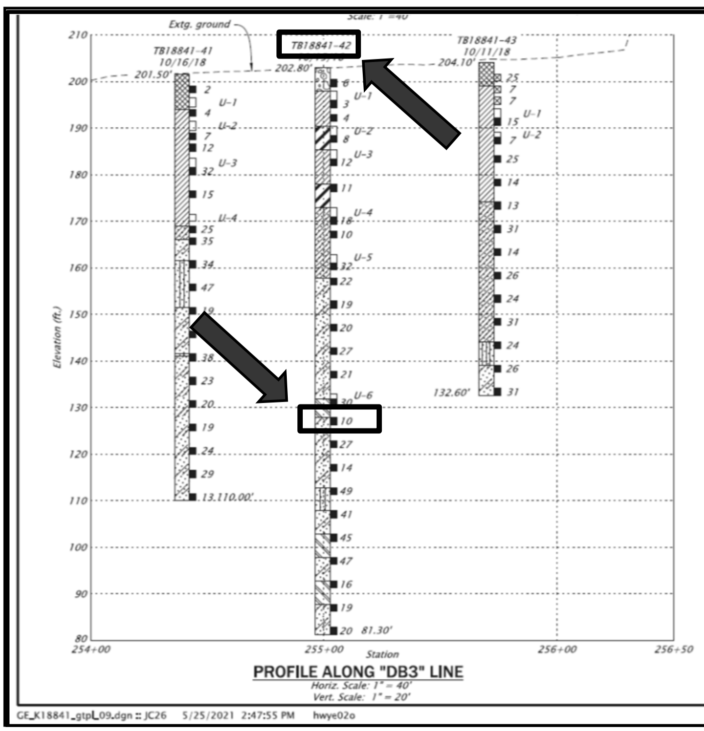


14

Geological Data Sheet Example



15



Geological Data Sheet Example

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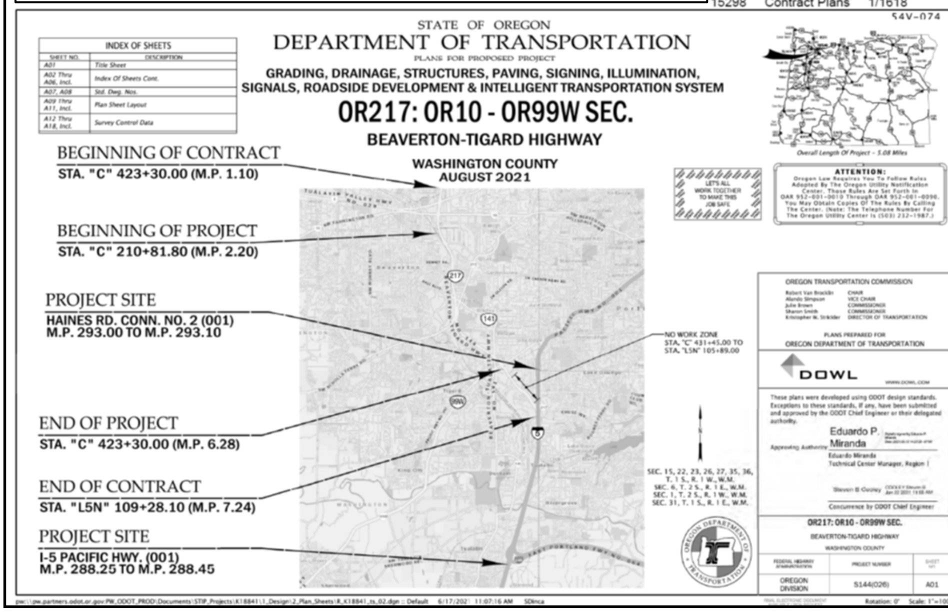
Contract Plans Review

Included in the 11x17 Resource Manual **Tab — Plans.**



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Key Parts of the Bridge Plans

Plan & Elevation	Shows plan and elevation views of the structure and foundations including the location of drilled shafts
General Notes	Concrete strength, construction sequencing,
Geological Data Plan Sheet	Shows subsurface materials and conditions discovered from the project borings.
Footing Plan	Shows shaft locations and diameters, location of temporary shoring/cofferdams, project-specific notes.
Bent Details	Shows shaft diameters, top-of-shaft and shaft tip elevations; shaft and column reinforcement, CSL tubes, concrete clearance, construction joints, permanent casing, minimum rock embedment

ODOT MATERIALS & INSPECTION

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Key Parts of Other Plans Sections
(Roadway Plan Sheets)

- Check utility locations
- Available right of way limits and easements
- Check proximity to other facilities or structures
- Traffic and construction staging plans
- Erosion control plans
- No Work Zones

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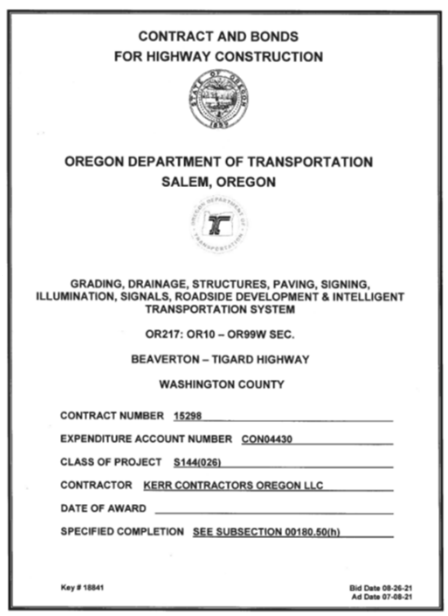
Drilled Shaft Specifications Section 512

Special Provisions

- Permanent casing requirements
- Additional equipment and reinforcement length requirements (due to anticipated variations in the soil bearing layer)
- Changes to concrete specifications
- Estimated quantities for concrete and steel



CONTRACT AND BONDS
FOR HIGHWAY CONSTRUCTION

OREGON DEPARTMENT OF TRANSPORTATION
SALEM, OREGON

GRADING, DRAINAGE, STRUCTURES, PAVING, SIGNING, ILLUMINATION, SIGNALS, ROADSIDE DEVELOPMENT & INTELLIGENT TRANSPORTATION SYSTEM

OR217: OR10 – OR99W SEC.

BEAVERTON – TIGARD HIGHWAY

WASHINGTON COUNTY

CONTRACT NUMBER 15298
EXPENDITURE ACCOUNT NUMBER CON04430
CLASS OF PROJECT S144(026)
CONTRACTOR KERR CONTRACTORS OREGON LLC
DATE OF AWARD
SPECIFIED COMPLETION SEE SUBSECTION 00180.50(h)

Key # 18841
Bid Date 08-26-21
Ad Date 07-08-21

20

Drilled Shafts

Design Types

Pre-Construction Meeting

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Drilled Shaft Foundation Types

There are two different design concepts and two different installation methods:

1. The basis of the geotechnical design model:
   End Bearing versus **Friction Pile**.
2. The groundwater condition during concrete placement:
   Dry versus **Wet Hole** Installation Procedures.

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Drilled Shaft Foundation Types

Geotechnical Design Models

End Bearing	The axial load resistance is based on the capacity of the subsurface conditions at the tip or base of the drilled shaft. Bottom of excavation must be thoroughly cleaned.
Side (Skin) Friction	The axial load resistance is based on the capacity of the subsurface conditions along the sides (surface area) of the drilled shaft.

ODOT MATERIALS & INSPECTION

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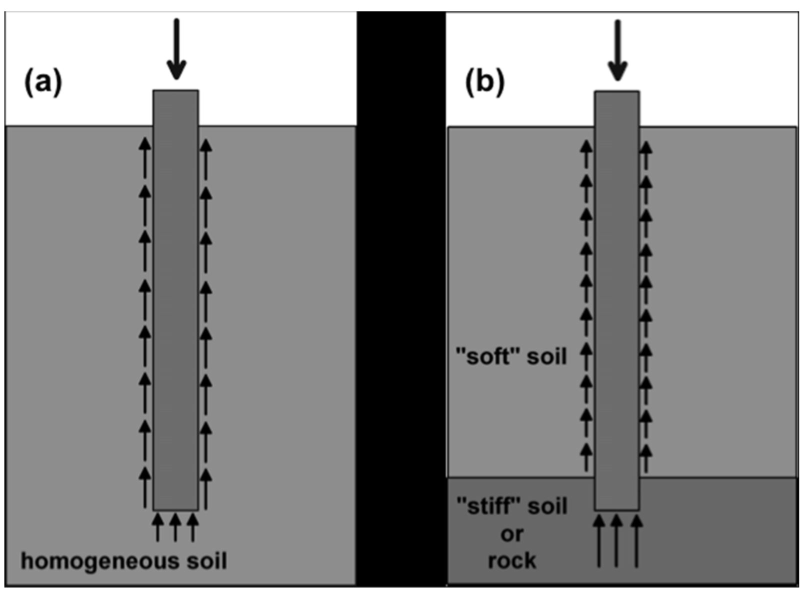

Side (Skin) Friction — End Bearing

24

Drilled Shaft Coordination Meeting

00512.41 Drill Shaft Coordination Meeting

- At least seven calendar days before beginning any shaft construction work
- To discuss:
  - Shaft Installation Plan
  - construction procedures
  - schedules
  - staging
  - personnel
  - equipment and other elements of the plan
  - status of outstanding submittals

ODOT MATERIALS & INSPECTION

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Drilled Shaft Coordination Meeting

00512.41 Drill Shaft Coordination Meeting

Representing the Contractor:

- The superintendent
- On-site supervisors
- All supervisors in charge of excavating the shaft, placing the casing, mixing and installing slurry (as applicable), placing the steel reinforcement, and placing the concrete
- Slurry manufacturer's representative (if used) and the Contractor's employee trained in the use of the slurry

ODOT MATERIALS & INSPECTION

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Drilled Shaft Coordination Meeting

00512.41 Drill Shaft Coordination Meeting

Representing the Contracting Agency:

- The Resident Engineer
- Key inspection personnel
- Professional of Record (POR) or the appointed representatives

Take these meetings seriously, as they can be part of future claims litigation.

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Checklist

Pre-Construction

Print Form

Oregon Department of Transportation

Drilled Shaft Inspector's Checklist

The following is a general checklist to follow when constructing a drilled shaft. The answer to each of these questions should be "Yes" or "NA" unless plans, specifications or specific approval has been given otherwise. Any answer of "No" should be explained in the Notes/Comments.
CONSULT WITH PROJECT MANAGER FOR YOUR SPECIFIC PROJECT RESPONSIBILITIES.

Pre-Construction

☐ Yes ☐ No ☐ NA 1. Has the Drilled Shaft Installation Plan been submitted and approved (00512.40)?

☐ Yes ☐ No ☐ NA 2. Has a list of project personnel been submitted and approved (00512.30)?

☐ Yes ☐ No ☐ NA 3. Have the Contractor's quality control technicians been submitted and verified?

☐ Yes ☐ No ☐ NA 4. Does the Contractor have an approved concrete mix design according to 02001.35? The Inspector should have a copy on the project site.

☐ Yes ☐ No ☐ NA 5. Has the Contractor run the required plastic concrete tests (slump loss tests) for their concrete mix design (02001.35(h))?

☐ Yes ☐ No ☐ NA 6. If the Contractor proposed a polymer slurry, do you have a copy of the quality control plan for the slurry (00512.40 and 00512.43(f)) and the name and phone number of the slurry manufacturer's representative who will be providing technical assistance?

☐ Yes ☐ No ☐ NA 7. If the Contractor plans to use a manufactured slurry, do they have the proper equipment to mix it?

☐ Yes ☐ No ☐ NA 8. Have you reviewed the Foundation Data sheet and drill logs and understand the subsurface conditions?

☐ Yes ☐ No ☐ NA 9. Has the Contractor addressed the Protection of Existing Structures (00512.40)?

☐ Yes ☐ No ☐ NA 10. Does the Contractor have all the equipment and tools shown in the Drilled Shaft Installation Plan (00512.40)?

☐ Yes ☐ No ☐ NA 11. If permanent casing is required, is it the right size and material in accordance with the plans and Section 00512.13?

☐ Yes ☐ No ☐ NA 12. If temporary casing is to be used, is it in accordance with the Drilled Shaft Installation Plan (00512.40)?

☐ Yes ☐ No ☐ NA 13. If there are contaminated media (materials), hazardous materials, or contaminated groundwater present, are they being treated in accordance with 00290 and 00294?

☐ Yes ☐ No ☐ NA 14. Do you have all the required drilled shaft forms that need to be filled out during shaft construction?
a. Drilled Shaft Excavation Log (form 734-2604)
b. Drilled Shaft Concrete Volume Log (form 734-2603)
c. Drilled Shaft Concrete Placement Log (form 734-2597)
d. Drilled Shaft Inspection Report (form 734-2598)

☐ Yes ☐ No ☐ NA 15. Has the drilled shaft coordination meeting been held (Section 00512.41)?

ODOT MATERIALS & INSPECTION

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Unit Review

- Identify key elements of the geotechnical documents
- Locate plan sheet details related to drilled shafts
- Identify key elements of the Drilled Shaft Pre Construction Meeting and Submittal.
- Understanding the Drilled Shaft Inspector’s Checklist.

ODOT MATERIALS & INSPECTION

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INSERT TAB

3. Drill Rigs & Equipment

Drill Rigs and Equipment

Lesson 3

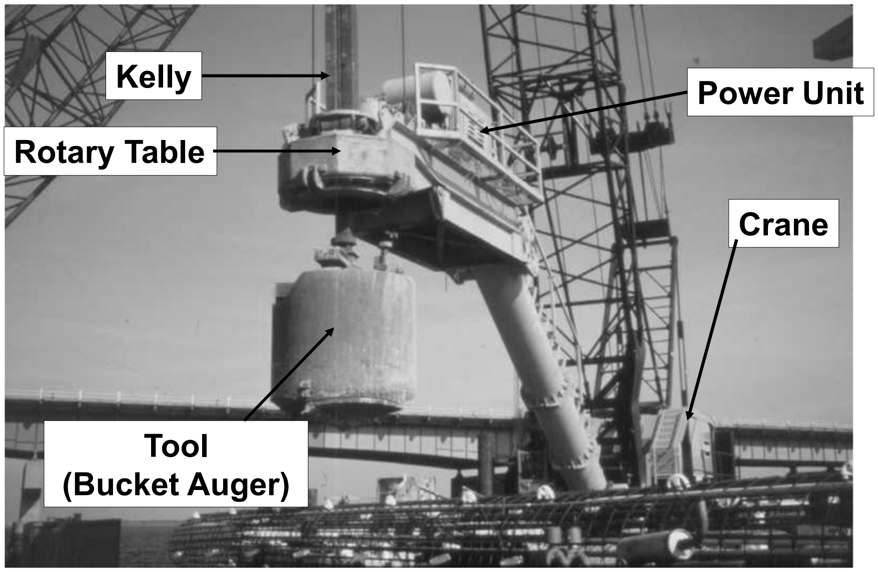
1

Learning Objectives

- Identify drilled shaft rig components
- Identify different types of drill rigs
- Identify drilling tools and explain their uses

2

Drill Rig Terminology



3

Drill Rigs

- American Manufacturer Types
  - Atlantic Equipment Company
  - American Equipment and Fabrication Corp.
  - Calweld
  - Stephen M. Hain Company
  - Reedrill/Texoma
  - Watson
  - LoDril (Bay Shore Systems)
- European Manufacturer Types
  - Bauer (Germany)
  - Casagrande (Italy)
  - IMT (Italy)
  - SoilMec (Italy)

ODOT MATERIALS & INSPECTION

4

Types of Rigs

- Truck-Mounted Rigs
- Carrier-Mounted Rigs
- Excavator-Mounted Rigs
- Crawler-Mounted Rigs
- Crane-Mounted Rigs

ODOT MATERIALS & INSPECTION

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Types of Rigs: Truck-Mounted

Watson 2200

The Model 2200 is a mid-size truck mounted drill unit that is fast and easy to operate. This drill model is designed for mounting on a 4-axle truck configuration.

6

Types of Rigs: Carrier-Mounted

Atlas RD20

7

Types of Rigs: Excavator-Mounted

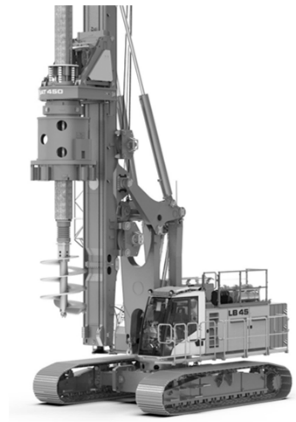
LoDril ®

A high torque drilling attachment to a traditional Track-Mounted Excavator

8

Types of Rigs: Crawler-Mounted

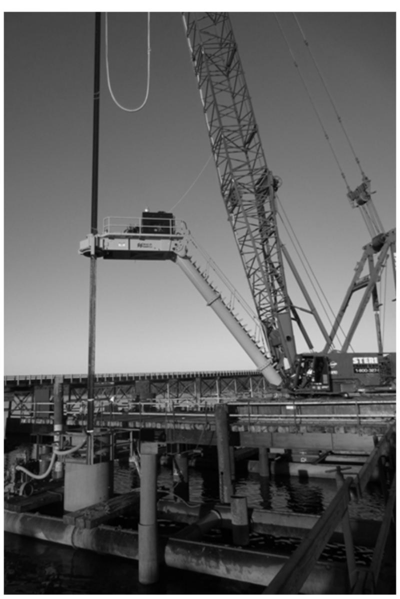
Liebherr LB 44-510
With Casing Advancer



9

Types of Rigs: Crane-Mounted

450T-3 Crane Drill



10

Learning Objective
Identify drill rig components

Table, Drive or Torque Unit

Kelly: One-piece or Telescoping

Rig: Truck, Track, Crane or Crawler

Tool: Bits and Buckets

11

Auger Bits and Other Drilling Tools

12

Augers & Tools

Auger bits are generally classified as either:

- **Earth (soil)**

or

- **Rock**

Earth Augers

- Single or double flight
- Double flight has superior soil removal capability

Rock Augers and Tools

- Double or triple flight
- Hard rock core barrels

ODOT MATERIALS & INSPECTION

13

Why is this important?

The Inspector must be able to:

- Compare on site tools and equipment to the approved Drilled Shaft Installation Plan
- Note on daily activity report the equipment on-site
- Recognize and document the tools being used
- Recognize and document the condition of the tools

ODOT MATERIALS & INSPECTION

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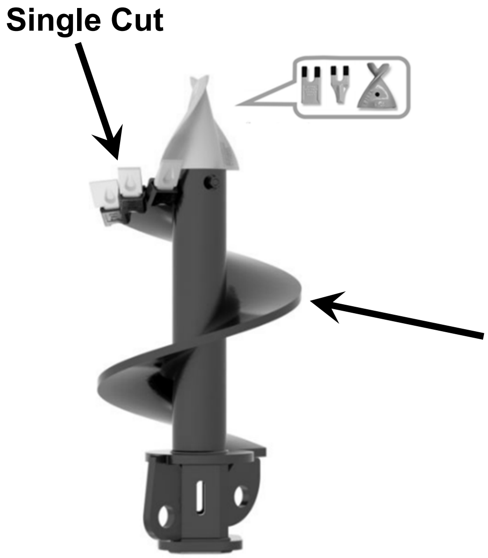
Earth Augers

Earth augers are generally used in loose soils, sands and weak cohesive materials.

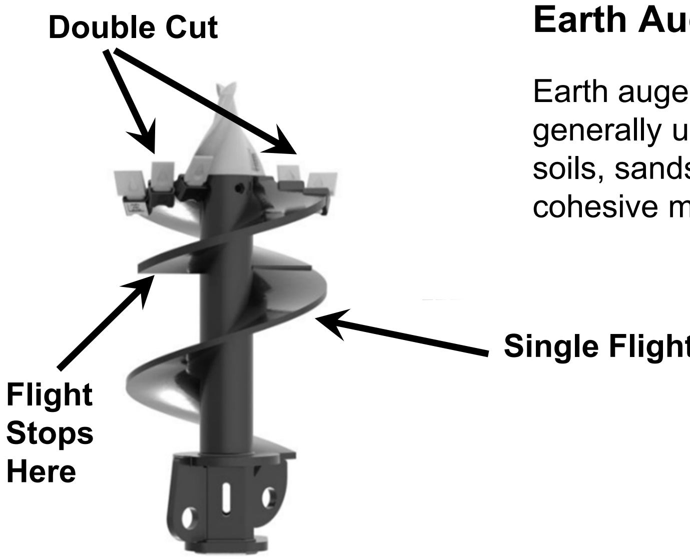


Flat Style Replacement Tooth

15

Earth Augers

Earth augers are generally used in loose soils, sands and weak cohesive materials.



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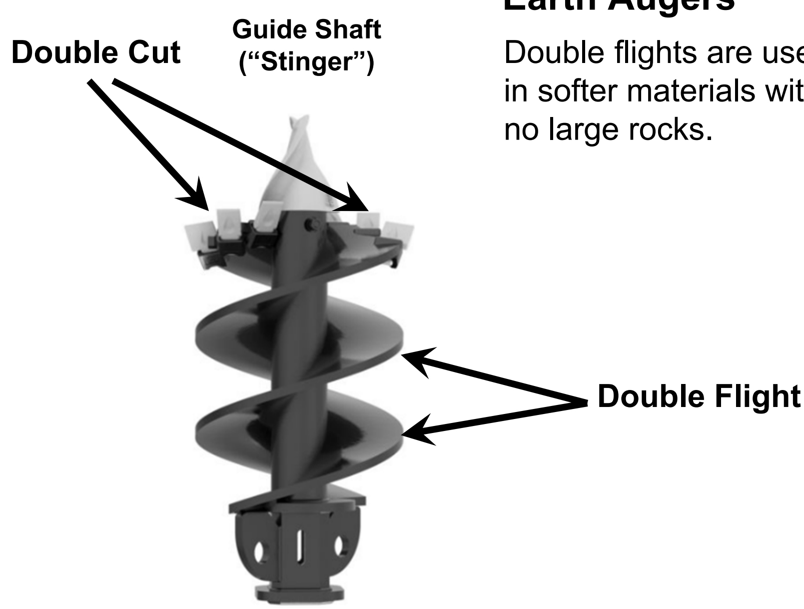
Earth Augers

Double flights are used in softer materials with no large rocks.



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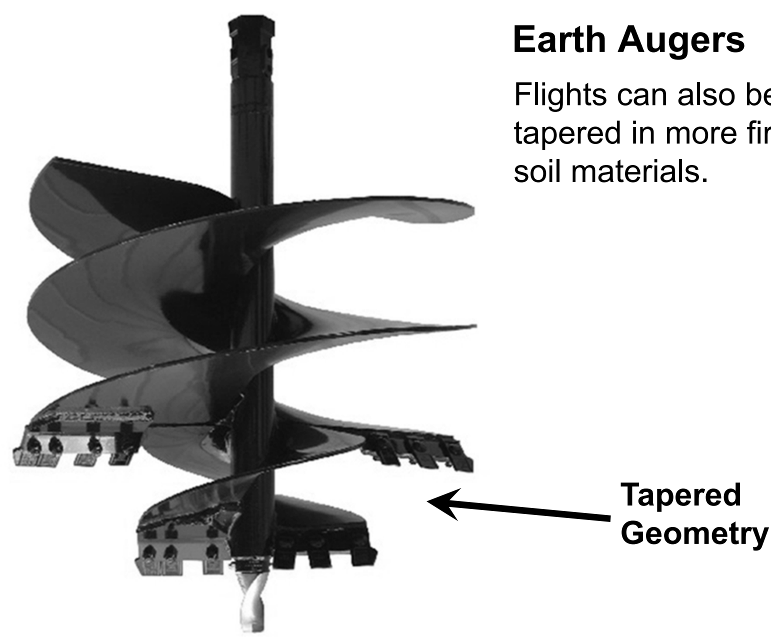
Earth Augers

Flights can also be tapered in more firm soil materials.



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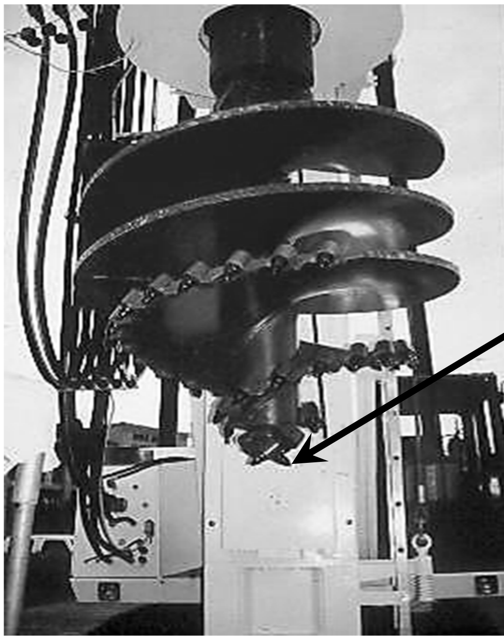


Rock Augers

Rock augers are generally used in soft to hard rock formations.

Conical (Bullet) Carbide Teeth

19

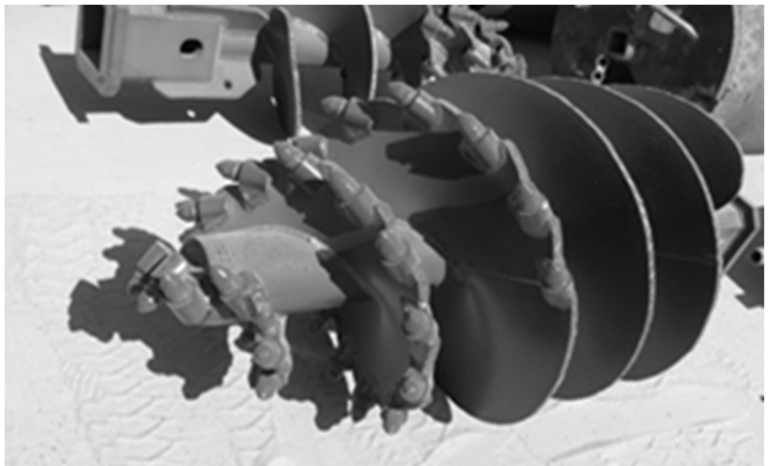
Rock Augers

Rock augers are designed to grind the rock into fine fragments and the then lift them out of the excavation.

20

Rock Augers

The harder the anticipated drilling conditions the greater the taper on the bit and the more teeth.



21

Barrel Tools

Bucket Auger

Used in soil or soft rock that has large clasts (boulders) that can be scooped up in the barrel.

22

Barrel Tools

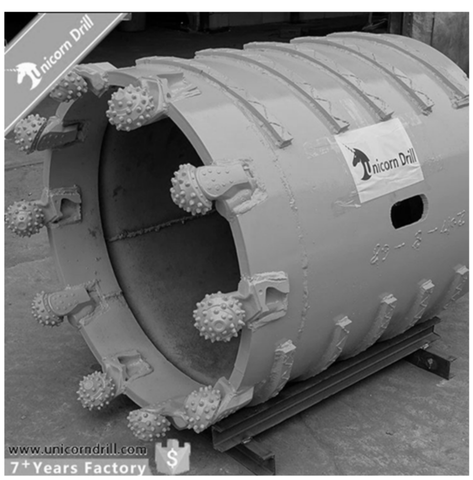
Muck Bucket

Smooth trowel blade at the bottom used to clean out the bottom of hole at the end of drilling process.

Sliding door closes off the barrel before extracting from the hole.

23

Barrel Tools



Hard Rock Core Barrels

These are design to excavate around the perimeter of the boring, thereby focusing the down-force from the weight of the drill rig along a small area.

The central plug of intact rock hangs in the barrel and can be extracted at the surface.

24

Barrel Tools

Core Barrels

The type of teeth indicate the hardness of the rock to be excavated

25

Barrel Tools

Core Barrels

Come in all different shapes and sizes

26

Rock Extraction Tools

Hammer Grab

Mechanical Clam-style excavation tool for large rocks.

27

Cleanout Tools

A vacuum like tool that is utilized for final cleaning of the hole bottom.

Commonly uses an air-lift system to suck out the soil and rocks at the bottom of the excavation.

28

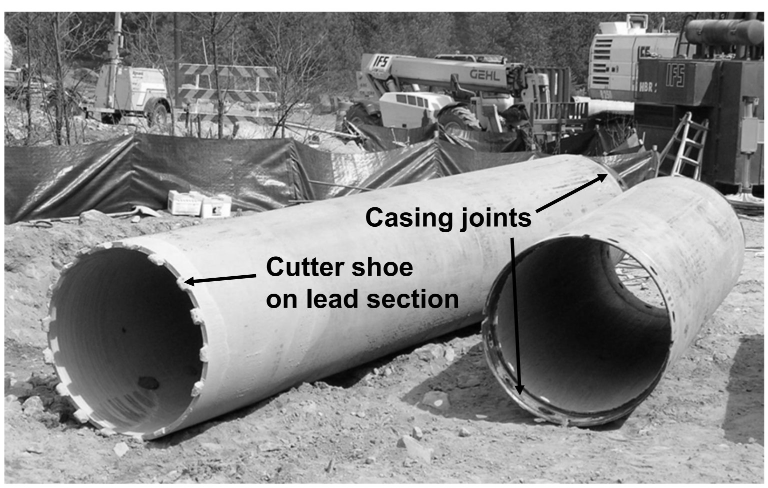
Casing

There are three major types of casing for drilled shafts:

1) **Temporary Casing** – used to stabilize the hole during drilling operations. This casing must be extracted during concrete placement.
2) **Permanent Casing** – can also be used to stabilize the hole during drilling operations or plug large voids. In such cases the shaft is designed for this casing to stay in place upon hole completion.
3) **Isolation Casing** – a special kind of permanent casing that allows post-construction access to the non-contact lap splice between the foundation shaft and the bridge column.

29

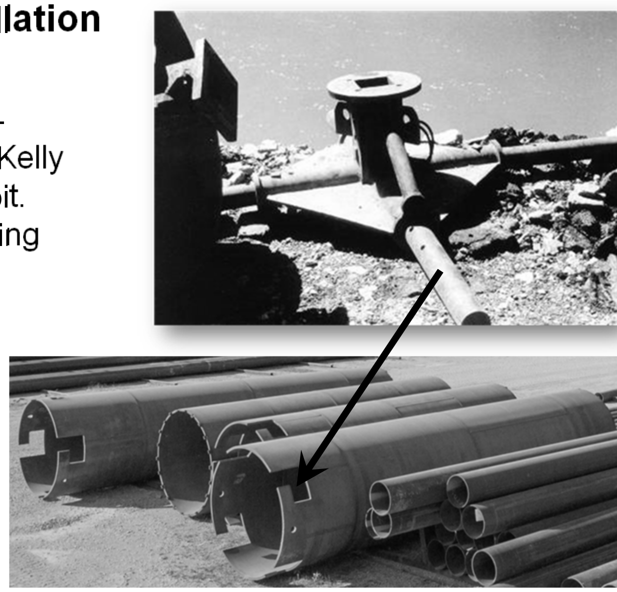
Casing



30

Casing Installation

- **Casing Tool** – placed on the Kelly rather than a bit. Twists the casing into place.



31

Casing Installation

- **Vibratory Tool** – used for both placement and extraction.

32

Casing Installation

- **Casing Advancer** – This is a special adaptation for modern drill rigs that allows the casing to be advanced at the same time as the drilling occurs.

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33

Casing Installation

- **Casing Oscillator** – A special device that can independently twist the casing in and out of the excavation.

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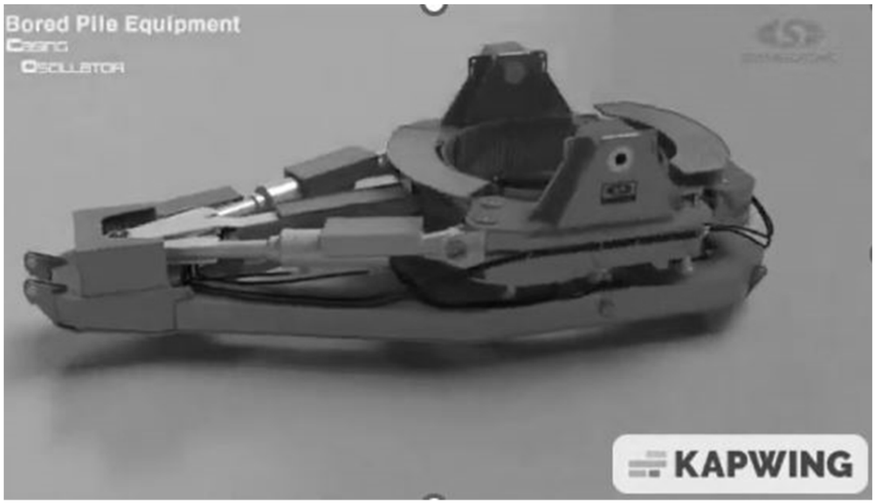
Casing Oscillator - Operation



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ODOT Drilled Shaft Inspection Checklist

Excavation

Shaft Excavation & Cleaning

☐ Yes ☐ No ☐ NA 16. Have the locations for the drilled shafts been accurately located and marked, and both the Contractor and Inspector understand the survey markings?

☐ Yes ☐ No ☐ NA 17. Is the shaft being constructed in the correct location and vertical alignment according to tolerances in Section (00512.42)?

☐ Yes ☐ No ☐ NA 18. Is the slurry level being properly maintained in accordance with 00512.43(f)?

☐ Yes ☐ No ☐ NA 19. Are the proper number and types of tests being performed on the slurry and reported in accordance with 00512.43(g)?

☐ Yes ☐ No ☐ NA 20. Are all excavated materials (spoils) properly contained and disposed of in accordance with 00512.43(a)?

☐ Yes ☐ No ☐ NA 21. If temporary casing is being used, does it meet the requirements of Section 00512.43(c)?

☐ Yes ☐ No ☐ NA 22. Is the shaft of proper depth?

☐ Yes ☐ No ☐ NA 23. Does the shaft bottom meet the clean-out requirements of Section 00512.43(h)?

☐ Yes ☐ No ☐ NA 24. Have the drilled shaft excavation forms been completed?

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ODOT Drilled Shaft Inspection Checklist

Concrete Placement

Concrete Operations

☐ Yes ☐ No ☐ NA 31. Prior to concrete placement, has the slurry (both manufactured and natural) been tested in accordance with Section 00512.43(g)??

☐ Yes ☐ No ☐ NA 32. If required, was the casing removed in accordance with Section 00512.47(e)?

☐ Yes ☐ No ☐ NA 33. Does the Contractor's tremie meet the requirements of Section 00512.47(a)?

☐ Yes ☐ No ☐ NA 34. Was the discharge end of the tremie maintained in the concrete mass with proper concrete head above it at all times (00512.47(c))?

☐ Yes ☐ No ☐ NA 35. For shafts with non-contact splices, have the cold joints been properly cleaned and roughened in accordance with Section 00512.47(a)?

☐ Yes ☐ No ☐ NA 36. For shafts without non-contact splices, did the Contractor overflow the shaft until good concrete flowed out of the top of the excavation (00512.47(a))?

☐ Yes ☐ No ☐ NA 37. Have the Concrete Placement and Concrete Volume logs been completed?

☐ Yes ☐ No ☐ NA 38. Were the concrete acceptance tests performed as required?

☐ Yes ☐ No ☐ NA 39. Were the Crosshole Sonic Log (CSL) tubes filled with water and capped in accordance to Section 00512.46?

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37

ODOT Drilled Shaft Inspection Checklist

Pile Acceptance

Post Installation

☐ Yes ☐ No ☐ NA 40. Is all casing removed to the proper elevations in accordance with 00512.47(e)?

☐ Yes ☐ No ☐ NA 41. Is the concrete being cured in accordance with Section 00540.51?

☐ Yes ☐ No ☐ NA 42. Has all Crosshole Sonic Log (CSL) Testing been completed in accordance with Section 00512.48?

☐ Yes ☐ No ☐ NA 43. Is the shaft within the allowable construction tolerances (00512.42)?

☐ Yes ☐ No ☐ NA 44. Has the Contractor completed the Drilled Shaft Inspection Report (00512.40(c))?

☐ Yes ☐ No ☐ NA 45. Has the Inspector completed the Drilled Shaft Inspection Report (00512.40(c))?

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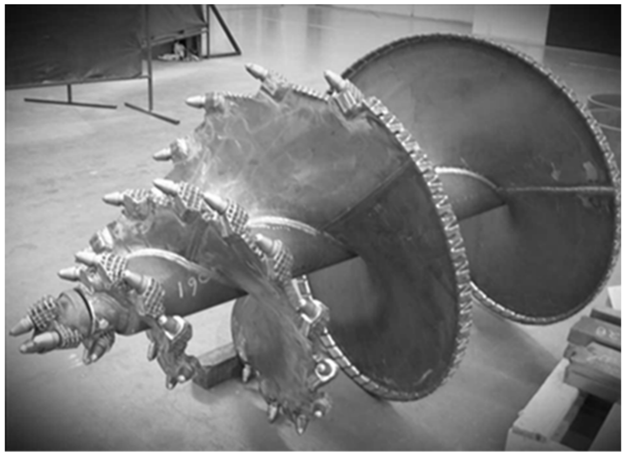
Unit Review



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Unit Review

- Drill rigs come in many shapes and sizes.
- Soil auger tools have square teeth.
- Rock auger tools have carbide “bullet” teeth.
- There are three kinds of casing, which as the inspector, you need to keep tract of for your checklist.

40

INSERT TAB

4. Shaft Excavation

Shaft Excavation

Shaft Types and Construction Issues

1

Inspector Duties
Shaft Excavation and Cleaning

- Verify Staking
- Classify soils and rock
- Prepare shaft excavation logs
- Verify shaft depth
- Perform shaft inspection
- Validate shaft inspection report
- Verify hole cleanliness
- Document casing use, type, length

2

Inspector's Drilled Shaft Excavation Log

Oregon Department of Transportation

DRILLED SHAFT EXCAVATION LOG

PROJECT		BRIDGE NO.	CONTRACT NO	
BENT	STATION	SHAFT NO.	SHAFT DIAMETER	
DRILLED SHAFT CONTRACTOR		INSPECTED BY	CERTIFICATION NO.	DATE

DATE/TIME EXCAVATED
START FINISH:

TYPE OF CONSTRUCTION
☐ DRY ☐ WET

ELEVATIONS
Reference Elev. ____
Grd. Surface Elev. ____
Water Table Elev. ____
Top Shaft Elev. ____
Msd Top Rock Elev. ____
Msd Avg. Shaft Bot Elev. ____

DIMENSIONS
Soil Auger Dia. ____
Soil Shaft Length ____
Rock Auger Dia. ____
Rock Socket Length ____
Construc. Shaft Length ____

DRILLING SLURRY
Slurry Type & Manufacturer : ____
Slurry Meets Specifications? Y N

CLEANOUT METHOD
Bucket ____ Airlift ____ Pump ____
Other: ____

BOTTOM INSPECTION
Visual ____ Tape/Probe ____
Record 5 depths to the bottom of finished shaft:
1 ____ 3 ____
4 ____
2 ____ 5 ____
Ave. Shaft Bottom Elev.: ____
Meet Cleanout Specification? Y N
Meet Alignment Specifications? Y N

CASING INFORMATION (if applicable)

Casing (Temp / Perm)	Casing (Temp / Perm)	Casing (Temp / Perm)
Type ____	Type ____	Type ____
OD (in.) ____	OD (in.) ____	OD (in.) ____
Thickness ____	Thickness ____	Thickness ____
Top Elev. ____	Top Elev. ____	Top Elev. ____
Length: ____	Length: ____	Length: ____

Record and describe all materials encountered during drilled shaft excavation, water table information, depths of seepage and seepage rates, obstructions encountered, equipment used and equip. breakdowns (use additional sheets if necessary).

3

Drilled Shaft Excavation Tolerance Criteria
00512.42

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

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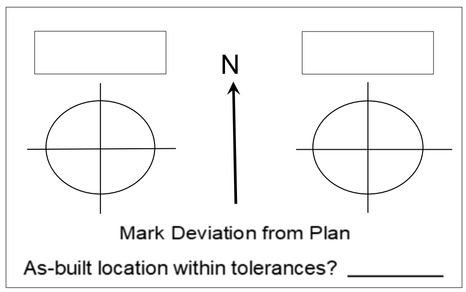
4

Drilled Shaft Excavation Tolerance Criteria

Horizontal Position
(at the Plan Top Elevation of the Shaft)

- **Shaft Diameter less than or equal to 6 feet** – 3-inch horizontal tolerance from the location shown.
- **Shaft Diameter greater than 6 feet** – 6-inch horizontal tolerance from the location shown.



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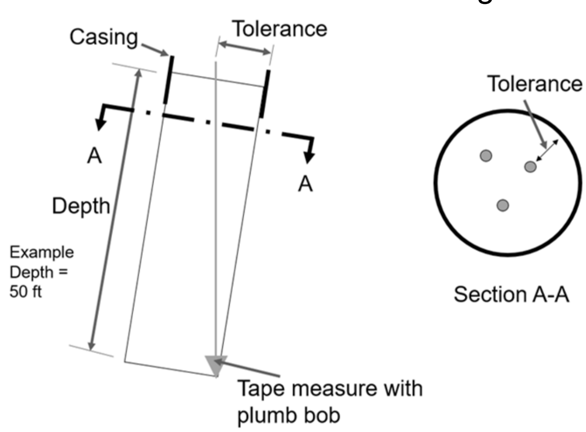
Drilled Shaft Excavation Tolerance Criteria

Vertical Alignment

- In soil – not more than 1.5% of shaft length
- In rock – not more than 2.0% of shaft length



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Drilled Shaft Excavation Tolerance Criteria

- Weighted Plumb-Bob

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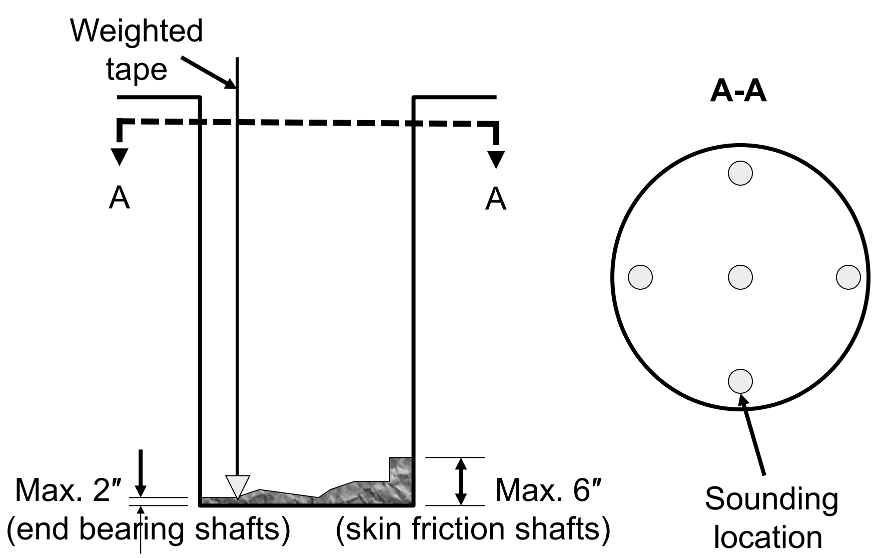
Checking Shaft Bottom – 00512.43(h)



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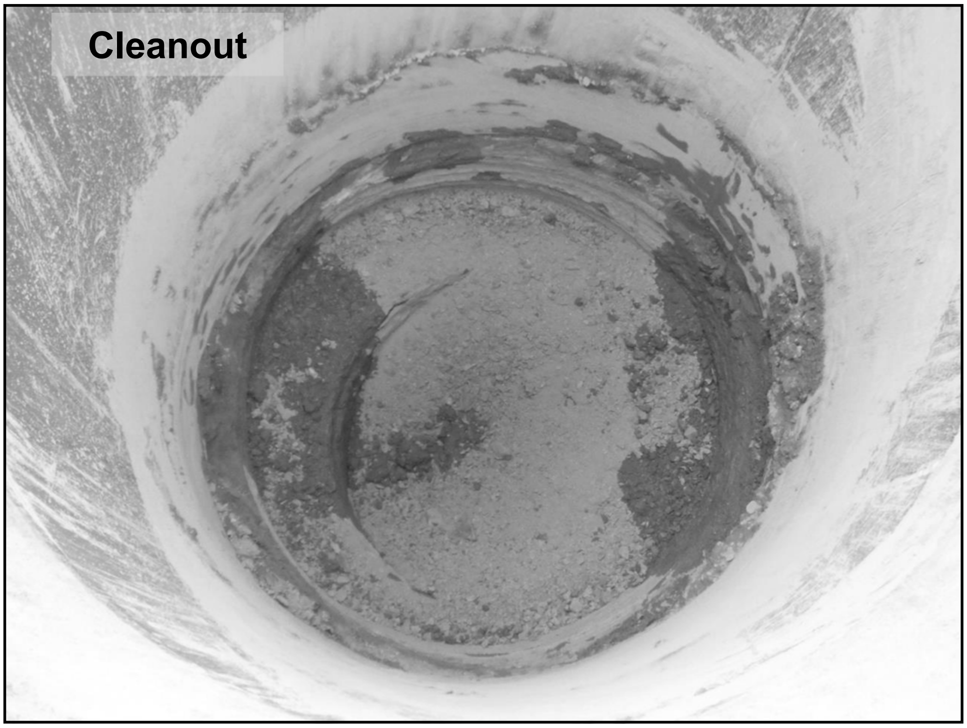
Cleanout



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Learning Objective

Explain methods of assessing and verifying shaft cleanliness

The maximum depth of sediment or debris permitted anywhere on the shaft bottom is ___?

10

Learning Objective
Explain methods of assessing and verifying shaft cleanliness

The maximum depth of sediment or debris permitted anywhere on the shaft bottom is ___?

00512.43(h) Clean Out
- 2 inches max if end-bearing
- 6 inches max if frictional bearing

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Learning Objective
Describe how to verify checklist questions 16-24.

What is the allowable horizontal tolerance for the plan position of a 6 ft. diameter shaft?

A. 2″
B. 3″
C. 5″
D. 6″

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Learning Objective
Describe how to verify checklist questions 16-24.

What is the allowable vertical alignment tolerance for a shaft constructed in soil?

A. 3″
B. 6″
C. 1.5%
D. 2.0%

13

Dry Shafts
Learning Objectives

Describe the dry shaft construction process.

Describe typical/potential construction problems associated with dry shafts.

14

What is a dry shaft?

A shaft excavation that can be excavated to its designed depth without the need for side support (slurry or casing).

00512.47 (b) Dry Shaft Concrete Placement –

- No more than **3 inches** of water is present in the bottom of the excavation at the beginning of the pour.
- Groundwater seepage into the excavation is at a rate of no more than **12 inches per hour**.
- Shaft diameter is greater than or equal to 3 feet.

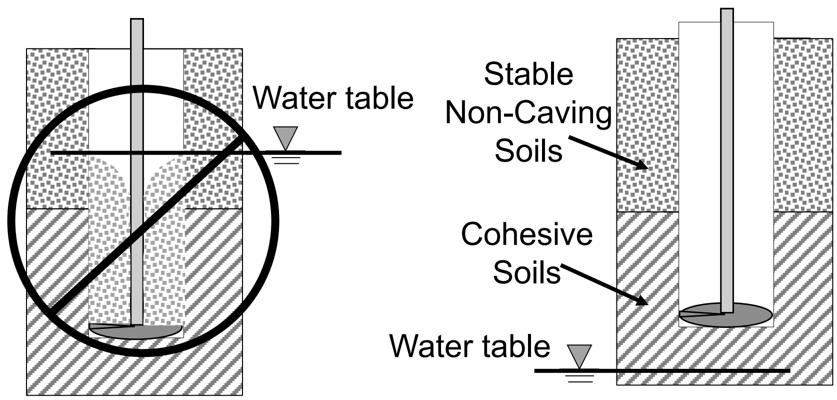
15

When Used

- In place soil/rock will keep the hole walls from collapsing.
- Construction of the shaft can be in relatively dry conditions.

16

Water Above or Below the Shaft Tip Elevation

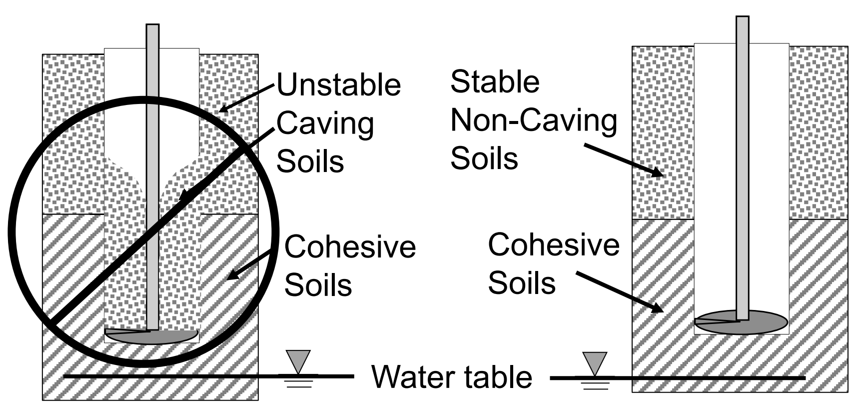


Generally, soils cave at the water table preventing hole stability

Water table below shaft tip does not impact hole stability

17

Stable vs. Unstable Soils

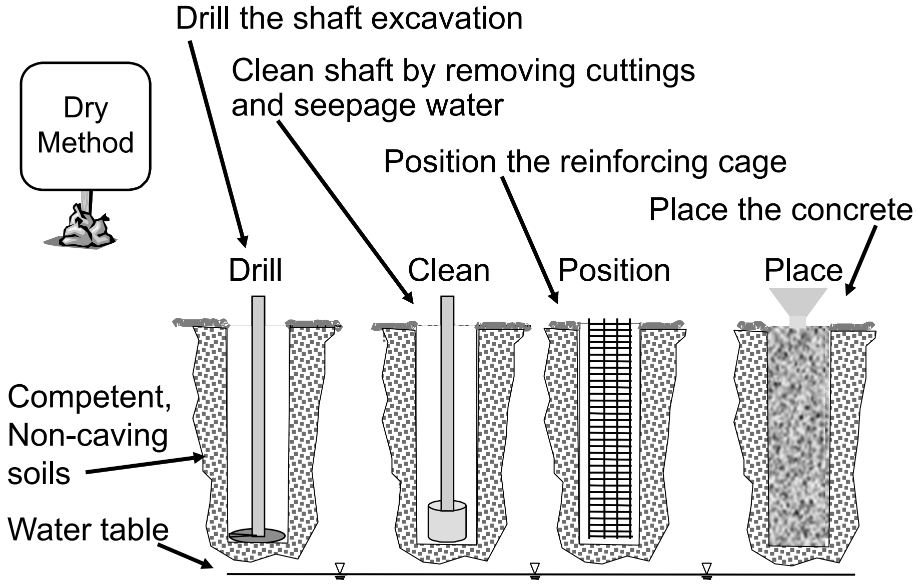


Unstable caving soils prevent maintaining hole stability

Stable non-caving soils maintain hole stability

18

Construction Process



19

Typical Problems

Soils are unstable and Contractor attempts to force dry shaft construction	Caving problems will lead to soil inclusions in the shaft concrete thereby affecting shaft integrity.
Water table is too high	Caving problems will lead to soil and sediment inclusions in the shaft concrete thereby affecting shaft integrity.

20

Typical Problems (continued)

Excavation open too long prior to concrete placement

Soils that were capable of maintaining hole stability slowly lose that ability, resulting in caving leading to soil inclusions in the shaft concrete.

21

Wet Shafts
Learning Objectives

- Recognize the difference between dry and wet shaft construction
- Describe the wet shaft construction process
- Describe and identify mineral and polymer slurry and other drilling fluids
- Describe typical construction problems associated with wet shafts

22

What is a wet shaft?

Often called the “slurry-method”, wet shaft construction is when a slurry or water is used to keep the hole stable for the entire depth of the shaft.

00512.47 (c) – Wet Shaft Concrete Placement
If the drilled shaft excavation does not meet the requirements for dry concrete placement,…

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23

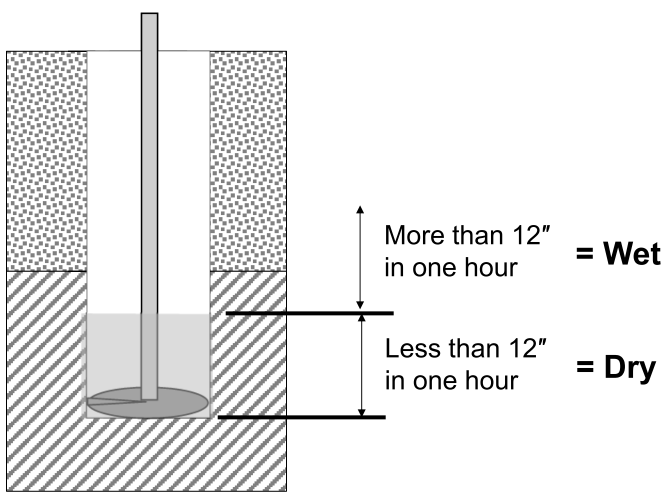
24

Wet vs. Dry?

- The sides of the hole will not remain stable.
- Accumulated loose material and water cannot be removed.
- Has more than 3″ of accumulated water in the bottom of the shaft at the time of the pour.
- Requires more equipment.
- Requires more Contractor expertise.
- It is more expensive.

25

When a dry excavation can not be maintained



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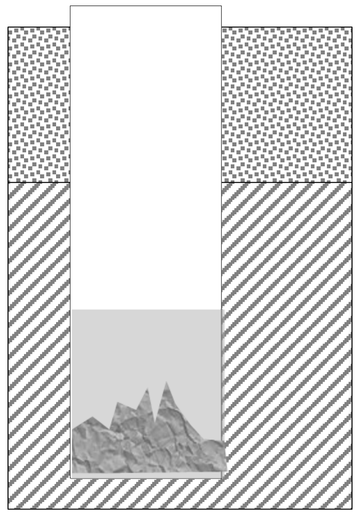
When loose material and water can not be satisfactorily removed



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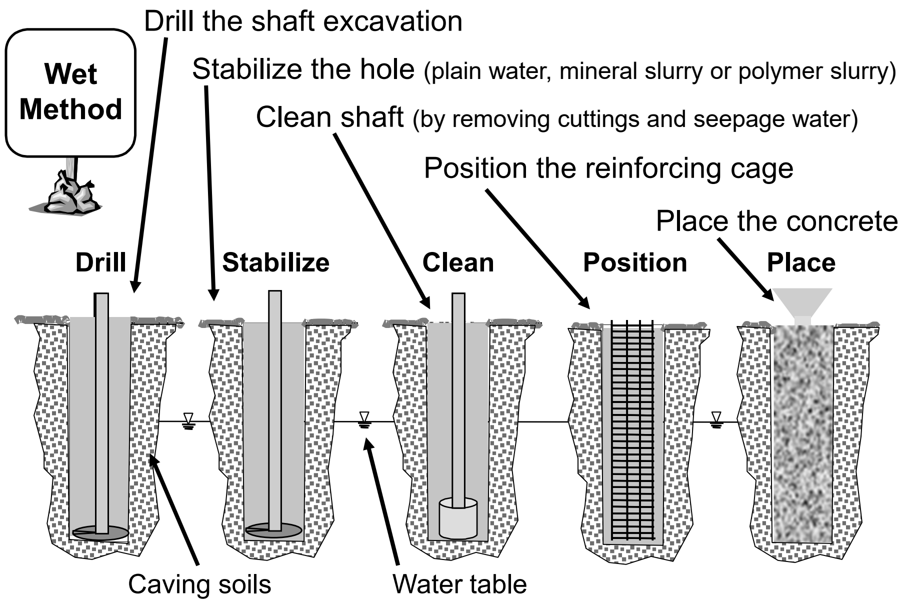
Construction Process



28

Learning Objective

Recognize the difference between dry and wet shaft construction

What is a significant difference between dry and wet construction to the Inspector?

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00512.14 – Drilling Slurry

Furnish drilling slurry meeting:

- Mineral Slurry
  - 40°F or more during testing
- Synthetic Slurries
  - From the QPL
- Water Slurry
  - Allowed with Engineer's approval
- **Do not use blended slurries**

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What does the slurry do?

- Maintains borehole stability prior to placement of concrete
- Retards softening or loosening of the soil while the hole is open
- Facilitates removal of cuttings in "circulation drilling"

31

Types of Slurry

- Water
- Polymer
  - Must be hydrated (i.e. mixed with water)
- Natural mineral clays
  - Bentonite, attapulgite and sepiolite
  - Bentonite is the most common
    - Attapulgite and sepiolite are typically used in saltwater environments
  - Must be hydrated (i.e. mixed with water)

Works by suspending cuttings.

32

Types of Slurry

Polymers are semi-synthetic or totally synthetic chemical slurries (works by allowing cuttings to settle).

33

How Drilling Slurries Work

Slurry Type	Mechanisms	Spec 00512.14(a), (b), (c)				Spec 00512.43(f)	Best Application	Caking Ability	Suspension Ability
		Density (lb/cu ft)	Viscosity (sec/qt)	pH	Sand Content (%)	Head above groundwater (ft)			
Water	Hydrostatic Pressure (moderate)	≤ 70	N/A	N/A	≤ 2.0	10	N/A	Low	Low
Synthetic (aka Polymer)	Hydrostatic Pressure (moderate) Cuttings settle, removed from bottom of hole (long chain polymers)	N/A	N/A	N/A	<2.0	10	Cohesive soils (clay) Iffy in silt rich soils	Moderate	Low
Natural Mineral Clay • Bentonite • Attapulgite- SW • Sepiolite -SW	Hydrostatic Pressure (high) Suspends cuttings, removed with circulation drilling	64-75	26-50	8-11	≤4.0	5	Cohesionless soils (sand, low PI silt)	High	High
Note: Potable water has a density of 62.4 lb/ cu ft and a viscosity of 26 sec/qt									

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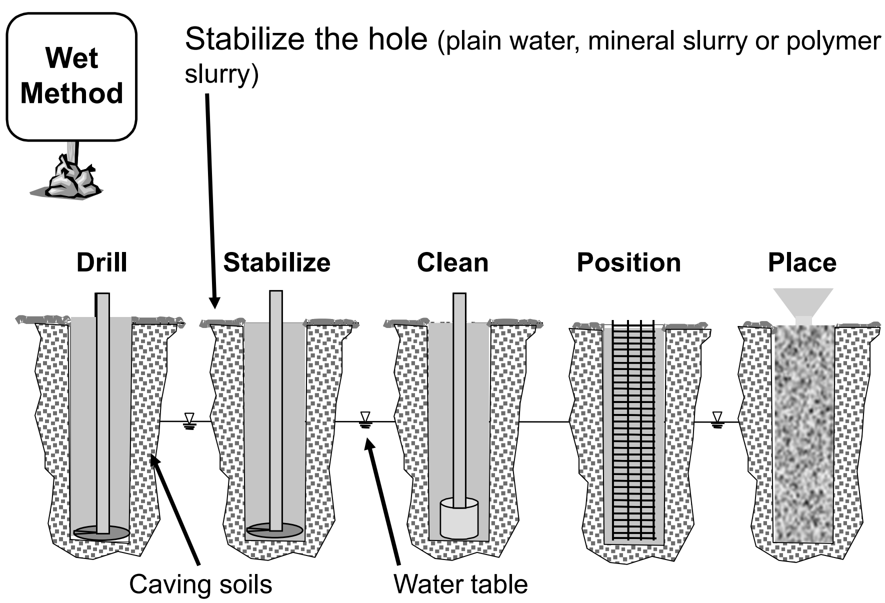
Slurry Comparisons

	Mineral Slurry	Polymer Slurry
Best Application	Cohesionless soils	Clays and argillaceous rock
Mixability	Difficult- must be hydrated for extended time	Easy
Mix Water Sensitivity	Saltwater sensitive	Yes/No
"Caking" Ability	Best	OK
Suspension Ability	Best	OK

35

Construction Process



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Synthetic Slurries on the Qualified Products List (QPL)

- 00512.14: SYNTHETIC SLURRY: **BIG-FOOT SLURRY SYSTEM**, MATRIX CONSTRUCTION PRODUCTS
- 00512.14: SYNTHETIC SLURRY: **SHORE PAC**, CETCO CONSTRUCTION DRILLING WAS CALLED SHORE PAC GCV
- 00512.14: SYNTHETIC SLURRY: **SLURRY PRO**, CDP KB INTERNATIONAL
- 00512.14: SYNTHETIC SLURRY: **SUPER MUD**, PDS COMPANY
- 00512.14: SYNTHETIC SLURRY: **TERRAGEL**, GEO-TECH SERVICES

37

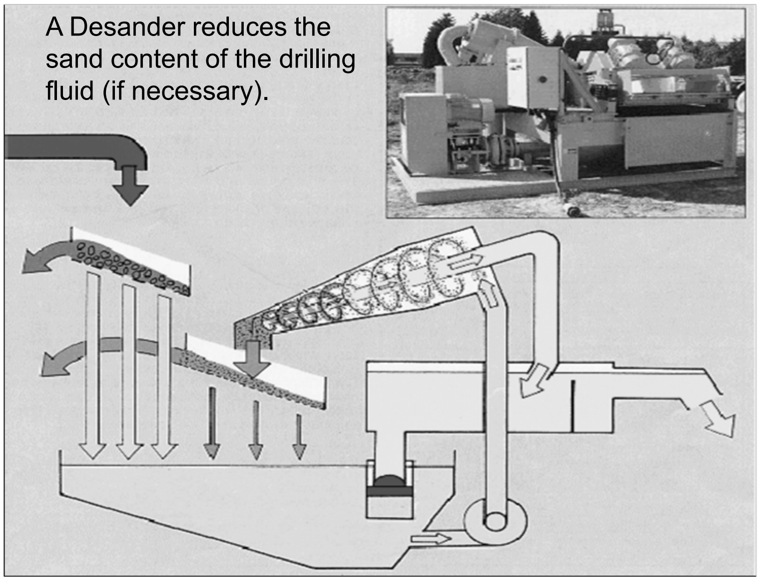
Controlling Slurry – 00512.43 (g)

Control tests are used to maintain proper slurry condition. Tests are conducted for:

- Density – the slurry weight.
- Viscosity – flow : consistency.
- pH – acidity : alkalinity.
- Sand content.
- **Slurry testing is performed by the contractor** in conformance with the quality control plan submitted with the Drilled Shaft Installation Plan.
- Two consecutive acceptable sets of tests are required.
- Each set consist of one test at mid-depth and one test within 24 inches of the bottom.

38

De-Sanding with Slurry



39

Slurry Sampling: Submersible Sampler

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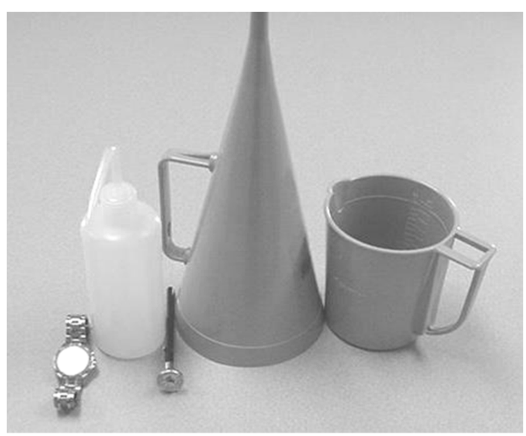
40

Slurry Testing Tools

41

Viscosity Test

- Also known as Marsh Funnel Test
- Measures the flow rate (i.e., consistency)



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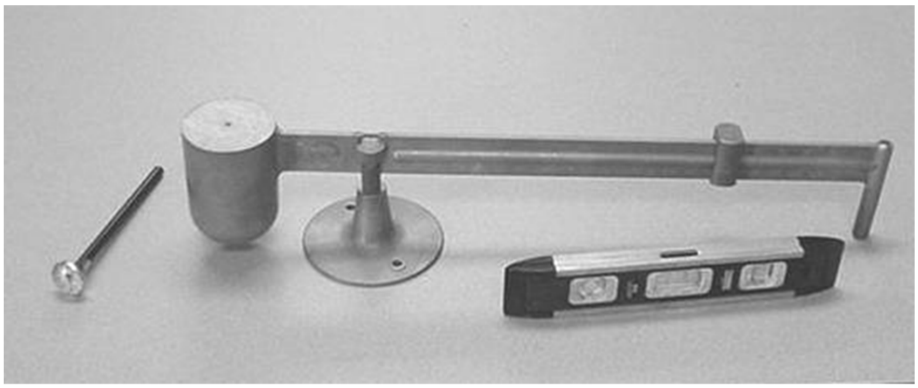
Mud Balance Test

- Also known as Mud Density Test
- Measures the density (i.e., weight)



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Sand Content Test

- For determining the sand content of the slurry mix
- Reported in volume percent

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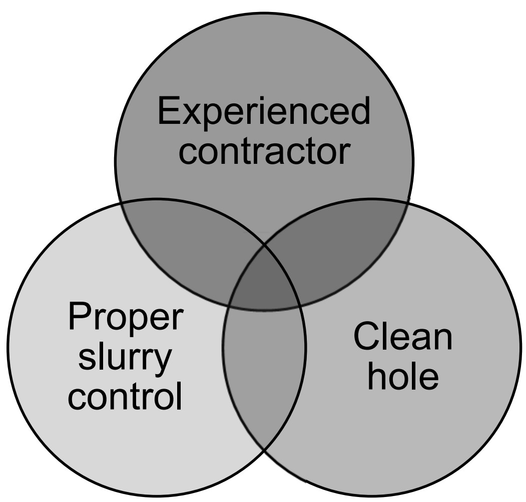
Key elements to quality wet shaft construction are:



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Problems with Improper Slurry Control

- Fails to properly suspend and facilitate the removal of sediments and cuttings.
- Does not control caving.
- Does not control swelling of soils.
- Hinders slurry removal during concrete placement.
- Leads to a soil contaminants in concrete.
- Creates anomalies in the concrete that can show up during CLS testing.

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Learning Objective
Describe and identify mineral and polymer slurry and other drilling fluids.

Which of the following is NOT a main type of slurry?

A. Mineral
B. Oil
C. Synthetic
D. Water

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Learning Objective

Describe and identify mineral and polymer slurry and other drilling fluids.

The sand content of mineral slurry is to be no greater than what percentage?

A. 2%
B. 3%
C. 4%
D. 5%

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Learning Objective

Describe and identify mineral and polymer slurry and other drilling fluids.

Which is NOT a common control test performed on mineral slurry?

A. Viscosity
B. Sand content
C. pH
D. Air content

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Cased Method
Learning Objectives

Explain why casing is used in both dry and wet holes.

Describe the cased shaft construction process.

Describe typical construction problems associated with the use of casing.

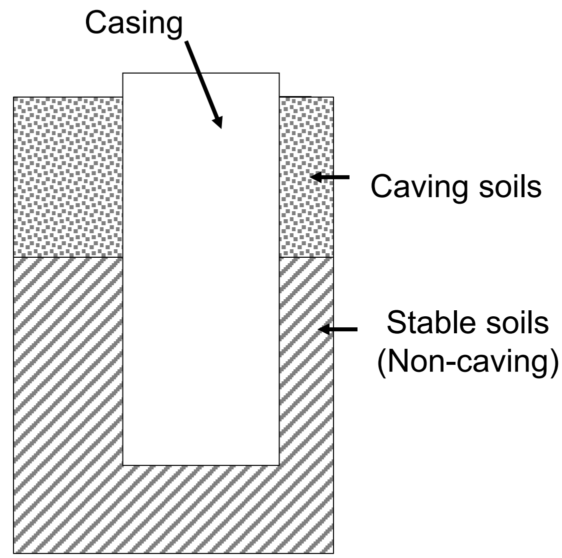
51

When is Casing Used?

- When an open hole **cannot** be maintained.
- When soil or rock deformation will occur.
- When constructing shafts below the water table or caving soils.

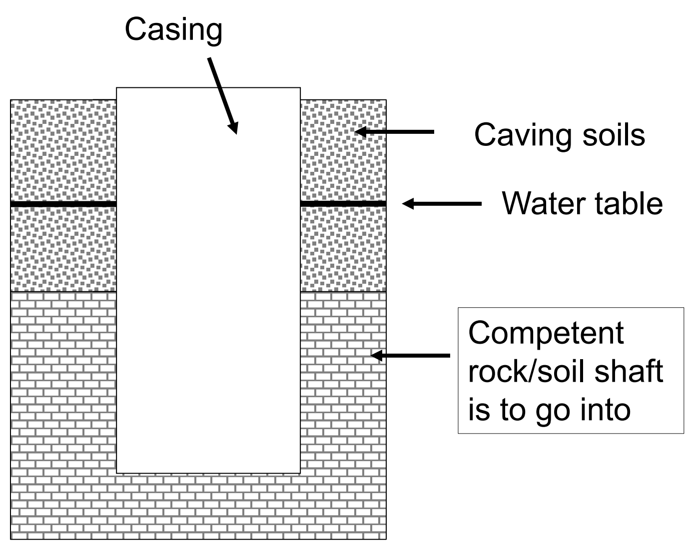
52

In Dry Holes (Animation)



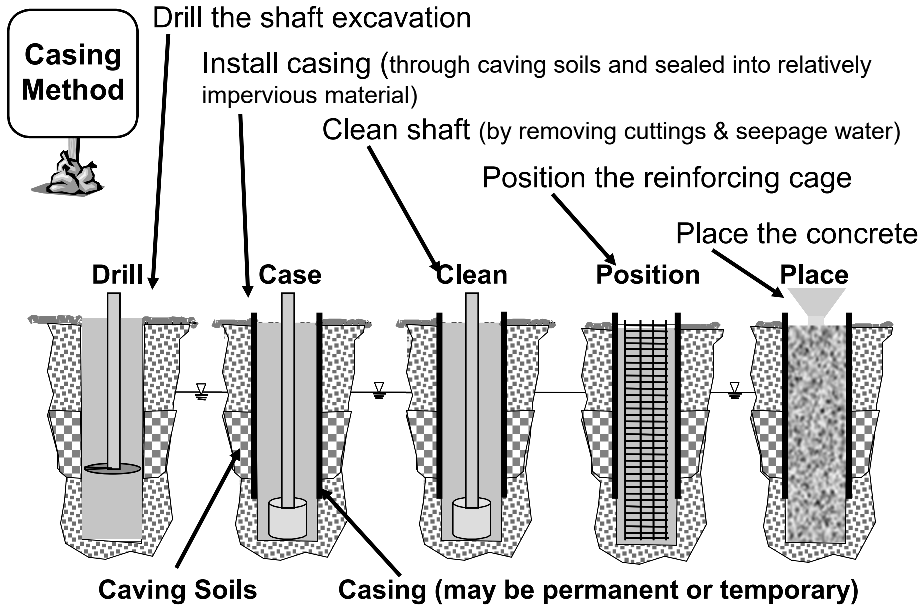
53

In Wet Holes (Animation)



54

Construction Process



55

The Casing Construction Process

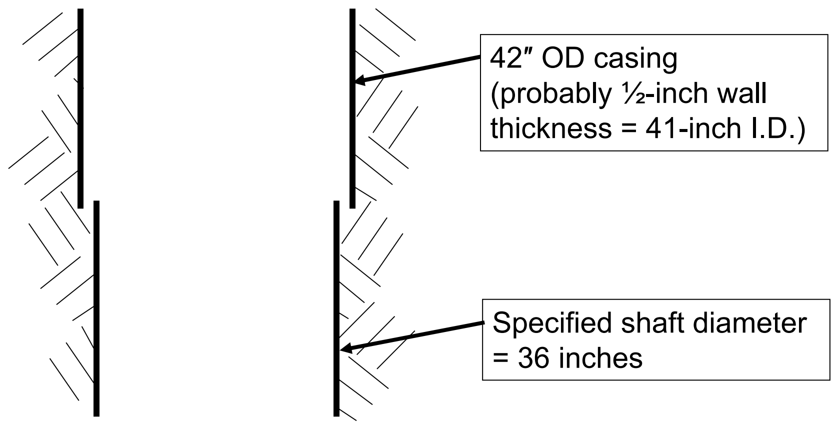
Generally, the casing method is more expensive and difficult than the dry construction method.

Key elements to quality cased holes are:

- Experienced Contractor
- Good casing material
- Experienced rig operator

56

Telescoping Casing



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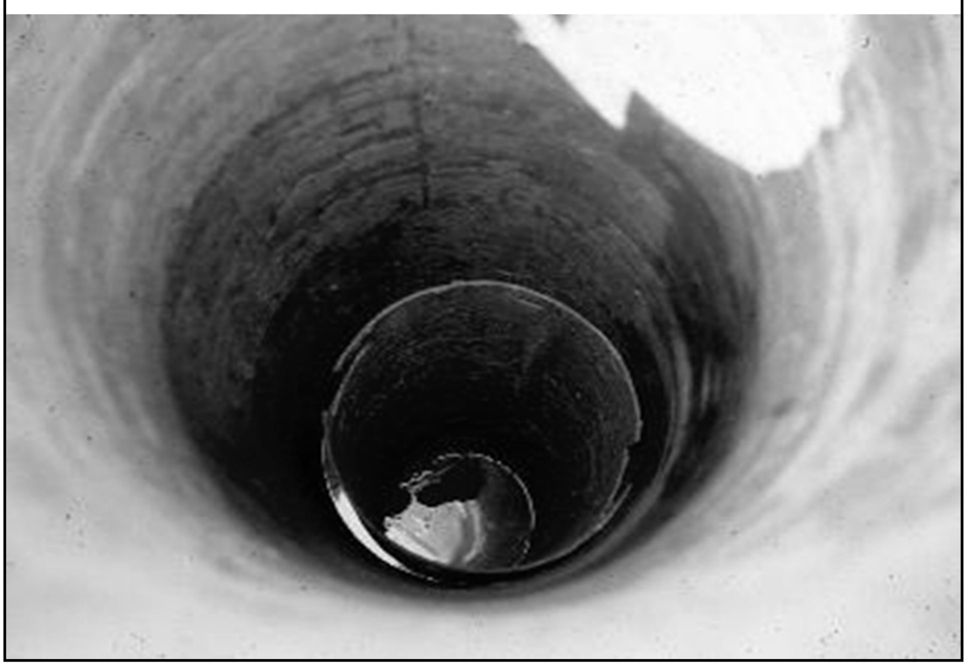
Telescoping Casing



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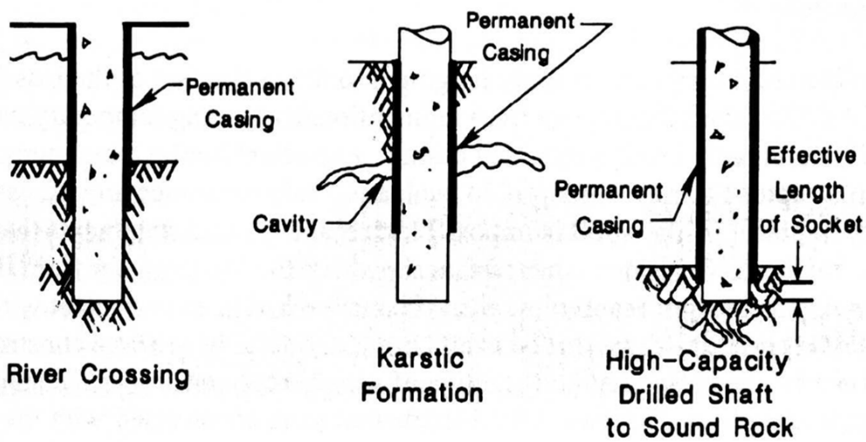
Examples of Permanent Casing



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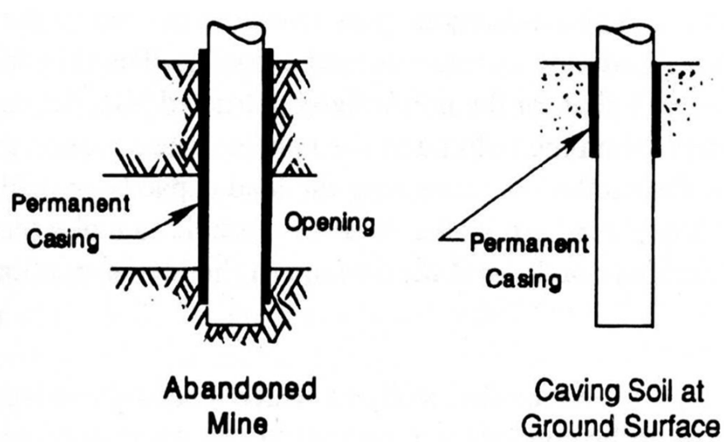
Examples of Permanent Casing



60

Typical Problems with Casing

- Casing not “clean”
- Casing damaged
- Casing not sealed properly
- Casing not structurally adequate
- Casing gets “stuck” during removal or installation.

61

Common Problems

- **Temporary casing that cannot be removed** – In some cases, especially cases with squeezing ground conditions, the crane handling the casing doesn’t have the power to pull out the casing.
- **Horizontal separation or severe necking** – This shaft problem can occur if the temporary casing has concrete adhering to it when pulled.

62

Specialty Tools: Shaft Inspection Device (SID)

- This is downhole video camera system designed to allow imaging at the bottom of a wet hole.

ODOT MATERIALS & INSPECTION

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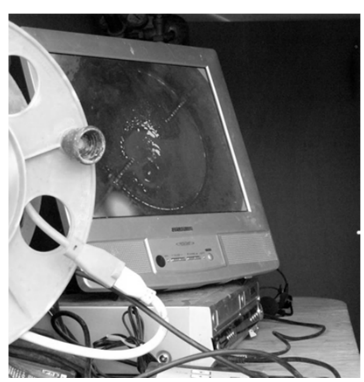
Shaft Inspection Device



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Lost Tools: 00512.43(e)

Remove any lost tools → No compensation will be made for lost tool removal

Lost Tools - Promptly remove drilling tools lost in the excavation. Lost tools will not be considered unexpected obstructions and shall be removed without additional compensation. Drilling tools lost during the course of removing unexpected drilled shaft obstructions will be paid according to 00195.20.

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Unexpected Drilled Shaft Obstructions

00512.43 (d) Unexpected Drilled Shaft Obstructions – Remove any natural or manmade object encountered that was not revealed by the Agency's site investigation, and that would cause a significant decrease in the rate of advancement if removed using the techniques and equipment used successfully to excavate the shaft. **The Engineer will be the sole judge of the significance of any reduced rate of shaft advancement and the classification of any unexpected obstructions.** Removal of unexpected obstructions from the shaft excavation will be paid according to section 00195.20.

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SS00512.80 – Measurement

(c) Drilled Shaft Excavation – Length

Drilled shaft excavation will be measured on the length basis by the vertical excavated length from the bottom of the shaft to the ground surface or to the mudline if under water. If the top of the shaft is located below the original ground surface, measurement will be made to the top of the shaft as shown or directed. If directed to excavate drilled shafts below the elevations shown, the drilled shaft excavation will be measured from the revised bottom of shaft.

67

SS00512.90 – Payment

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

Pay Item	Unit of Measurement
(c) Drilled Shaft Excavation, ___ Diameter	Foot

In item (c), the diameter of the shaft will be inserted in the blank. Item (c) includes excavating the shafts and disposing of the excavated material and for furnishing, placing, splicing, and removing temporary shaft casing and forms.

68

Unit Review

- Know your construction tolerances.
- Know the difference between dry and wet hole construction.
- Understand slurry types and use.
- Understand the use of casing.

69

Learning Objective

Describe how to verify checklist questions 16-24.

How high above the groundwater level must water slurry be maintained?

A. 5′
B. 10′
C. 15′
D. Does not apply for water slurries

70

Learning Objective
Describe how to verify checklist questions 16-24.

How many sets of tests are to be performed within the first 8 hours of slurry use?

A. 1
B. 2
C. 3
D. 4

71

Learning Objective
Describe how to verify checklist questions 16-24.

What intervals up the slurry column, within the excavation, should slurry samples be obtained for testing?

A. Random locations
B. Mid-depth
C. Within 24″ of bottom
D. Both B and C

72

INSERT TAB

5. Steel Reinforcement

Steel Reinforcement

Lesson 5

1

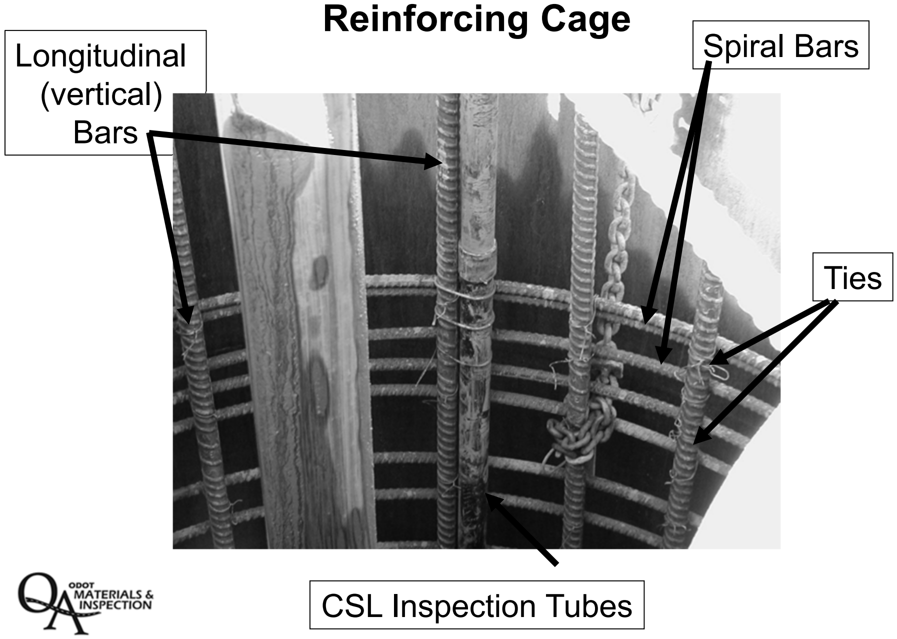
Steel Reinforcement
Learning Objectives

- Review inspector's checklist for inspection
- Use inspection checklist to ensure contractor’s compliance with cage construction/placement
- Determine the circumference of a shaft and rebar cage
- Calculate the required number of side spacers

2

3

Reinforcing Cage



4

Rebar Design

Longitudinal reinforcement (vertical)

- Resist bending stresses
- Resist tension stresses

Transverse reinforcement (spirals or hoops)

- Resist shearing forces
- Hold longitudinal steel in place
- Resist flexural stresses

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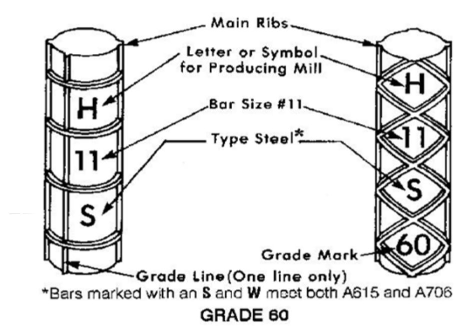
5

Rebar Cages

- "Deformed" bars
- With specified strength
  - 40 ksi
  - 50 ksi
  - 60 ksi
- See QPL for approved rebar manufacturers



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ODOT Drilled Shaft Inspection Checklist

Post-Excavation – Steel Placement

Reinforcing Cage (Construction & Placement)

☐ Yes ☐ No ☐ NA 25. Is the rebar the proper grade steel, correct sizes and correct configurations as shown in the project plans and shop drawings?

☐ Yes ☐ No ☐ NA 26. Is the rebar properly tied in accordance with Section 00530.41(b)?

☐ Yes ☐ No ☐ NA 27. Are the proper number of Crosshole Sonic Log (CSL) tubes furnished and installed according to the project plans?

☐ Yes ☐ No ☐ 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 00512.45(d)?

☐ Yes ☐ No ☐ NA 29. If the steel cage was spliced, was it done in accordance with the details shown on the contract plans?

☐ Yes ☐ No ☐ NA 30. Is the steel cage adequately secured to maintain vertical tolerance during concrete placement operations (00512.45(a) and 00512.47(e))?

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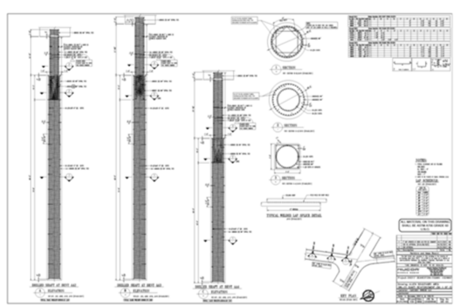
Inspector's Roles, and Responsibilities

Are the shop drawings consistent with the Plans?

- Size and number of longitudinal bars
- Size, pitch (slope) and spacing of transverse bars
- Number of CSL tubes
- Splice length



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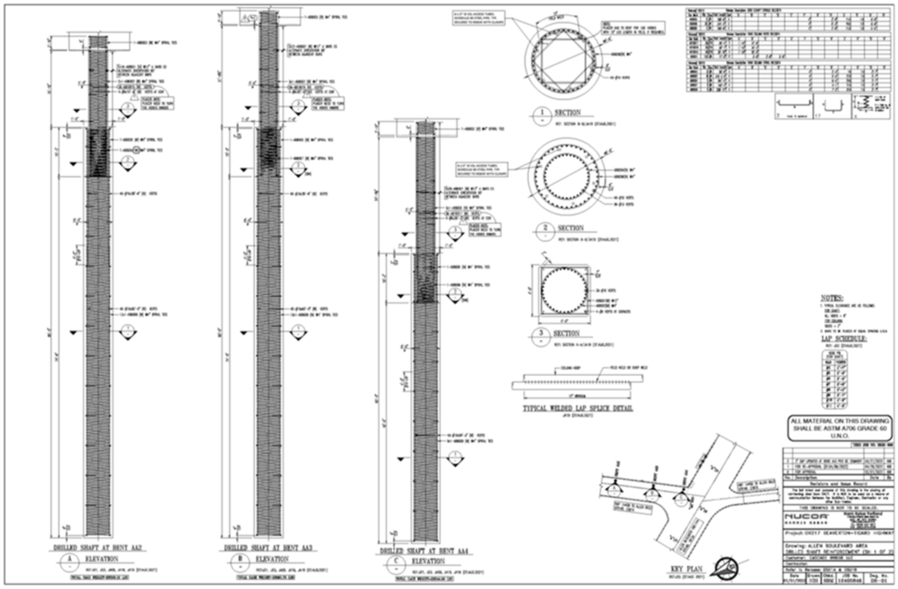
8

Shop Drawings Need to Match the Plan Details



9

Inspector's Roles, and Responsibilities (Rebar)

Is the rebar properly tied?

- 00530.41(b):
- Tie all bars unless closer than 1 foot, then every other.
- If bars are epoxy coated or stainless steel then so shall be the ties.
- Turn up legs at least 1/8 of an inch.

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10

Inspector's Roles, and Responsibilities (CSL Tubes)

Are the proper number of CSL tubes furnished and installed according to the plans?

11

Inspector's Roles, and Responsibilities (Splices)

Verify Splices

- Lap
- Mechanical
- Non-contact lap splice

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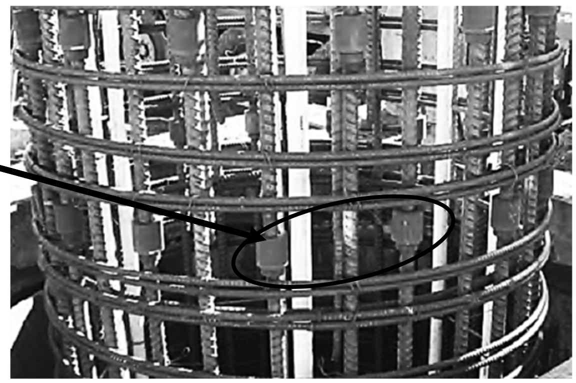
Inspector's Roles, and Responsibilities (Splices)

Verify Splices

- Lap
- Mechanical
- Non-contact lap splice



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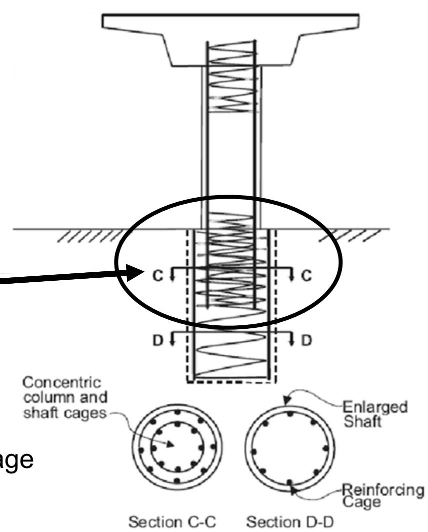
Inspector's Roles, and Responsibilities (Splices)

Verify Splices

- Lap
- Mechanical
- Non-contact lap splice



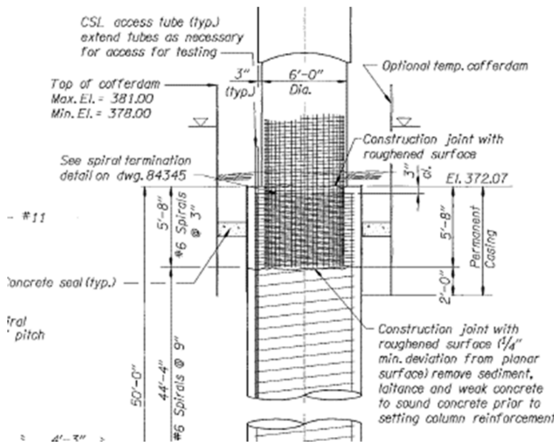
Any splicing of the reinforcement cage requires the **approval of the Structural Design Engineer**

14

Non-Contact Splice Example

Top of steel reinforcement

512.42 – Plus or minus 6 inches from the plan top of steel elevation



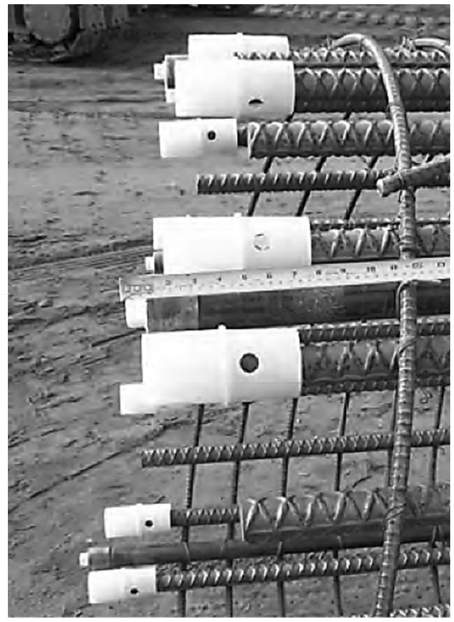
15

Rebar Cage Storage and Handling

- Cage should not be in contact with soil
- Keep away from oil or other deleterious materials
- These materials will degrade the bond with the concrete and may show up as anomalies during CLS testing.

16

Standoffs



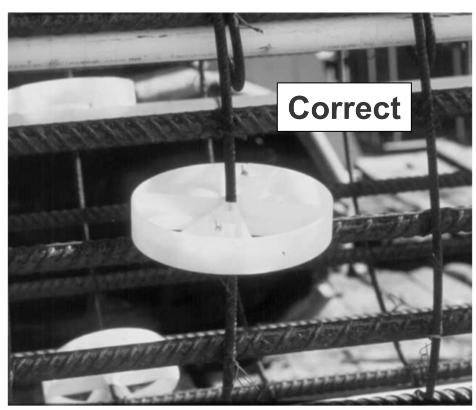
Standoffs

Used to maintain the bottom of the cage a certain distance, generally 6″, off of the ground

17

Spacers

Spacers: Used to maintain the minimum concrete cover between the cage and the walls of the shaft



18

Epoxy Coated Rebar Spacer

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Learning Objective

Spacers are used to:

A. Support the rebar cage
B. Aid the installation of the rebar cage
C. Maintain the minimum required concrete cover between the cage and the walls of the shaft
D. Make extra work for the Inspector and the Contractor

20

Learning Objective

Splice all drilled shaft reinforcement using approved __________ splicer's unless otherwise shown or approved.

A. mechanical
B. lap
C. welded
D. A & C are acceptable

21

Spacer Requirement

How many spacers are needed around the cage at each 10 ft. or less interval? Go to your approved Drilled Shaft Installation Plan!

Special Provisions 00512.45(d) Concrete Cover –
a maximum 30-inch circumferential spacing with at least three spaces per level

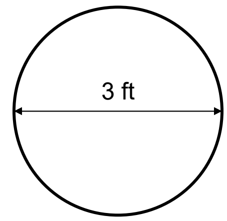
maximum 10-foot vertical spacings the full length of the shaft

Note: 30 inches = 2.5 ft

22

Circumference of Rebar Cage

- Where: C = circumference
  D = diameter
  π = 3.14



- What is the circumference of the rebar cage in feet?
  $C = \pi D$
  C = 3.14 (3’)
  C = 9.42 ft

23

Spacer Example

4 ft Drilled Shaft

6" clearance

How many spacers are required on each level?

C = π x D

C = 3.14 x __**3**__ = 9.42'

# of Spacers = 9.42' / 2.5' /Spacer = **2.6**

# of Spacers = **3**

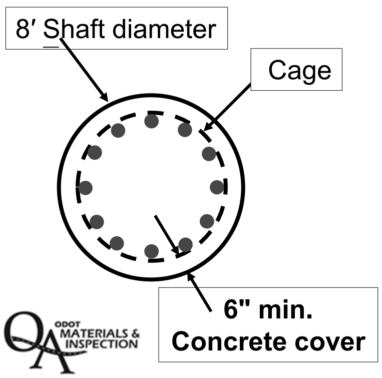
24

Circumference of the Reinforcing Cage

Where: Diameter of cage (D) = Shaft diameter – (2 x Concrete cover)
Circumference (C) = πD

π = 3.14

What is the circumference of the cage in feet?



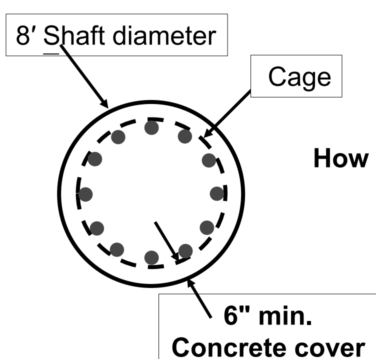
A. 16.3
B. 20.3
C. 21.9
D. 25.0

25

Circumference and Spacers

Where: Diameter of cage (D) = Shaft diameter – (2 x Concrete cover)
Circumference (C) = πD

π = 3.14



What is the circumference of the cage in feet?

$$C = 3.14(8' - 2(0.5'))$$

$$C = 3.14x7' = 22'$$

How many spacers are required per level?

\# of spacers = C / 2.5 ft
\# of spacers = 22 ft / 2.5 ft
\# of spacers = 8.8
\# of spacers = 9 per level

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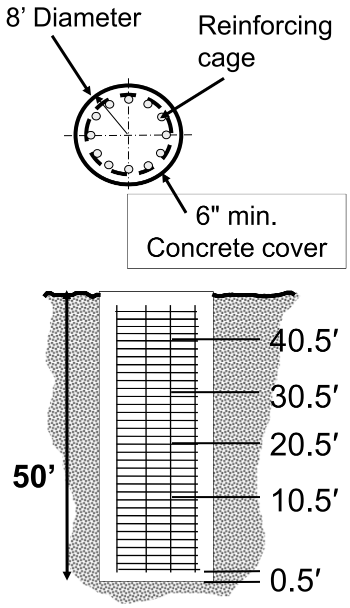
Side Spacers for Shaft Alignment



How many side spacers are required per level?

9 per level

If the length of the shaft is 50 feet how many levels are required? = 4

Total number of spacers = 4 x 9 = 36

27

Learning Objective

What is the required spacer placement around the circumference of a rebar cage?

A. 15″
B. 30″
C. 45″
D. North, South, East, West

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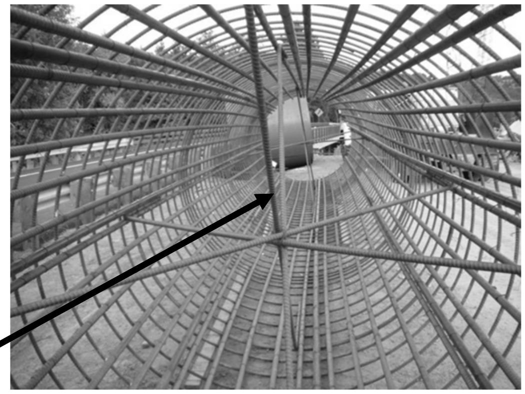
Rebar Cage Placement

00512.40(a): Unstamped reinforcing steel shop drawings and details of reinforcement placement, **including bracing**, splicing, centering, **and lifting methods and the method for supporting the reinforcement** according to 00150.35



Temporary Bracing or other internal supports removed during cage placement unless otherwise approved.

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Rebar Cage Placement

Lifting:

- Cage must remain strait and plumb.
- Any bent steel reinforcement must be replaced.
- Steel ties must not break.
- Any broken ties must be redone.

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Columbia River Crossing
Test Shaft: Cage Installation

June 2012

Drilled Shaft Inspection Certification

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Entire cage must
be replaced due
to excessive
flexure.

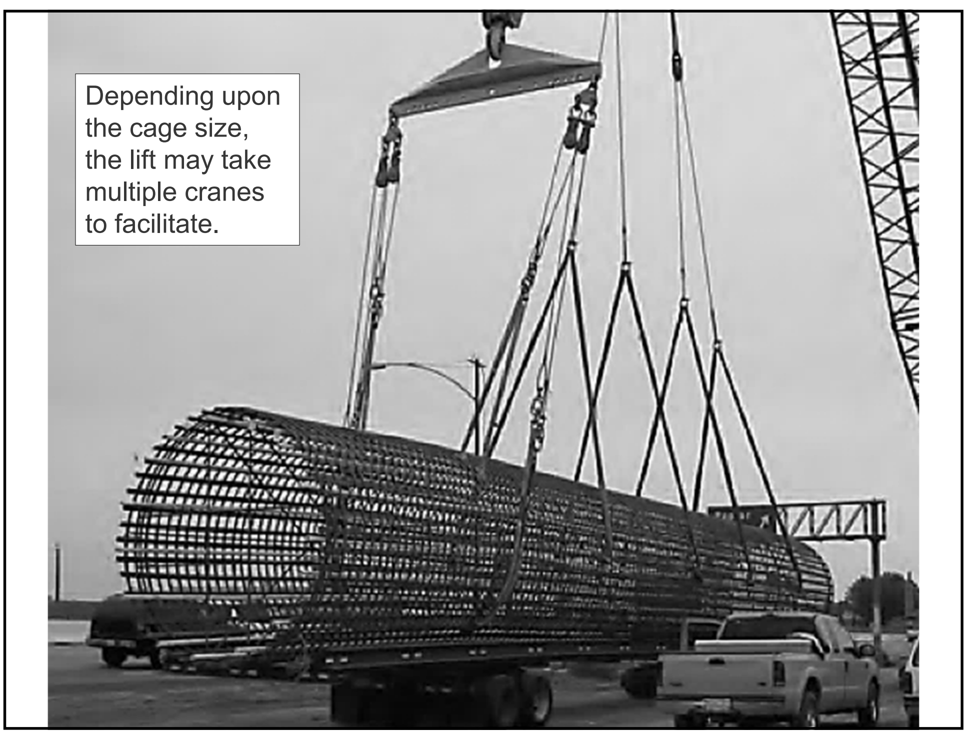
33


Entire cage must
be replaced due
to excessive
rotational flexure.
Note that steel is
not vertical.

34


Cage is contact with
soil can create CLS
anomalies.

35


Depending upon
the cage size,
the lift may take
multiple cranes
to facilitate.

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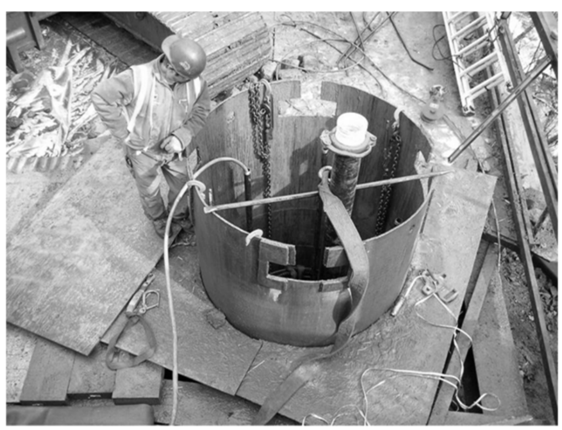
Securing the Rebar Cage

Suspend using

- Chains
- Equipment



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Learning Objective

Who is responsible for providing the rebar cage lift plan?

A. ODOT
B. Inspector
C. Contractor
D. Resident Engineer

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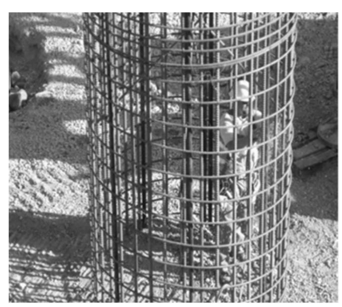
Unit Review

What details of the rebar cage construction are you verifying?

- Size
- Grade
- Configuration – bracing
- Steel tied correctly
- Splice construction
- Splice placement
- Number of CSL tubes
- Number and type of spacers



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6. Concrete Operations

Concrete Operations

Lesson 6

ODOT MATERIALS & INSPECTION

1

Concrete Operations
Learning Objectives

- Concrete Mix Design Requirements
- Concrete Placement in Dry and Wet shaft
- Concrete Placement Log
- Concrete Volume Log
  - Theoretical Volume vs Actual Volume
  - Graphing and tracking concrete during placement

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2

Concrete Requirements

Standard Specifications

00512.10(b) Concrete – Use Class 4000 drilled shaft concrete according to Section 02001, except as modified in this Section. *Water may be added to the concrete mix at the Project Site only if allowed by the approved mix design.*

3

Concrete Requirements (continued)

02001 Concrete Properties, Tolerances and Limits

Table 02001-1

Concrete Strength and Water/Cementitious Material (w/cm) Ratio		
Type of Concrete	**Strength f'_c (psi)**	**Maximum w/cm Ratio**
Structural	3300	0.50
	3300 (Seal)	0.45
	4000	0.48
	4000 (Drilled Shaft)	
	HPC4500	0.40
	HPC (IC) 4500	
	5000 +	
Paving	4000	0.44
	5000	0.48
PPCM's (with cast-in-place decks and no entrained air)	5500	0.44
	6000 +	0.42

4

Concrete Requirements (continued)

2001 Concrete Properties, Tolerances and Limits

Air Entrainment required for Drilled Shafts

2001.20 (b) Air Entrainment – Provide all concrete, except PPCM with cast-in-place decks, seal concrete, and drilled shaft concrete with entrained air in the amounts shown in Table 02001-2. *Field measured entrained air content shall be within ± 1.5 percent of target air entrainment values.*

Table 02001-2

Air Entrainment		
Nominal Maximum Aggregate Size, inch.	Moderate Exposure (Percent)	Severe Exposure (Percent)
3/8	6.0	7.5
1/2	5.5	7.0
3/4	5.0	6.0
1	4.5	6.0
1 1/2	4.5	5.5

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Concrete Requirements (continued)

02001 Concrete Properties, Tolerances and Limits

Slump required for Drilled Shafts

Table 02001-3

Concrete Slump	
Condition	**Slump**
Concrete without WRA	4" max.
Concrete with WRA	5" max.
Concrete with HRWRA	6" ± 2"
Precast Prestressed Concrete with HRWRA	10" max.
Seal Concrete	8" ± 2"
Drilled Shaft Concrete	8 1/2" ± 1 1/2" [1]
[1] Maintain a minimum slump of 4 inches throughout drilled shaft placement, including temporary casing extraction.	

* (HR)WRA = (High Range) Water Reducing Admixtures

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Concrete Requirements

02001.30 Concrete Mix Design –

- Submit new or current mix designs, prepared by a CCT (Concrete Control Technician), for each required class of structural or paving concrete to the Engineer for review. Allow 21 Calendar Days for the review.
- Do not proceed with concrete placement until the Engineer has determined that the mix design complies with the Specifications.
- Review of concrete mix designs does not relieve the Contractor of the responsibility to provide concrete meeting the Specification requirements.

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Concrete Mix Design Example

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CONCRETE MIX DESIGN SUBMITTAL
Hood River Sand, Gravel and Ready Mix, Inc.

Project	US97:Spanish Hollow Crk & Trout Crk Bridges	Conc. Class	4000
Contractor	Malcolm Drilling	Agg Size	3/8"
Contract #	15035	Mix Design	406DS
Intended Use:	Drilled Shafts		

MIX PROPORTIONS - QUANTITIES PER CUBIC YARD

		Weight (lbs)	Absolute Volume	Brand	Type
Cement		480 #	2.442 ft³	Lafarge - Richmond	1 L
Flyash	20%	120 #	0.740 ft³	Lafarge - Centrailia	F
Agg. Size 1 1/2"		#(SSD)	0.000 ft³		
Agg. Size 3/4"		#(SSD)	0.000 ft³		
Agg. Size 3/8"	48%	1420 #(SSD)	8.587 ft³		
Agg. Size Sand		1614 #(SSD)	9.474 ft³		
Mix Water	City	275 #	4.407 ft³		
Admix		7 #	0.105 ft³		
Entrained Air		5 %+/- 1.5	1.350 ft³		
Total		3909 #	27.00 ft³		

Master Builders
Admixtures-Brand/Type/Dosage

AEA	Ae 90	.5oz/100
WRA	Pozz 80	5oz/100
HRWRA	PS 1466	4oz/100
Vis Mod	VMA 358	
Stabilizer	Delvo	8oz/100

Unit Wt: 144.8 **Design slump:** 8.5" +/- 1.5" with super **Design W/C Ratio:** 0.469

Spec Max W/C 0.48

AGGREGATE DATA (used in calculating the mix design)

Coarse Agg. Souce	Curtiss - Dallesport, WA	State Source #	WA-20-001-4 / Z-94
Coarse Agg. Souce	Gregory - Dallesport, WA	State Source #	WA-20-003-4 / Z-94
Fine Agg. Source	Gregory - Dallesport, WA	State Source #	WA-20-003-4 / Z-94

Size	Specific Gravity(SSD)	Absorption
1 1/2" - 3/4"	2.78	1.3
3/4" - #4	2.77	1.6
3/8 - #4	2.65	2.3
Sand	2.73	1.8

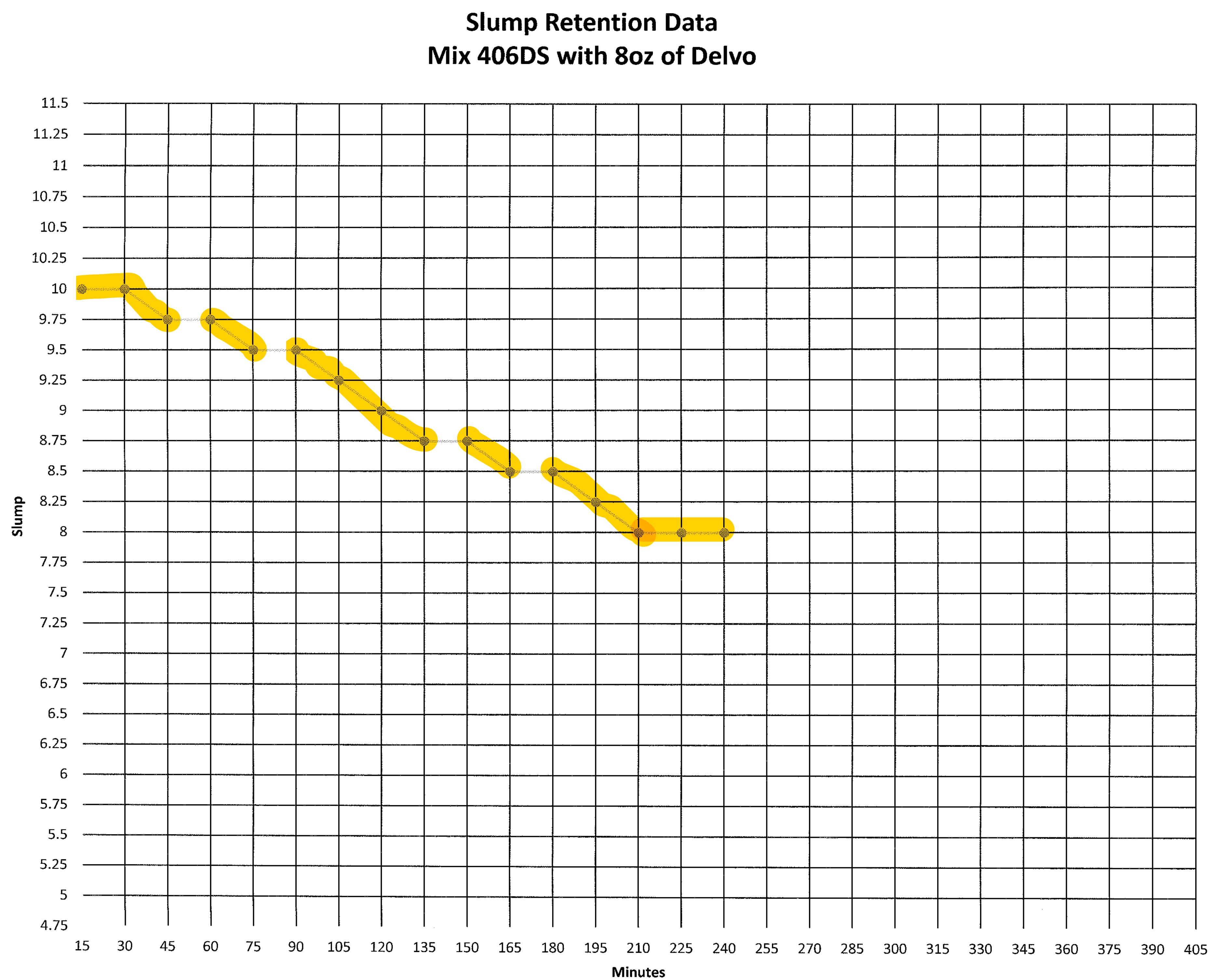
Dry Rodded Wt. 107.8

Avg. Sand F.M. 2.75

Remarks:

- Concrete proportioned in accordance with ASCI 211.1 standard practices. This information is CONFIDENTIAL to contract personnel. Approval of this mix design carries the inclusion of Hood River Sand Gravel and Ready Mix on the distribution list for all concrete test results.
- Hood River Sand and Gravel has no authority regarding the appropriate application of this mix. Therefore, it is the responsibility of the project architect, engineer, and/or contractor to insure that the above mix parameters are appropriate for the anticipated use and environmental conditions for the intended placement of this mix.
- The mix will meet the stated strength, when test specimens are sampled, fabricated, transported, cured (initial & final), and tested in strict compliance with current ASTM Standards, and evaluated for acceptance per ACI standards and practices. Deviations from ASTM standard methods, unless expressly authorized on this mix design, invalidate test results. Hood River Sand Gravel and Ready Mix reserve the right to conduct third part testing by an accredited independent laboratory.
- Design mix cementitious content is stated as a minimum and Hood River Sand Gravel and Ready Mix reserve the right to increase cementitious content. Chemical admixtures are added in accordance with the manufacture's recommendations, and may be adjusted to maintain mix properties. Aggregate weights may be adjusted to maintain yield and design gradations.
- No party other than those to whom HRS&G has distributed this report shall be entitled to use or rely upon the information contained in this document.

Prepared By: Alan Schweller 6/18/2018


Slump Retention Data
Mix 406DS with 8oz of Delvo
Slump
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11
10.75
10.5
10.25
10
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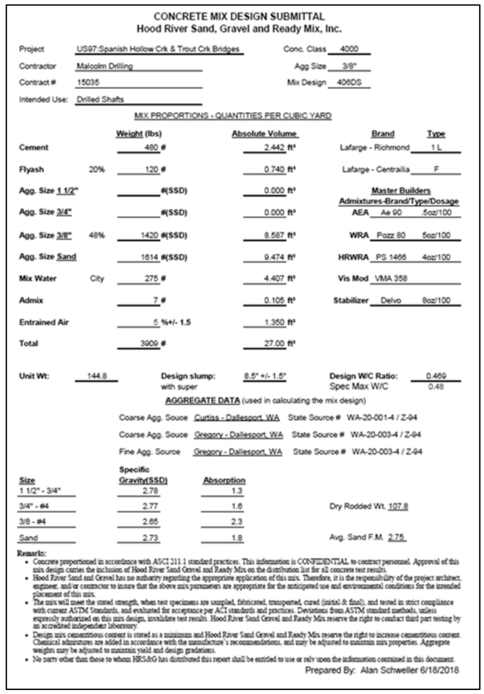
375
390
405
Minutes

Required Submittals for Mix Designs

1. Supplier's Unique Mix Design Identification Number
2. Mix Design Constituent Proportions
3. Aggregates
4. Cementitious Material
5. Modifiers
6. Admixtures
7. Water
8. Plastic Concrete Tests
9. Compressive Strength Test Results
10. Strength Analysis
11. Quality Control Personnel



CONCRETE MIX DESIGN SUBMITTAL
Hood River Sand, Gravel and Ready Mix, Inc.

Project: US97:Spanish Hollow Crk & Trout Crk Bridges — Conc. Class: 4000
Contractor: Malcolm Drilling — Agg Size: 3/8"
Contract #: 15035 — Mix Design: 406DS
Intended Use: Drilled Shafts

MIX PROPORTIONS - QUANTITIES PER CUBIC YARD

		Weight (lbs)	Absolute Volume	Brand	Type
Cement		480 #	2.442 ft³	Lafarge - Richmond	1 L
Flyash	20%	120 #	0.740 ft³	Lafarge - Centrailia	F
Agg. Size 1 1/2"		#(SSD)	0.000 ft³		
Agg. Size 3/4"		#(SSD)	0.000 ft³		
Agg. Size 3/8"	48%	1420 #(SSD)	8.587 ft³		
Agg. Size Sand		1614 #(SSD)	9.474 ft³		
Mix Water	City	275 #	4.407 ft³		
Admix		7 #	0.105 ft³		
Entrained Air		5 %+/- 1.5	1.350 ft³		
Total		3909 #	27.00 ft³		

Master Builders Admixtures-Brand/Type/Dosage

AEA	Ae 90	.5oz/100
WRA	Pozz 80	5oz/100
HRWRA	PS 1466	4oz/100
Vis Mod	VMA 358	
Stabilizer	Delvo	8oz/100

Unit Wt: 144.8 — Design slump: 8.5" +/- 1.5" with super — Design W/C Ratio: 0.469 — Spec Max W/C 0.48

AGGREGATE DATA (used in calculating the mix design)

Coarse Agg. Souce: Curtiss - Dallesport, WA — State Source # WA-20-001-4 / Z-94
Coarse Agg. Souce: Gregory - Dallesport, WA — State Source # WA-20-003-4 / Z-94
Fine Agg. Source: Gregory - Dallesport, WA — State Source # WA-20-003-4 / Z-94

Size	Specific Gravity(SSD)	Absorption
1 1/2" - 3/4"	2.78	1.3
3/4" - #4	2.77	1.6
3/8 - #4	2.65	2.3
Sand	2.73	1.8

Dry Rodded Wt. 107.8
Avg. Sand F.M. 2.75

Remarks:
- Concrete proportioned in accordance with ASCI 211.1 standard practices. This information is CONFIDENTIAL to contract personnel. Approval of this mix design carries the inclusion of Hood River Sand Gravel and Ready Mix on the distribution list for all concrete test results.
- Hood River Sand and Gravel has no authority regarding the appropriate application of this mix. Therefore, it is the responsibility of the project architect, engineer, and/or contractor to insure that the above mix parameters are appropriate for the anticipated use and environmental conditions for the intended placement of this mix.
- The mix will meet the stated strength, when test specimens are sampled, fabricated, transported, cured (initial & final), and tested in strict compliance with current ASTM Standards, and evaluated for acceptance per ACI standards and practices. Deviations from ASTM standard methods, unless expressly authorized on this mix design, invalidate test results. Hood River Sand Gravel and Ready Mix reserve the right to conduct third part testing by an accredited independent laboratory.
- Design mix cementitious content is stated as a minimum and Hood River Sand Gravel and Ready Mix reserve the right to increase cementitious content. Chemical admixtures are added in accordance with the manufacture's recommendations, and may be adjusted to maintain mix properties. Aggregate weights may be adjusted to maintain yield and design gradations.
- No party other than those to whom HRS&G has distributed this report shall be entitled to use or rely upon the information contained in this document.

Prepared By: Alan Schweller 6/18/2018

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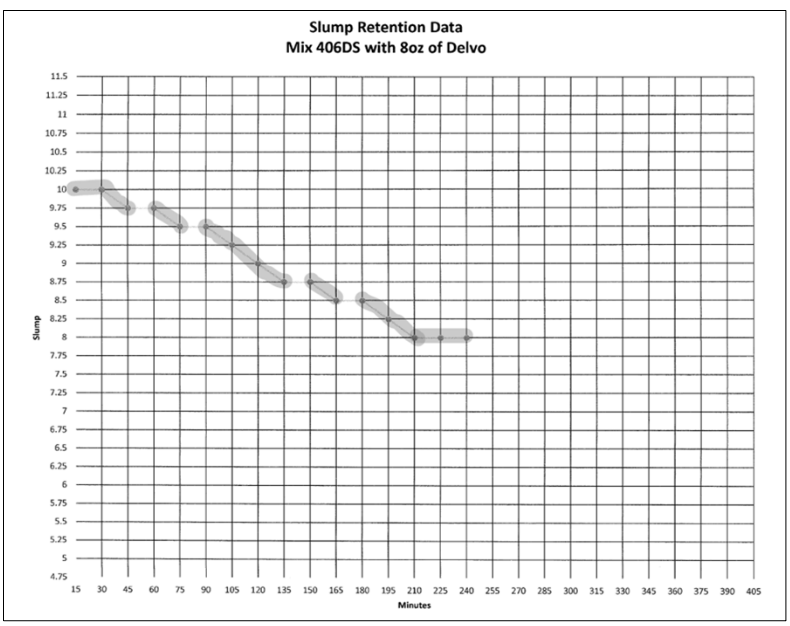
Slump Retention = Workability



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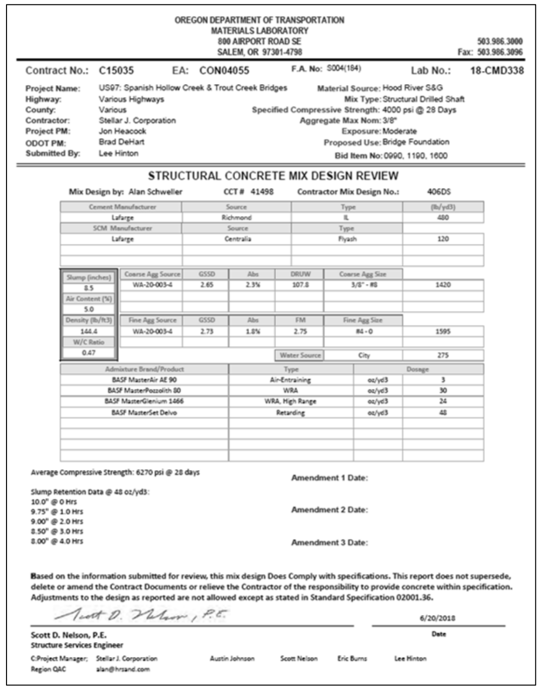
Concrete Mix Design Report issued by Structure Services



OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT ROAD SE
SALEM, OR 97301-4798

503.986.3000
Fax: 503.986.3096

Contract No.: C15035 EA: CON04055 F.A. No: S004(184) Lab No.: 18-CMD338

Project Name: US97: Spanish Hollow Creek & Trout Creek Bridges
Highway: Various Highways
County: Various
Contractor: Stellar J. Corporation
Project PM: Jon Heacock
ODOT PM: Brad DeHart
Submitted By: Lee Hinton

Material Source: Hood River S&G
Mix Type: Structural Drilled Shaft
Specified Compressive Strength: 4000 psi @ 28 Days
Aggregate Max Nom: 3/8"
Exposure: Moderate
Proposed Use: Bridge Foundation
Bid Item No: 0990, 1190, 1600

STRUCTURAL CONCRETE MIX DESIGN REVIEW

Mix Design by: Alan Schweller CCT # 41498 Contractor Mix Design No.: 406DS

Cement Manufacturer	Source	Type	(lb/yd3)
Lafarge	Richmond	IL	480
SCM Manufacturer	Source	Type	
Lafarge	Centralia	Flyash	120

Slump (inches)
8.5
Air Content (%)
5.0
Density (lb/ft3)
144.4
W/C Ratio
0.47

Coarse Agg Source	GSSD	Abs	DRUW	Coarse Agg Size	
WA-20-003-4	2.65	2.3%	107.8	3/8" - #8	1420

Fine Agg Source	GSSD	Abs	FM	Fine Agg Size	
WA-20-003-4	2.73	1.8%	2.75	#4 - 0	1595
			Water Source	City	275

Admixture Brand/Product	Type	Dosage	
BASF MasterAir AE 90	Air-Entraining	oz/yd3	3
BASF MasterPozzolith 80	WRA	oz/yd3	30
BASF MasterGlenium 1466	WRA, High Range	oz/yd3	24
BASF MasterSet Delvo	Retarding	oz/yd3	48

Average Compressive Strength: 6270 psi @ 28 days

Slump Retention Data @ 48 oz/yd3:
10.0" @ 0 Hrs
9.75" @ 1.0 Hrs
9.00" @ 2.0 Hrs
8.50" @ 3.0 Hrs
8.00" @ 4.0 Hrs

Amendment 1 Date:

Amendment 2 Date:

Amendment 3 Date:

Based on the information submitted for review, this mix design Does Comply with specifications. This report does not supersede, delete or amend the Contract Documents or relieve the Contractor of the responsibility to provide concrete within specification. Adjustments to the design as reported are not allowed except as stated in Standard Specification 02001.36.

Scott D. Nelson, P.E. 6/20/2018

Scott D. Nelson, P.E.
Structure Services Engineer
Date

C:Project Manager; Stellar J. Corporation Austin Johnson Scott Nelson Eric Burns Lee Hinton
Region QAC alan@hrsand.com

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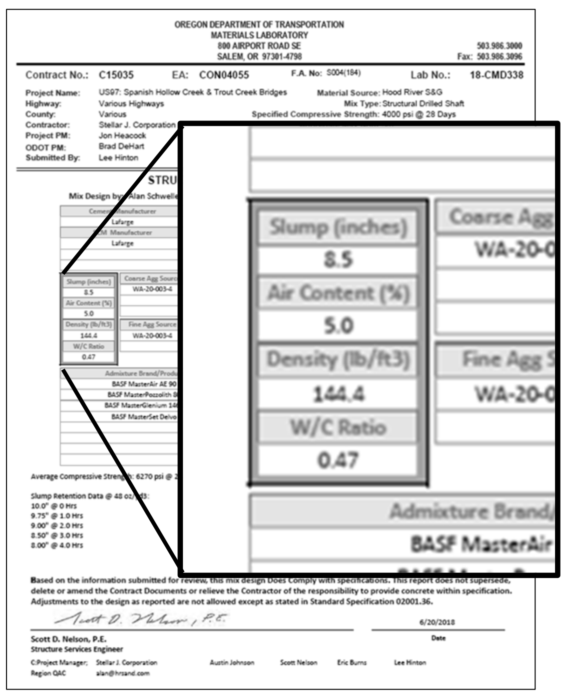
Concrete Mix Design Report issued by Structure Services



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OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT ROAD SE
SALEM, OR 97301-4798

503.986.3000
Fax: 503.986.3096

Contract No.: C15035 **EA:** CON04055 **F.A. No:** S004(184) **Lab No.:** 18-CMD338

Project Name: US97: Spanish Hollow Creek & Trout Creek Bridges
Highway: Various Highways
County: Various
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Aggregate Max Nom: 3/8"
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Proposed Use: Bridge Foundation
Bid Item No: 0990, 1190, 1600

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Mix Design by: Alan Schweller **CCT #** 41498 **Contractor Mix Design No.:** 406DS

Cement Manufacturer	Source	Type	(lb/yd3)
Lafarge	Richmond	IL	480
SCM Manufacturer	**Source**	**Type**	
Lafarge	Centralia	Flyash	120

Slump (inches)	Air Content (%)	Density (lb/ft3)	W/C Ratio
8.5	5.0	144.4	0.47

Coarse Agg Source	GSSD	Abs	DRUW	Coarse Agg Size	
WA-20-003-4	2.65	2.3%	107.8	3/8" - #8	1420
Fine Agg Source	**GSSD**	**Abs**	**FM**	**Fine Agg Size**	
WA-20-003-4	2.73	1.8%	2.75	#4 - 0	1595
			Water Source	City	275

Admixture Brand/Product	Type	Dosage	
BASF MasterAir AE 90	Air-Entraining	oz/yd3	3
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6/20/2018

Scott D. Nelson, P.E.
Structure Services Engineer

Date

C:Project Manager; Stellar J. Corporation Austin Johnson Scott Nelson Eric Burns Lee Hinton
Region QAC alan@hrsand.com

Learning Objective

Concrete arrives at the job site with a slump of 8.5″. The contractor wants to add 1 gallon of water per cubic yard to the concrete to make the concrete more flowable. What do you say?

A. Yes, the specification allows for it!

B. No, the specification does not allow for it!

C. Maybe, let me call my RE.

D. Water may be added if it is included in the concrete mix design that has been approved.

E. Contractor can do what he want. It’s his risk.

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Concrete Mix Design

How much water is the contractor allowed to add to the concrete at the job site?

Standard Specifications

00512.10(b) Concrete – Use Class 4000 drilled shaft concrete according to Section 02001, except as modified in this Section. **Water may be added to the concrete mix at the Project Site only if allowed by the approved mix design.**

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Begin Concrete Placement

- Place concrete immediately after cleanout.
- Place concrete continuously.
- Place concrete without interruption.
- Place concrete from the bottom of the hole to the top.

ODOT MATERIALS & INSPECTION QA

15

00512.47 (a) – Concrete Placement (Time Limits)

- A maximum of 60 minutes between placements.
- No concrete older than 90 minutes from batch time.

Should a delay in concrete placement occur:

- Reduce the placement rate to maintain fresh concrete flow in the shaft.

ODOT MATERIALS & INSPECTION QA

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Dry Hole 00512.47(b)

- No more than 3″ of water on bottom of shaft at time of pour.
- Seepage rate of no more than 12″ per hour.
- Shaft diameter is greater than or equal to 3 feet.

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Concrete Placement – Dry Shaft

- Drop chute (8″ minimum I.D.)
- Pump hose line (4″ min. ID - 1″ Agg.) (5″ min. ID - 1.5″ Agg.)

ID = Inside Diameter

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Concrete Placement

Dry Shaft Concrete Placement:

00512.47(b) Under free-fall placement, deposit concrete through the center of the reinforcement cage by a method which prevents segregation of aggregates and splashing of concrete on the reinforcement cage. Place concrete so that the free-fall is vertical down the center of the shaft without hitting the sides, the steel reinforcing bars or steel cage bracing.

There is not a specified maximum free fall distance.

ODOT MATERIALS & INSPECTION

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Concrete Placement – Wet Shaft

- Tremie 10″ minimum diameter - 00512.47(c) sends you to 00540.48(e) and that sends you to 00540.22(d).
  - Gravity/free fall is not allowed in a wet shaft
  - Pressurized tremie
    - Plug/pig is used to maintain initial pressure
- Equipment
  - Pump
  - Crane

ODOT MATERIALS & INSPECTION

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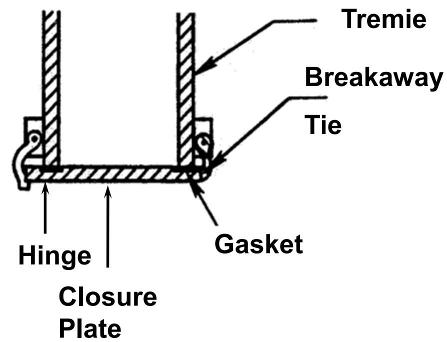
Gravity Tremie Placement

10″ min dia.



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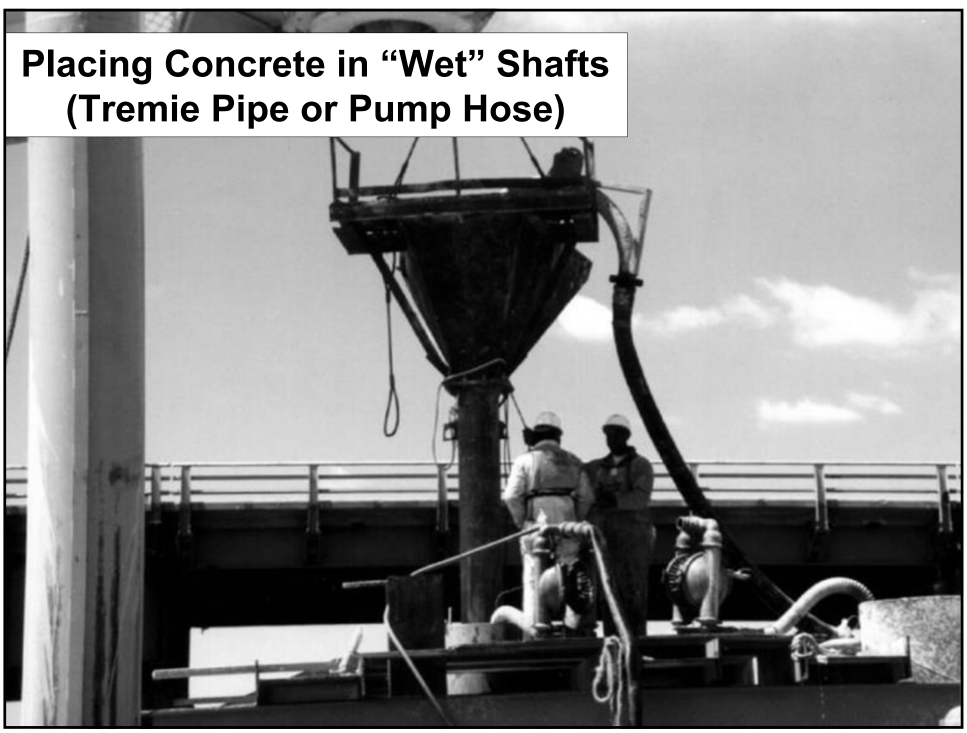
Placing Concrete in "Wet" Shafts (Tremie Pipe or Pump Hose)



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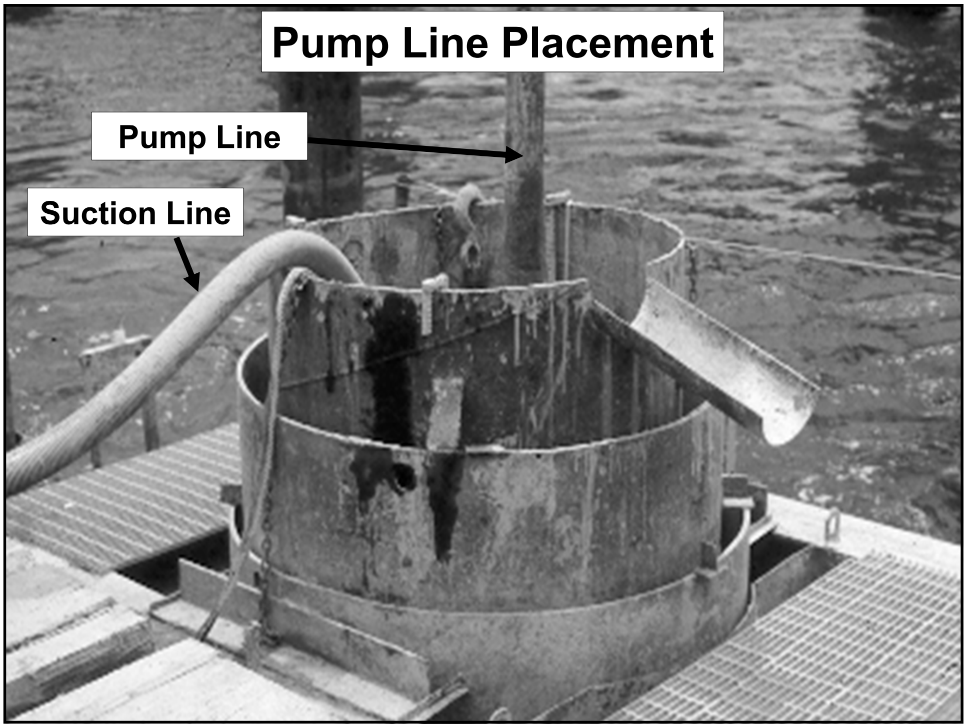

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Tremie Concrete Placement

- Discharge end of tremie must be **immersed a minimum of 5 ft. in the concrete at all times**. 00512.47(c)
- Flow of concrete must be continuous.
- Concrete level in tremie must be above slurry or water level in hole.
- **If tremie breaches, the shaft is considered defective.**

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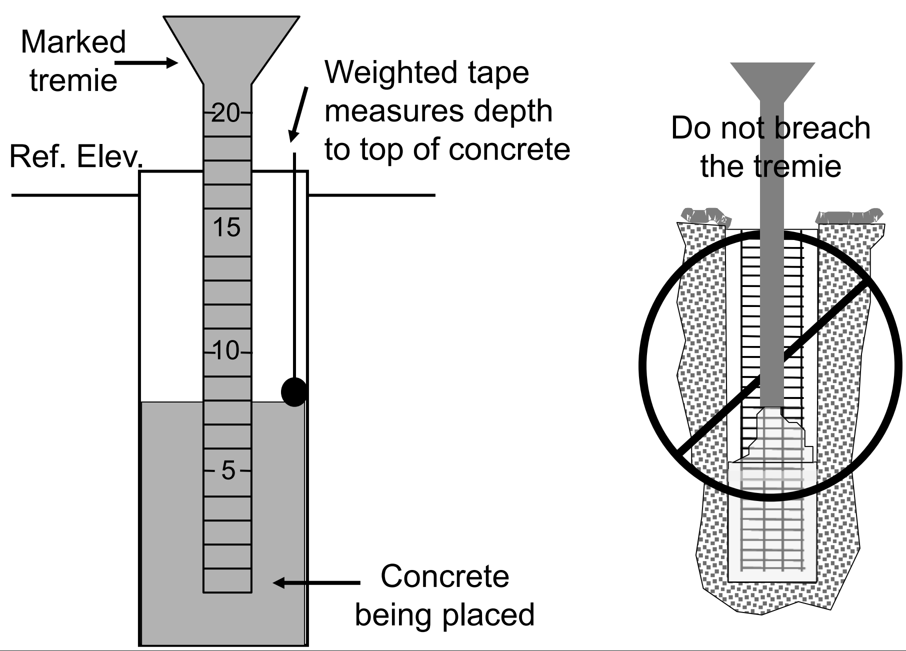
Do Not Breach the Tremie



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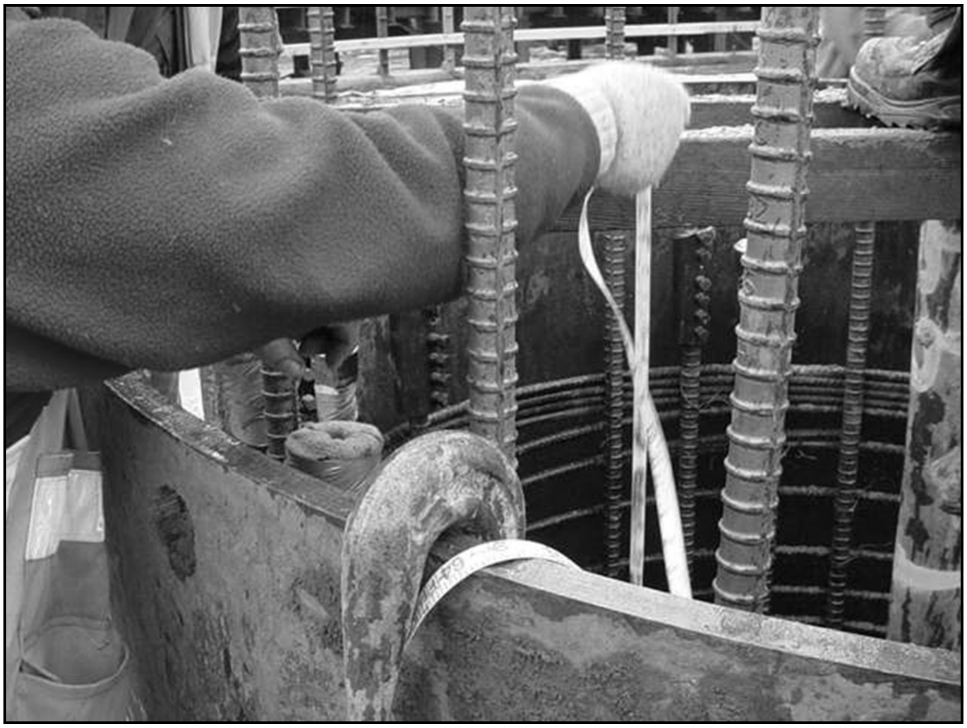

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End of Concrete Placement

- Place concrete until fresh concrete is coming out of the top of shaft, free of water, soil debris or other deleterious materials.
- Wet cure the top of shaft for **a minimum of seven days.** 00512.47(d)
- 00512.49 – After the first drilled shaft on the Project has been accepted, make no significant change in construction methods, equipment or materials used in the construction of subsequent shafts, unless approved by the Engineer.

ODOT MATERIALS & INSPECTION

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Concrete Placement – Casing Removal 00512.47(e)

- Minimum of 10 feet of concrete above the bottom of casing before the start of removal
- Maintain at least 5 feet of concrete above the bottom of casing at all times

ODOT MATERIALS & INSPECTION

30

002001.50(b) – Quality Control Technician (QCT)

- Be at the concrete placement site when concrete placement is in progress.
- Have a copy of the mix design on-site and available during concrete placement.
- Obtain and check each batch ticket upon arrival of the concrete at the jobsite for the correct mix design.
- Notify the Contractor and the Engineer immediately when the concrete is not in compliance with the Specifications.

Note: Inspector should verify contractors QCT certificate is current and valid.

ODOT MATERIALS & INSPECTION

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Drilled Shaft Concrete Testing

Tests performed

- Slump
- Temperature
- Air content
- Unit weight w/cm ratio
- Yield

ODOT MATERIALS & INSPECTION

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Inspector Duties

- Record start and finish times of each concrete load.
- Verify placement is continuous
- Record concrete quantity per load/truck.
- Measure and record depth/elevation of top of concrete to avoid tremie breach and maintain proper temp casing .
- Plot concrete volume curve.

ODOT MATERIALS & INSPECTION

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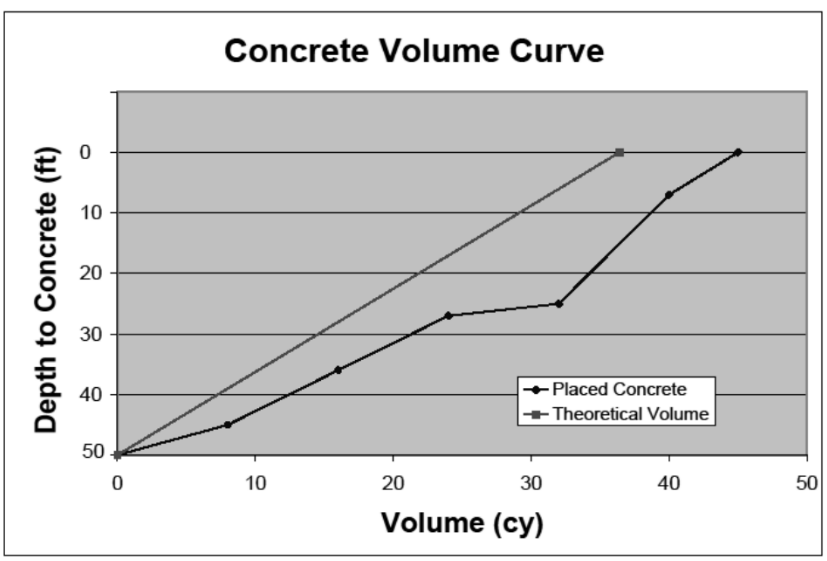

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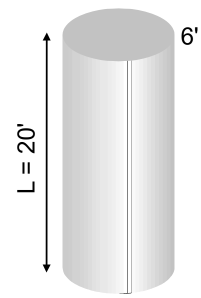
Concrete Placement Equations

Theoretical Volume of a shaft = Area x Length

$$V = \frac{\pi d^2}{4} \times L$$

To determine the volume of a shaft with a diameter of 6′ that is 20 feet long:



$$(A = \frac{3.14 \times 6^2}{4}) \times 20' = 565.20 \text{ cubic feet}$$

565.20 cf x 1 cy / 27 cf = 20.93 cy

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Calculate Theoretical Volume of Concrete

- **D**iameter = 8′
- Shaft **L**ength = 50′
- Volume = $\frac{\pi d^2}{4}$ x **L**
- Volume = $\frac{3.14 \times 8^2}{4}$ x **50**
- Volume = 2,512 cubic feet
- **Volume** = 2,512 cf/27 = **93 cy**

If the shaft is perfectly shaped, it will take 93 cy to fill it completely. Drilled shafts are like painting projects. Never goes as planned.

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Oregon Department of Transportation

DRILLED SHAFT CONCRETE PLACEMENT LOG

PROJECT		BRIDGE NO.	CONTRACT NO	
BENT	STATION	SHAFT NO.	SHAFT DIAMETER	
DRILLED SHAFT CONTRACTOR		INSPECTED BY	CERT. NO.	DATE

REFERENCE ELEVATION	SHAFT TOP ELEVATION	REBAR CAGE TOP ELEVATION:	AT START	AT FINISH
DEPTH TO WATER OR SLURRY	SHAFT BOTTOM ELEVATION	REBAR DESIGN ELEV.	WITHIN SPEC? ☐ YES	☐ NO
TOP OF ROCK ELEVATION	SHAFT LENGTH	REBAR CAGE CENTERED WITHIN SPEC?	☐ YES	☐ NO

SHAFT CONCRETE INFORMATION

Placement Method

____ Free Fall

____ Tremie

De-Airing Method

____ Tremie Plug

____ Tremie Cap

____ Relief Valve

Volume in Lines

#	ID	Length	Volume
______	______	______	______ cy
______	______	______	______ cy
______	______	______	______ cy

Total Volume in Lines (VL) ______ cy

Estimated Waste Concrete (VW) ______ cy

Begin Pour: Date: __________ Time: __________

End Pour: Date: __________ Time: __________

Shaft Completion Time: __________
(including casing removal)

__________ **Total Concrete Volume Delivered (TVD)**

__________ **Total Concrete Volume In Shaft; cy (=TVD-VL-VW)**

Truck No.	Concrete Volume	Slump	Arrival Time	Start Time	Finish Time	Tremie Depth	Depth To Concrete	NOTES (delays, additives, breaching, casing removal)

__________ **Total Concrete Volume Delivered (TVD)**

INSPECTOR SIGNATURE ____________________ DATE __________

NOTES: ____

CASING REMOVAL

	OD	Top Elev.	Bot. Elev.	Start	Finish
	______	______	______	______	______
	______	______	______	______	______
	______	______	______	______	______
Permanent Casing	______	______	______		

Concrete Placement Log

Oregon Department of Transportation

DRILLED SHAFT CONCRETE PLACEMENT LOG

PROJECT	BRIDGE NO.	CONTRACT NO
BENT / STATION	SHAFT NO.	SHAFT DIAMETER
DRILLED SHAFT CONTRACTOR	INSPECTED BY	CERT. NO. / DATE

REFERENCE ELEVATION	SHAFT TOP ELEVATION	REBAR CAGE TOP ELEVATION: AT START / AT FINISH
DEPTH TO WATER OR SLURRY	SHAFT BOTTOM ELEVATION	REBAR DESIGN ELEV. / WITHIN SPEC? ☐ YES ☐ NO
TOP OF ROCK ELEVATION	SHAFT LENGTH	REBAR CAGE CENTERED WITHIN SPEC? ☐ YES ☐ NO

SHAFT CONCRETE INFORMATION

Placement Method — **Volume in Lines** (#, ID, Length, Volume)

____Free Fall
____Tremie ____ ____ ____ ______cy
De-Airing Method ____ ____ ____ ______cy
____Tremie Plug ____ ____ ____ ______cy
____Tremie Cap — Total Volume in Lines (VL) ______cy
____Relief Valve — Estimated Waste Concrete (VW) ______cy

Begin Pour: Date: ________ Time: ________
End Pour: Date: ________ Time: ________
Shaft Completion Time: (including casing removal) ________
________ Total Concrete Volume Delivered (TVD)
________ Total Concrete Volume in Shaft; cy (=TVD-VL-VW)

Truck No.	Concrete Volume	Slump	Arrival Time	Start Time	Finish Time	Tremie Depth	Depth To Concrete	NOTES (delays, additives, breaching, casing removal)

________ Total Concrete Volume Delivered (TVD)

INSPECTOR SIGNATURE ________ DATE ________

NOTES: ________

CASING REMOVAL

	OD	Top Elev.	Bot. Elev.	Start	Finish
Permanent Casing					

734-2597 (11-2011)

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Concrete Placement Log

Inspector needs to know size of each truck load and depth to concrete after each load

Truck No.	Concrete Volume	Slump	Arrival Time	Start Time	Finish Time	Tremie Depth	Depth To Concrete	NOTES (delays, additives, breaching, casing removal)
1	8 cy		7:25	7:40	7:55	48	42	Initial QCT concrete test
2	8 cy		7:40	8:00	8:10	48	39	
3	8 cy		8:00	8:20	8:50	48	35	
4	8 cy		8:45	9:05	9:25	38	32	Second QCT concrete test
5	8 cy		9:10	9:30	9:50	38	28	
6	8 cy		9:50	10:00	10:10	28	20	Truck was delayed by traffic
7	8 cy		10:00	10:15	10:45	28	19	talked to contractor about the depth of concrete
8	8 cy		10:40	10:50	11:20	28	19	talked to contractor about the depth of concrete
9	8 cy		11:00	11:30	11:40	28	15	Truck was delayed at plant
10	8 cy		11:20	11:50	12:20	18	10	Third QCT concrete test
11	8 cy		12:25	12:30	12:50	18	5	
12	8 cy		12:40	1:00	1:45	18	0	Finished pour

96 cy Total Concrete Volume Delivered (TVD)

ODOT MATERIALS & INSPECTION

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DRILLED SHAFT CONCRETE VOLUMES

PROJECT		BRIDGE NO.	CONTRACT NO	
BENT	STATION	SHAFT NO.	SHAFT DIAMETER	
DRILLED SHAFT CONTRACTOR		INSPECTED BY	CERT. NO.	DATE

CONCRETING CURVE

Prior to pouring concrete, a plot should be made showing the theoretical concrete surface (by depth or elev.) vs. concrete volume placed. During concrete placement the actual concrete surface vs. the actual concrete volume placed is then plotted.

Shaft Top

DEPTH/ELEVATION (Feet

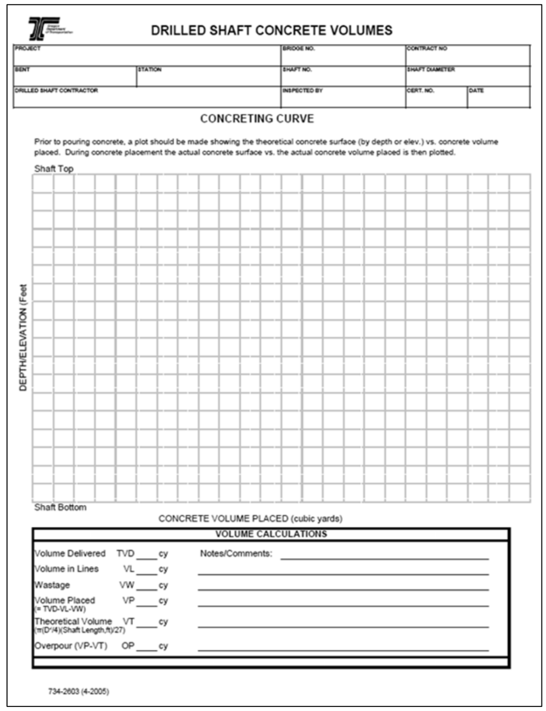
Shaft Bottom

CONCRETE VOLUME PLACED (cubic yards)

VOLUME CALCULATIONS

Volume Delivered	TVD ____ cy	Notes/Comments:	____
Volume in Lines	VL ____ cy		____
Wastage	VW ____ cy		____
Volume Placed (= TVD-VL-VW)	VP ____ cy		____
Theoretical Volume ($\pi(D^2/4)$(Shaft Length,ft)/27)	VT ____ cy		____
Overpour (VP-VT)	OP ____ cy		____

Drilled Shaft Concrete Volume Form



DRILLED SHAFT CONCRETE VOLUMES

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BENT	STATION	SHAFT NO.	SHAFT DIAMETER
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DEPTH/ELEVATION (Feet

Shaft Bottom

CONCRETE VOLUME PLACED (cubic yards)

VOLUME CALCULATIONS

Volume Delivered	TVD ____ cy	Notes/Comments:
Volume in Lines	VL ____ cy	
Wastage	VW ____ cy	
Volume Placed (= TVD-VL-VW)	VP ____ cy	
Theoretical Volume (π(D²/4)(Shaft Length,ft)/27)	VT ____ cy	
Overpour (VP-VT)	OP ____ cy	

734-2603 (4-2005)

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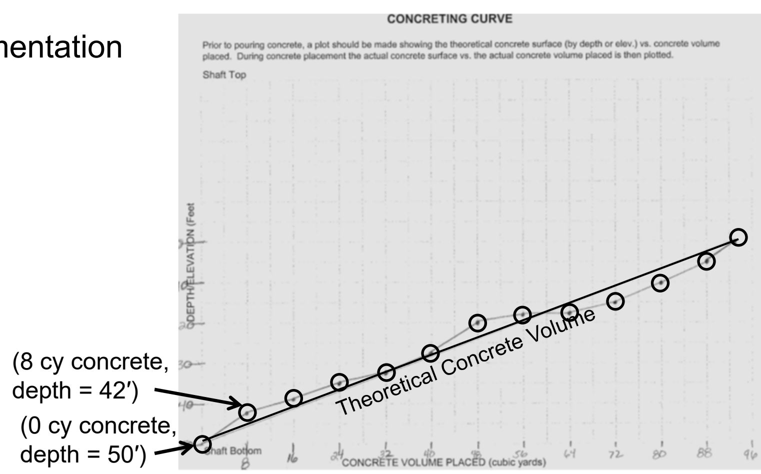
Concrete Placement

Documentation



ODOT MATERIALS & INSPECTION

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Calculate Theoretical Volume of Shaft

5′ Diameter Drilled Shaft

50′ Long

Volume = $\frac{\pi d^2}{4} X L$

V = $\frac{3.14 X 5^2}{4}$ X 50 ft

V = 981.25 cf

V = 981.25 cf X $\frac{\text{1 cubic yard}}{\text{27 cubic feet}}$

V = 36.3 cy Theoretical Volume = 36 cy

ODOT MATERIALS & INSPECTION

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Convert Field Measurements

6 Truck Loads of 8 cubic yards each:

Truck	CY	Depth to Concrete Ft	Accumulated Concrete Volume CY
0	0	50	0
1	8	45	8
2	8	36	16
3	8	27	24
4	8	25	32
5	8	7	40
6	5	0	45

Waste = 3 cy

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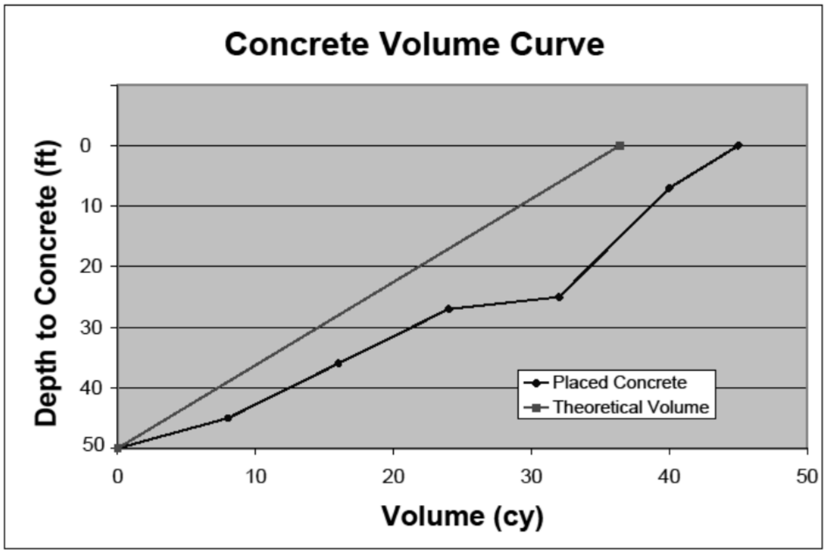
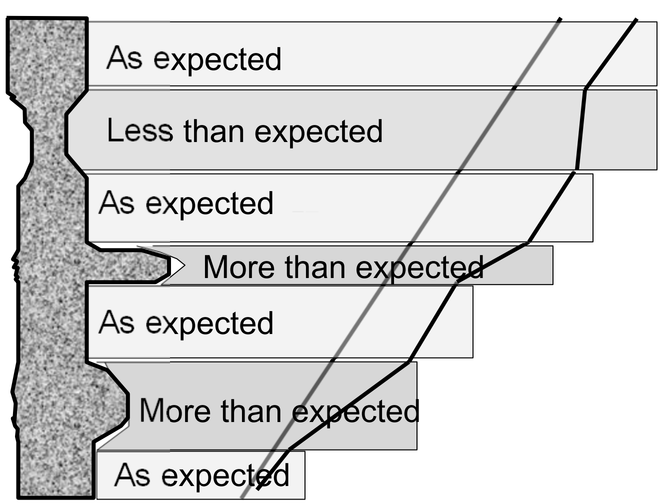


43

Possible Causes of Curve Irregularities



44

Concrete Volume Curve Exercise

45

Concrete Placement Conversions

1 foot = 12"

- To convert 3" to feet:
- 3" x 1 foot/12" = 0.25 feet

1 yard = 3′

- To convert 4′ to yards:
- 4′ x 1 yard/3′ = 1.33 yards

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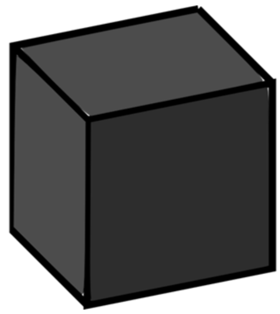
Concrete Placement Conversions

1 cubic yard = 27 cubic feet

- To convert 300 cubic feet to cubic yards:

- 300 cubic feet x $\frac{\text{1 cubic yard}}{\text{27 cubic feet}}$

= 11.11 cubic yards



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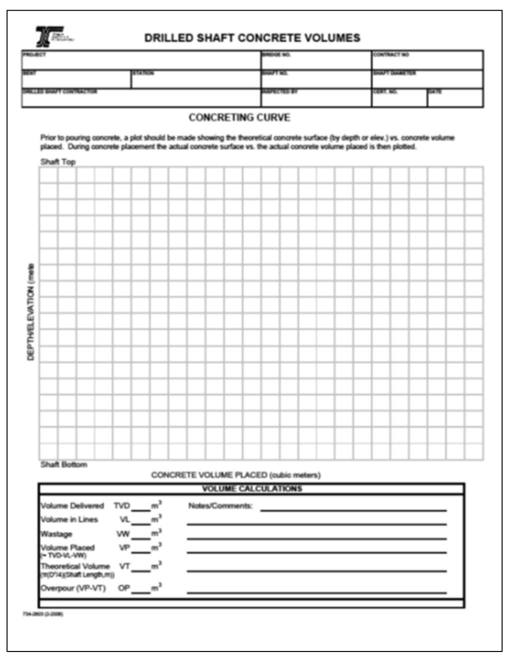
Complete Curve Practice



DRILLED SHAFT CONCRETE VOLUMES

PROJECT		BRIDGE NO.	CONTRACT NO
BENT	STATION	SHAFT NO.	SHAFT DIAMETER
DRILLED SHAFT CONTRACTOR		INSPECTED BY	CERT. NO. / DATE

CONCRETING CURVE

Prior to pouring concrete, a plot should be made showing the theoretical concrete surface (by depth or elev.) vs. concrete volume placed. During concrete placement the actual concrete surface vs. the actual concrete volume placed is then plotted.

Shaft Top

DEPTH/ELEVATION (mete

Shaft Bottom

CONCRETE VOLUME PLACED (cubic meters)

VOLUME CALCULATIONS

Volume Delivered TVD ___ m^3 Notes/Comments: ___

Volume in Lines VL ___ m^3

Wastage VW ___ m^3

Volume Placed (= TVD-VL-VW) VP ___ m^3

Theoretical Volume (π(D²/4)(Shaft Length,m)) VT ___ m^3

Overpour (VP-VT) OP ___ m^3

734-2603 (2-2006)

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Calculate Theoretical Volume of Shaft

- 6′ Dia. Drilled Shaft
- 60′ Long

Theoretical Volume =____ cubic yards

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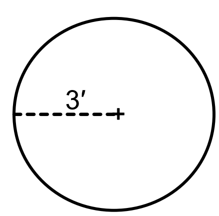
Concrete Placement Equations

- Circumference of a circle = π X Diameter
- Diameter = Radius X 2
- To determine the circumference of a circle with a diameter of 6′: 6 X 3.14 = 18.84′



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Calculate Theoretical Volume of Shaft

- 6′ Dia. Drilled Shaft
- 60′ Long
- Volume = $\frac{\pi d^2}{4}$ x L
- Volume = $\frac{3.14 \times 6^2}{4}$ x 60 ft
- Volume = 28.26 x 60 ft
- Volume = 1,695.6 cubic feet
- Volume = 1,695.6 cubic feet x $\frac{\text{1 cubic yard}}{\text{27 cubic feet}}$

Theoretical Volume = **62.8** cubic yards

51

Each truck holds 7cy and the depth of the concrete after each truck are shown (no waste):

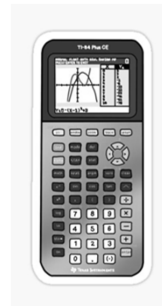
Truck	CY	Depth to Concrete Ft	Accumulated Concrete Volume
0	0	60	0
1.	7	56	______
2.	7	49	______
3.	7	42	______
4.	7	40	______
5.	7	33	______
6.	7	20	______
7.	7	13	______
8.	7	02	______
9.	7	0	______

Plot the concrete curve on the next sheet. What issues may there be?

52

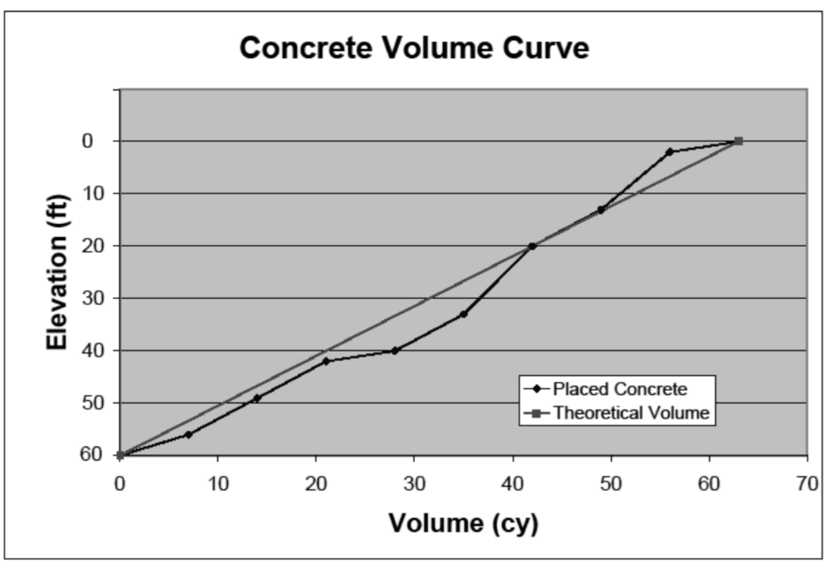
Each truck holds 7cy and the depth of the concrete after each truck are shown (no waste):

Truck	CY	Depth to Concrete Ft	Accumulated Concrete Volume
0	0	60	0
1.	7	56	7
2.	7	49	14
3.	7	42	21
4.	7	40	28
5.	7	33	35
6.	7	20	42
7.	7	13	49
8.	7	02	56
9.	7	0	63



Plot the concrete curve on the next sheet. What issues may there be?

53



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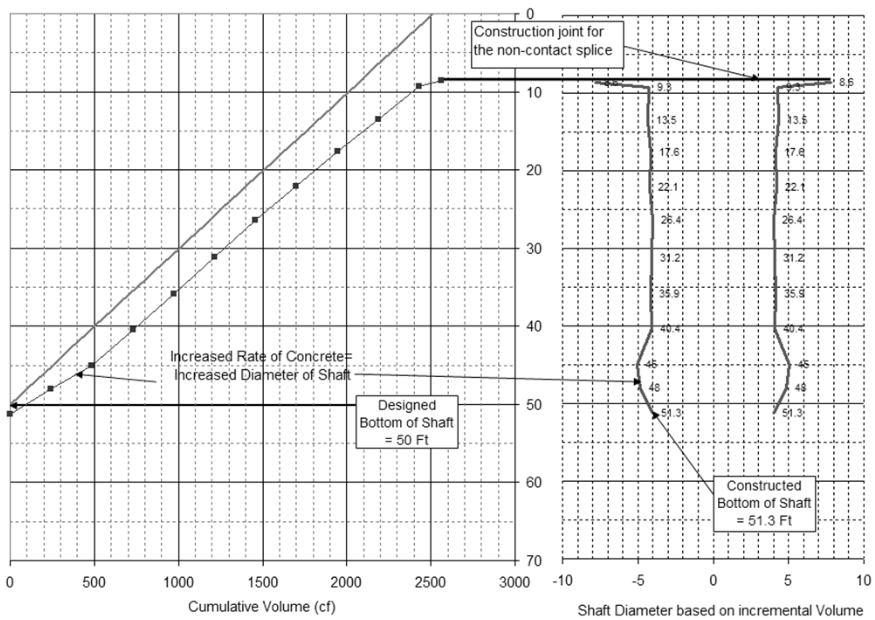
Concrete Placement



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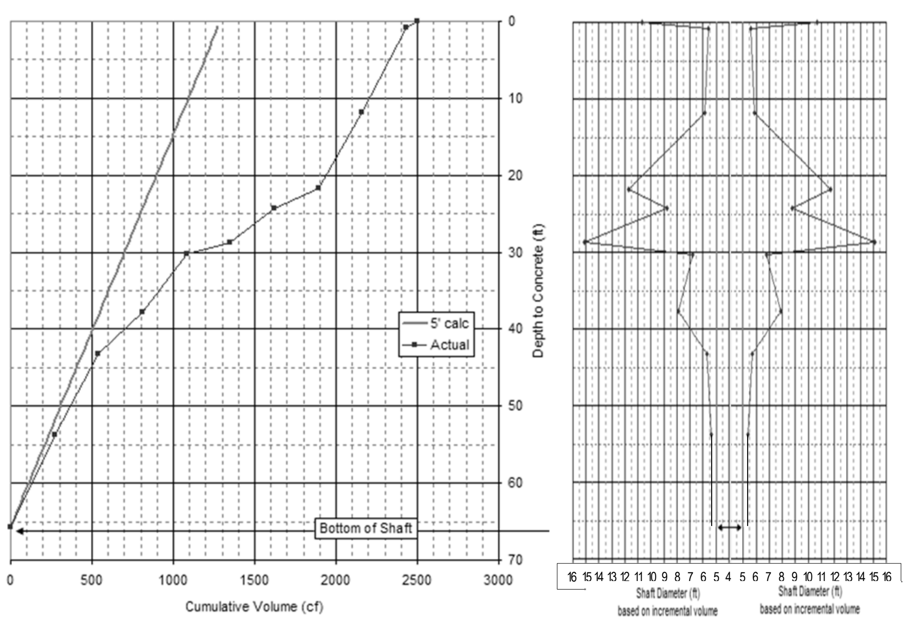
Concrete Placement



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Completed Concrete Placement Log

EXAMPLE Class Drilled Shaft		12345	CON10000
BENT: 2	STATION: 100+00	SHAFT NO.: #1	SHAFT DIAMETER: 6 feet
DRILLED SHAFT CONTRACTOR: Diggin Deep Drilled Shaft Construction		INSPECTED BY: Abby Normal	CERT. NO.: 41071 / DATE: 2/1/2013

REFERENCE ELEVATION: 315	SHAFT TOP ELEVATION: 310	REBAR CAGE TOP ELEVATION:	AT START: 314.9	AT FINISH: 315.8
DEPTH TO WATER OR SLURRY: N/A	SHAFT BOTTOM ELEVATION: 245	REBAR DESIGN ELEV.: 315.5	WITHIN SPEC? ☑ YES	☐ NO
TOP OF ROCK ELEVATION: 266.9	SHAFT LENGTH: 65	EBAR CAGE CENTERED WITHIN SPEC?	☑ YES	☐ NO

SHAFT CONCRETE INFORMATION

Placement Method — **Volume in Lines** (#, ID, Length, Volume)

Begin Pour: Date: 7/18/2013 Time: 8:00 AM

End Pour: Date: 7/18/2013 Time: 11:15 AM

YES Free Fall

NO Tremie — # 0, ID 0, Volume 0.0 cy

Shaft Completion Time: (including casing removal) 11:45 AM

De-Airing Method ____ cy

NO Tremie Plug ____ cy — 75 cyd **Total Concrete Volume Delivered (TVD)**

NO Tremie Cap — **Total Volume in Lines (VL)** ____ cy — 74 cyd **Total Concrete Volume In Shaft; cy (=TVD-VL-VW)**

NO Relief Valve — **Estimated Waste Concrete (VW)** 1 cy

Truck No.	Concrete Volume	Slump	Arrival Time	Start Time	Finish Time	Tremie Depth	Depth To Concrete	NOTES (delays, additives, breaching, casing removal)
1	10 cy	9.8	7:50 AM	8:00 AM	8:15 AM	55.5	58.75	Initial QCT concrete test - passes
2	10 cy	9.5	8:00 AM	8:20 AM	8:28 AM	51	53.25	Talked to contractor about depth of concrete
3	10 cy	10	8:15 AM	8:35 AM	8:50 AM	42	42.5	Second QCT concrete test - passes
4	10 cy	9.1	8:45 AM	8:55 AM	9:05 AM	35	35	
5	10 cy	9.6	8:50 AM	9:10 AM	9:30 AM	25	25	Talked to contractor about depth of concrete
6	10 cy	10.2	9:20 AM	9:40 AM	9:55 AM	10	10	Third QCT concrete test -See notes below
7	10 cy	9.9	9:40 AM	10:00 AM	10:35 AM	3	3	Finished pour
8	5 cy	9.5	10:30 AM	10:50 AM	11:15 AM	0	0	
								Truck #6 notes: slump 0.2 out of specifications. Contractor
								opted to pour. Confirmed with assistant PM to continue

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Measurement

Standard Specifications
00512.80 Measurement

(d) Drilled Shaft Concrete – No measurement of quantities will be made for drilled shaft concrete. Estimated quantities of concrete will be listed in the Special Provisions.

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Measurement

Special Provisions
00512.80 Measurement

00512.80(d) Drilled Shaft Concrete - Add the following at the end of this subsection:

The estimated quantity of drilled shaft concrete is:

Structure	Quantity (Cubic Yard)
Bridge No. 09671	37
Bridge No. 23235	18
Bridge No. 23873	315
Bridge No. 23874	241
Bridge No. 23901	287

ODOT MATERIALS & INSPECTION

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Measurement

Special Provisions
00512.80 Measurement

00512.80(e) Drilled Shaft Reinforcement - Add the following at the end of the paragraph:

The estimated quantity of drilled shaft reinforcement is:

Structure Number	Uncoated Reinforcement Quantity (Pound)		
	Grade 60	Grade 80	Grade 100
Bridge No. 09671	7,050	0	0
Bridge No. 23235	9,600	0	0
Bridge No. 23873	74,564	0	0
Bridge No. 23874	56,716	0	0
Bridge No. 23901	95,000	0	0

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Payment

Standard Specifications
SS00512.90 Payment
The payment specifications address what the pay items are, the unit of measurement, and defines what work is included with each pay item.

Pay Item	Unit of Measurement
(d) Drilled Shaft Concrete	Lump Sum

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

If the Contractor chooses to use a larger shaft diameter casing than the shaft diameter shown, no additional payment will be made for the larger casing, or for the additional excavation, concrete, and reinforcement.

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Learning Objective

Is a tremie required for dry shaft construction?

A. Yes
B. No

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Learning Objective

What is the criteria for determining dry shaft construction?

A. No more than 3 inches of water at the bottom of the shaft at the beginning of the pour
B. Groundwater seepage is less than 12 inches per hour
C. Shaft diameter is greater than or equal to 3 feet.
D. All three criteria items must be met to be considered a dry shaft

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Learning Objective

During wet shaft what is the minimum head above the bottom of the tremie that must be maintained at all times?

A. 3 feet
B. 5 feet
C. 6 feet
D. 10 feet

64

Learning Objective

As the temporary casing is withdrawn, maintain a minimum _______ head of concrete above the bottom of the casing.

A. 3 feet
B. 5 feet
C. 6 feet
D. 10 feet

65

Learning Objective

How much time does the contractor have between placing loads of concrete?

A. 15 minutes
B. 60 minutes
C. 90 minutes
D. As much as he needs

66

Drilled Shaft Inspector's checklist

Concrete Operations

- ☐ Yes ☐ No ☐ NA 31. Prior to concrete placement, has the slurry (both manufactured and natural) been tested in accordance with Section 00512.43(g)??
- ☐ Yes ☐ No ☐ NA 32. If required, was the casing removed in accordance with Section 00512.47(e)?
- ☐ Yes ☐ No ☐ NA 33. Does the Contractor's tremie meet the requirements of Section 00512.47(a)?
- ☐ Yes ☐ No ☐ NA 34. Was the discharge end of the tremie maintained in the concrete mass with proper concrete head above it at all times (00512.47(c))?
- ☐ Yes ☐ No ☐ NA 35. For shafts with non-contact splices, have the cold joints been properly cleaned and roughened in accordance with Section 00512.47(a)?
- ☐ Yes ☐ No ☐ NA 36. For shafts without non-contact splices, did the Contractor overflow the shaft until good concrete flowed out of the top of the excavation (00512.47(a))?
- ☐ Yes ☐ No ☐ NA 37. Have the Concrete Placement and Concrete Volume logs been completed?
- ☐ Yes ☐ No ☐ NA 38. Were the concrete acceptance tests performed as required?
- ☐ Yes ☐ No ☐ NA 39. Were the Crosshole Sonic Log (CSL) tubes filled with water and capped in accordance to Section 00512.46?

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Inspector's Roles and Responsibilities

Documentation

Drilled Shaft Placement Log 00512.40

Concrete Placement Logs and Volume Curves – Measure and record all concrete placed into drilled shafts using standard ODOT forms designated for this purpose or other forms approved by the Engineer. Provide the Engineer with a completed Drilled Shaft Concrete Placement Log and Concrete Volume Curve Form for each drilled shaft within 24 hours after completion of shaft concrete placement.

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Concrete Operations
Learning Objectives

- Concrete basics
  - Mix design
  - Concrete placement
- Concrete Placement Log
- Concrete Volume Log
- Inspector's Roles, and Responsibilities

ODOT MATERIALS & INSPECTION

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INSERT TAB

7. Acceptance Test

Acceptance Testing

Lesson 7

1

Learning Objectives

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

2

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.

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3

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.

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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.

5

ODOT Standard Specifications
00512.49 Scheduling and Restrictions

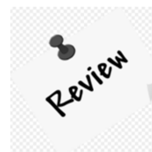
- Do not proceed with the third drilled shaft until the final CSL test results from the first drilled shaft has been received and reviewed and the shaft accepted, in writing, by the Engineer.
- After the first drilled shaft on the Project has been accepted, make no significant changes in construction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

6

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.



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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.

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Very large defect found by Sonic Echo test.

Probably due to a partial collapse.

No concrete.

9

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.

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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.

11

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.

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Integrity Tests Types

- Crosshole Sonic Log (CSL)
  - Currently the only test that is done by ODOT
  - Allow at least 3 Calendar Days of curing time before testing unless otherwise approved
- Other Tests in the industry
  - Sonic echo
  - Gamma-gamma
  - Thermal integrity

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

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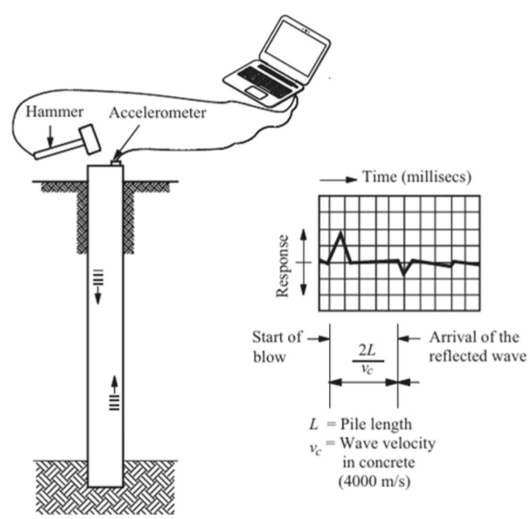
Sonic Echo Testing

- Primarily used to verify axial shaft length.
- Can be used on old shafts to verify length records.



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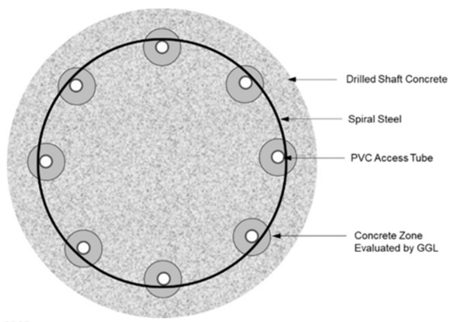
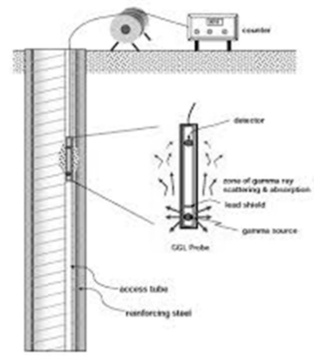
Gamma-Gamma Testing

- Measures material density in all directions around the access tubes, which must be PVC.





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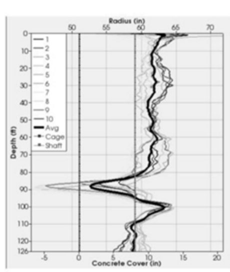
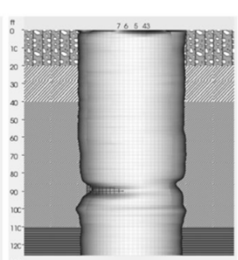
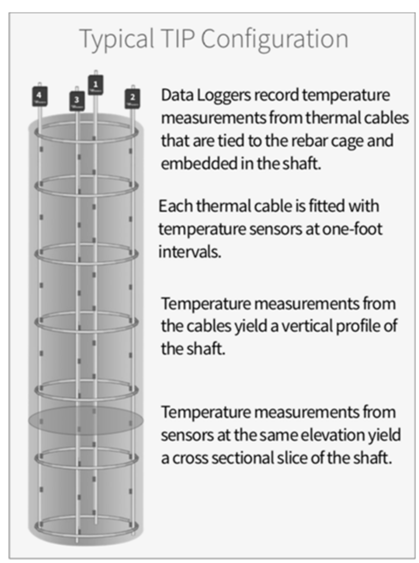
Thermal Testing

- Measures the temperature of the curing heat from the concrete to determine concrete cover.







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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.

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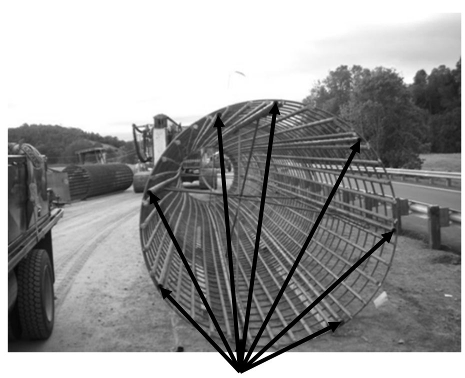
Crosshole Sonic Log (CSL) Test

- 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

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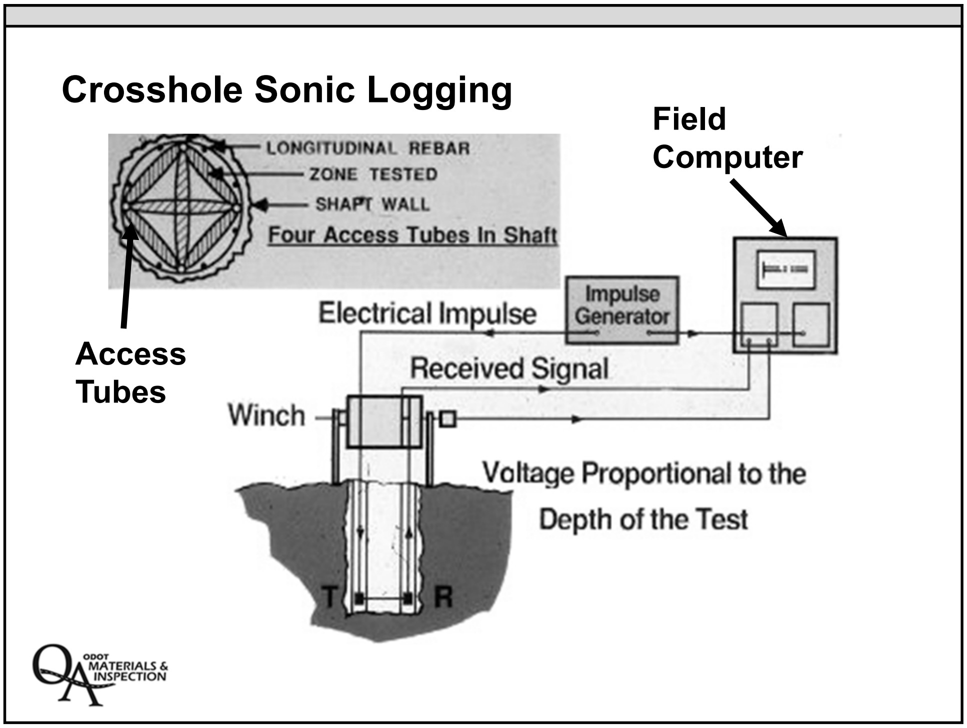
Crosshole Sonic Logging
LONGITUDINAL REBAR
ZONE TESTED
SHAFT WALL
Four Access Tubes In Shaft
Access Tubes
Field Computer
Impulse Generator
Electrical Impulse
Received Signal
Winch
Voltage Proportional to the Depth of the Test
T
R
ODOT MATERIALS & INSPECTION

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Source and Receiver Tools for CSL Test

20


Performing the CSL Test

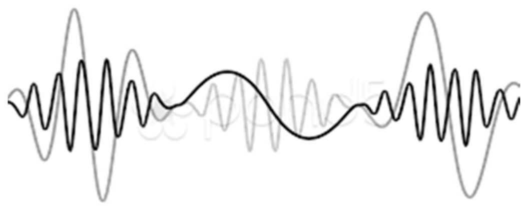
21

Performing the CSL Test

22

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.



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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.

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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.

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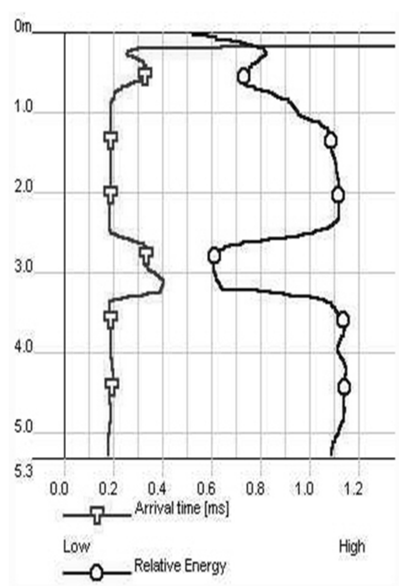
Crosshole Sonic Log Test Results



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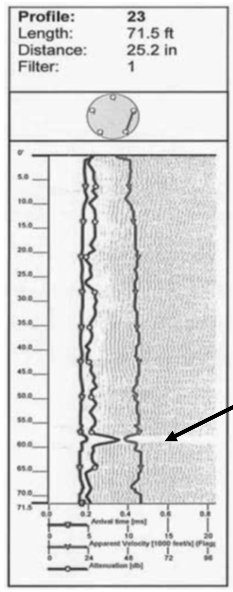
Crosshole Sonic Log Test Results



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

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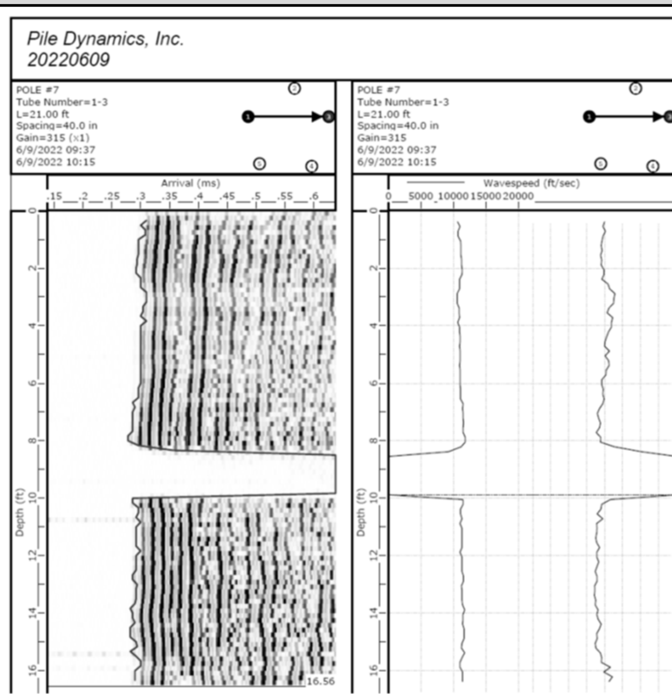
- Example of a CLS testing depicting a major anomaly.
- This same low velocity zone appears on all the CLS testing combinations.



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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.

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Integrity Test Results

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

- Additional CSL testing or analysis via 3D Tomography.
- Excavation around shaft to expose defect, if shallow.
- Core drilling to the anomaly.
- 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.

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Concrete Coring

- Number of core holes, locations and depths determined by Engineer.
- Log the cores like a regular subsurface borehole.
- Take photos.
- Engineer may choose to perform Unconfined Compressive tests on selected core samples.

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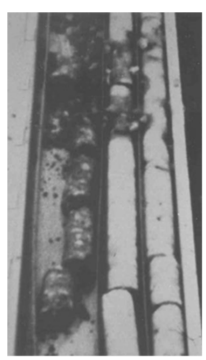
Concrete Coring

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



Unacceptable

Acceptable

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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.
- Add additional piling or other deep foundation elements around perimeter of shaft.
- Replace Shaft.

33

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.

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Shaft Repairs

Excavate upper portion of shaft and repair defect area.

35

A Good Shaft

36

Learning Objective

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

37

Learning Objective

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

38

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

ODOT MATERIALS & INSPECTION

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ODOT Drilled Shaft Inspection Checklist

Pile Acceptance

Post Installation

☐ Yes ☐ No ☐ NA 40. Is all casing removed to the proper elevations in accordance with 00512.47(e)?

☐ Yes ☐ No ☐ NA 41. Is the concrete being cured in accordance with Section 00540.51?

☐ Yes ☐ No ☐ NA 42. Has all Crosshole Sonic Log (CSL) Testing been completed in accordance with Section 00512.48?

☐ Yes ☐ No ☐ NA 43. Is the shaft within the allowable construction tolerances (00512.42)?

☐ Yes ☐ No ☐ NA 44. Has the Contractor completed the Drilled Shaft Inspection Report (00512.40(c))?

☐ Yes ☐ No ☐ NA 45. Has the Inspector completed the Drilled Shaft Inspection Report (00512.40(c))?

ODOT MATERIALS & INSPECTION

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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.

ODOT MATERIALS & INSPECTION

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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.

Pay Item	Unit of Measurement
(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.

ODOT MATERIALS & INSPECTION

42

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.

ODOT MATERIALS & INSPECTION

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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.

Pay Item	Unit of Measurement
(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.

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INSERT TAB

8. Safety / Environmental

Safety and Environmental

ODOT MATERIALS & INSPECTION

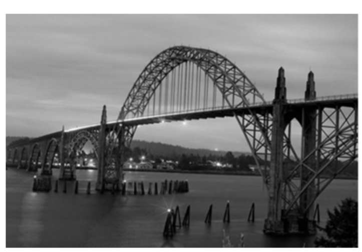
1

Safety is Job One!

ODOT structures have a design life of at least 75 years, and as such, the projects that you work on today will last into the next century, beyond the year 2100.

These projects are great stories and connections to the state of Oregon to share with your grandkids.

There is no story unless you are around to tell it. Always remember that safety is job one.

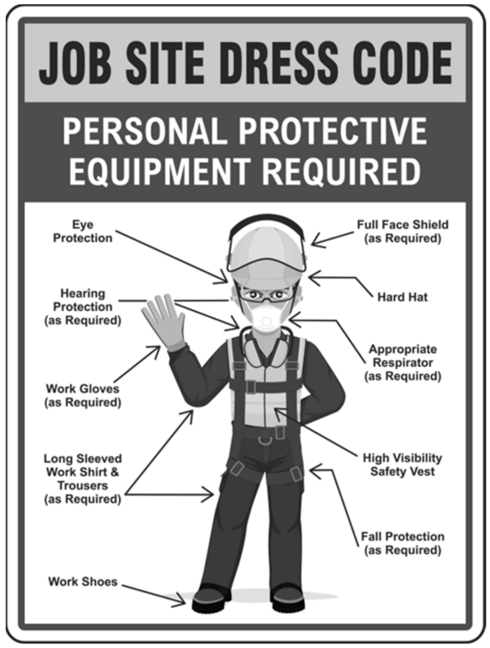


ODOT MATERIALS & INSPECTION

2

Personal Safety

- Keep your PPE gear with you at all times.
- High visibility vests, Steel-toed boots, and hard hats are required at all times.
- Other safety gear may be required depending upon the situation.



3

Drilling Safety

- Drilled shafts present a unique set of safety challenges.
- Very large, top heavy equipment.
- Crowded conditions.
- Large fall radius.


Fatal accident at the York University in Toronto, 2012

4

Portland Oregon Health and Science University Drill Rig Accident August 2022

5

Salt Lake City Drill Rig Accident March, 2022

6

Philadelphia Drill Rig Accident July, 2021

7

Phoenix Drill Rig Accident May, 2018

8

Drilling Safety

- It happens more often than you think.
- Be aware at all times!
- If the rig is doing anything other than drilling, make sure you are beyond its tower height should it fall.
- Drill rigs and especially Casing Oscillators can collapse entire temporary work bridges.

Accident from an ODOT Project in Region 3

ODOT MATERIALS & INSPECTION

9

Environmental Safety

- Environmental Safety protects environmental and cultural resources that are important to the people of Oregon.
- Erosion and Sediment Control (00280) prevent excessive silt runoff that could affect surrounding resources and infrastructure.
- Environmental Protections are presented in 00290.
  - These items can include Water Quality Protection, Turbidity Monitoring, Noise Control, Fish Protection, Regulated Work Areas, Prohibited Operations, Work Area Isolation, Water Intake Screening, Hydro-Acoustic Monitoring, Work Containment Plans.
  - **Know your 200 specifications.**

ODOT MATERIALS & INSPECTION

10

Learning Objective

- Rig tower set to close to power lines if not de-energized.

11

Learning Objective

- Workers without proper fall protection.

12

Learning Objective

- Excavations not properly secured or demarcated for worker safety.

13

Learning Objective

- Improper work area containment, notice adjacent natural water course.

14

Learning Objective

- Improper work hazard containment.

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