Concrete Operations

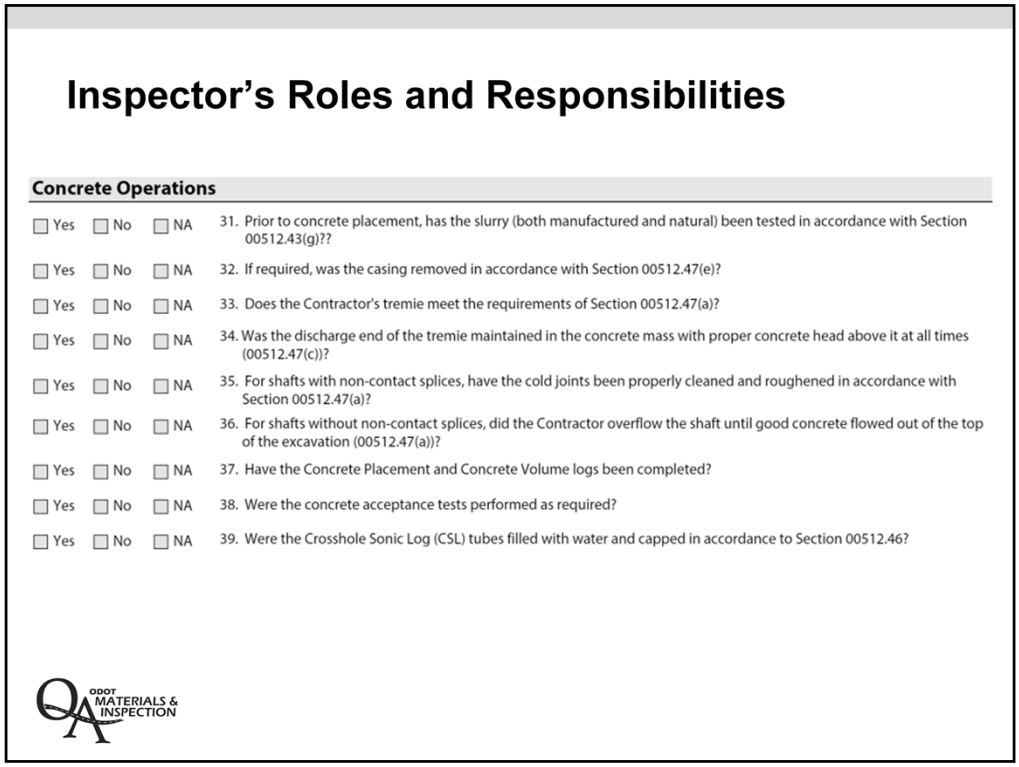
Lesson 7

Standard and Special Provisions to be familiar with:
00512 – Drilled Shafts
00530 – Steel Reinforcement for Concrete
00540 – Structural Concrete
02001 – Concrete
00290 – Environmental Protection

Documents that you will need:
Drilled Shaft Inspector's Checklist
Drilled Shaft Installation Plan
Drilled Shaft Inspector's Report
Drilled Shaft Concrete Volumes
Drilled Shaft Concrete Volume Logs

Concrete Operations
Learning Objectives

- Concrete basics
  - mix design
  - concrete placement
  - concrete sampling and testing
- Concrete Placement Log
- Concrete Volume Log
- Inspector's roles, and responsibilities



Change to checklist image.

Concrete Basics

What do you think are the desired characteristics of drilled shaft concrete?

- Workability
- Self-consolidating
- Nominal aggregate size
- Temperature
- Strength

ODOT MATERIALS & INSPECTION

Concrete Basics

What are the concrete properties, tolerances, and limits?

Standard Provisions 02001 Concrete

- Strength
- Air entrainment
- Slump
- Temperature

ODOT MATERIALS & INSPECTION

OSSC 2015

00512.12 Concrete Mix Design - Design the drilled shaft concrete for minimum segregation. Use the Engineer's reviewed and approved mix design.

- Add water to the concrete mix at the Project Site only if allowed by the approved mix design. Accurately measure water added at the site by water meters, buckets or other approved devices. Limit the addition of water at the Project Site to 1 gallon per cubic yard.
- Provide concrete having the appropriate initial slump according to Table 02001-3. Use chemical admixtures from the QPL to control and maintain slump and to facilitate temporary casing extraction.
- Design the concrete mix to maintain at least 4 inches of slump after placement and throughout the entire duration of the pour including during temporary casing extraction.

Concrete Basics

2001 concrete properties, tolerances and limits (continued)

Strength required for Drilled Shafts

(a) Strength – Provide concrete meeting the required Classes shown in the Contract Documents. The class of concrete designates the minimum required compressive strength, f'_c at 28 days, and the nominal maximum size of aggregate to be used in the concrete (for example, Class 3300 - ¾: f'_c is 3,300 psi with a nominal maximum size aggregate of ¾-inch).

Table 02001-1

Concrete Strength and Water/Cementitious Material (w/cm) Ratio		
Type of Concrete	**Strength (psi)**	**Maximum w/cm Ratio**
Structural	3300	0.50
	3300 (Seal)	0.45
	4000	0.48
	4000 (Deck)	0.40
	HPC4000	0.40
	5000 and above	0.40 [1]
	HPC5000 and above	0.40
Drilled Shaft	4000	0.48
Paving	4000	0.44

ODOT MATERIALS & INSPECTION

Concrete Basics
Required concrete strength?

Special Provisions

00512.10(b) Concrete – Replace this subsection, except for the subsection number and title, with the following:

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.

Concrete Basics

2001 concrete properties, tolerances and limits (continued)

Air Entrainment required for Drilled Shafts

(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.

ODOT MATERIALS & INSPECTION

Concrete Basics

2001 concrete properties, tolerances and limits (continued)

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	5 1/2" ± 2 1/2"
Precast Prestressed Concrete with HRWRA	10" max.
Seal Concrete	8" ± 2"
Drilled Shaft Concrete	8 1/2" ± 1 1/2"

ODOT MATERIALS & INSPECTION

Concrete Basics

2001 concrete properties, tolerances and limits (continued)

Temperature required for Drilled Shafts

(d) Temperature – Provide concrete, at time of placement, at a temperature between a minimum of 50° F and a maximum of 90° F, except the maximum bridge deck concrete temperature shall be 80° F.

ODOT MATERIALS & INSPECTION

Concrete Basics

What are the concrete mix design criteria?

Standard Specifications

00512.12 Concrete Mix Design – Design the drilled shaft concrete for minimum segregation. Use the Engineer's reviewed and approved mix design.

- Add water to the concrete mix at the Project Site only if allowed by the approved mix design. Accurately measure water added at the site by water meters, b[illegible]. Limit the addition of water at [illegible]ic yard.
- Provide concrete h[illegible]p according to Table 02001-3. Use chemical admixtures from the QPL to control and maintain slump and to facilitate temporary casing extraction.
- Design the concrete mix to maintain at least 4 inches of slump after placement and throughout the entire duration of the pour including during temporary casing extraction.

Concrete Basics

What are the concrete mix design criteria?

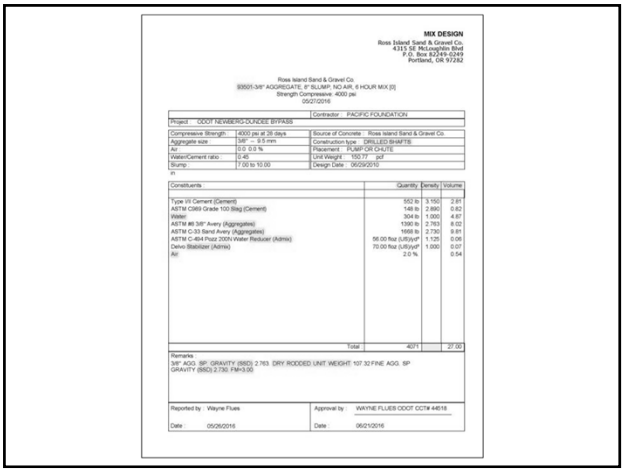
Special Provisions

00512.10(b) Concrete – Replace this subsection, except for the subsection number and title, with the following:

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.

00512.12 Concrete Mix Design – Delete this subsection.

What does a Concrete Mix Design look like?



MIX DESIGN

Ross Island Sand & Gravel Co.
4315 SE McLoughlin Blvd
P.O. Box 82249-0249
Portland, OR 97282

Ross Island Sand & Gravel Co.
93501/3/8" AGGREGATE, 8" SLUMP, NO AIR, 6 HOUR MIX [0]
Strength Compressive: 4000 psi
05/27/2016

		Contractor :	PACIFIC FOUNDATION
Project :	ODOT NEWBERG-DUNDEE BYPASS		
Compressive Strength :	4000 psi at 28 days	Source of Concrete :	Ross Island Sand & Gravel Co.
Aggregate size :	3/8" -- 9.5 mm	Construction type :	DRILLED SHAFTS
Air :	0.0 0.0 %	Placement :	PUMP OR CHUTE
Water/Cement ratio :	0.45	Unit Weight :	150.77 pcf
Slump :	7.00 to 10.00 in	Design Date :	06/29/2010

Constituents	Quantity	Density	Volume
Type I/II Cement (Cement)	552 lb	3.150	2.81
ASTM C989 Grade 100 Slag (Cement)	148 lb	2.890	0.82
Water	304 lb	1.000	4.87
ASTM #8 3/8" Avery (Aggregates)	1390 lb	2.763	8.02
ASTM C-33 Sand Avery (Aggregates)	1656 lb	2.730	9.81
ASTM C-494 Polyz 200N Water Reducer (Admix)	56.00 floz (US)/cwt	1.125	0.06
Delvo Stabilizer (Admix)	70.00 floz (US)/cwt	1.000	0.07
Air	2.0 %		0.54
Total	4071		27.00

Remarks :
3/8" AGG. SP. GRAVITY (SSD) 2.763. DRY RODDED UNIT WEIGHT 107.32 FINE AGG. SP. GRAVITY (SSD) 2.730. FM=3.00

Reported by : Wayne Flues	Approval by : WAYNE FLUES ODOT CCT# 44618
Date : 05/26/2016	Date : 06/21/2016

OSSC 2015
02001.35 Required Submittals for Mix Designs - Submit the following information for each concrete mix design:
(a) Supplier's Unique Mix Design Identification Number
(b) Mix Design Constituent Proportions:
• Weight per cubic yard (pounds per cubic yard) of cementitious material, modifiers, fine and coarse aggregates (SSD), and mix water.
• Absolute volumes of cementitious material, modifiers, fine aggregates and coarse aggregates (SSD), and mix water.
• Dosage rates for chemical admixtures.
(c) Aggregates - Identify the aggregate source by the ODOT source number. Report current values of the following:
• Bulk specific gravities (SSD)
• Fine aggregate absorptions
• Coarse aggregate absorptions
• Dry-rodded density of coarse aggregates
• Fineness modulus of sand used in the mix design calculations
(d) Cementitious Material - For each cementitious material used, identify the following:
• Manufacturer
• Brand name
• Type
• Relevant Specification
• Source or location plant
(e) Modifiers - For each modifier used, identify the following:
• Manufacturer
• Brand name
• Source
• Relevant specification
• Class
(f) Admixtures - For each admixture used, identify the following:
• Manufacturer
• Brand name
• Design dosage rate
(g) Water - Identify the source of water to be used.
(h) Plastic Concrete Tests - Report the temperature, slump, density, air content, yield, and w/cm ratio of the trial batch or the average of these values for the cylinder sets presented for evaluation of a current mix design.
(i) Compressive Strength Test Results - Report the individual test results and the ASTV of cylinders from the trial batch or the average for the cylinder sets presented for evaluation of a current mix design.
(j) Strength Analysis - Provide an analysis, showing all calculations, demonstrating that the mix design meets the requirements of 02001.33.
(k) Quality Control Personnel - Provide the name and certification number of the CCT who prepared the mix design, the QCT who performed the plastic concrete tests and cast the test cylinders, the laboratory where the cylinders were tested, and the CSTT who tested the cylinders.

Test Results

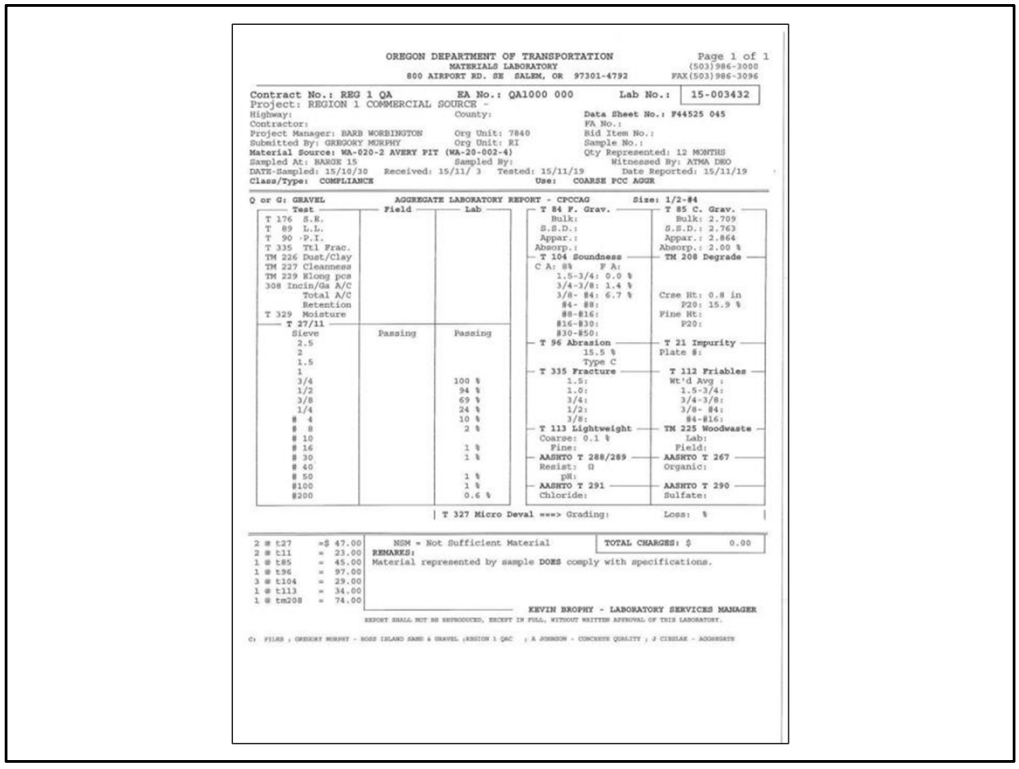
ODOT
Ross Island Sand & Gravel Co.
4315 SE McLoughlin Blvd P.O. Box 82249-0249
Portland, OR 97282
93501 - 3/8" AGGREGATE, 8" SLUMP, NO AIR, 6 HOUR MIX [0]

		Concrete	Concrete							
Cast date	Sample ID	Slump	% Air	Temp	Unit Weight	W/C Ratio	Yield	7 Day PSI	28 Day PSI	Avg 3 - 28 Day
1/16/2015	KERR	5.50	2.10	58.00	151.20	0.46	0.00	4420	10187	10187
2/23/2015	KERR	5.75	1.90	56.00	150.50	0.43	5.99	6730	9103	9103
2/24/2015	KERR	6.00	1.70	68.00	151.60	0.41	8.86	6360	10450	10450
2/25/2015	Extreme Ex	5.25	2.20	57.00	151.30	0.42	8.93	6820	11163	11163
2/25/2015	KERR	6.25	2.00	58.00	148.40	0.42	7.57	5990	10527	10527
2/26/2015	Extreme Ex	6.00	1.50	60.00	151.00	0.41	7.43	5190	9310	9310
3/5/2015	KERR	7.75	1.40	54.00	150.70	0.43	8.95	4780	9213	9213
3/5/2015	Extreme Ex	7.25	1.50	60.00	151.40	0.41	8.88	6310	10550	10550
3/16/2015	KERR	7.00	1.20	67.00	150.50	0.41	8.90	7910	9203	9203
3/17/2015	KERR	7.00	1.30	80.00	150.40	0.41	8.98	6770	9640	9640
3/18/2015	KERR	7.75	1.20	69.00	150.20	0.42	9.91	5410	8473	8473
4/28/2015	KERR	6.00	1.80	69.00	151.10	0.41	10.91	5820	8853	8853
5/15/2015	KERR	6.25	1.50	73.00	154.20	0.41	8.73	8080	8797	8797
6/17/2015	Extreme Ex	7.00	1.70	77.00	147.40	0.40	7.10	5700	7227	7227
8/25/2015	Pacific Fo	0.00	0.00	82.00	0.00	0.00	0.00	4870	6753	6753
8/31/2015	Pacific Fo	0.00	0.00	79.00	0.00	0.00	0.00	4890	7717	7717
9/1/2015	Pacific Fo	0.00	0.00	82.00	0.00	0.00	0.00	4480	6777	6777
9/2/2015	Pacific Fo	0.00	0.00	82.00	0.00	0.00	0.00	5040	6833	6833
9/3/2015	Pacific Fo	0.00	0.00	81.00	0.00	0.00	0.00	5170	6860	6860
9/8/2015	Pacific Fo	5.00	1.40	77.00	0.00	0.00	0.00	5040	6720	6720
9/11/2015	Pacific Fo	6.50	1.40	91.00	0.00	0.00	0.00	4600	6740	6740
9/15/2015	Pacific Fo	0.00	0.00	77.00	0.00	0.00	0.00	4630	8197	8197
9/15/2015	Pacific Fo	8.00	1.20	76.00	0.00	0.00	0.00	4300	7117	7117
9/16/2015	Pacific Fo	9.50	1.80	79.00	0.00	0.00	0.00	4080	6090	6090
9/17/2015	Pacific Fo	8.00	2.70	80.00	0.00	0.00	0.00	4640	7833	7833
9/17/2015	Pacific Fo	8.00	1.50	78.00	0.00	0.00	0.00	5290	7263	7263
9/18/2015	Pacific Fo	8.50	1.40	81.00	0.00	0.00	0.00	4290	6877	6877
9/21/2015	Pacific Fo	7.00	1.80	77.00	0.00	0.00	0.00	3370	6527	6527
9/21/2015	Pacific Fo	7.50	1.60	78.00	0.00	0.00	0.00	5170	6857	6857
9/24/2015	Pacific Fo	7.50	1.80	81.00	0.00	0.00	0.00	4980	6907	6907
9/25/2015	Pacific Fo	7.00	1.80	78.00	0.00	0.00	0.00	5090	6780	6780
9/25/2015	Pacific Fo	6.50	1.80	78.00	0.00	0.00	0.00	5260	6793	6793
9/29/2015	Pacific Fo	8.00	2.10	80.00	0.00	0.00	0.00	3370	6690	6690
10/1/2015	Pacific Fo	9.00	1.80	78.00	0.00	0.00	0.00	3690	5233	5233
10/2/2015	Pacific Fo	7.00	1.70	67.00	0.00	0.00	0.00	5730	8877	8877
10/5/2015	Pacific Fo	8.00	0.00	79.00	0.00	0.00	0.00	4480	6870	6870
10/6/2015	Pacific Fo	8.00	1.80	78.00	0.00	0.00	0.00	4290	6800	6800
10/8/2015	Pacific Fo	8.00	1.60	76.00	0.00	0.00	0.00	4580	6887	6887
10/12/2015	Pacific Fo	7.50	1.50	78.00	0.00	0.00	0.00	3750	6750	6750
10/13/2015	Pacific Fo	9.00	3.20	76.00	0.00	0.00	0.00	4400	6810	6810
4/15/2016	Pacific Fo	0.00	0.00	0.00	0.00	0.00	0.00	5050	7323	7323
4/18/2016	Pacific Fo	8.50	1.70	75.00	0.00	0.00	0.00	5700	7930	7930
4/19/2016	Pacific Fo	8.00	1.40	77.00	0.00	0.00	0.00	5900	7240	7240
4/20/2016	Pacific Fo	8.50	1.20	75.00	0.00	0.00	0.00	5700	7887	7887
4/21/2016	Pacific Fo	8.00	1.30	73.00	0.00	0.00	0.00	5680	7863	7863
4/22/2016	Pacific Fo	7.00	1.60	70.00	0.00	0.00	0.00	5340	7933	7933
4/25/2016	Pacific Fo	8.50	1.30	68.00	0.00	0.00	0.00	5400	8250	8250
4/26/2016	Pacific Fo	8.50	1.60	68.00	0.00	0.00	0.00	0	8670	8670
4/28/2016	Pacific Fo	7.00	1.50	69.00	0.00	0.00	0.00	5530	8037	8037
		7.61	1.50	78.00	150.71	0.42	8.62	4851	7478	7478 Average
		1.00	0.38	8.00	1.54	0.01	1.30	1813	1421	1421 STD
		5.50	2.80	42.00	8.80	0.06	4.92	5420	6906	6906 Range
		4.00	0.40	54.00	147.40	0.40	5.99	2690	4257	4257 Low
		9.50	3.20	96.00	154.20	0.46	10.91	8080	11163	11163 High

Number of observations: 49

Workability

TIME	SLUMP
HOUR 1	9.5
HOUR 2	8.25
HOUR 3	7
HOUR 3.5	7
HOUR 4	7
HOUR 4.5	6.25
HOUR 5	5.75
HOUR 5.5	5
HOUR 6	4.5



OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4792

Page 1 of 1
(503)986-3000
FAX(503)986-3096

Contract No.: REG 1 QA EA No.: QA1000 000 Lab No.: 15-003432
Project: REGION 1 COMMERCIAL SOURCE -
Highway: County: Data Sheet No.: P44525 045
Contractor: FA No.:
Project Manager: BARB WORBINGTON Org Unit: 7840 Bid Item No.:
Submitted By: GREGORY MURPHY Org Unit: RI Sample No.:
Material Source: WA-020-2 AVERY PIT (WA-20-002-4) Qty Represented: 12 MONTHS
Sampled At: BARGE 15 Sampled By: Witnessed By: ATMA DEO
DATE-Sampled: 15/10/30 Received: 15/11/ 3 Tested: 15/11/19 Date Reported: 15/11/19
Class/Type: COMPLIANCE Use: COARSE PCC AGGR

Q or G: GRAVEL — AGGREGATE LABORATORY REPORT - CPCCAG — Size: 1/2-#4

Test	Field	Lab
T 176 S.E.		
T 89 L.L.		
T 90 P.I.		
T 335 Ttl Frac.		
TM 226 Dust/Clay		
TM 227 Cleanness		
TM 229 Klong pcs		
308 Incin/Gs A/C		
Total A/C		
Retention		
T 329 Moisture		

T 27/11 Sieve	Passing	Passing
2.5		
2		
1.5		
1		
3/4		100 %
1/2		94 %
3/8		69 %
1/4		24 %
# 4		10 %
# 8		2 %
# 10		
# 16		1 %
# 30		1 %
# 40		
# 50		1 %
#100		1 %
#200		0.6 %

T 84 F. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

T 85 C. Grav.
Bulk: 2.709
S.S.D.: 2.763
Appar.: 2.864
Absorp.: 2.00 %

T 104 Soundness
C A: 8%
F A:
1.5-3/4: 0.0 %
3/4-3/8: 1.4 %
3/8- #4: 6.7 %
#4- #8:
#8-#16:
#16-#30:
#30-#50:

TM 208 Degrade
Cree Nt: 0.8 in
P20: 15.9 %
Fine Nt:
P20:

T 96 Abrasion
15.5 %
Type C

T 21 Impurity
Plate #:

T 335 Fracture
1.5:
1.0:
3/4:
1/2:
3/8:

T 112 Friables
Wt'd Avg :
1.5-3/4:
3/4-3/8:
3/8- #4:
#4-#16:

T 113 Lightweight
Coarse: 0.1 %
Fine:

TM 225 Woodwaste
Lab:
Field:

AASHTO T 288/289
Resist: Ω
pH:

AASHTO T 267
Organic:

AASHTO T 291
Chloride:

AASHTO T 290
Sulfate:

T 327 Micro Deval ===> Grading: Loss: %

2 @ t27 =$ 47.00
2 @ t11 = 23.00
1 @ t85 = 45.00
1 @ t96 = 97.00
3 @ t104 = 29.00
1 @ t113 = 34.00
1 @ tm208 = 74.00

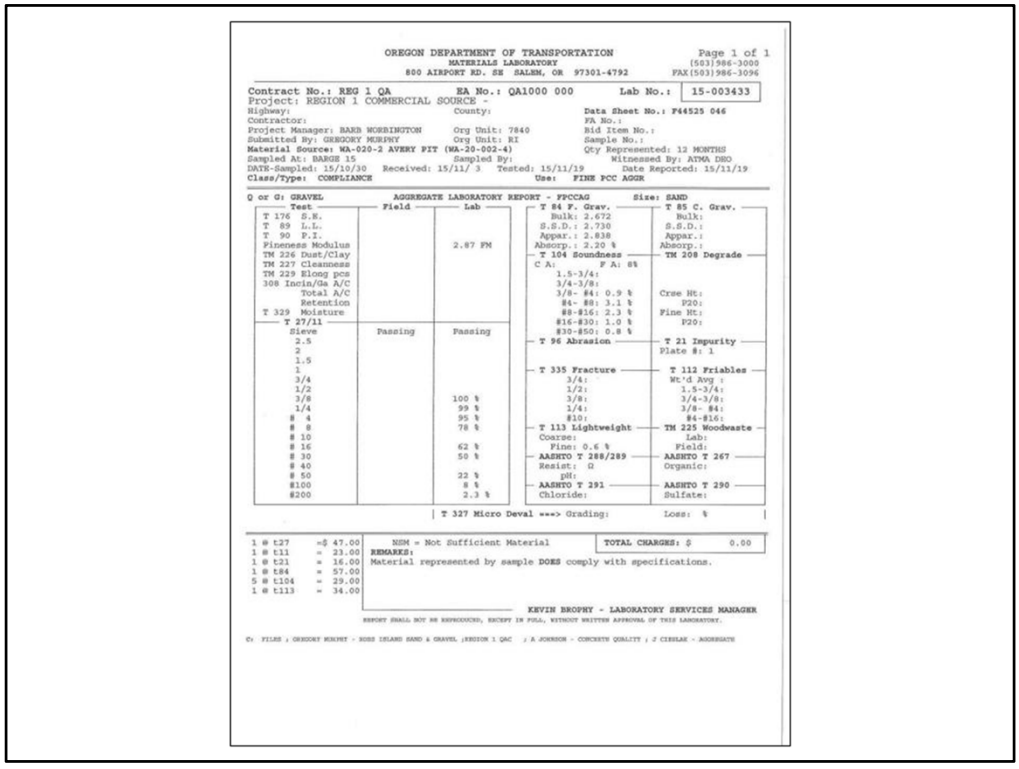
NSM = Not Sufficient Material

TOTAL CHARGES: $ 0.00

REMARKS:
Material represented by sample DOES comply with specifications.

KEVIN BRophy - LABORATORY SERVICES MANAGER

C: FILES ; GREGORY MURPHY - ROSS ISLAND SAND & GRAVEL ;REGION 1 QAC ; A JOHNSON - CONCRETE QUALITY ; J CISLAK - ACCESSATE



OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4792

Page 1 of 1
(503)986-3000
FAX(503)986-3096

Contract No.: REG 1 QA EA No.: QA1000 000 Lab No.: 15-003433
Project: REGION 1 COMMERCIAL SOURCE -
Highway: County:
Contractor:
Project Manager: BARB WORDINGTON Org Unit: 7840
Submitted By: GREGORY MURPHY Org Unit: RI
Material Source: WA-020-2 AVERY PIT (WA-20-002-4)
Sampled At: BARGE 15 Sampled By:
DATE-Sampled: 15/10/30 Received: 15/11/ 3 Tested: 15/11/19
Class/Type: COMPLIANCE

Data Sheet No.: P44525 046
FA No.:
Bid Item No.:
Sample No.:
Qty Represented: 12 MONTHS
Witnessed By: ATMA DEO
Date Reported: 15/11/19
Use: FINE PCC AGGR

Q or G: GRAVEL AGGREGATE LABORATORY REPORT - FPCCAG Size: SAND

Test	Field	Lab
T 176 S.E.		
T 89 L.L.		
T 90 P.I.		
Fineness Modulus		2.87 FM
TM 226 Dust/Clay		
TM 227 Cleanness		
TM 229 Elong pcs		
308 Incin/Ga A/C		
Total A/C		
Retention		
T 329 Moisture		

T 27/11 Sieve	Passing	Passing
2.5		
2		
1.5		
1		
3/4		
1/2		100 %
3/8		99 %
1/4		95 %
# 4		78 %
# 8		
# 10		62 %
# 16		50 %
# 30		
# 40		22 %
# 50		8 %
#100		2.3 %
#200		

T 84 F. Grav.: Bulk: 2.672, S.S.D.: 2.730, Appar.: 2.838, Absorp.: 2.20 %
T 85 C. Grav.: Bulk: , S.S.D.: , Appar.: , Absorp.:
T 104 Soundness: C A: F A: 6%
1.5-3/4:
3/4-3/8:
3/8- #4: 0.9 %
#4- #8: 3.1 %
#8-#16: 2.3 %
#16-#30: 1.0 %
#30-#50: 0.8 %
TM 208 Degrade: Crse Nt: P20: Fine Nt: P20:
T 96 Abrasion:
T 21 Impurity: Plate #: 1
T 335 Fracture: 3/4: 1/2: 3/8: 1/4: #10:
T 112 Friables: Wt'd Avg : 1.5-3/4: 3/4-3/8: 3/8- #4: #4-#16:
T 113 Lightweight: Coarse: Fine: 0.6 %
TM 225 Woodwaste: Lab: Field:
AASHTO T 288/289: Resist: Ω pH:
AASHTO T 267: Organic:
AASHTO T 291: Chloride:
AASHTO T 290: Sulfate:

T 327 Micro Deval ===> Grading: Loss: %

1 @ t27 =$ 47.00
1 @ t11 = 23.00
1 @ t21 = 16.00
1 @ t84 = 57.00
5 @ t104 = 34.00
1 @ t113 = 34.00

NSM = Not Sufficient Material

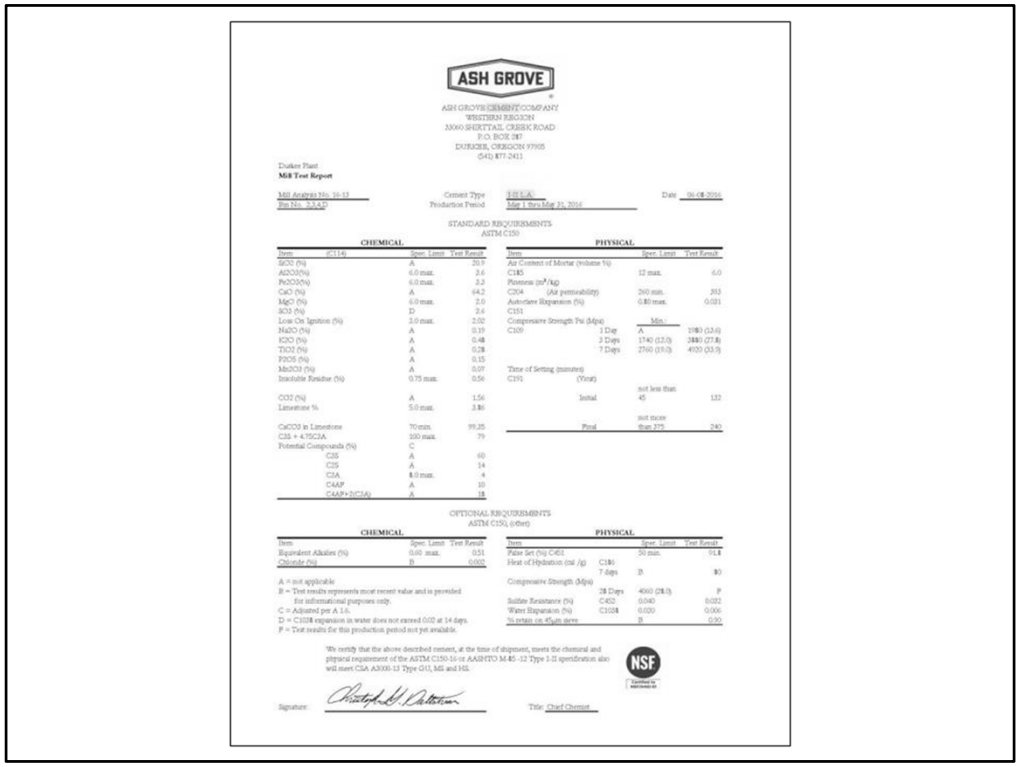
TOTAL CHARGES: $ 0.00

REMARKS:
Material represented by sample DOES comply with specifications.

KEVIN BROPHY - LABORATORY SERVICES MANAGER

REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT WRITTEN APPROVAL OF THIS LABORATORY.

Cc FILES ; GREGORY MURPHY - ROSS ISLAND SAND & GRAVEL ;REGION 1 QAC ; A JOHNSON - CONCRETE QUALITY ; J CIESLAK - AGGREGATE



ASH GROVE

ASH GROVE CEMENT COMPANY
WESTERN REGION
30000 SHEETTAIL CREEK ROAD
P.O. BOX 387
DURKEE, OREGON 97905
(541) 877-2411

Durkee Plant
Mill Test Report

Mill Analysis No. 16-13 — Cement Type: I (L)A — Date: 04-08-2016
Bin No. 2,3,4,5 — Production Period: Mar 1 thru Mar 31, 2016

STANDARD REQUIREMENTS
ASTM C150

CHEMICAL

Item	(C114)	Spec. Limit	Test Result
SiO2 (%)		A	20.9
Al2O3(%)		6.0 max.	3.6
Fe2O3(%)		6.0 max.	2.2
CaO (%)		A	64.2
MgO (%)		6.0 max.	2.0
SO3 (%)		D	2.6
Loss On Ignition (%)		3.0 max.	2.02
Na2O (%)		A	0.19
K2O (%)		A	0.48
TiO2 (%)		A	0.28
P2O5 (%)		A	0.15
Mn2O3 (%)		A	0.07
Insoluble Residue (%)		0.75 max.	0.56
CO2 (%)		A	1.56
Limestone %		5.0 max.	3.86
CaCO3 in Limestone		70 min.	99.25
C3S + 4.75C3A		100 max.	79
Potential Compounds (%)		C	
	C3S	A	60
	C2S	A	14
	C3A	8.0 max.	4
	C4AF	A	10
	C4AF+2(C3A)	A	18

PHYSICAL

Item		Spec. Limit	Test Result
Air Content of Mortar (volume %)			
C185		12 max.	6.0
Fineness (m^2/kg)			
C204	(Air permeability)	260 min.	393
Autoclave Expansion (%)		0.80 max.	0.021
C151			
Compressive Strength Psi (Mpa)		Min./	
C109	1 Day	A	1980 (13.6)
	3 Days	1740 (12.0)	2880 (27.8)
	7 Days	2760 (19.0)	4020 (33.5)
Time of Setting (minutes)			
C191	(Vicat)		
		not less than	
	Initial	45	132
		not more	
	Final	than 375	240

OPTIONAL REQUIREMENTS
ASTM C151, (Other)

CHEMICAL

Item	Spec. Limit	Test Result
Equivalent Alkalies (%)	0.60 max.	0.51
Chloride (%)	B	0.002

PHYSICAL

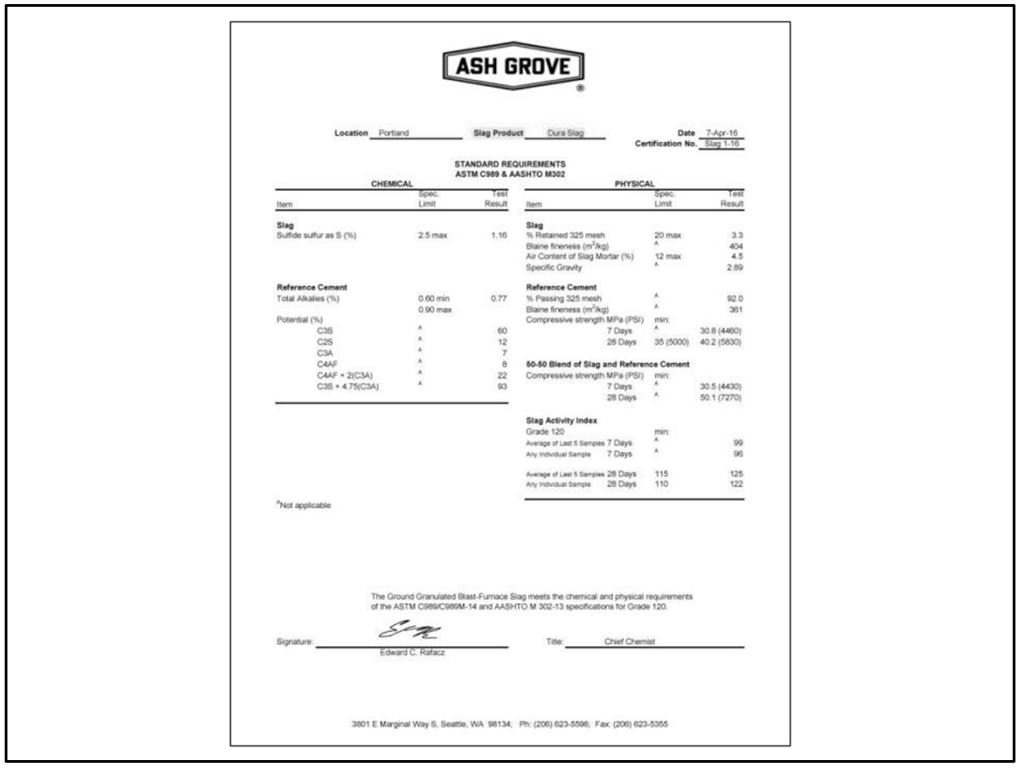
Item		Spec. Limit	Test Result
False Set (%) C451		50 min.	91.8
Heat of Hydration (cal /g)	C186		
	7 days	B	80
Compressive Strength (Mpa)			
	28 Days	4060 (28.0)	F
Sulfate Resistance (%)	C452	0.040	0.032
Water Expansion (%)	C1038	0.020	0.006
% retain on 45µm sieve		B	0.30

A = not applicable
B = Test results represents most recent value and is provided for informational purposes only.
C = Adjusted per A 1.6.
D = C1038 expansion in water does not exceed 0.02 at 14 days.
F = Test results for this production period not yet available.

We certify that the above described cement, at the time of shipment, meets the chemical and physical requirement of the ASTM C150-16 et AASHTO M 85 -12 Type I-II specification also will meet CSA A3000-13 Type GU, MS and HS.

NSF

Signature: _____ Title: Chief Chemist



ASH GROVE

Location Portland Slag Product Dura Slag Date 7-Apr-16
Certification No. Slag 1-16

STANDARD REQUIREMENTS
ASTM C989 & AASHTO M302

CHEMICAL		
Item	Spec. Limit	Test Result
Slag		
Sulfide sulfur as S (%)	2.5 max	1.16
Reference Cement		
Total Alkalies (%)	0.60 min 0.90 max	0.77
Potential (%)		
C3S	A	60
C2S	A	12
C3A	A	7
C4AF	A	8
C4AF + 2(C3A)	A	22
C3S + 4.75(C3A)	A	93

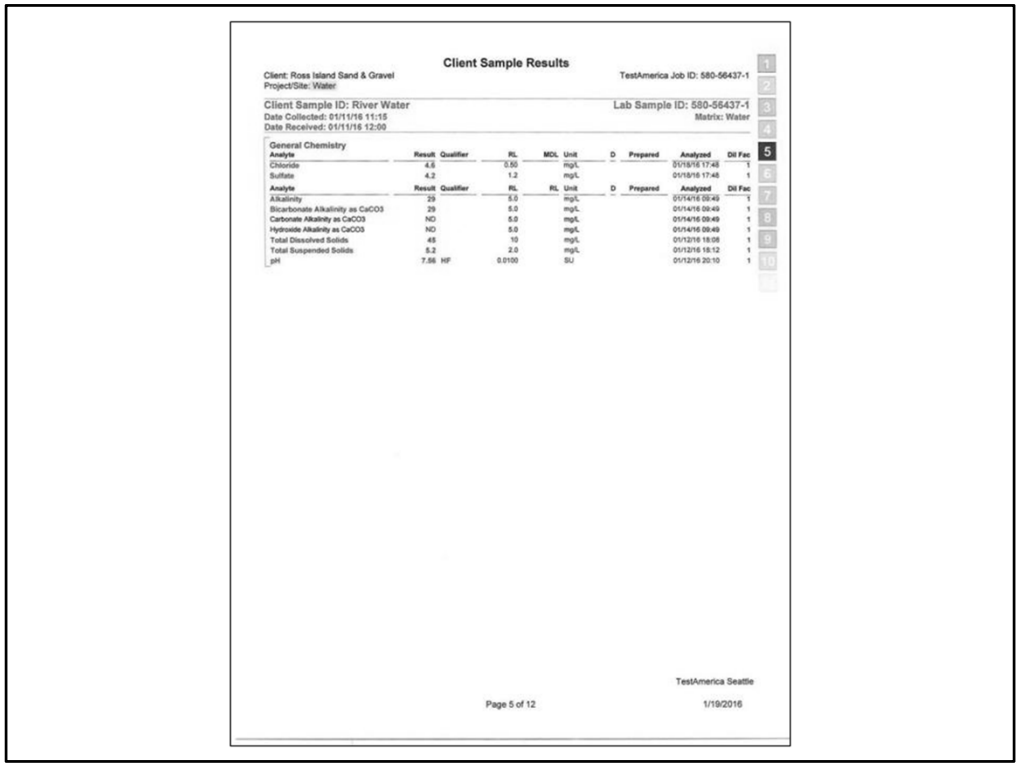
PHYSICAL		
Item	Spec. Limit	Test Result
Slag		
% Retained 325 mesh	20 max	3.3
Blaine fineness (m^2/kg)	A	404
Air Content of Slag Mortar (%)	12 max	4.5
Specific Gravity	A	2.89
Reference Cement		
% Passing 325 mesh	A	92.0
Blaine fineness (m^2/kg)	A	361
Compressive strength MPa (PSI)	min:	
7 Days	A	30.8 (4460)
28 Days	35 (5000)	40.2 (5830)
50-50 Blend of Slag and Reference Cement		
Compressive strength MPa (PSI)	min:	
7 Days	A	30.5 (4430)
28 Days	A	50.1 (7270)
Slag Activity Index		
Grade 120	min:	
Average of Last 5 Samples 7 Days	A	99
Any Individual Sample 7 Days	A	96
Average of Last 5 Samples 28 Days	115	125
Any Individual Sample 28 Days	110	122

[A]Not applicable

The Ground Granulated Blast-Furnace Slag meets the chemical and physical requirements of the ASTM C989/C989M-14 and AASHTO M 302-13 specifications for Grade 120.

Signature: Edward C. Rafacz Title: Chief Chemist

3801 E Marginal Way S, Seattle, WA 98134; Ph: (206) 623-5596; Fax: (206) 623-5355



Client Sample Results

Client: Ross Island Sand & Gravel
Project/Site: Water

TestAmerica Job ID: 580-56437-1

Client Sample ID: River Water
Date Collected: 01/11/16 11:15
Date Received: 01/11/16 12:00

Lab Sample ID: 580-56437-1
Matrix: Water

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	4.6		0.50		mg/L			01/18/16 17:46	1
Sulfate	4.2		1.2		mg/L			01/18/16 17:46	1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	29		5.0		mg/L			01/14/16 09:49	1
Bicarbonate Alkalinity as CaCO3	29		5.0		mg/L			01/14/16 09:49	1
Carbonate Alkalinity as CaCO3	ND		5.0		mg/L			01/14/16 09:49	1
Hydroxide Alkalinity as CaCO3	ND		5.0		mg/L			01/14/16 09:49	1
Total Dissolved Solids	45		10		mg/L			01/12/16 18:08	1
Total Suspended Solids	5.2		2.0		mg/L			01/12/16 18:12	1
pH	7.56	HF	0.0100		SU			01/12/16 20:10	1

TestAmerica Seattle

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1/19/2016

Concrete Mix Design

Knife River Materials (Rsbg Division)R4000FDS

Specified Strength= 4000

Required Strength = Specified Strength + 1.34 X Standard Deviation

Required Strength = 4591.2

Average of 28 day breaks = 6375.3 which exceeds Required Strength

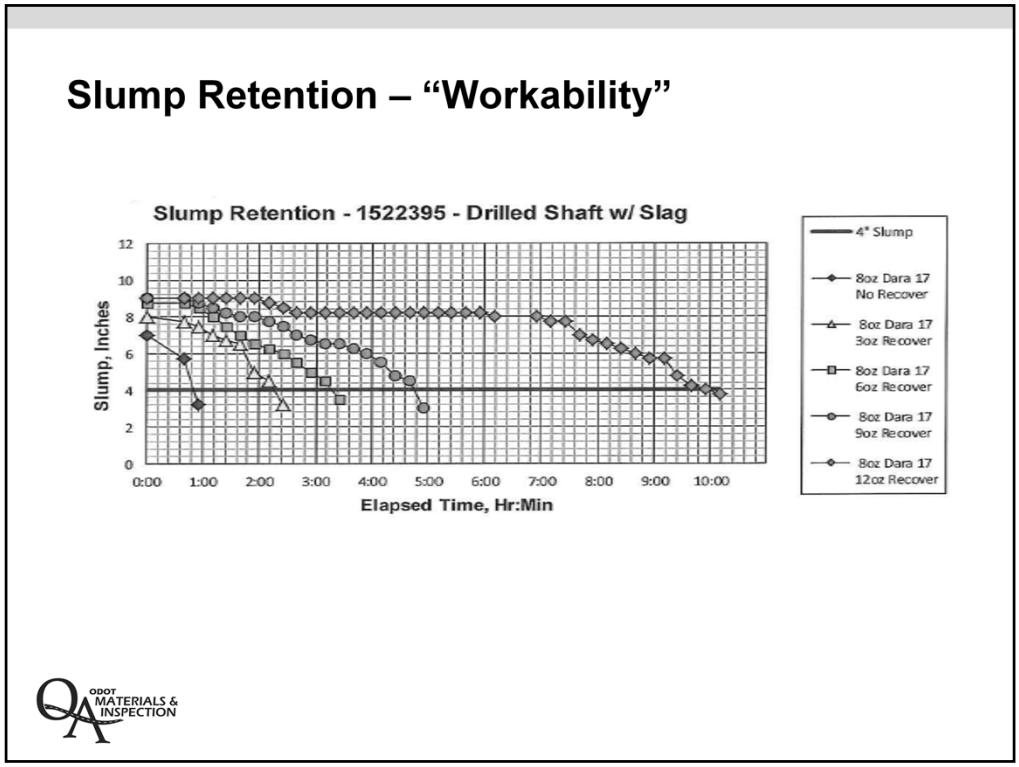
STDEV	SUM A1:A25	AVG Strength	AIR AVG	W/C AVG	Unit Wt. AVG
441.2	95630	6375.3	3.8	0.44	148

Plastic Concrete Test Results

	Specified Targets						
	7 day PSI	28 day PSI	Slump inch	Air (%)	Temp (F)	W/C Ratio	Unit Wt. (lb/ft3)
		4000	7"-10"	NA		0.45	145.7

Test Data							
Date	7 day PSI	28 day PSI	Slump inch	Air (%)	Temp (F)	W/C Ratio	Unit Wt. (lb/ft3)
9/22/2009	5280	7320	9	4.5	87	0.43	146.9
4/13/2010		5780.0	9.5	3.3	61.2	0.46	147
4/13/2010		5870.0	9.5	3.2	61.3	0.46	147.5
4/13/2010		6150.0	9	3.8	64	0.45	147.1
4/13/2010		6120.0	9	3.8	64	0.45	147.1
4/14/2010		6120.0	9	3.8	64	0.45	147.1
4/14/2010		6150.0	9	3.8	64	0.45	147.1
4/15/2010		6840.0	7.5	3.7	65.4	0.43	147.1
4/15/2010		6660.0	8	3.8	64.5	0.43	147.1
4/19/2010		6430.0	8	3.8	66.7	0.44	147.5
7/12/2010	4140	6330.0	8.75		82	0.45	148.7
7/12/2010	4050	6330.0	8.75		81	0.46	148.6
7/12/2010		7100.0	8.75		83	0.43	148.7
7/13/2010	3850	5980.0	10		74	0.44	147.5
7/13/2010	4380	6450.0	9		76	0.42	147.5

ODOT MATERIALS & INSPECTION



4″ Minimum slump has been changed to 6" in OSSC 2015

OSSC 2015
SP00512.12 Concrete Mix Design - Delete this subsection.

SP02001.20(c) Slump - Add the following paragraph to the end of this subsection:

For drilled shaft concrete, maintain a minimum slump of 6 inches throughout the drilled shaft placement, including temporary casing extraction.

SP02001.35(h) Plastic Concrete Tests - Add the following paragraph and bullets to the end of this subsection:

For drilled shaft concrete, report the following additional information:

- The total time estimate from initial batching through drilled shaft placement, including haul time, placing concrete, and temporary casing extraction.
- Initial slump test results and subsequent results at 15-minute intervals, verifying a minimum slump of **6 inches** is maintained for the total time estimated for drilled shaft placement, including temporary casing extraction. Report data in a table or graph format.

Concrete Mix Design

- Aggregate
  - Coarse aggregate
  - Fine aggregate
- Water
- Cement

ODOT MATERIALS & INSPECTION

Concrete Mix Design

MIX DESIGN QUANTITIES:

			English Units		Metric Units	
Material	Product/Source	Spec Grav	Weight	Volume (ft3)	Mass	Volume (m3)
Cement	Lehigh	3.150	530 lb	2.70	314 kg	0.100
Fly Ash	Lehigh Type F Centralia	2.560	132 lb	0.83	78 kg	0.030
Silica Fume	Master Builders	2.200	0 lb	0.00	0 kg	0.000
Water (Total)	City	1.000	285 lb	4.57	169 kg	0.169
		2.620 *	0 lb*	0.00	0 kg*	0.000
3/4"-#4 Round	Round Prairie Source #10-029-3	2.743 *	0 lb*	0.00	0 kg*	0.000
3/8"-#4 Round	Round Prairie Source #10-029-3	2.728 *	1430 lb*	8.40	848 kg*	0.311
Fine Aggregate	Round Prairie Source #10-029-3	2.658 *	1549 lb*	9.34	922 kg*	0.347
Admixtures	Master Builders	1.000	13 lb	0.21	8 kg	0.008
	Total Mix Weight:		3939 lb		2339 kg	
	Air (Entrap/Entrain)	3.5 %		0.95		0.035
	Total Mix Volume:			27.00		1.000

ODOT MATERIALS & INSPECTION

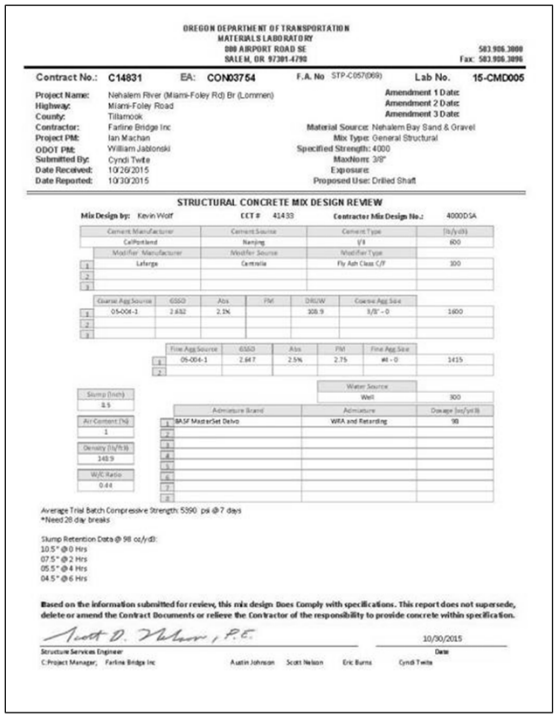
Concrete Mix Design

ADMIXTURES:

Product	Product Name/Type	Dosage Rate	Dosage (English)	Dosage (Metric)
Air Entrainment	MB-AE 90	0.00 oz/cwt**	0.0 oz/cy**	0 mL/m3**
Water Reducer	PolyHead 997	12.0 oz/cwt**	79.0 oz/cy**	3059 mL/m3**
Mid-Range WR	PolyHead 997	0.0 oz/cwt**	0.0 oz/cy**	0 mL/m3**
Superplasticizer	PS 1466	6.0 oz/cwt**	33.0 oz/cy**	1278 mL/m3**
Retarder		0.0 oz/cwt**	0.0 oz/cy**	0 mL/m3**
	Delvo	15.0 oz/cwt**	99.0 oz/cy**	3833 mL/m3**
Fibers		0.0 lb/cy**	0.0 lb/cy**	0.0 kg/m3**

ODOT MATERIALS & INSPECTION

Concrete Mix Design Review



OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT ROAD SE
SALEM, OR 97301-4798
503.986.3000
Fax: 503.986.3096

Contract No.: C14831 EA: CON03754 F.A. No STP-C057(069) Lab No. 15-CMD005

Project Name: Nehalem River (Miami-Foley Rd) Br (Lommen)
Highway: Miami-Foley Road
County: Tillamook
Contractor: Farline Bridge Inc
Project PM: Ian Machan
ODOT PM: William Jablonski
Submitted By: Cyndi Twite
Date Received: 10/29/2015
Date Reported: 10/30/2015

Amendment 1 Date:
Amendment 2 Date:
Amendment 3 Date:
Material Source: Nehalem Bay Sand & Gravel
Mix Type: General Structural
Specified Strength: 4000
MaxNom: 3/8"
Exposure:
Proposed Use: Drilled Shaft

STRUCTURAL CONCRETE MIX DESIGN REVIEW

Mix Design by: Kevin Wolf CCT # 41433 Contractor Mix Design No.: 4000DSA

	Cement Manufacturer	Cement Source	Cement Type	lb/yd3
	CalPortland	Nampa	I/II	600
	Modifier Manufacturer	Modifier Source	Modifier Type	
1	Lafarge	Centralia	Fly Ash Class C/F	100
2				
3				

	Coarse Agg Source	GSSD	Abs	FM	DRUW	Coarse Agg Size	
1	05-004-1	2.682	2.3%		108.9	3/8" - 0	1800
2							
3							

	Fine Agg Source	GSSD	Abs	FM	Fine Agg Size	
1	05-004-1	2.647	2.5%	2.75	#4 - 0	1415
2						

Slump (inch)
3.5

Air Content (%)
1

Density (lb/ft3)
148.9

W/C Ratio
0.44

Water Source	
Well	300

	Admixture Brand	Admixture	Dosage (oz/yd3)
1	BASF MasterSet Delvo	WRA and Retarding	90
2			
3			
4			
5			
6			
7			
8			

Average Trial Batch Compressive Strength: 5390 psi @ 7 days
*Need 28 day breaks

Slump Retention Data @ 98 oz/yd3:
10.5" @ 0 Hrs
07.5" @ 2 Hrs
05.5" @ 4 Hrs
04.5" @ 6 Hrs

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.

Scott D. Nelson, P.E. 10/30/2015
Structure Services Engineer Date
C:Project Manager; Farline Bridge Inc Austin Johnson Scott Nelson Eric Burns Cyndi Twite

The Drilled Shaft mix design needs to follow the concrete mix design submittal requirements of 02001. Consequently - there really is no "transfer" meaning here's a mix design (Lab Report) from this other project -> please assign it to this current project. There are a number of concerns with the "transfer" approach. We've had instances where a mix design approved on a project is then approved on other projects sometimes without any direct contact or involvement from the Concrete Producer. This could be a problem if the Concrete Producer wants or needs to change an additive or update the physical properties of materials. So there's a little more to it than just passing a recipe.

A recent example - a previously approved version of a Drilled Shaft mix used GGBFS instead of fly ash due to a shortage of fly ash when that particular mix design was reviewed. The Concrete Producer had since gone back to fly ash but I had a request to "transfer" the Drilled Shaft mix design with GGBFS. You see the problem?

So the contractor needs to send in a complete submittal for each Contract.

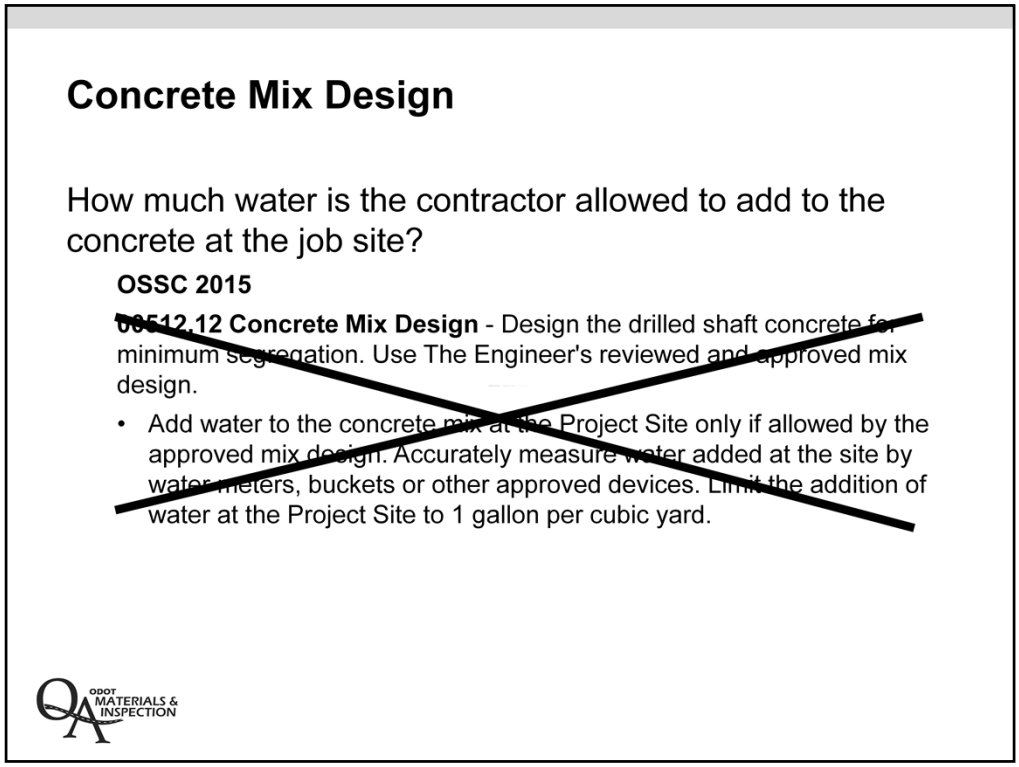
As you now or are learning ~ Drilled Shaft concrete has two critical submittals. The Drilled Shaft mix design which is evaluated according to 00512.12 and 02001 and the Drilled Shaft Installation Plan evaluated according to 00512.40 Submittals.

I'm sure that some people have assumed that an approved mix design = an approved Drilled Shaft Installation Plan. NOT TRUE! I do not review nor approve the Drilled Shaft Installation Plan. The mix design (being a separate submittal) is but one aspect of the Drilled Shaft Installation Plan. Therefore - the mix design submittal should typically precede the Drilled Shaft Installation Plan.

One of the things that I look for concerns the slump retention (workability) requirement of the specifications. The concrete producer may or may not identify the anticipated duration of the drilled shaft placement. However, there will usually be an additive used to hold the slump as required. The exact details about duration of the placement - are to be included in and assured by the Drilled Shaft Installation Plan which has its own 21-day review period.

Call me if you still have any questions.

Austin Johnson
503.986.5461



Contractor may want to add water to the concrete at the job site for various reasons:

- increase workability
- increase slump
- change the temperature

In adding water to the concrete the mix design is effectively changed. By adding water this changes important concrete parameters such as:

- water/cement ratio
- strength
- slump
- density

OSSC 2015

00512.12 Concrete Mix Design - ~~Design the drilled shaft concrete for minimum segregation. Use The Engineer's reviewed and approved mix design.~~

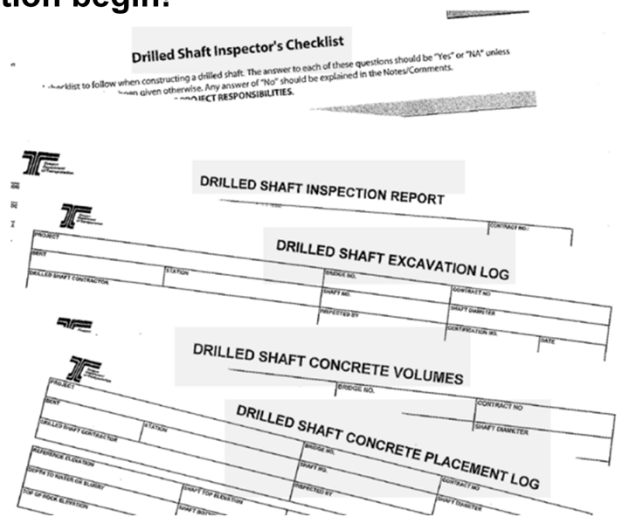
~~• Add water to the concrete mix at the Project Site only if allowed by the approved mix design. Accurately measure water added at the site by water meters, buckets or other approved devices. Limit the addition of water at the Project Site to 1 gallon per cubic yard.~~

SP00512.12 Concrete Mix Design - Delete this subsection.

02001 and **SP2001** does not allow for the addition of water unless it is approved in the mix design!

Concrete Placement

Let the documentation begin!

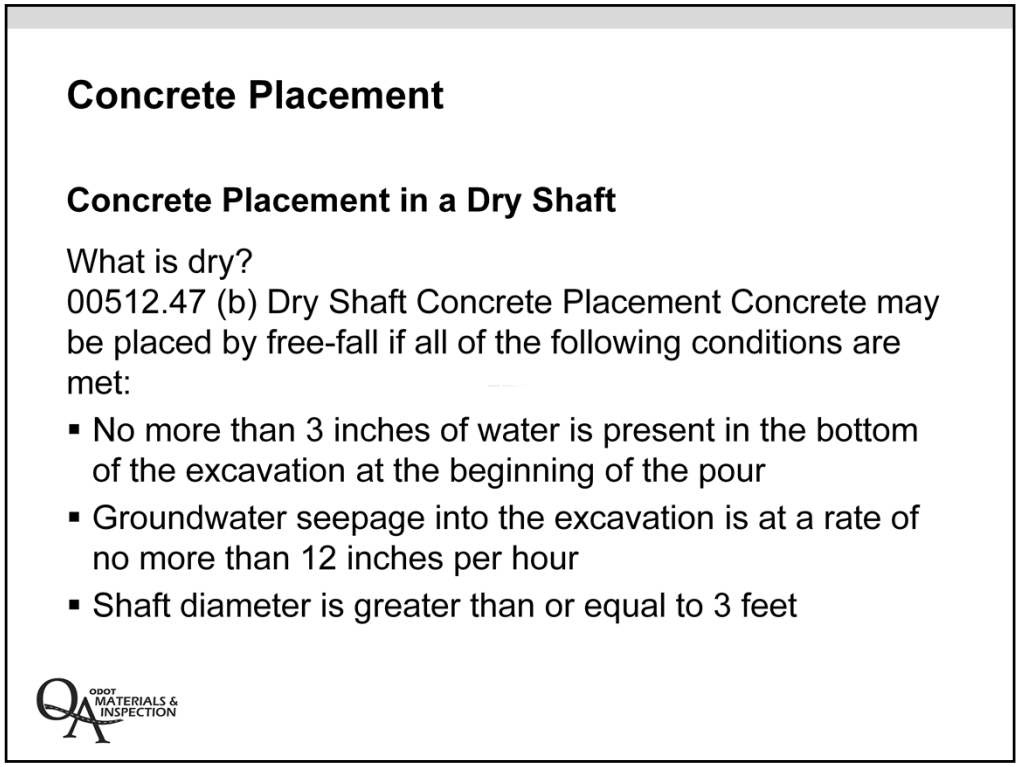


ODOT MATERIALS & INSPECTION

Concrete Placement

Completed documentation

- What is the placement procedure? What do you need to know?
  - Drilled Shaft Installation Plan
  - Equipment
  - On-site testing
    - Who?



OSSC 2015

00512.47 Concrete – furnish and place concrete according to the following:

(b) Dry Shaft Concrete Placement - Concrete may be placed by free-fall if all of the following conditions are met:

- 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

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.

Concrete Placement

Equipment Dry Shaft

- Drop chute (8" minimum diameter)
- Pumped Tremie (4" minimum diameter)

ODOT MATERIALS & INSPECTION

What are the safety issues?

Tie-off,

hard hat.

Note Beaver Ball – contaminated concrete

Concrete Placement

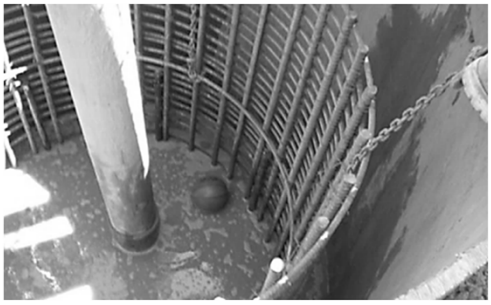
Dry Shaft Concrete Placement:
What is the allowable free fall distance?

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.

Concrete Placement

Wet Shaft Concrete Placement Equipment

- Tremie 4″ minimum diameter
  - Gravity/free fall is not allowed in a wet shaft
  - Pressurized
    - Plug/pig
- Equipment
  - Pump



ODOT MATERIALS & INSPECTION

Placement of concrete by freefall into a wet shaft is not allowed.

OSSC 2015

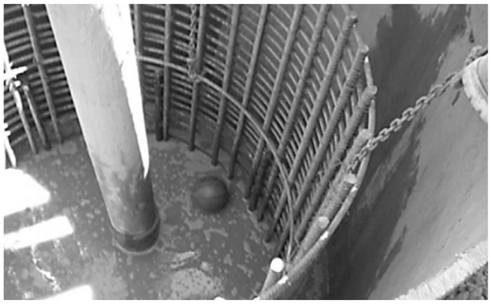
00512.47 Concrete - Furnish and place concrete according to the following:

(c) Wet Shaft Concrete Placement - If the drilled shaft excavation does not meet the requirements for dry concrete placement, stabilize water inflow and place the concrete under water or slurry with a tremie pipe or pump hose according to 00540.48(e). Place concrete continuously from the bottom of the shaft to the top-of-shaft elevation shown. Use a plug in the tremie pipe or pump hose to force water or slurry ahead of the advancing flow of fresh concrete. Dispose of all displaced water, slurry, or waste concrete according to 00290.20. When groundwater, the drilling water or slurry in the shaft excavation is to be removed by pumping during concrete placement, have a standby pump available. Place concrete in a continuous operation so that the concrete always flows upward within the shaft. Withdraw the delivery hose or pipe slowly as the elevation of the fresh concrete rises in the shaft. Keep the discharge **end of the pipe or hose at least 5 feet below the surface of the concrete** after the concrete has reached a depth of 5 feet. Maintain sufficient concrete inside the hose or pipe to prevent drilling fluid from entering. During concrete placement, provide and maintain markings on the tremie pipe or pump hose, or a sounding device or other appropriate method to determine the relative elevations of the fresh concrete surface and the bottom end of the pipe or hose. Raise the bottom end of the pipe or hose only when the pipe or hose has a sufficient head of fresh concrete to prevent the formation of a void at the bottom.

Concrete Placement

What are important factors in using a tremie?

- Initially plugged
- Maintained a minimum of 5-foot head at all times
- Diameter of the tremie



ODOT MATERIALS & INSPECTION

Concrete Placement

- "Place concrete continuously until concrete at the top of the shaft is free of water, soil, and debris, and uncontaminated concrete extends to the plan of top-of-shaft elevation."
- Is the casing being removed too fast?

ODOT MATERIALS & INSPECTION

There must be enough concrete to "overflow" the shaft to push out the water, soil, etc. until there is uncontaminated concrete.

This picture shows an example where "overflow" is not happening.

OSSC 2015

00512.47 Concrete - Furnish and place concrete according to the following:

Place concrete continuously until concrete at the top of the shaft is free of water, soil, and debris, and uncontaminated concrete extends to the plan top-of-shaft elevation. Dispose of all contaminated concrete expelled from the top of the shaft in an approved manner. Remove waste concrete from the site. If a delay in concrete placement occurs because of a delay in concrete delivery or other factors, reduce the placement rate to maintain a flow of fresh concrete into the shaft excavation

Concrete Placement

- Minimum of 10 feet of concrete above the bottom of casing before the start of removal

AND

- Maintain at least 5 feet above the bottom of casing at all times

ODOT MATERIALS & INSPECTION

OSSC 2015

(e) Casing Removal - Remove all temporary casing during or after completion of concrete placement. Do not start temporary casing removal until the level of fresh concrete within the casing has reached a depth of at least 10 feet or the level necessary to adequately counteract the external hydrostatic pressure head. As the temporary casing is withdrawn, maintain a minimum 5 feet head of concrete above the bottom of the casing. A slight downward movement of the casing while exerting downward pressure, or hammering or vibrating the casing will be allowed to facilitate extraction.

Extract the casing so that concrete is cast directly against the surrounding in-situ material. Check the elevation of the top of the reinforcing cage before and after temporary casing extraction for conformance with the construction tolerance criteria of 00512.42. Casing that cannot be extracted during, or immediately after, the concrete placement operation may be cause for rejection of the shaft.

Remove the tops of permanent casing to the top of the drilled shaft or the finished groundline, whichever is lower, unless otherwise shown or directed. Remove the tops of permanent casing for shafts constructed in a permanent body of water to the low water elevation, unless otherwise shown or directed.

Concrete Placement

How much time does the contractor have to batch, transport and place the concrete?

00512.47(a) Concrete Placement – Unless otherwise approved by mix design, allow a maximum of 60 minutes between concrete placements and use no concrete older than 90 minutes from batch time.

Concrete Placement – On-site Testing

- What tests are performed for drilled shaft concrete?
  - Slump
  - Temperature

ODOT MATERIALS & INSPECTION

On first test, at ODOT have Region come out and do Verification testing through the Region Quality Assurance Coordinator.

Concrete Placement – On-site Testing

(b) Quality Control Technician (QCT):

Duties:

- Attend pre-placement meetings for bridge deck pours and paving.
- 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.
- Sample the concrete and test for ambient air temperature, plastic concrete temperature, slump, air content, density, w/cm ratio and yield at the frequencies required by and according to the tests listed in the MFTP, after concrete mixture proportions are adjusted in the field, and at such times as requested by the Engineer.

ODOT MATERIALS & INSPECTION

Concrete Placement – On-site Testing (continued)

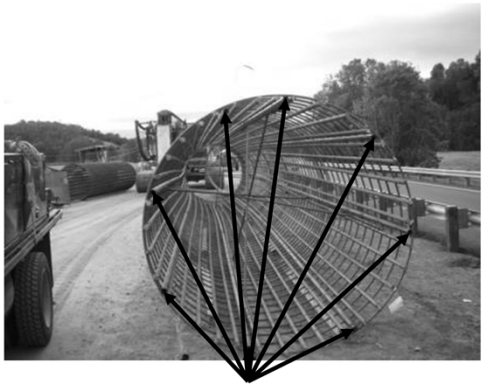
(b) Quality Control Technician (QCT):

Duties:

- Notify the Contractor and the Engineer immediately when the concrete is not in compliance with the Specifications.
- Be in direct contact with the CCT by telephone, radio or other means to convey information.
- Notify the CCT of loads rejected and the reason for rejection.
- Notify the CCT immediately whenever the density of the plastic concrete varies from the mix design target by more than ± 3 pounds per cubic foot.
- Notify the CCT immediately whenever the w/cm ratio varies from the mix design target by more than ± 0.03.

Concrete Placement

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



CSL Tubes

ODOT MATERIALS & INSPECTION

Filling the CSL tubes with water allows the CSL tubes to remain at the same temperature as the concrete so that they do not debond from the concrete.

Debonding from the concrete will result in erroneous CSL test results.

Crosshole sonic log testing requires access tubes cast into the shaft concrete and attached inside the steel cage. The access tubes for CSL testing are always steel to provide the best possible bond between the tube and the concrete. These tubes need to be cast into the concrete at the time of construction. The tubes must be filled with water to dissipate heat from concrete curing process. Without water in the tubes they may debond from the concrete rendering them useless for testing.

It is very important that the tubes are installed on the proper spacing and maintain a straight alignment the full length of the shafts. The results of the test are affected by the distance between each pair of tubes.

Different tests require different types of tubes (e.g., PVC for gamma-gamma versus schedule 40 steel for CSL). Some tests require that the tubes are filled with water, and some don't.

OSSC 2015

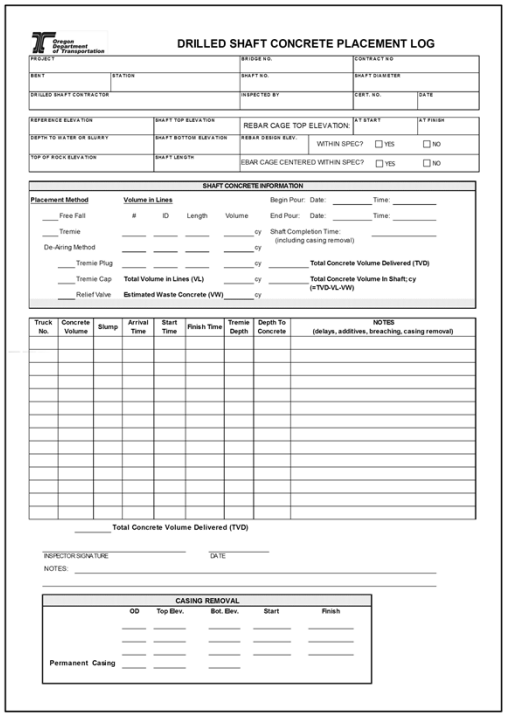
00512.46 Crosshole Sonic Log Test Access Tubes - Furnish and install access tubes for CSL testing as shown. Attach CSL access tubes securely to the interior of the reinforcement cage as near to parallel as possible in each drilled shaft and in the pattern shown. Extend the access tubes from the bottom of the reinforcement cage to at least 24 inches above the top of the shaft. Joints required to achieve full-length access tubes shall be watertight. Do not damage the access tubes during reinforcement cage installation and concrete placement. **Fill the tubes with potable water**, according to 02020.10(b), as soon as possible, but no more than one hour after concrete placement and reinstall the top watertight caps. Check water level and top off as needed.

Replace all access tubes that the test probe cannot pass through to the full depth of the shaft at no additional cost to the Agency. Replace all damaged access tubes with 1.5 inch to 2.0 inch diameter holes cored through the concrete for the entire length of the shaft. Unless otherwise directed, locate replacement core holes approximately 6 inches inside the reinforcement. Do not damage the shaft reinforcement during coring operations.

Fill the access tubes with grout only after all CSL testing has been completed and the shaft has been accepted.

Concrete Placement

PRIOR to Arrival of Concrete



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
Begin Pour: Date: _____ Time: _____
End Pour: Date: _____ Time: _____
Shaft Completion Time: (including casing removal)
Total Concrete Volume Delivered (TVD)
Total Volume in Lines (VL) _____ cy
Estimated Waste Concrete (WW) _____ cy
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					

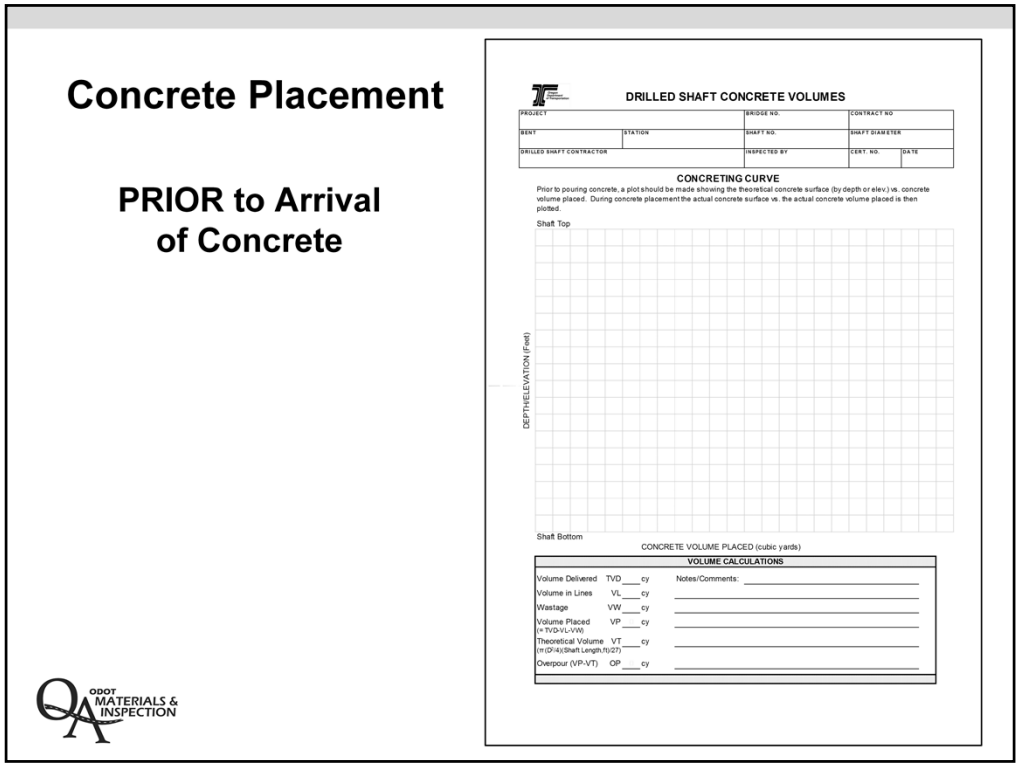
ODOT MATERIALS & INSPECTION

OSSC2015

00512.40 Submittals - Provide the following submittals to the Agency for review and approval:

(c) Drilled Shaft Inspection Reports - Provide the Engineer with a completed Drilled Shaft Inspection Report for each drilled shaft, detailing the actual location, alignment, elevations, dimensions, and quantities of the shafts. Submit the report within 21 calendar days after the completion and acceptance of each shaft. A "Drilled Shaft Inspection Report" form is available from the Engineer.

(d) 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.



OSSC2015
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Concrete Placement

Arrival of Concrete

Documentation

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

OSSC2015

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(c) Drilled Shaft Inspection Reports - Provide the Engineer with a completed Drilled Shaft Inspection Report for each drilled shaft, detailing the actual location, alignment, elevations, dimensions, and quantities of the shafts. Submit the report within 21 calendar days after the completion and acceptance of each shaft. A "Drilled Shaft Inspection Report" form is available from the Engineer.

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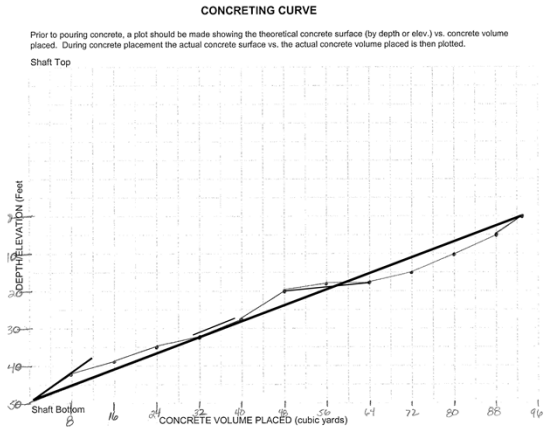
Concrete Placement

Documentation



Concrete Placement

For example

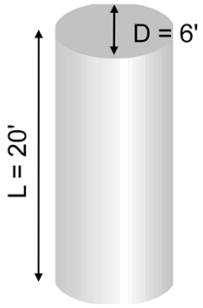
- If you have a 5-gallon gas can but during filling up it takes only 3 gallons there is a problem. Something is taking up space in the can has partially collapsed/dented. This is like a hole wall cave-in a drilled shaft.
- If filling the gas can and it takes more than 5 gallons your feet are wet, you notice leaking. This is like a void in a drilled shaft.

Concrete Placement Equations, Last One!

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:

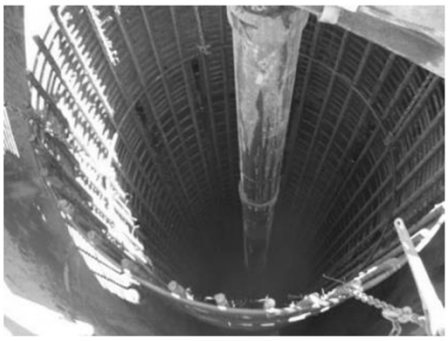
  $(A = \frac{3.14 \times 6^2}{4}) \times 20' = 565.20$ cubic feet
- 565.20 cf x 1 cy/27 cf = 20.93 cy



ODOT MATERIALS & INSPECTION

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**



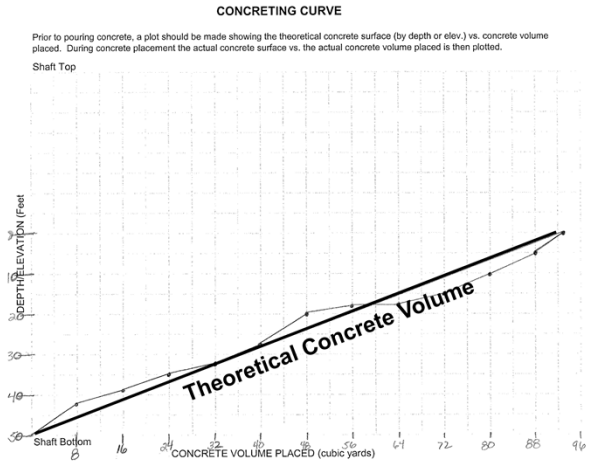
If the shaft is perfectly shaped, it will take 93 cy to fill it completely. Are drilled shafts ever perfect?

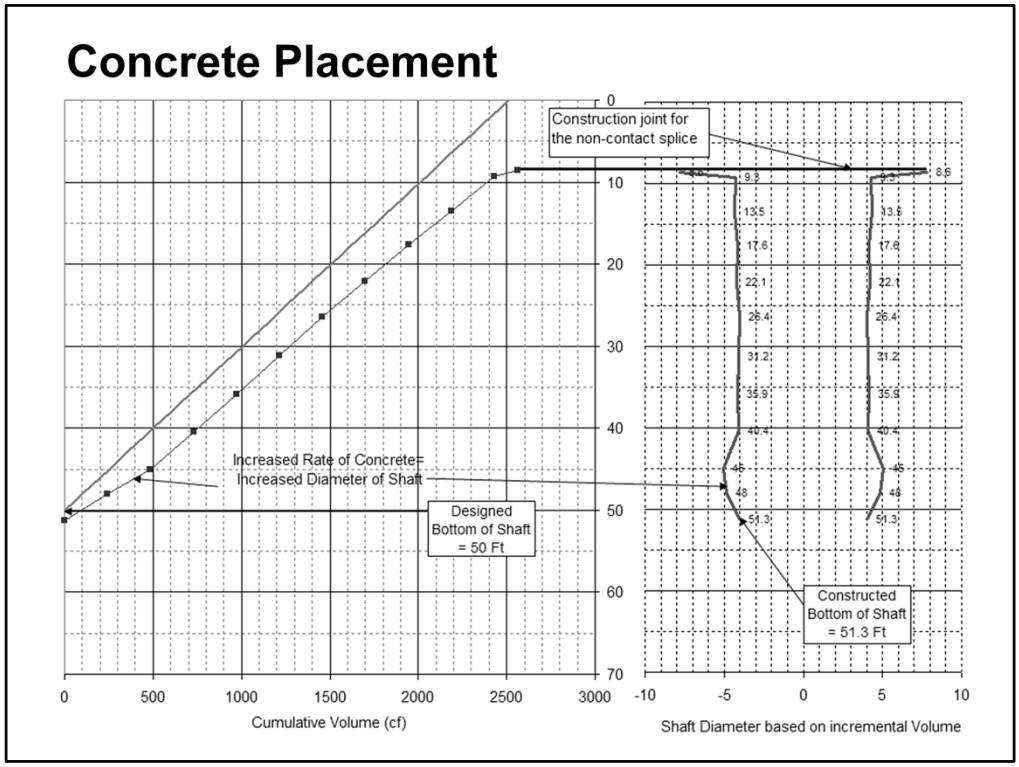
ODOT MATERIALS & INSPECTION

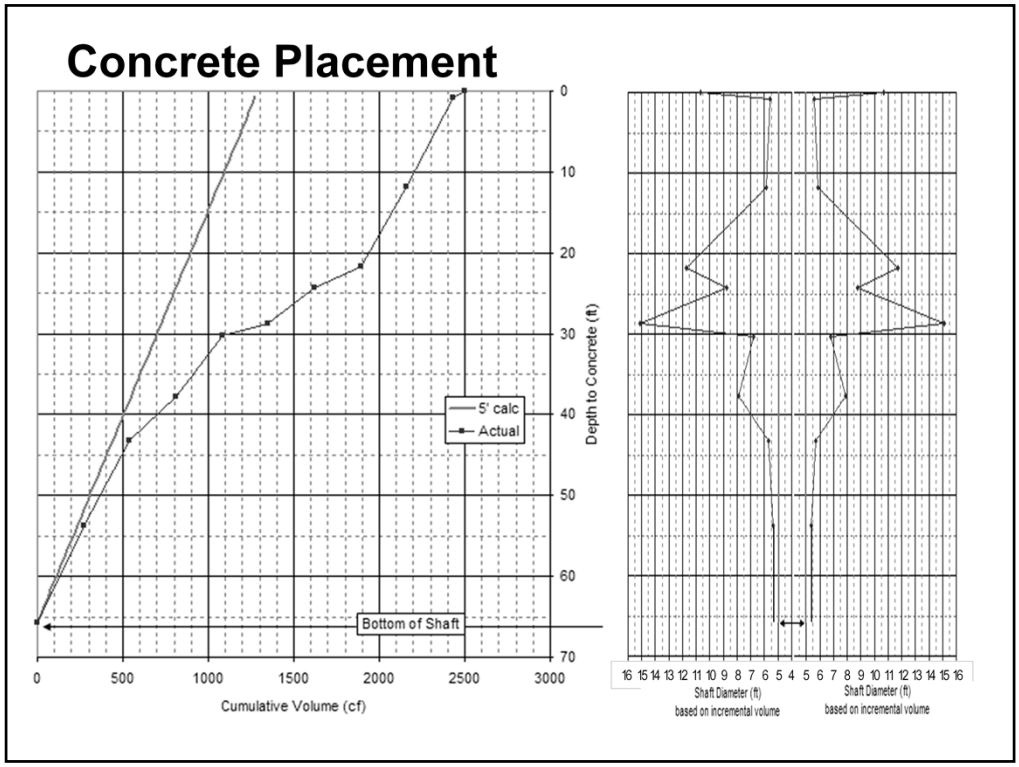
Concrete Placement

So what does it mean?

- Theoretical line represents Volume (cy)/LF
- At Calapooya 1.86 cy/LF




Concrete Placement
Construction joint for the non-contact splice
Increased Rate of Concrete= Increased Diameter of Shaft
Designed Bottom of Shaft = 50 Ft
Constructed Bottom of Shaft = 51.3 Ft
Cumulative Volume (cf)
Shaft Diameter based on incremental Volume
0
10
20
30
40
50
60
70
0
500
1000
1500
2000
2500
3000
-10
-5
0
5
10
8.6
9.3
13.5
17.6
22.1
26.4
31.2
35.9
40.4
45
48
51.3


Concrete Placement
0
10
20
30
40
50
60
70
Depth to Concrete (ft)
5' calc
Actual
Bottom of Shaft
0
500
1000
1500
2000
2500
3000
Cumulative Volume (cf)
16 15 14 13 12 11 10 9 8 7 6 5 4
Shaft Diameter (ft)
based on incremental volume
5 6 7 8 9 10 11 12 13 14 15 16
Shaft Diameter (ft)
based on incremental volume

Concrete Placement Conversions

1 foot = 12"

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

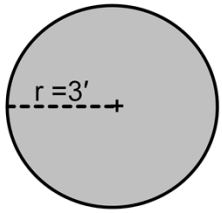
1 yard = 3′

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

ODOT MATERIALS & INSPECTION

Concrete Placement Equations (continued)

- Area of a circle = $\pi \times r^2$
- To determine the area of a circle with a diameter of 6′: $3.14 \times 3^2 = 28.26$ sf



ODOT MATERIALS & INSPECTION

Concrete Placement Conversions

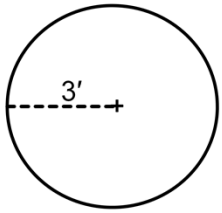
1 cubic yard = 27 cubic feet

- To convert 300 cubic feet to cubic yards:
- 300 cubic feet x 1 cubic yard/27 cubic feet = 11.11 cubic yards

ODOT MATERIALS & INSPECTION

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′



ODOT MATERIALS & INSPECTION

Concrete Placement

EXAMPLE Class Drilled Shaft | 12345 | CON10000

DENT: 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
YES Free Fall				
NO Tremie	0	0		0.0 cy
De-Airing Method				cy
NO Tremie Plug				cy
NO Tremie Cap	Total Volume in Lines (VL)			cy
NO Relief Valve	Estimated Waste Concrete (VW)			1 cy

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

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

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

75 cyd **Total Concrete Volume Delivered (TVD)**

74 cyd **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)
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

Concrete Placement

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
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5	10 cy	9.6	8:50 AM	9:10 AM	9:30 AM	25	25	Talked to contractor about depth of concrete
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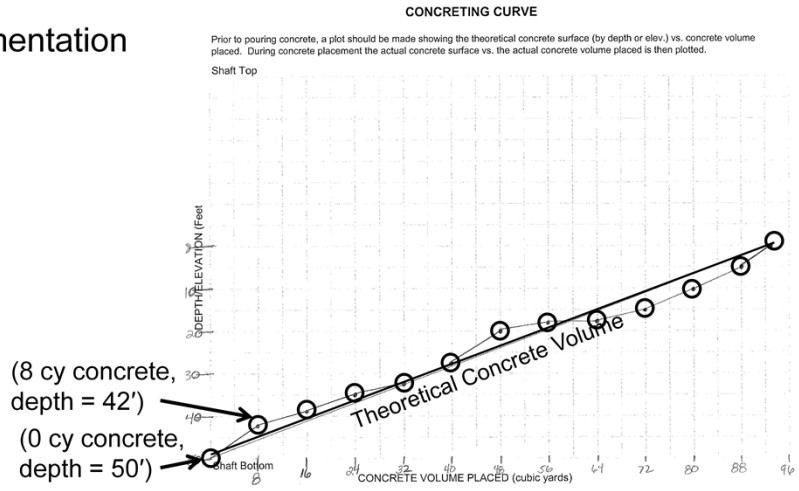
7	10 cy	9.9	9:40 AM	10:00 AM	10:35 AM	3	3	Finished pour
8	5 cy	9.5	10:30 AM	10:50 AM	11:15 AM	0	0	
								Truck #6 notes: slump 0.2 out of specifications. Contractor
								opted to pour. Confirmed with assistant PM to continue

ODOT MATERIALS & INSPECTION

Concrete Placement

Documentation



ODOT MATERIALS & INSPECTION

Inspector's Roles and Responsibilities

What are the Inspector's Roles and Responsibilities?

- Communicate
- Document

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.

ODOT MATERIALS & INSPECTION

- It is the contractors' responsibility to complete the Concrete Placement Logs and Volume Curves.
- The drilled shaft inspector will keep ODOT's own set of records.
- It is the Inspector's responsibility to document on ODOT's behalf.

Inspector's Roles and Responsibilities

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?

ODOT MATERIALS & INSPECTION

Concrete Operations
Learning Objectives

- Concrete basics
  - mix design
  - concrete placement
  - Concrete sampling and testing
- Concrete Placement Log
- Concrete Volume Log
- Inspector's roles, and responsibilities