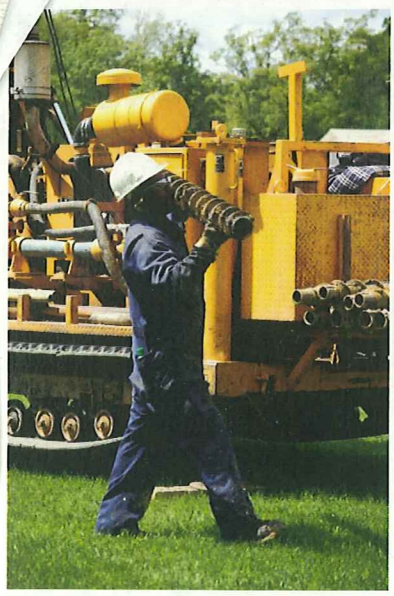
FROEHLING & ROBERTSON, INC.



SUBSURFACE INVESTIGATION AND BRIDGE FOUNDATION DESIGN RECOMMENDATIONS

WBS Element No. 50000.1.STR03T1B TIP No. P-5208A
Haydock to Junker (H2J) Double Track Project
Cabarrus County, North Carolina
F&R PROJECT NO. 63P-0090

Prepared for:

HDR Engineering
440 S. Church Street – Suite 1000
Charlotte, North Carolina 28202

February 1, 2013

2505 Hutchison-McDonald Road Charlotte, North Carolina 28269 704.596.2889

SINCE
1881

FROEHLING & ROBERTSON, INC.
Engineering Stability Since 1881

2505 Hutchison-McDonald Road
Charlotte, North Carolina 28269
T 704.596.2889 I F 704.596.3784
NC License #F-0266

February 1, 2013

Mr. Kevin V. LaGreca
HDR Engineering
440 S. Church Street – Suite 1000
Charlotte, North Carolina 28202

Re: **Subsurface Investigation and Bridge Foundation Design Recommendations**
Haydock to Junker (H2J) Double Track Project
WBS Element No.: 50000.1.STR03T1B
TIP No.: P-5208A
County: Cabarrus
F&R Project No.: 63P-0090

Dear Mr. LaGreca:

Froehling & Robertson, Inc. (F&R) has completed the subsurface investigation and bridge foundation design recommendations for the proposed structure crossing Coddle Creek. F&R's evaluation is based on information provided to us by HDR. The work was performed in general accordance with the executed "Geotechnical Subconsultant Agreement" between F&R and HDR. This report contains the foundation recommendations, NCDOT legend sheet, site location plan, boring location plan, Borelog Reports, Core Boring Reports, laboratory test results, and supporting calculations.

Please do not hesitate to contact us if you have any questions regarding this report or if you need additional services.

Sincerely,

FROEHLING & ROBERTSON, INC.

Robert E. Kral, E.I.
Project Manager

Michael J. Walko, P.E.
Senior Engineer
N.C. Registration No. 026917

NORTH CAROLINA PROFESSIONAL SEAL 026917 ENGINEER MICHAEL J. WALKO
2/1/13

APPENDIX A

FOUNDATION RECOMMENDATIONS

FOUNDATION RECOMMENDATIONS

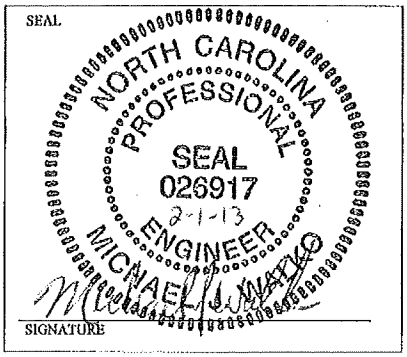
WBS # 50000.1.STR03T1B

DESCRIPTION Railroad Bridge over Coddle Creek

T.I.P. NO. P-5208A

COUNTY Cabarrus

STATION 10282+62.09 -Main Track 1-



	INITIALS	DATE
DESIGN	MJW	Feb-13
CHECK	WPA	Feb-13
APPROVAL		

	STATION	FOUNDATION TYPE	ALLOWABLE BEARING	MISCELLANEOUS DETAILS
END BENT 1	10281+83.76	Footing on HP 14X89 Steel Piles	70 Tons/Pile	BOC Elevation = 538 ft. Avg Pile Length = 30 ft. (Lt), 35 ft. (Rt) 3 rows of 15 vertical piles @ 3'-9" spacing
BENT 1	10282+37.09	Footing on HP 14X89 Steel Piles	65 Tons/Pile	BOC Elevation = 526 ft. Avg. Pile Length = 25 ft. POF Elevation = 507.5' Min Tip Elevation* = 505' 4 rows of 12 vertical piles @ 3'-9" spacing
BENT 2	10283+10.09	Footing on HP 14X89 Steel Piles	65 Tons/Pile	BOC Elevation = 526 ft. Avg. Pile Length = 25 ft. POF Elevation = 508' Min Tip Elevation* = 502' 4 rows of 12 vertical piles @ 3'-9" spacing
END BENT 2	10283+40.43	Footing on HP 14X89 Steel Piles	70 Tons/Pile	BOC Elevation = 550 ft. Avg Pile Length = 25 ft. (Lt), 30 ft. (Rt) 3 rows of 15 vertical piles @ 3'-9" spacing

* For the interior bent foundations, the Minimum Tip Elevation controls the design.

NOTES ON PLANS & COMMENTS (See following page)

TIP # P-5208A **County** Cabarrus

FOUNDATION RECOMMENDATION NOTES ON PLANS

1) For Piles, see Special Provisions.

2) The allowable bearing capacity for piles at End Bent 1 and End Bent 2 is 70 tons per pile.

3) Drive piles at End Bent 1 and End Bent 2 to a required bearing capacity of 140 tons per pile. The required bearing capacity is equal to the allowable bearing capacity with a minimum factor of safety of two.

4) The allowable bearing capacity for piles at Bent 1 and Bent 2 is 65 tons per pile.

5) Drive piles at Bent 1 and Bent 2 to a required bearing capacity of 130 tons per pile. The required bearing capacity is equal to the allowable bearing capacity with a minimum factor of safety of two.

6) Steel pile points are required for steel piles at End Bent 1, Bent 1, Bent 2 and End Bent 2.

7) Install piles at Bent 1 to a tip elevation no higher than 505 feet.

8) Install piles at Bent 2 to a tip elevation no higher than 502 feet.

9) Testing piles with the pile driving analyzer (PDA) during driving, restriking or redriving may be required. The engineer will determine the need for PDA testing. For pile driving analyzer, see Special Provisions.

10) Pile excavation is required to install piles at Bent 1. Excavate holes to Elevation 505 ft. For Pile Excavation, see Special Provision.

11) Pile excavation is required to install piles at Bent 2. Excavate holes to Elevation 502 ft. For Pile Excavation, see Special Provision.

12) Concrete is required to fill holes for pile excavation at Bent 1 and Bent 2.

13) The Scour Critical Elevation for Bent 1 and Bent 2 is 516 feet. Scour Critical Elevations are used to monitor possible scour problems during the life of the structure.

14) It has been estimated that a hammer with an equivalent rated energy in the range of 30,000 to 55,000 ft-lbs per blow will be required to drive piles. This estimated energy range does not release the contractor from providing driving equipment in accordance with Subarticle 450-3(D)(2) of the Standard Specifications.

FOUNDATION RECOMMENDATION SPECIAL NOTES ON PLANS

1) Pile driving is required to install piles at Bent 1 and Bent 2 subsequent to pile excavation in order to confirm that the required bearing capacity has been achieved.

FOUNDATION RECOMMENDATION COMMENTS

1) A Delmag D19-32 pile hammer was utilized as a common hammer type to determine potential pile driving stresses. This hammer should provide sufficient energy to drive the piles to the required driving resistance at the end bents and interior bents. The actual hammer to be utilized will be submitted by the contractor and analyzed after letting.

PILE PAY ITEMS

(Revised 8/15/12)

WBS ELEMENT: 50000.1.STR03T1B — DATE: Jan-13

TIP NO.: P-5208A — DESIGNED BY: MJW

COUNTY: Cabarrus — CHECKED BY: WPA

STATION: 10282+62.09 -Main Track 1-

DESCRIPTION: Haydock to Junker (H2J) Double Track Project - Railroad Bridge over Coddle Creek

NUMBER OF BENTS WITH PILES: 2

NUMBER OF PILES PER BENT: 48

NUMBER OF END BENTS WITH PILES:

NUMBER OF PILES PER END BENT:

Only required for "Predrilling for Piles" & "Pile Excavation" pay items

	PILE PAY ITEM QUANTITIES						
Bent # or End Bent #	Steel Pile Points (yes/no)	Pipe Pile Plates (yes/no/maybe)	Predrilling For Piles (per linear ft)	Pile Redrives (per each)	Pile Excavation (per linear ft)		PDA Testing (per each)
					In Soil	Not In Soil	
Bent 1	Yes	No	0	0	780	228	
Bent 2	Yes	No	0	0	648	504	
TOTALS			0	0	1428	732	2

Notes:

Blanks or "no" represent quantity of zero.

If steel pile points are required, calculate quantity of "Steel Pile Points" as equal to the number of steel piles.

If pipe pile plates are or may be required, calculate the quantity of "Pipe Pile Plates" as equal to the number of pipe piles.

Show quantity of "PDA Testing" on the plans as total only.

If quantity of "PDA Testing" is 3 or less, reference "Pile Driving Criteria" provision in PDA notes on plans and include "Pile

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION DIVISION OF HIGHWAYS HIGHWAY BUILDING 1589 MAIL SERVICE CENTER RALEIGH, NORTH CAROLINA 27699-1589	SUBJECT: H2J Railroad Bridge over Coddle Creek		WBS Element No. 50000.1.STR03T1B
	PREPARED BY:	MJW	COUNTY: Cabarrus
	DATE:	Jan-13	TIP # P-5208A
	CHECKED BY:	WPA	
	DATE:	Jan-13	

END BENTS SUMMARY

END BENT 1

Pile Type: HP 14X89 Steel Piles
Bottom of Cap Elevation: 538 ft. — Provided By HDR Engineering (HDR)
Anticipated Pile Length: 28 ft. ± (Lt), 33 ft. ± (Rt) — BOC Elev - Anticipated Pile Ref Elev + 1' Pile Embed
Average Pile Length: 30 ft. ± (Lt), 35 ft. ± (Rt) — Anticipated pile length rounded up to the nearest 5 feet
Allowable Bearing Capacity: 70 Tons/Pile — Provided by HDR, rounded up to the nearest 5 tons
Required Bearing Capacity: 140 Tons/Pile — Allowable Bearing Capacity with Factor of Safety of 2

END BENT 2

Pile Type: HP 14X89 Steel Piles
Bottom of Cap Elevation: 550 ft. — Provided By HDR Engineering (HDR)
Anticipated Pile Length: 24 ft. ± (Lt), 28 ft. ± (Rt) — BOC Elev - Anticipated Pile Ref Elev + 1' Pile Embed
Average Pile Length: 25 ft. ± (Lt), 30 ft. ± (Rt) — Anticipated pile length rounded up to the nearest 5 feet
Allowable Bearing Capacity: 70 Tons/Pile — Provided by HDR, rounded up to the nearest 5 tons
Required Bearing Capacity: 140 Tons/Pile — Allowable Bearing Capacity with Factor of Safety of 2

NOTES

See Notes on Sheet 2

COMMENTS

1. A Delmag D19-32 pile hammer was utilized as a common hammer type to determine potential pile driving stresses. This hammer should provide sufficient energy to drive the piles to the required driving resistance at the end bents and interior bent. The actual hammer to be utilized will be submitted by the contractor and analyzed after letting.

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION DIVISION OF HIGHWAYS HIGHWAY BUILDING 1589 MAIL SERVICE CENTER RALEIGH, NORTH CAROLINA 27699-1589	SUBJECT: H2J Railroad Bridge over Coddle Creek		WBS Element No. 50000.1.STR03T1B
	PREPARED BY:	MJW	COUNTY: Cabarrus
	DATE:	Jan-13	TIP # P-5208A
	CHECKED BY:	WPA	
	DATE:	Jan-13	

INTERIOR BENT SUMMARY

BENT 1

Pile Type: HP 14x89 Steel Piles	
Bottom of Cap Elevation: 526 ft.	Provided By HDR Engineering (HDR)
Minimum Pile Tip Elevation: 505 ft.	Based on Lateral Analysis
Anticipated Pile Length: 25' ±	BOC Elevation - Pile Tip Elevation + 1 foot Embed into Cap
Average Pile Length: 25' ±	Anticipated pile length rounded up to the nearest 5 feet
Pile Excavation In Soil: 780 ft.	
Pile Excavation Not In Soil: 228 ft.	Includes 1/2 of WR depth, if encountered
Allowable Bearing Capacity: 65 Tons/Pile	Provided by HDR, rounded up to the nearest 5 tons
Required Bearing Capacity: 130 Tons/Pile	Allowable Bearing Capacity with Factor of Safety of 2
Point of Fixity (POF) Elevation: 507.5'	Lpile Analysis

BENT 2

Pile Type: HP 14x89 Steel Piles	
Bottom of Cap Elevation: 526 ft.	Provided By HDR Engineering (HDR)
Minimum Pile Tip Elevation: 502 ft.	Based on Lateral Analysis
Anticipated Pile Length: 25' ±	BOC Elevation - Pile Tip Elevation + 1 foot Embed into Cap
Average Pile Length: 25' ±	Anticipated pile length rounded up to the nearest 5 feet
Pile Excavation In Soil: 648 ft.	
Pile Excavation Not In Soil: 504 ft.	Includes 1/2 of WR depth, if encountered
Allowable Bearing Capacity: 65 Tons/Pile	Provided by HDR, rounded up to the nearest 5 tons
Required Bearing Capacity: 130 Tons/Pile	Allowable Bearing Capacity with Factor of Safety of 2
Point of Fixity (POF) Elevation: 508'	Lpile Analysis

NOTES

See Notes on Sheet 2

COMMENTS

1. A Delmag D19-32 pile hammer was utilized as a common hammer type to determine potential pile driving stresses. This hammer should provide sufficient energy to drive the piles to the required driving resistance at the end bents and interior bent. The actual hammer to be utilized will be submitted by the contractor and analyzed after letting.

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION DIVISION OF HIGHWAYS HIGHWAY BUILDING 1589 MAIL SERVICE CENTER RALEIGH, NORTH CAROLINA 27699-1589	SUBJECT: H2J Railroad Bridge over Coddle Creek		WBS Element No. 50000.1.STR03T1B
	PREPARED BY:	MJW	COUNTY: Cabarrus
	DATE:	Jan-13	TIP # P-5208A
	CHECKED BY:	WPA	
	DATE:	Jan-13	

SCOUR DETERMINATION

DESIGN SCOUR ELEVATIONS

(100- year scour elevations provided by HDR)

BENT #1	**519.0**	ft
BENT #2	**519.0**	ft

SCOUR CRITICAL ELEVATIONS

(Used 2 to 3 feet below the design scour elevation)

BENT #1	**516.0**	ft
BENT #2	**516.0**	ft

LPILE+ 5.0 INPUT SHEET (ENGLISH)

Filename: H2J Bridge Foundation Recommendations.xlsx

Designer: MJW Checker: WPA

Sheet #:

Project Title

TIP # P-5208A Bent # 1 - Boring B1-A

COUNTY: Cabarrus

Pile Properties

Total Pile Length	21.0	(feet)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	7.0	(feet)
Combined Ground Slope & Batter Angles	0	(degrees)

Pile Sections

Section #	Depth (feet)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0.0	14.695	904	26.1	29000000
2	21.0	14.695	904	26.1	29000000
3					
4					
5					
6					

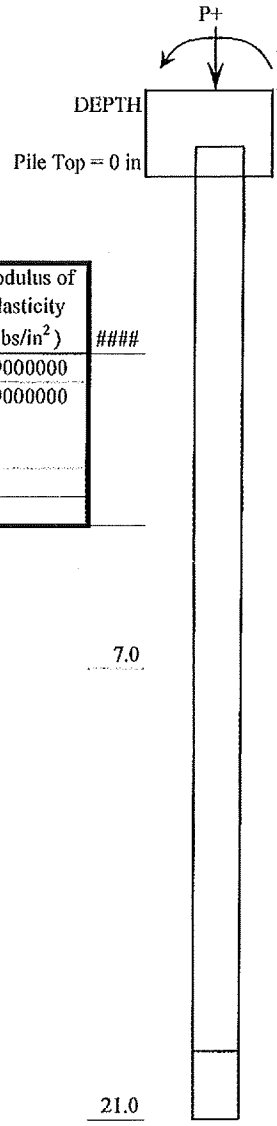
Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Slope	4000	0	126000
Shear & Moment	4000	0	126000

Soil Layers

Layer #	Soil Type	Layer Top (feet)	Layer Bottom (feet)
1	4	7.0	16.2
2	3	16.2	18.7
3	6	18.7	30.0
4			

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)



Input Elevation

BOC Elev. = 526.0 ft

TOS Elev. = N/A ft

7.0 Design Scour 519.0 ft

Bot of Casing N/A ft

21.0 Tip Elev. = 505.0 ft

SOIL and ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain ε_{50}
4	125	125	N/A	40	N/A
3	130	2000	8000	N/A	0.004

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	p-y Mod.* k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Strain ε_{50}

Strong Rock Properties (Vuggy Limestone)		Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)
6		170	3500

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}		First Neg.	Pile Length
0.25"		16.17'	21.0'
0.07"		18.06'	21.0'
Max. Neg.	@	18.69'	21.0'

COMMENTS:

Minimum tip elevation controls the desgin.

Drive piles to the required bearing capacity after pile excavation to the minumum tip elevation.

PT. OF FIXITY ELEV. = 507.5 ft

TIP NO HIGHER THAN EL. = 505.0 ft

LPILE+ 5.0 INPUT SHEET (ENGLISH)

Filename: H2J Bridge Foundation Recommendations.xlsx

Designer: MJW Checker: WPA

Sheet #:

Project Title

TIP # P-5208A Bent # 2

COUNTY: Cabarrus

Pile Properties

Total Pile Length	24.0	(feet)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	7.0	(feet)
Combined Ground Slope & Batter Angles	0	(degrees)

Pile Sections

Section #	Depth (feet)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0.0	14.695	904	26.1	29000000
2	24.0	14.695	904	26.1	29000000
3					
4					
5					
6					

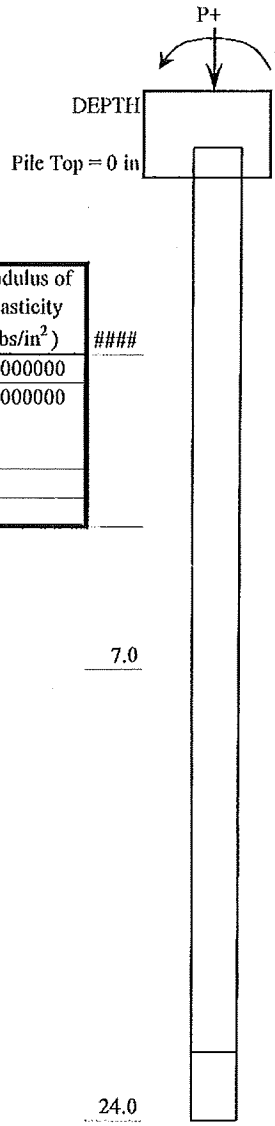
Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Slope	4000	0	126000
Shear & Moment	4000	0	126000

Soil Layers

Layer #	Soil Type	Layer Top (feet)	Layer Bottom (feet)
1	4	7.0	30.0
2			
3			
4			

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)



Input Elevation

BOC Elev. = 526.0 ft

TOS Elev. = N/A ft

7.0 Design Scour 519.0 ft

Bot of Casing N/A ft

24.0 Tip Elev. = 502.0 ft

SOIL and ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain ε_{50}
4	125	125	N/A	40	N/A

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	p-y Mod.* k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Strain ε_{50}

Strong Rock Properties (Vuggy Limestone)	Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}	First Neg.	Pile Length
0.26"	14.88'	24.0'
0.07"	16.32'	24.0'
Max. Neg. @	19.44'	24.0'

COMMENTS:

Minimum tip elevation controls the desgin.

Drive piles to the required bearing capacity after pile excavation to the minumum tip elevation.

PT. OF FIXITY ELEV. = 508.0 ft

TIP NO HIGHER THAN EL. = 502.0 ft

APPENDIX B

NCDOT LEGEND SHEET, SITE LOCATION PLAN,

BORING LOCATION PLAN, BORELOG REPORTS

CORE BORING REPORTS & ROCK CORE PHOTOGRAPHS

PROJECT REFERENCE NO.	SHEET NO.
P-5208A	1

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION

SOIL IS CONSIDERED TO BE THE UNCONSOLIDATED, SEMI-CONSOLIDATED, OR WEATHERED EARTH MATERIALS THAT CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER, AND YIELD LESS THAN 100 BLOWS PER FOOT ACCORDING TO STANDARD PENETRATION TEST (AASHTO T206, ASTM D-1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY SHALL INCLUDE: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. EXAMPLE:

VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6

SOIL LEGEND AND AASHTO CLASSIFICATION

GENERAL CLASS.	GRANULAR MATERIALS (≤ 35% PASSING #200)							SILT-CLAY MATERIALS (> 35% PASSING #200)				ORGANIC MATERIALS		
GROUP CLASS.	A-1		A-3	A-2				A-4	A-5	A-6	A-7	A-1, A-2, A-3	A-4, A-5, A-6, A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5, A-7-6			
SYMBOL														
% PASSING #10	50 MX											GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
#40	30 MX	50 MX	51 MN											
#200	15 MX	25 MX	10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN			
LIQUID LIMIT	6 MX		NP	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
PLASTIC INDEX				10 MX	10 MX	11 MN	11 MN	10 MX	10 MX	11 MN	11 MN			
GROUP INDEX	0		0	0		4 MX		8 MX	12 MX	16 MX	No MX			
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND				SILTY SOILS		CLAYEY SOILS				
GEN. RATING AS A SUBGRADE	EXCELLENT TO GOOD							FAIR TO POOR				FAIR TO POOR	POOR	UNSUITABLE

PI OF A-7-5 SUBGROUP IS ≤ LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30

CONSISTENCY OR DENSENESS

PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH ($TONS/FT^2$)
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE	<4	N/A
	LOOSE	4 TO 10	
	MEDIUM DENSE	10 TO 30	
	DENSE	30 TO 50	
	VERY DENSE	>50	
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT	<2	<0.25
	SOFT	2 TO 4	0.25 TO 0.50
	MEDIUM STIFF	4 TO 8	0.5 TO 1.0
	STIFF	8 TO 15	1 TO 2
	VERY STIFF	15 TO 30	2 TO 4
	HARD	>30	>4

TEXTURE OR GRAIN SIZE

U.S. STD. SIEVE SIZE	4	10	40	60	200	270
OPENING (MM)	4.76	2.00	0.42	0.25	0.075	0.053

BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE. SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)

GRAIN SIZE	MM	305	75	2.0	0.25	0.05	0.005
	IN.	12	3				

SOIL MOISTURE - CORRELATION OF TERMS

SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION
	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE
LL - LIQUID LIMIT		
PLASTIC RANGE (PI)	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
PL - PLASTIC LIMIT		
OM - OPTIMUM MOISTURE	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
SL - SHRINKAGE LIMIT		
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NONPLASTIC	0-5	VERY LOW
LOW PLASTICITY	6-15	SLIGHT
MED. PLASTICITY	16-25	MEDIUM
HIGH PLASTICITY	26 OR MORE	HIGH

COLOR

DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-GRAY), MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.

GRADATION

WELL GRADED - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE.
UNIFORM - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. (ALSO POORLY GRADED)
GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLES OF TWO OR MORE SIZES.

ANGULARITY OF GRAINS

THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.

MINERALOGICAL COMPOSITION

MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHENEVER THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LIQUID LIMIT LESS THAN 31
MODERATELY COMPRESSIBLE	LIQUID LIMIT EQUAL TO 31-50
HIGHLY COMPRESSIBLE	LIQUID LIMIT GREATER THAN 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%
MODERATELY ORGANIC	5 - 10%	12 - 20%
HIGHLY ORGANIC	>10%	>20%

OTHER MATERIAL	
TRACE	1 - 10%
LITTLE	10 - 20%
SOME	20 - 35%
HIGHLY	35% AND ABOVE

GROUND WATER

- WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING
- STATIC WATER LEVEL AFTER 24 HOURS
- PW - PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA
- SPRING OR SEEP

MISCELLANEOUS SYMBOLS

- ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION
- SOIL SYMBOL
- ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT
- INFERRED SOIL BOUNDARY
- INFERRED ROCK LINE
- ALLUVIAL SOIL BOUNDARY
- 25/025 - DIP & DIP DIRECTION OF ROCK STRUCTURES
- SPT, CPT, DMT, VST, PMT - TEST BORING
- AUGER BORING
- CORE BORING
- MW - MONITORING WELL
- PIEZOMETER INSTALLATION
- SLOPE INDICATOR INSTALLATION
- CONE PENETROMETER TEST
- SOUNDING ROD
- TEST BORING W/ CORE
- SPT N-VALUE
- REF - SPT REFUSAL

ABBREVIATIONS

AR - AUGER REFUSAL	MED. - MEDIUM	VST - VANE SHEAR TEST
BT - BORING TERMINATED	MICA. - MICACEOUS	WEA. - WEATHERED
CL. - CLAY	MOD. - MODERATELY	γ - UNIT WEIGHT
CPT - CONE PENETRATION TEST	NP - NON PLASTIC	γ_d - DRY UNIT WEIGHT
CSE. - COARSE	ORG. - ORGANIC	
DMT - DILATOMETER TEST	PMT - PRESSUREMETER TEST	SAMPLE ABBREVIATIONS
DPT - DYNAMIC PENETRATION TEST	SAP. - SAPROLITIC	S - BULK
e - VOID RATIO	SD. - SAND, SANDY	SS - SPLIT SPOON
F - FINE	SL. - SILT, SILTY	ST - SHELBY TUBE
FOSS. - FOSSILIFEROUS	SLI. - SLIGHTLY	RS - ROCK
FRAC. - FRACTURED, FRACTURES	TCR - TRICONE REFUSAL	RT - RECOMPACTED TRIAXIAL
FRAGS. - FRAGMENTS	w - MOISTURE CONTENT	CBR - CALIFORNIA BEARING RATIO
HI. - HIGHLY	V - VERY	

EQUIPMENT USED ON SUBJECT PROJECT

DRILL UNITS:
- [ ] MOBILE B-__
- [ ] BK-51
- [ ] CME-45C
- [X] CME-550X
- [ ] PORTABLE HOIST
- [ ] _____
- [ ] _____

ADVANCING TOOLS:
- [ ] CLAY BITS
- [ ] 6" CONTINUOUS FLIGHT AUGER
- [X] 8" HOLLOW AUGERS
- [ ] HARD FACED FINGER BITS
- [ ] TUNG.-CARBIDE INSERTS
- [ ] CASING [ ] W/ ADVANCER
- [ ] TRICONE _____" STEEL TEETH
- [ ] TRICONE _____" TUNG.-CARB.
- [ ] CORE BIT
- [ ] _____

HAMMER TYPE:
- [X] AUTOMATIC [ ] MANUAL

CORE SIZE:
- [ ] -B-__
- [ ] -N-__
- [ ] -H-__

HAND TOOLS:
- [ ] POST HOLE DIGGER
- [ ] HAND AUGER
- [ ] SOUNDING ROD
- [ ] VANE SHEAR TEST
- [ ] _____

REVISED 09/23/09

PROJECT REFERENCE NO.	SHEET NO.
P-5208A	1A

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

ROCK DESCRIPTION

HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT IF TESTED, WOULD YIELD SPT REFUSAL. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS. IN NON-COASTAL PLAIN MATERIAL, THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK.

ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:

WEATHERED ROCK (WR)		NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.
CRYSTALLINE ROCK (CR)		FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.
NON-CRYSTALLINE ROCK (NCR)		FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YEILD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.
COASTAL PLAIN SEDIMENTARY ROCK (CP)		COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.

WEATHERING

FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.
VERY SLIGHT (V SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN, CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.
SLIGHT (SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.
MODERATE (MOD.)	SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.
MODERATELY SEVERE (MOD. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES 'CLUNK' SOUND WHEN STRUCK. *IF TESTED, WOULD YIELD SPT REFUSAL*
SEVERE (SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. *IF TESTED, YIELDS SPT N VALUES > 100 BPF*
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT THE MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE SUCH THAT ONLY MINOR VESTIGES OF THE ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, YIELDS SPT N VALUES < 100 BPF*
COMPLETE	ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.

ROCK HARDNESS

VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.
MODERATELY HARD	CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.
MEDIUM HARD	CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PEICES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.
SOFT	CAN BE GROVED OR GOUGED READILY BY KNIFE OR PICK. CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT. SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.
VERY SOFT	CAN BE CARVED WITH KNIFE. CAN BE EXCAVATED READILY WITH POINT OF PICK. PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE. CAN BE SCRATCHED READILY BY FINGERNAIL.

FRACTURE SPACING

TERM	SPACING
VERY WIDE	MORE THAN 10 FEET
WIDE	3 TO 10 FEET
MODERATELY CLOSE	1 TO 3 FEET
CLOSE	0.16 TO 1 FEET
VERY CLOSE	LESS THAN 0.16 FEET

BEDDING

TERM	THICKNESS
VERY THICKLY BEDDED	> 4 FEET
THICKLY BEDDED	1.5 - 4 FEET
THINLY BEDDED	0.16 - 1.5 FEET
VERY THINLY BEDDED	0.03 - 0.16 FEET
THICKLY LAMINATED	0.008 - 0.03 FEET
THINLY LAMINATED	< 0.008 FEET

INDURATION

FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF THE MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.

FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.

TERMS AND DEFINITIONS

ALLUVIUM (ALLUV.) - SOILS THAT HAVE BEEN TRANSPORTED BY WATER.

AQUIFER - A WATER BEARING FORMATION OR STRATA.

ARENACEOUS - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND.

ARGILLACEOUS - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, AS SHALE, SLATE, ETC.

ARTESIAN - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IT IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE.

CALCAREOUS (CALC.) - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE.

COLLUVIUM - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE.

CORE RECOVERY (REC.) - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

DIKE - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK.

DIP - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL.

DIP DIRECTION (DIP AZIMUTH) - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH.

FAULT - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE.

FISSILE - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES.

FLOAT - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL.

FLOOD PLAIN (FP) - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM.

FORMATION (FM.) - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD.

JOINT - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED.

LEDGE - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT.

LENS - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS.

MOTTLED (MOT.) - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE.

PERCHED WATER - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM.

RESIDUAL (RES.) SOIL - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK.

ROCK QUALITY DESIGNATION (RQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

SAPROLITE (SAP.) - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK.

SILL - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, THAT HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRUDED ROCKS.

SLICKENSIDE - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE.

STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT) - NUMBER OF BLOWS (N OR BPF) OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO PRODUCE A PENETRATION OF 1 FOOT INTO SOIL WITH A 2 INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER. SPT REFUSAL IS PENETRATION EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS.

STRATA CORE RECOVERY (SREC.) - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE.

STRATA ROCK QUALITY DESIGNATION (SRQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS WITHIN A STRATUM EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF STRATA AND EXPRESSED AS A PERCENTAGE.

TOPSOIL (TS.) - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.

BENCH MARK: SURVEY INFORMATION PROVIDED BY MULKEY, INC.

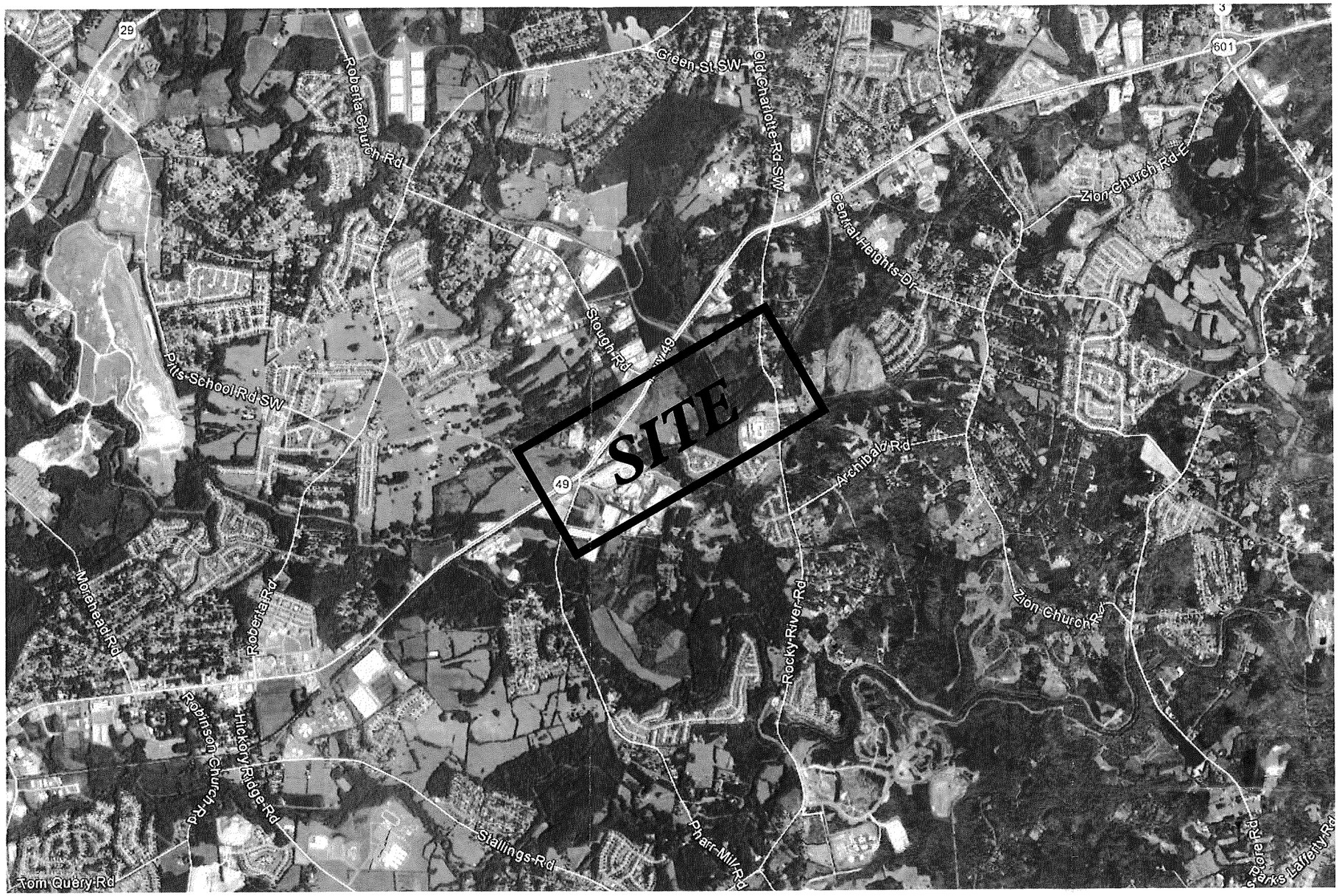
ELEVATION: _ FT.

NOTES:

REVISED 09/23/09

PROJECT REFERENCE NO.	SHEET
P-5208A	2

2nd Main Track, Concord, NC
Site Location Plan

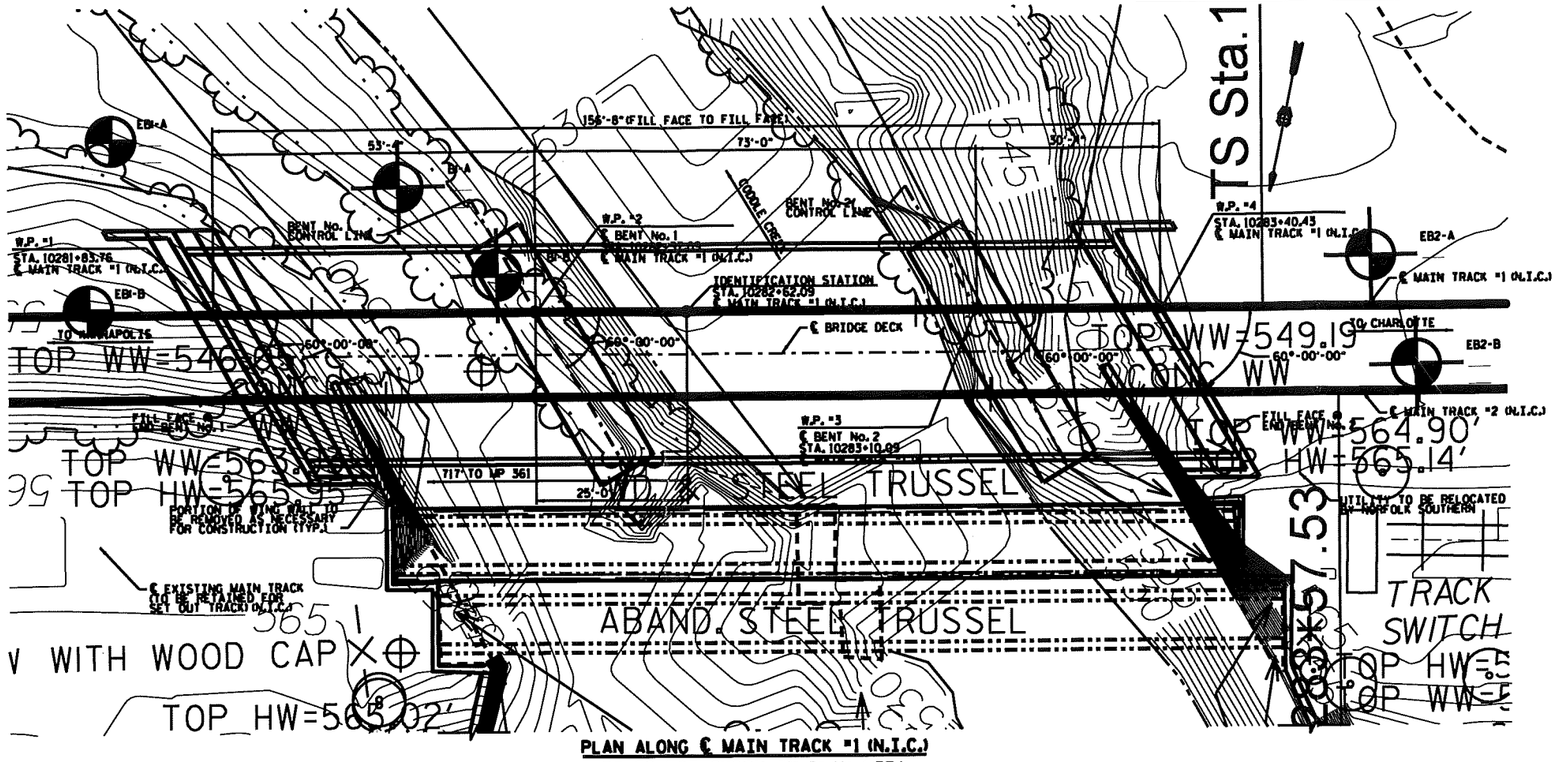


SINCE F&R 1881

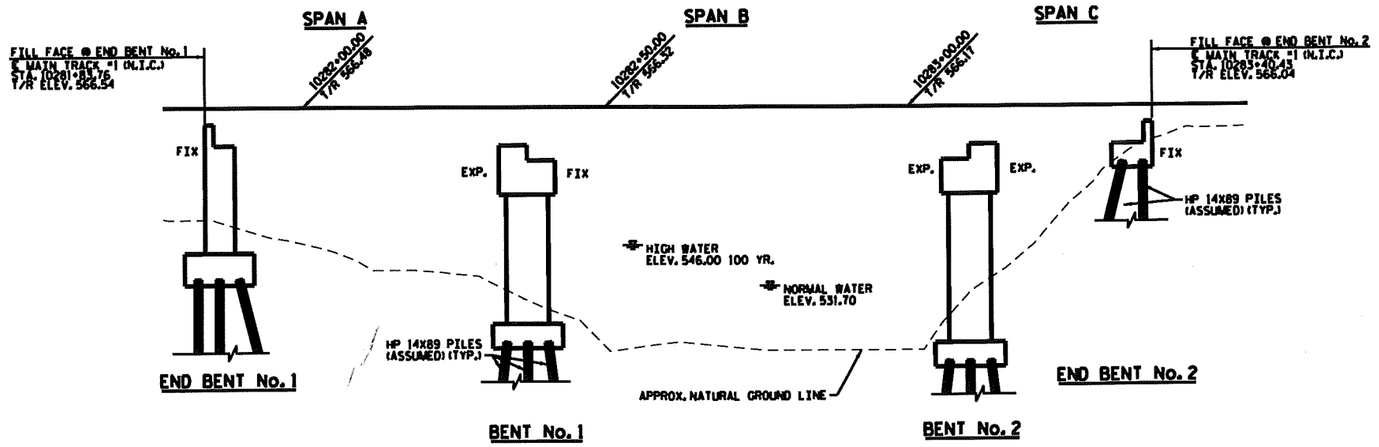
0	25	50
FEET		
1" = 25'		

PROJECT REFERENCE NO.	SHEET
P-5208A	3

2nd Main Track, Concord, NC
Boring Location Plan



PLAN ALONG ℄ MAIN TRACK #1 (N.I.C.)
PILES NOT SHOWN IN PLAN VIEW



SECTION ALONG ℄ MAIN TRACK #1 (N.I.C.)

NOTE: BORINGS FOR THE PROPOSED STRUCTURE WERE OFFSET DUE TO EXISTING SITE CONTOURS, DEBRIS, AND ABANDONED EQUIPMENT.

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. EB1-A	STATION 10281+67	OFFSET 29 ft LT	ALIGNMENT M1 — 0 HR. 13.0
COLLAR ELEV. 541.0 ft	TOTAL DEPTH 36.0 ft	NORTHING 582,659	EASTING 1,520,031 — 24 HR. 15.5
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/20/12	COMP. DATE 08/20/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
545										
	541.0	0.0								541.0 GROUND SURFACE 0.0
540			2	3	4	7		M		**ROADWAY EMBANKMENT** Brown silty fine to coarse SAND (A-2-4)
	537.5	3.5								
535			3	3	3	6		M		
	532.5	8.5								
530			2	2	2	4		M		
	527.5	13.5								529.0 12.0
525			2	1	3	4	SS-4	23%		**RESIDUAL** Brown and gray fine to coarse sandy SILT (A-4(0)) * Some rock fragments from 18.5 to 20 feet
	522.5	18.5								
520			6	22	21	43		W		
	517.5	23.5								
515			21	46	45	91		W		
	512.5	28.5								512.0 29.0
510			29	51	49/0.4	100/0.9				**WEATHERED ROCK** Tan and brown (GRANITE)
	507.5	33.5								
505			70	30/0.2		100/0.7				
	505.0	36.0	60/0.0			60/0.0				505.0 36.0

Boring Terminated with Standard Penetration Test Refusal at Elevation 505.0 ft On CRYSTALLINE ROCK (GRANITE)

1) Driller indicated approximately 5 inches of Surficial Organic Laden soil.

NCDOT BORE SINGLE 63P-0090 HADDOCK TO JUNKER.GPJ NC_DOT.GDT 1/31/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. EB1-B	STATION 10281+63	OFFSET 1 ft LT	ALIGNMENT M1 — 0 HR. 18.0
COLLAR ELEV. 549.0 ft	TOTAL DEPTH 42.5 ft	NORTHING 582,687	EASTING 1,520,029 — 24 HR. 12.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/21/12	COMP. DATE 08/21/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
550	549.0	0.0								549.0 GROUND SURFACE 0.0
545	545.5	3.5	2	3	5	8		M		**ROADWAY EMBANKMENT** Brown, tan, and orange silty fine to coarse SAND (A-2-4), trace to some gravel
540	540.5	8.5	5	5	5	10		M		* Wood encountered from 13.5 to 15 feet
535	535.5	13.5	5	4	4	8		M		
530	530.5	18.5	4	4	4	8		M		531.0 18.0
525	525.5	23.5	4	4	3	7	SS-9	28%		**ALLUVIAL** Brown and gray sandy CLAY (A-6(10))
520	520.5	28.5	0	1	1	2		W		526.0 23.0 Gray and tan silty fine to coarse SAND (A-2-4)
515	515.5	33.5	16	25	37	62		W		521.0 28.0 **RESIDUAL** Gray and tan silty fine to coarse SAND (A-2-4)
510	510.5	38.5	10	30	70/0.2	100/0.7				515.0 34.0 **WEATHERED ROCK** Tan and brown (GRANITE)
	506.5	42.5	22	30	54	84		M		511.0 38.0 **RESIDUAL** Tan and brown silty fine to coarse SAND (A-2-4)
			60/0.0			60/0.0				506.5 42.5 Boring Terminated with Standard Penetration Test Refusal at Elevation 506.5 ft On CRYSTALLINE ROCK (GRANITE)

1) Driller indicated approximately 4 inches of Surficial Organic Laden soil.

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/31/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. B1-A	STATION 10282+14	OFFSET 21 ft LT	ALIGNMENT M1 — 0 HR. 5.0
COLLAR ELEV. 538.8 ft	TOTAL DEPTH 51.5 ft	NORTHING 582,657	EASTING 1,519,983 — 24 HR. 10.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/21/12	COMP. DATE 08/24/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
540										
	538.8	0.0								538.8 GROUND SURFACE 0.0
			1	2	1	3		M		ROADWAY EMBANKMENT
535										Dark brown fine to coarse sandy CLAY (A-6), trace gravel
	535.3	3.5	3	4	5	9		D		535.3 3.5
										Tan and brown silty fine sand (A-2-4)
530	530.3	8.5								530.8 8.0
			0	0	0	0	SS-16	34%		ALLUVIAL
										Brown and gray fine to coarse sandy SILT (A-4(0))
525	525.3	13.5								526.8 12.0
			0	0	3	3		M		Gray silty CLAY (A-7-6) with organic odor
520	520.3	18.5								520.8 18.0
			35	21	23	44		M		RESIDUAL
										Brown, tan, and black silty fine to coarse SAND (A-2-4(0))
515	515.3	23.5								
			8	9	15	24	SS-19	16%		
510	510.3	28.5								509.8 29.0
			28	43	57/0.6	100/1.0				WEATHERED ROCK
	507.3	31.5	60/0.0			60/0.0				Brown and tan (GRANITE) 507.3 31.5
505										CRYSTALLINE ROCK
										Gray, pink, and white (GRANITE)
500										
										497.3 41.5
495										CRYSTALLINE ROCK
										Gray, pink, and white (GRANITE)
490										
										487.3 51.5
										Boring Terminated at Elevation 487.3 ft In CRYSTALLINE ROCK (GRANITE)
										1) Driller indicated approximately 3 inches of Surficial Organic Laden soil.

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/31/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. B1-A	STATION 10282+14	OFFSET 21 ft LT	ALIGNMENT M1 — 0 HR. 5.0
COLLAR ELEV. 538.8 ft	TOTAL DEPTH 51.5 ft	NORTHING 582,657	EASTING 1,519,983 — 24 HR. 10.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/21/12	COMP. DATE 08/24/12	SURFACE WATER DEPTH N/A
CORE SIZE NQ2	TOTAL RUN 20.0 ft		

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
507.3											Begin Coring @ 31.5 ft
505	507.3	31.5	5.0	N=60/0.0 00:42/1.0 01:20/1.0 01:18/1.0 01:28/1.0 01:42/1.0	(4.8) 97%	(3.4) 68%		(9.8) 98%	(7.5) 75%		ELEV. 507.3 DEPTH 31.5 **CRYSTALLINE ROCK** Gray pink and white, moderately hard to very hard, very slightly to slightly weathered, very close to moderately closely spaced fractured (GRANITE) RS-1: 35.7' - 36.2', qu = 700 psi
500	502.3	36.5	5.0	01:53/1.0 02:03/1.0 01:58/1.0 01:58/1.0 01:38/1.0	(5.0) 100%	(4.1) 82%					
495	497.3	41.5	5.0	01:53/1.0 01:56/1.0 01:54/1.0 02:04/1.0 02:21/1.0	(5.0) 100%	(4.9) 98%		(10.0) 100%	(9.5) 95%		ELEV. 497.3 DEPTH 41.5 **CRYSTALLINE ROCK** Gray pink and white, very hard, fresh to very slightly weathered, close to moderately closely spaced fractured (GRANITE) RS-2: 44.9' - 45.4', qu = 3,985 psi
490	492.3	46.5	5.0	02:08/1.0 01:57/1.0 02:03/1.0 01:57/1.0 02:51/1.0	(5.0) 100%	(4.6) 92%					
	487.3	51.5									ELEV. 487.3 DEPTH 51.5 Boring Terminated at Elevation 487.3 ft In CRYSTALLINE ROCK (GRANITE) 1) Driller indicated approximately 3 inches of Surficial Organic Laden soil.

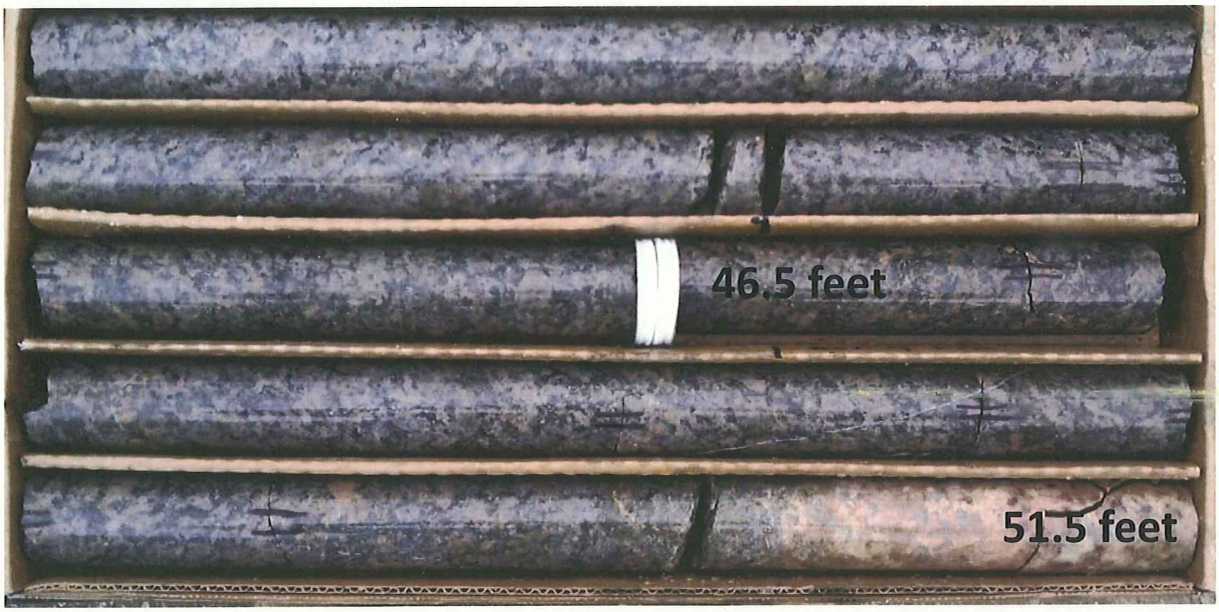
NCDOT CORE SINGLE 63P-0090 HADCCK TO JUNKER.GPJ NC_DOT.GDT 2/1/13

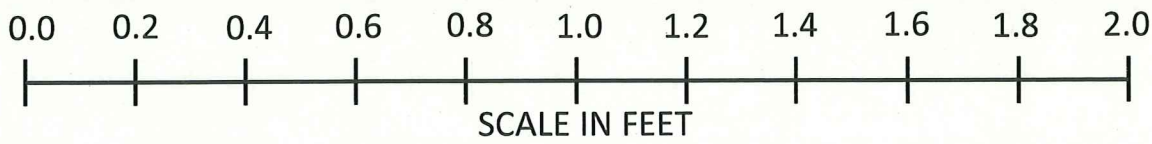
Railroad Bridge across Coddle Creek

CORE PHOTOGRAPHS: B1-A: Station 10282+14

31.5 feet

41.5 feet





NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. B1-B	STATION 10282+31	OFFSET 6 ft LT	ALIGNMENT M1 — 0 HR. 11.0
COLLAR ELEV. 538.4 ft	TOTAL DEPTH 51.5 ft	NORTHING 582,668	EASTING 1,519,964 — 24 HR. 8.5
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/23/12	COMP. DATE 08/23/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
540	538.4	0.0								538.4 GROUND SURFACE 0.0
			1	1	3	4		M		**ROADWAY EMBANKMENT** Dark brown silty fine SAND (A-2-4), trace gravel
535	534.9	3.5	3	3	3	6		W		533.4 5.0
530	529.9	8.5	0	0	0	0	SS-23	45%		**ALLUVIAL** Gray and black silty CLAY (A-7-6(18)) with organic odor
525	524.9	13.5	11	9	7	16		W		
520	519.9	18.5	27	34	45	79	SS-25	9%		520.4 18.0 **RESIDUAL** Brown, orange, and gray silty fine to coarse SAND (A-2-4(0))
515	514.9	23.5	37	63/0.4		100/0.9				514.9 23.5 **WEATHERED ROCK** Brown and tan (GRANITE)
510	509.9	28.5	36	28	72/0.3	100/0.8				
	506.9	31.5	60/0.0			60/0.0				506.9 31.5 **CRYSTALLINE ROCK** Gray, green, and pink (GRANITE)
505										
500										
										496.9 41.5 **CRYSTALLINE ROCK** Pink, gray, and white (GRANITE)
495										
490										
										486.9 51.5

Boring Terminated with Standard Penetration Test Refusal at Elevation 486.9 ft in CRYSTALLINE ROCK (GRANITE)

1) Driller indicated approximately 4 inches of Surficial Organic Laden soil.

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/31/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. B1-B	STATION 10282+31	OFFSET 6 ft LT	ALIGNMENT M1	0 HR. 11.0
COLLAR ELEV. 538.4 ft	TOTAL DEPTH 51.5 ft	NORTHING 582,668	EASTING 1,519,964	24 HR. 8.5
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/23/12	COMP. DATE 08/23/12	SURFACE WATER DEPTH N/A
CORE SIZE NQ2	TOTAL RUN 20.0 ft		

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
506.9											Begin Coring @ 31.5 ft
505	506.9	31.5	5.0	N=60/0.0 01:42/1.0 01:45/1.0 01:55/1.0 02:00/1.0 02:20/1.0	(5.0) 100%	(3.0) 60%		(10.0) 100%	(6.7) 67%		506.9 ELEV. (ft) **CRYSTALLINE ROCK** 31.5 DEPTH (ft) Gray green and pink, moderately hard to hard, very slightly to moderately weathered, very close to moderately closely spaced fractured (GRANITE) RS-3: 36.8' - 37.3', qu = 4,100 psi
	501.9	36.5									
500			5.0	03:00/1.0 03:01/1.0 02:32/1.0 02:33/1.0 02:47/1.0	(5.0) 100%	(3.7) 73%					
	496.9	41.5									496.9 41.5
495			5.0	02:32/1.0 02:17/1.0 02:25/1.0 02:32/1.0 02:38/1.0	(5.0) 100%	(4.2) 83%		(10.0) 100%	(8.2) 82%		**CRYSTALLINE ROCK** Pink gray and white, hard, very slightly weathered, very close to moderately closely spaced fractured (GRANITE) RS-4: 50.9' - 51.4', qu = 5,945 psi
	491.9	46.5									
490			5.0	02:05/1.0 02:59/1.0 03:02/1.0 02:32/1.0 02:35/1.0	(5.0) 100%	(4.0) 80%					
	486.9	51.5									486.9 51.5 Boring Terminated with Standard Penetration Test Refusal at Elevation 486.9 ft In CRYSTALLINE ROCK (GRANITE) 1) Driller indicated approximately 4 inches of Surficial Organic Laden soil.

Railroad Bridge across Coddle Creek

CORE PHOTOGRAPHS: B1-B: Station 10282+31

31.5 feet

0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0

SCALE IN FEET

41.5 feet

0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0

SCALE IN FEET

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. EB2-A	STATION 10283+75	OFFSET 8 ft LT	ALIGNMENT M1 — 0 HR. 43.0
COLLAR ELEV. 562.3 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,636	EASTING 1,519,823 — 24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 09/07/12	COMP. DATE 09/07/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
565										
	562.3	0.0								562.3 GROUND SURFACE 0.0
560			5	12	18	30		D		**ARTIFICIAL FILL** Gray ABC Stone
	558.8	3.5								
555			8	9	5	14		D		
	553.8	8.5								553.8 8.5
550			1	3	4	7		M		Brown fine to coarse sandy CLAY (A-6) with intermittent ABC stone layers
	548.8	13.5								548.8 13.5
545			0	1	2	3		M		**RESIDUAL** Tan, orange, and brown fine to coarse sandy SILT (A-4(0))
	543.8	18.5								
540			3	3	2	5	SS-32	22%		539.3 23.0
	538.8	23.5								Tan, orange, gray, and white silty fine to coarse SAND (A-2-4)
535			8	12	17	29		M		
	533.8	28.5								
530			14	20	28	48		M		
	528.8	33.5								528.8 33.5
525			51	49/0.2		100/0.7				**WEATHERED ROCK** Tan and gray (GRANITE)
	523.8	38.5								
520			61	39/0.0		100/0.5				
	518.8	43.5								
515			69	31/0.0		100/0.5				
	513.8	48.5								
510			46	54/0.3		100/0.8				
	508.8	53.5								509.3 53.0
505			11	13	51	64		M		**RESIDUAL** Tan and gray silty fine to coarse SAND (A-2-4)
	503.8	58.5								503.8 58.5
500	501.3	61.0	100/0.4			100/0.4				**WEATHERED ROCK** Tan and gray (GRANITE) 501.3 61.0
			60/0.0			60/0.0				**CRYSTALLINE ROCK** Gray, white, and pink (GRANITE)
495										496.3 66.0
										CRYSTALLINE ROCK Gray, white, and pink (GRANITE)
490										
485										

NCDOT BORE SINGLE 63P-0090 HADDOCK TO JUNKER.GPJ NC_DOT.GDT 1/31/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris	
SITE DESCRIPTION P-5208A Haydock to Junker Double Track				GROUND WTR (ft)
BORING NO. EB2-A	STATION 10283+75	OFFSET 8 ft LT	ALIGNMENT M1	0 HR. 43.0
COLLAR ELEV. 562.3 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,636	EASTING 1,519,823	24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic	
DRILLER C. Boyce	START DATE 09/07/12	COMP. DATE 09/07/12	SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
485						Match Line					
										CRYSTALLINE ROCK Gray, white, and pink (GRANITE) *(continued)*	
										481.3	81.0
										Boring Terminated at Elevation 481.3 ft In CRYSTALLINE ROCK (GRANITE)	

NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. EB2-A	STATION 10283+75	OFFSET 8 ft LT	ALIGNMENT M1 — 0 HR. 43.0
COLLAR ELEV. 562.3 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,636	EASTING 1,519,823 — 24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 09/07/12	COMP. DATE 09/07/12	SURFACE WATER DEPTH N/A
CORE SIZE NQ2	TOTAL RUN 20.0 ft		

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
501.3											Begin Coring @ 61.0 ft
500	501.3	61.0	5.0	*N=60/0.0* 00:54/1.0 01:58/1.0 01:56/1.0 01:46/1.0 02:10/1.0	(3.8) 77%	(2.8) 55%		(3.8) 77%	(2.8) 55%		ELEV. 501.3 — DEPTH 61.0 **CRYSTALLINE ROCK** Gray white and pink, moderately hard to very hard, fresh to moderately weathered, very close to moderately closely spaced fractured (GRANITE)
	496.3	66.0									ELEV. 496.3 — DEPTH 66.0
495			5.0	03:31/1.0 02:30/1.0 03:07/1.0 03:09/1.0 03:24/1.0	(5.0) 100%	(4.7) 93%		(15.0) 100%	(14.1) 94%		**CRYSTALLINE ROCK** Gray white and pink, very hard, fresh to very slightly weathered, close to moderately closely spaced fractured (GRANITE) RS-5: 67.0 - 67.4' - 45.4', qu = 4,005 psi RS-6: 80.2' - 80.7', qu = 7,135 psi
	491.3	71.0									
490			5.0	02:41/1.0 02:52/1.0 02:31/1.0 02:47/1.0 02:45/1.0	(5.0) 100%	(5.0) 100%					
	486.3	76.0									
485			5.0	02:47/1.0 02:39/1.0 03:02/1.0 02:20/1.0 03:30/1.0	(5.0) 100%	(4.4) 88%					
	481.3	81.0									ELEV. 481.3 — DEPTH 81.0 Boring Terminated at Elevation 481.3 ft In CRYSTALLINE ROCK (GRANITE)

Railroad Bridge across Coddle Creek

CORE PHOTOGRAPHS: EB2-A: Station 10283+75

61.0 feet

71.0 feet

NCDOT GEOTECHNICAL ENGINEERING UNIT
BOREHOLE REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris	
SITE DESCRIPTION P-5208A Haydock to Junker Double Track				GROUND WTR (ft)
BORING NO. EB2-B	STATION 10283+83	OFFSET 10 ft RT	ALIGNMENT M1	0 HR. 43.0
COLLAR ELEV. 563.0 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,652	EASTING 1,519,812	24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers		HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 09/04/12	COMP. DATE 09/05/12	SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
565										
	563.0	0.0								563.0 GROUND SURFACE 0.0
			8	10	8	18		D		ARTIFICIAL FILL
560	559.5	3.5								561.0 Gray ABC Stone 2.0
			3	4	1	5		M		Tan and gray silty fine to coarse SAND (A-2-4), some gravel
555	554.5	8.5								555.0 8.0
			2	1	1	2		M		Brown and gray silty CLAY (A-7-6(9)), trace gravel
550	549.5	13.5								
			2	1	3	4	SS-44	25%		
545	544.5	18.5								544.5 18.5
			3	5	6	11		M		RESIDUAL Tan, orange, and brown silty fine to coarse SAND (A-2-4(0))
540	539.5	23.5								
			6	10	13	23		M		
535	534.5	28.5								
			14	14	26	40	SS-47	8%		
530	529.5	33.5								
			23	27	34	61		M		
525	524.5	38.5								524.5 38.5
			47	53/0.3		100/0.8				WEATHERED ROCK Tan, brown, and orange (GRANITE)
520	519.5	43.5								* Hard rock lens from 40.5 to 43 feet
			100/0.2			100/0.2				
515	514.5	48.5								
			100/0.4			100/0.4				
510	509.5	53.5								
			32	63/0.3		100/0.8				
505	504.5	58.5								504.5 58.5
			60/0.1			60/0.1				CRYSTALLINE ROCK
	502.0	61.0								502.0 Tan, brown, and orange (GRANITE) 61.0
500			60/0.0			60/0.0				CRYSTALLINE ROCK Gray, pink, and white (GRANITE)
495										
490										
485										

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/31/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. EB2-B	STATION 10283+83	OFFSET 10 ft RT	ALIGNMENT M1 — 0 HR. 43.0
COLLAR ELEV. 563.0 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,652	EASTING 1,519,812 — 24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 09/04/12	COMP. DATE 09/05/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
485						Match Line				ELEV. (ft) DEPTH (ft)
										CRYSTALLINE ROCK Gray, pink, and white (GRANITE) *(continued)* 482.0 81.0
										Boring Terminated at Elevation 482.0 ft In CRYSTALLINE ROCK (GRANITE) 1) Driller indicated lens of hard rock from 40.5 to 42 feet.

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/31/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. EB2-B	STATION 10283+83	OFFSET 10 ft RT	ALIGNMENT M1 — 0 HR. 43.0
COLLAR ELEV. 563.0 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,652	EASTING 1,519,812 — 24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 09/04/12	COMP. DATE 09/05/12	SURFACE WATER DEPTH N/A
CORE SIZE NQ2	TOTAL RUN 20.0 ft		

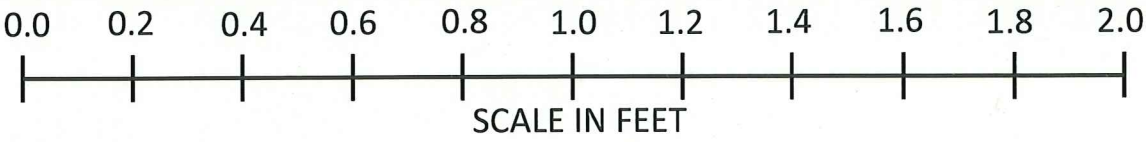
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
502											Begin Coring @ 61.0 ft
500	502.0	61.0	5.0	*N=60/0.0* 02:00/1.0 03:10/1.0 02:10/1.0 02:40/1.0 02:24/1.0	(4.8) 97%	(4.3) 87%		(19.8) 99%	(17.5) 87%		502.0 CRYSTALLINE ROCK 61.0 Gray pink and white, very hard, fresh to very slightly weathered, close to moderately closely spaced fractured (GRANITE) RS-7: 67.0' - 67.5', qu = 10,325 psi RS-8: 73.0' - 73.4', qu = 3,820 psi
495	497.0	66.0	5.0	02:38/1.0 03:03/1.0 02:34/1.0 02:11/1.0 02:08/1.0	(5.0) 100%	(4.8) 97%					
490	492.0	71.0	5.0	02:25/1.0 02:17/1.0 02:35/1.0 02:22/1.0 02:49/1.0	(5.0) 100%	(4.5) 90%					
485	487.0	76.0	5.0	02:29/1.0 03:33/1.0 03:44/1.0 02:58/1.0 02:50/1.0	(5.0) 100%	(3.8) 77%					
	482.0	81.0									482.0 81.0 Boring Terminated at Elevation 482.0 ft In CRYSTALLINE ROCK (GRANITE) 1) Driller indicated lens of hard rock from 40.5 to 42 feet.

NCDOT CORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 2/1/13

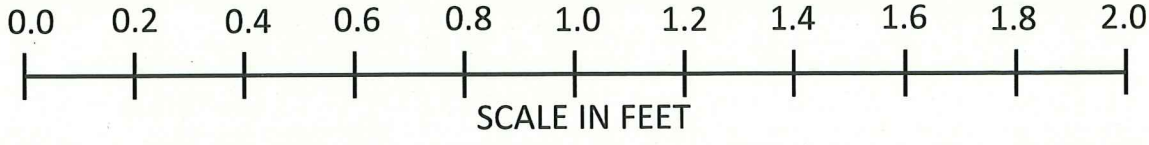
Railroad Bridge across Coddle Creek

CORE PHOTOGRAPHS: EB2-B: Station 10283+83

61.0 feet



71.0 feet



APPENDIX C

LABORATORY TEST RESULTS

SINCE F&R 1881

North Carolina Department of Transportation
Division of Highways
Materials and Test Unit
Soils Laboratory

M&T Form 503

T.I.P. ID NO.: P-5208A

REPORT ON SAMPLES OF: SOIL FOR QUALITY

PROJECT:	H2J Double Track Project	COUNTY:	Cabarrus
DATE SAMPLED:	12-14-2012	RECEIVED:	12-14-2012
SAMPLED FROM:	On Site	REPORTED:	12-30-2012
SUBMITTED BY:	F&R Inc.	BY:	B. Aziz

TEST RESULTS

PROJ. SAMPLE NO.	EB1-A	EB-1B	B1-A	B1-A	B1-B	B1-B	EB-2A
LAB SAMPLE NO.	SS-4	SS-9	SS-16	SS-19	SS-23	SS-25	SS-32
Retained #4 Sieve %	0.0	0.0	0.0	17.4	0.0	14.8	0.0
Passing #10 Sieve %	100.0	100.0	97.7	55.7	100.0	58.6	100.0
Passing #40 Sieve %	99.2	93.2	82.4	30.3	98.9	34.2	87.5
Passing #200 Sieve %	40.9	70.0	40.3	11.5	83.9	14.4	53.7

MINUS #10 FRACTION

SOIL MORTAR - 100%							
Coarse Sand Ret - #60 %	8.0	9.0	26.0	58.2	2.6	53.4	21.9
Fine Sand Ret - #270 %	58.9	29.2	36.9	24.9	17.4	25.8	29.8
Silt 0.053 - 0.010 mm %	19.7	36.5	17.5	13.7	41.2	14.3	27.7
Clay < 0.010 mm %	13.4	25.3	19.6	3.2	38.8	6.5	20.6
L.L.	24	36	28	26	47	24	26
P.L.	21	20	21	24	27	21	22
P.I.	3	16	7	2	20	3	4
AASHTO Classification	A-4(0)	A-6(10)	A-4(0)	A-2-4(0)	A-7-6(18)	A-2-4(0)	A-4(0)
Station	10281+67	10281+63	10282+14	10282+14	10282+31	10282+31	10283+75
Offset	29' LT	1' LT	21' LT	21' LT	6' LT	6' LT	8' LT
Depth (ft.)	13.5	18.5	8.5	23.5	8.5	18.5	18.5
to	15.0	20.0	10.0	25.0	10.0	20.0	20.0
Moisture Content	22.8	27.9	33.8	15.7	45.1	8.9	22.0
Organic Content	NT	NT	NT	NT	NT	NT	NT

NT = Not Tested
NP = Not Plastic
NA = Not Applicable

Michael J. Walko, P.E.
Soils Engineer

SINCE F&R 1861

North Carolina Department of Transportation
Division of Highways
Materials and Test Unit
Soils Laboratory

M&T Form 503

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SUBMITTED BY:	F&R Inc.	BY:	B. Aziz

TEST RESULTS

PROJ. SAMPLE NO.	EB-2B	EB-2B					
LAB SAMPLE NO.	SS-44	SS-47					
Retained #4 Sieve %	0.0	4.8					
Passing #10 Sieve %	100.0	77.2					
Passing #40 Sieve %	77.0	52.9					
Passing #200 Sieve %	57.3	22.3					

MINUS #10 FRACTION

SOIL MORTAR - 100%							
Coarse Sand Ret - #60 %	28.6	44.2					
Fine Sand Ret - #270 %	16.8	31.9					
Silt 0.053 - 0.010 mm %	14.9	17.4					
Clay < 0.010 mm %	39.7	6.5					
L.L.	41	29					
P.L.	21	25					
P.I.	20	4					
AASHTO Classification	A-7-6(9)	A-2-4(0)					
Station	10283+83	10283+83					
Offset	10' RT	10' RT					
Depth (ft.)	13.5	28.5					
to	15.0	30.0					
Moisture Content	25.4	8.4					
Organic Content	NT	NT					

NT = Not Tested
NP = Not Plastic
NA = Not Applicable

Michael J. Walko, P.E.
Soils Engineer

LABORATORY SUMMARY SHEET FOR ROCK CORE SAMPLES

PROJECT NO.: 50000.1.STR03T1B
TIP NO.: P-5208A
COUNTY: Cabarrus
DESCRIPTION: Haydock to Junker (H2J) Double Track Project – Bridge over Coddle Creek

Sample ID	Boring No.	Depth (feet)	Rock Type	Run RQD	Length (inches)	Diameter (inches)	Unit Weight (pcf)	Unconfined Compressive Strength (psi)	Young's Modulus (ksf)
RS-1	B1-A	35.7 – 36.2	Granite	68%	4.96	2.00	171.0	700	1.82×10^4
RS-2	B1-A	44.9 – 45.4	Granite	98%	4.95	2.00	175.5	3,985	5.13×10^4
RS-3	B1-B	36.8 – 37.3	Granite	73%	4.87	2.00	170.7	4,100	5.82×10^4
RS-4	B1-B	50.9 – 51.4	Granite	80%	4.96	2.00	170.0	5,945	7.21×10^4
RS-5	EB2-A	67.0 – 67.4	Granite	93%	4.28	2.00	174.1	4,005	7.25×10^4
RS-6	EB2-A	80.2 – 80.7	Granite	88%	4.80	2.00	174.5	7,135	6.40×10^4
RS-7	EB2-B	67.0 – 67.5	Granite	97%	4.97	2.00	173.0	10,325	1.77×10^5
RS-8	EB2-B	73.0 – 73.4	Granite	90%	4.21	2.00	172.2	3,820	4.74×10^4

Unconfined Compression Test

Test Data Sheet

Project: P-5208

F&R Project No.: 63P-0090

Boring No.: B1-A

Sample ID: RS-1

Depth, ft.: 35.7 - 36.2

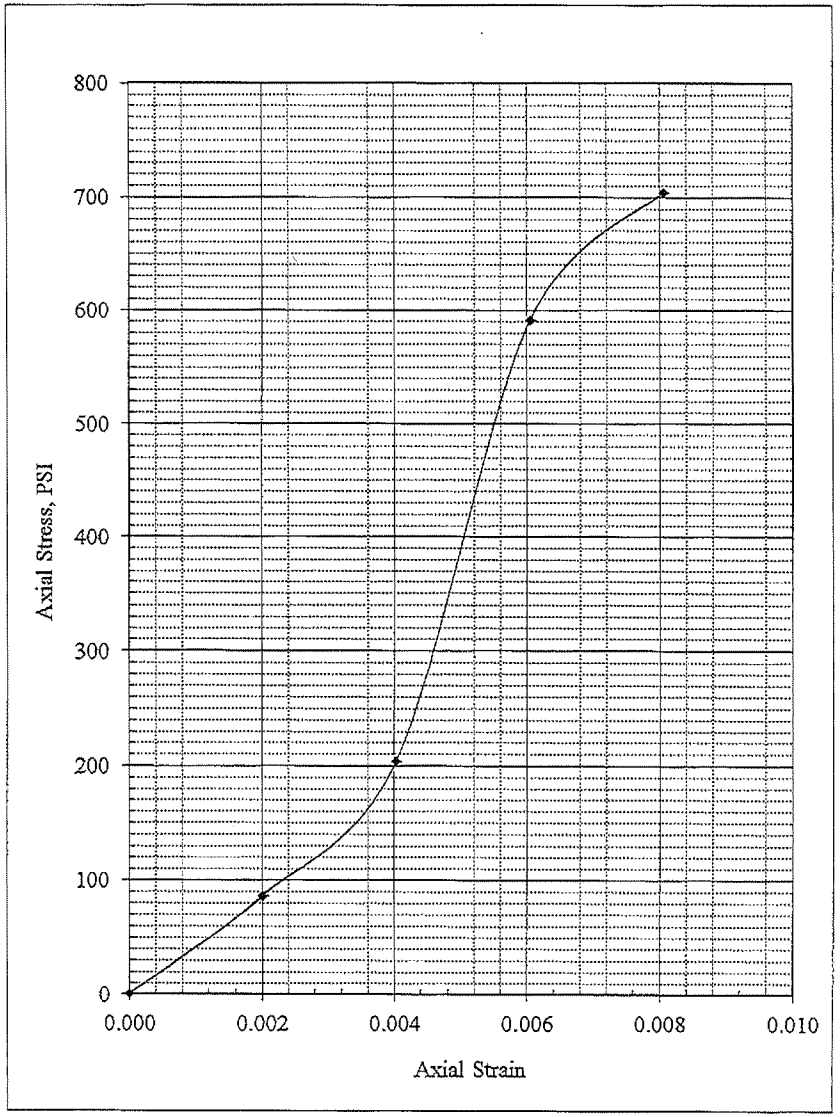
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.96
Area (in^2)	3.13
Unit Wt. (pcf)	171.0

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 1.82 x 10^4 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	270	0.010	0.0020	3.13	86.17	594.10
3	0.020	640	0.020	0.0040	3.14	203.83	1405.38
4	0.030	1860	0.030	0.0060	3.15	591.19	4076.12
5	0.040	2220	0.040	0.0081	3.15	704.18	4855.18



Notes: 1. Right Cylinder Correction Method

Unconfined Compression Test

Test Data Sheet

Project: P-5208

F&R Project No.: 63P-0090

Boring No.: B1-A

Sample ID: RS-2

Depth, ft.: 44.9 - 45.4

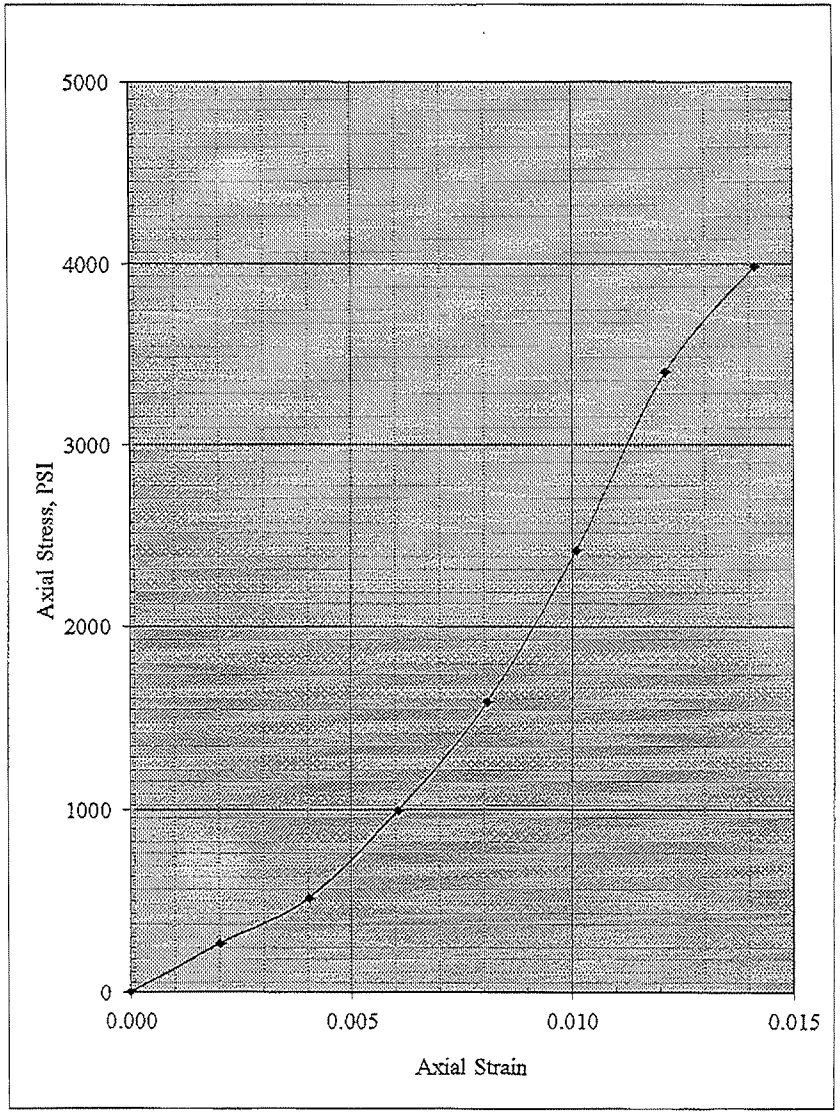
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.95
Area (in^2)	3.13
Unit Wt. (pcf)	175.5

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 5.13 x 10^4 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	840	0.010	0.0020	3.13	268.07	1848.29
3	0.020	1630	0.020	0.0040	3.14	519.13	3579.30
4	0.030	3130	0.030	0.0061	3.15	994.84	6859.19
5	0.040	5000	0.040	0.0081	3.15	1585.97	10934.90
6	0.050	7640	0.050	0.0101	3.16	2418.43	16674.50
7	0.060	10770	0.060	0.0121	3.17	3402.27	23457.84
8	0.070	12650	0.070	0.0141	3.17	3988.00	27496.27



Notes: 1. Right Cylinder Correction Method

Unconfined Compression Test

Test Data Sheet

Project: P-5208
F&R Project No.: 63P-0090

Boring No.: B1-B
Sample ID: RS-3
Depth, ft.: 36.8 - 37.3

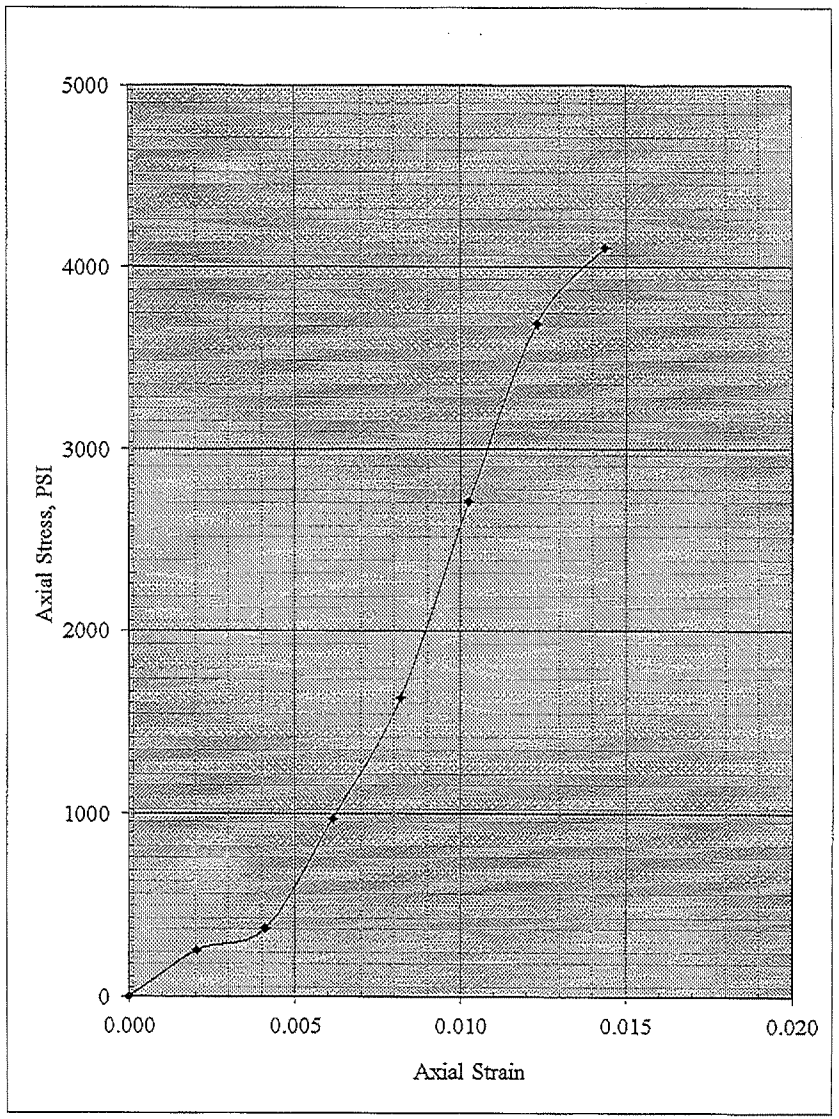
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.87
Area (in^2)	3.13
Unit Wt. (pcf)	170.7

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 5.82×10^4 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	800	0.010	0.0021	3.13	255.30	1760.22
3	0.020	1180	0.020	0.0041	3.14	375.79	2590.98
4	0.030	3060	0.030	0.0062	3.15	972.50	6705.12
5	0.040	5150	0.040	0.0082	3.15	1633.33	11261.44
6	0.050	8560	0.050	0.0103	3.16	2709.20	18679.30
7	0.060	11680	0.060	0.0123	3.17	3689.00	25434.76
8	0.070	13020	0.070	0.0144	3.17	4103.67	28293.84



Notes: 1. Right Cylinder Correction Method

Unconfined Compression Test

Test Data Sheet

Project: P-5208

F&R Project No.: 63P-0090

Boring No.: B1-B

Sample ID: RS-4

Depth, ft.: 50.9 - 51.4

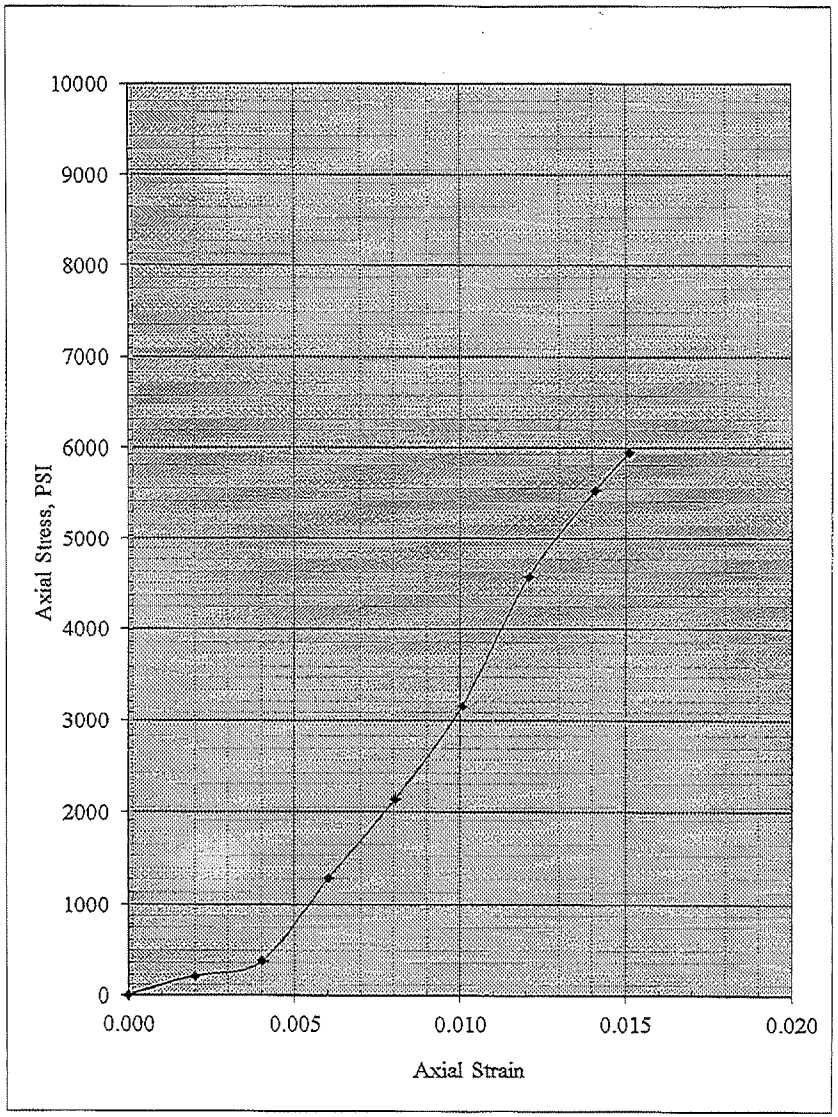
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.96
Area (in^2)	3.13
Unit Wt. (pcf)	170.0

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 7.21 x 10^4 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	660	0.010	0.0020	3.13	210.63	1452.23
3	0.020	1210	0.020	0.0040	3.14	385.37	2657.05
4	0.030	4030	0.030	0.0060	3.15	1280.91	8831.59
5	0.040	6760	0.040	0.0081	3.15	2144.27	14784.23
6	0.050	9980	0.050	0.0101	3.16	3159.22	21782.07
7	0.060	14480	0.060	0.0121	3.17	4574.38	31539.27
8	0.070	17540	0.070	0.0141	3.17	5529.76	38126.37
9	0.075	18880	0.075	0.0151	3.18	5946.13	40997.14



Notes: 1. Right Cylinder Correction Method

Unconfined Compression Test

Test Data Sheet

Project: P-5208
F&R Project No.: 63P-0090

Boring No.: EB2-A
Sample ID: RS-5
Depth, ft.: 67.0 - 67.4

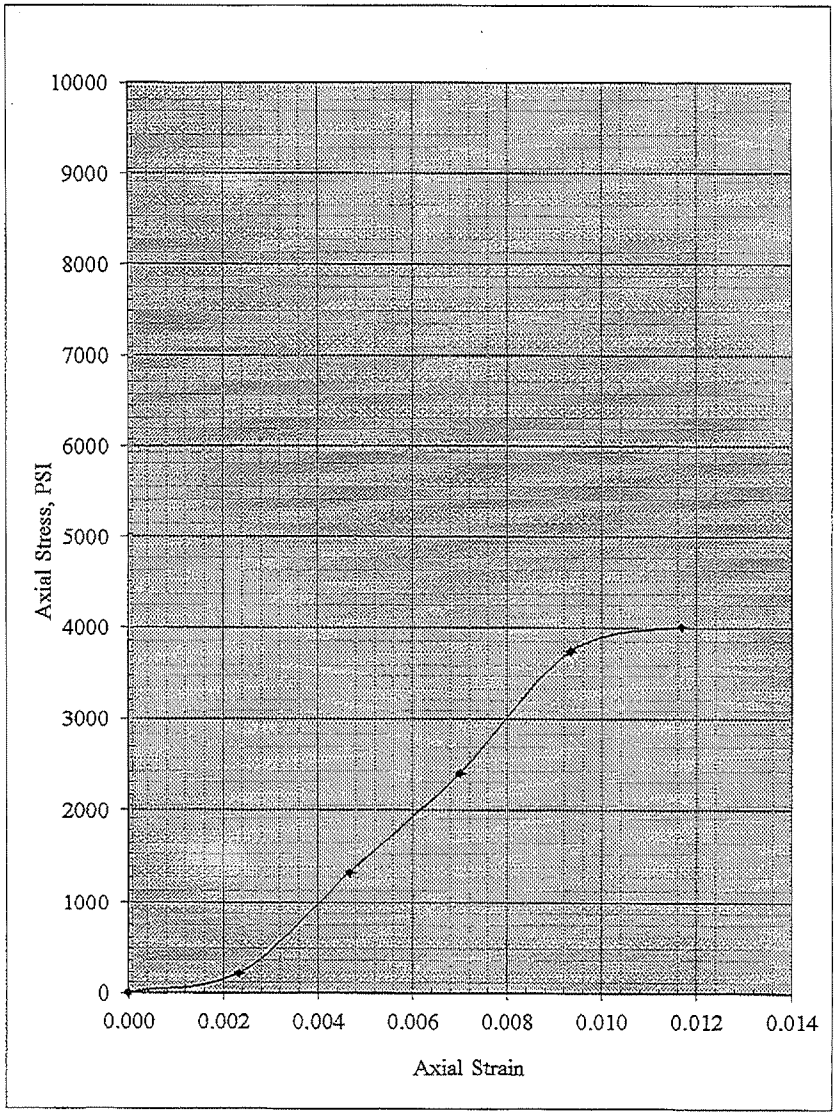
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.28
Area (in^2)	3.13
Unit Wt. (pcf)	174.1

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 7.25 x 10^4 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	680	0.010	0.0023	3.13	216.94	1495.76
3	0.020	4150	0.020	0.0047	3.14	1320.88	9107.15
4	0.030	7580	0.030	0.0070	3.15	2406.93	16595.22
5	0.040	11810	0.040	0.0093	3.16	3741.29	25795.31
6	0.050	12680	0.050	0.0117	3.16	4007.42	27630.23



Notes: 1. Right Cylinder Correction Method

Unconfined Compression Test

Test Data Sheet

Project: P-5208
F&R Project No.: 63P-0090

Boring No.: EB2-A
Sample ID: RS-6
Depth, ft.: 80.2 - 80.7

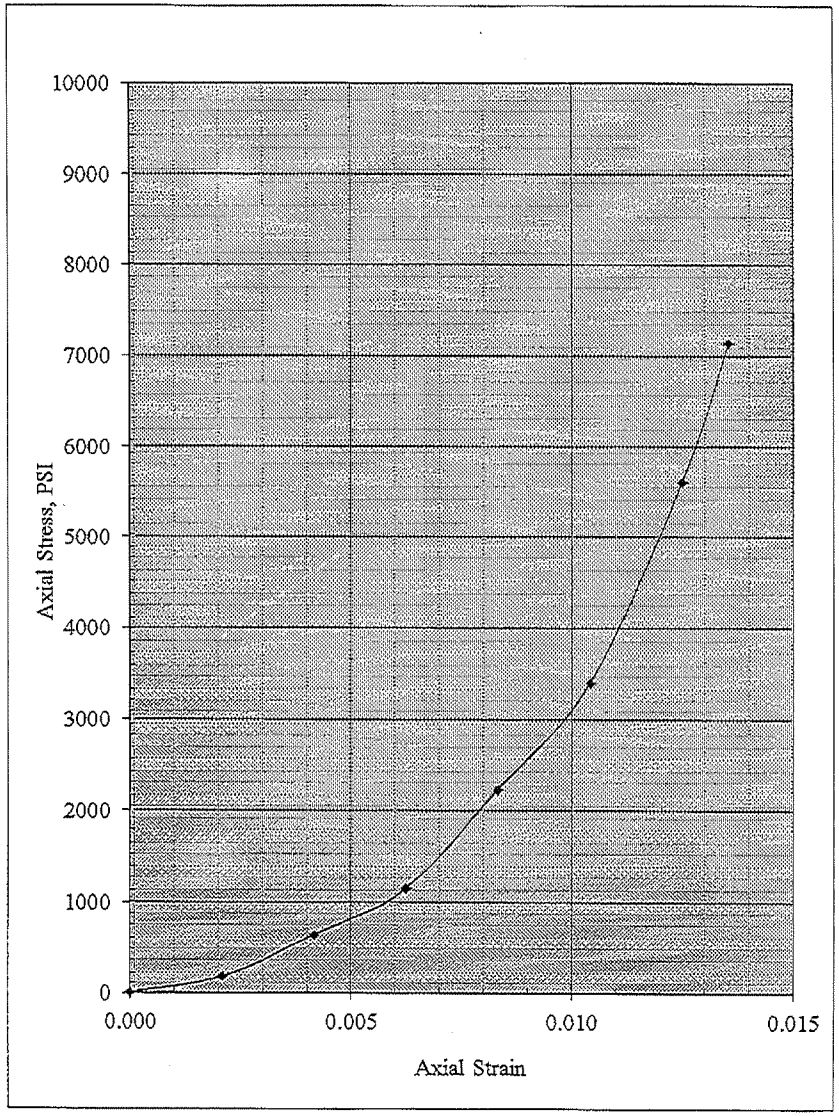
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.80
Area (in^2)	3.13
Unit Wt. (pcf)	174.5

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 6.40 x 10^4 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	570	0.010	0.0021	3.13	181.89	1254.12
3	0.020	2010	0.020	0.0042	3.14	640.08	4413.18
4	0.030	3600	0.030	0.0063	3.15	1144.01	7887.66
5	0.040	7040	0.040	0.0083	3.15	2232.48	15392.43
6	0.050	10730	0.050	0.0104	3.16	3395.48	23411.04
7	0.060	17740	0.060	0.0125	3.17	5601.96	38624.19
8	0.065	22630	0.065	0.0135	3.17	7138.60	49218.91



Notes: 1. Right Cylinder Correction Method

Unconfined Compression Test

Test Data Sheet

Project: P-5208

F&R Project No.: 63P-0090

Boring No.: EB2-B

Sample ID: RS-7

Depth, ft.: 67.0 - 67.5

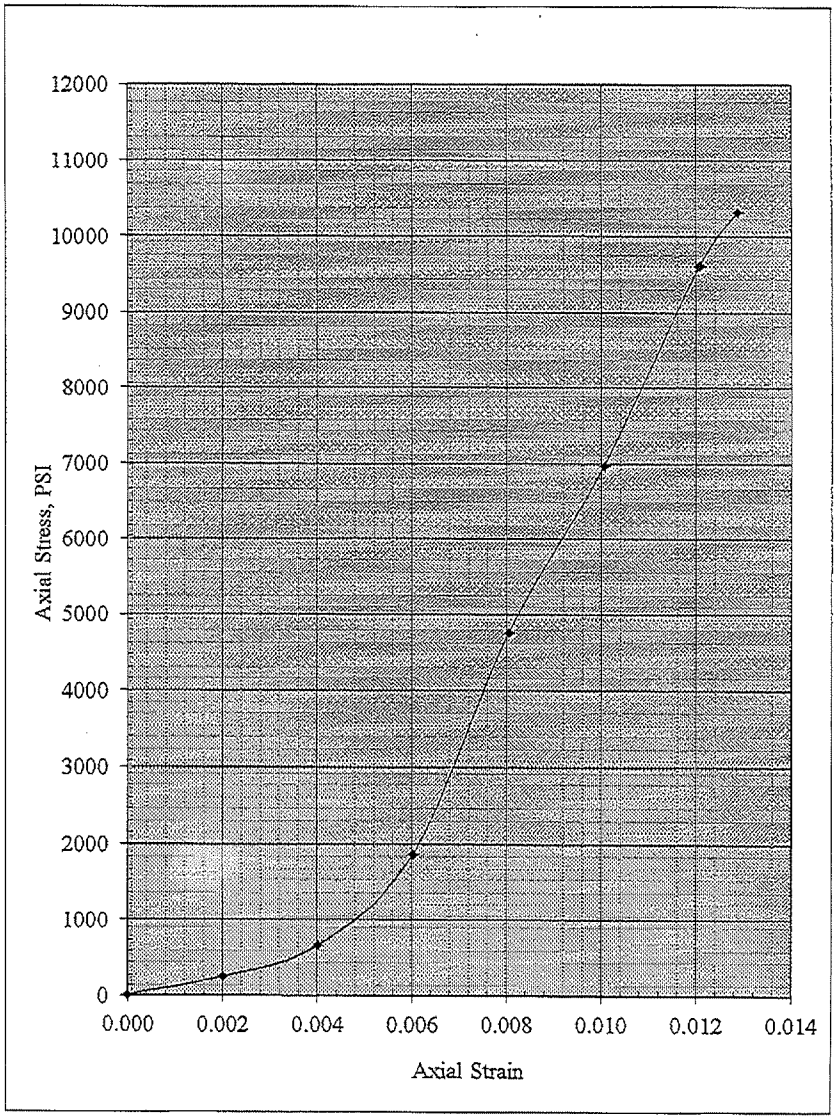
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.97
Area (in^2)	3.13
Unit Wt. (pcf)	173.0

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 1.77 x 10^5 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	780	0.010	0.0020	3.13	248.93	1716.28
3	0.020	2080	0.020	0.0040	3.14	662.46	4567.52
4	0.030	5870	0.030	0.0060	3.15	1865.77	12864.04
5	0.040	14990	0.040	0.0080	3.15	4754.90	32783.92
6	0.050	22010	0.050	0.0101	3.16	6967.52	48039.39
7	0.060	30440	0.060	0.0121	3.17	9616.55	66303.81
8	0.064	32720	0.064	0.0129	3.17	10328.42	71212.00



Notes: 1. Right Cylinder Correction Method

Unconfined Compression Test

Test Data Sheet

Project: P-5208

F&R Project No.: 63P-0090

Boring No.: EB2-B

Sample ID: RS-8

Depth, ft.: 73.0 - 73.4

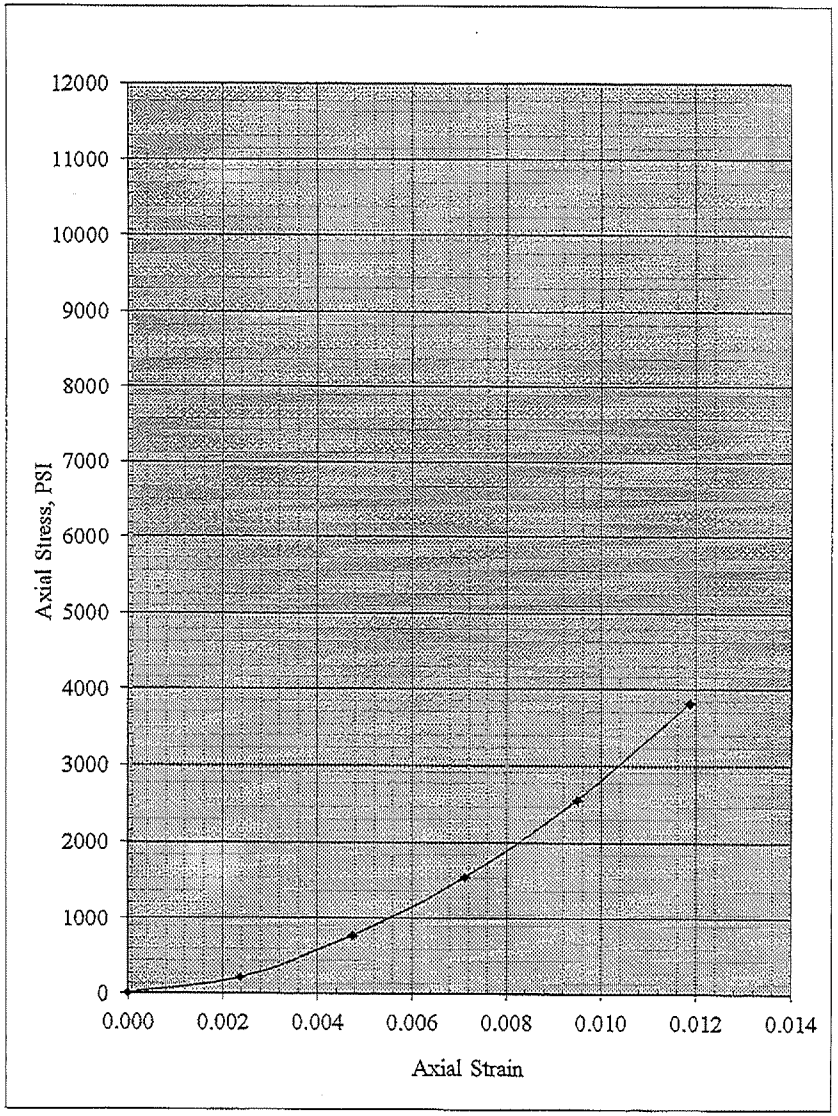
Specimen Description: Granite

Specimen Conditions	
Diameter (in.)	2.00
Height (in.)	4.21
Area (in^2)	3.13
Unit Wt. (pcf)	172.2

Shear Testing Conditions	
Loading Rate (%/min):	0.02 in/min.

Youngs Modulus (average): 4.74 x 10^4 ksf

Reading No.	Dial Guage Reading (in.)	Axial Load (lbs)	Total Axial Deformation (in.)	Axial Strain	Corrected Area[1] (in^2)	Axial Stress (psi)	Axial Stress (Kpa)
1	0.000	0	0.000	0.0000	3.13	0.00	0.00
2	0.010	680	0.010	0.0024	3.13	216.93	1495.70
3	0.020	2410	0.020	0.0048	3.14	767.01	5288.32
4	0.030	4840	0.030	0.0071	3.15	1536.70	10595.18
5	0.040	8060	0.040	0.0095	3.16	2552.93	17601.83
6	0.050	12100	0.050	0.0119	3.16	3823.37	26361.21



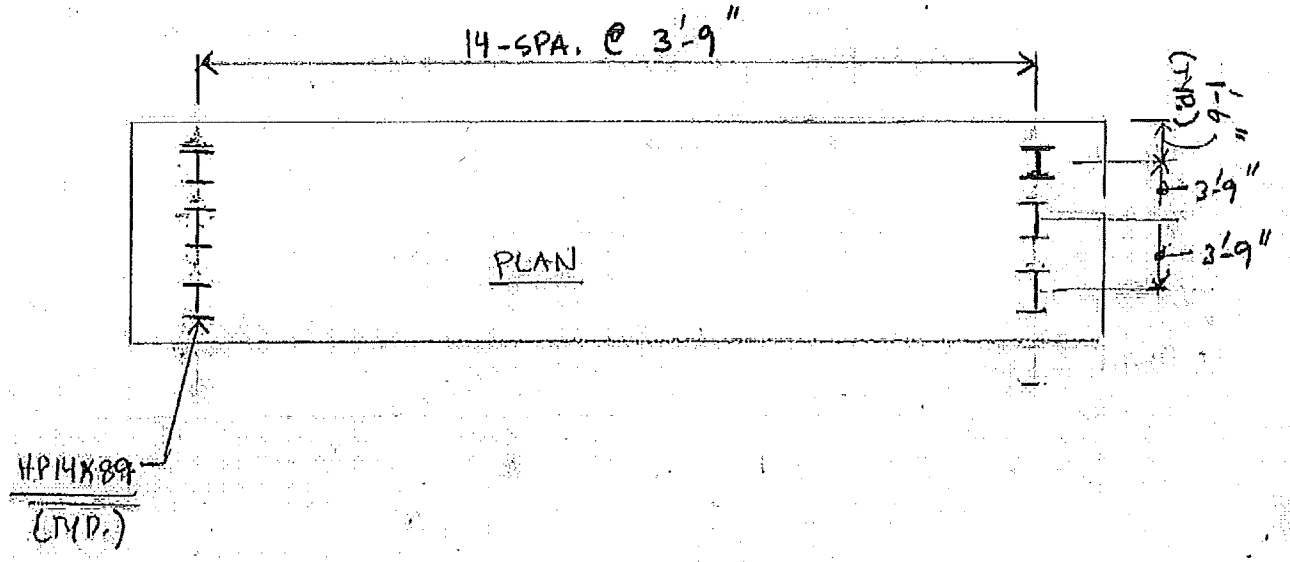
Notes: 1. Right Cylinder Correction Method

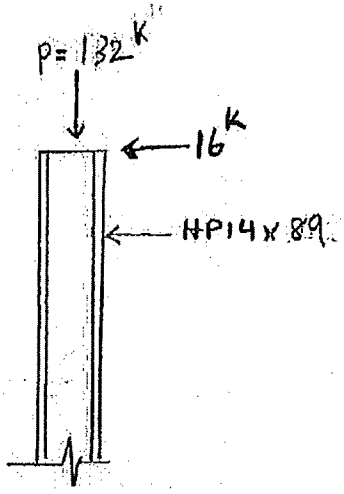
APPENDIX D

SUPPORTING CALCULATIONS

HDR

Project: NCDOT CODDLE CREEK		Computed: KKM	Date: 1/22/13
Subject: ABUTMENT DESIGN EB1		Checked:	Date:
Task: PILE LOADS		Page:	of:
Job #: 182838		No:	





132 K = 66 TONS, SAY 70 TONS/PILE ALLOWABLE

Job No. 182838 Sht No.

HDR Computation

Project	NCDOT - Coddle Creek Bridge		Computed	KKM	Date 1/24/13
Subject	Abutment Design		Checked		Date
Task	Pile Design		Sheet		Of

Determine No. of Piles

Check Piles w/o Moments

Pile Axial Capacity = 150 k assumed - ASD (HP14x89)
Total Load = 2588 k

Pile Lateral Capacity = 36.4 k from batter
Total Load = 712 k

Min. No. of Piles = 19.6
= 20.0

Check Piles w/ Moments (and Transverse Demand)

No. of Piles = 45
Transverse Spacing = 3.75 ft

$\sum d^2$ 394.38 ft^2

Max Transverse Load = 11 k
Transverse Demand = 0.2 k/pile
Max Trans Load / Vert Load = 0.008
Assume friction is enough to resist transv load

Group Load Combo	P_{total} (kip)	M_{long} (k-ft)	Vert Load/Pile from P (k)	Max Vert Load from M_{Long}/Pile (k)	Min Vert Load from M_{Long}/Pile (k)	Max Total Vert Load/Pile (k)	Min Total Vert Load/Pile (k)	Max Pile Axial Capacity (k)	Max Pile Vert Capacity (k)	Min Pile Axial Capacity (k)	Min Pile Vert Capacity (k)	
I	2588	6103	58	57	-55	114.2	2.1	150	146	-200	-194	OK
II	1482	4077	33	38	-37	71	-4.1	150	146	-200	-194	OK
III	2070	8785	46	82	-80	128	-33.8	150	146	-200	-194	OK
IV	0	0	0	0	0	0	0.0	150	146	-200	-194	OK

Check Pile Batter

No. of Piles = 45
Longitudinal Batter = 3 :12
= 0 :12 (First Row)
= 0 :12 (Second Row)
= 0 :12 (Third Row)
= 0 :12 (Fourth Row)
= 0 :12 (Fifth Row)

Lateral Bending Allowable = 0 k/pile
No. of Battered Piles = 0 (First Row Longitudinal)
= 0 (Second Row Longitudinal)
= 0 (Third Row Longitudinal)
= 0 (Fourth Row Longitudinal)
= 0 (Fifth Row Longitudinal)

Group Load Combo	V_{long} (k-ft)	First Row Resistance (k)	Second Row Resistance (k)	Third Row Resistance (k)	Fourth Row Resistance (k)	Total Resistance	Additional Resistance Required	Lateral Resistance/Pile
I	667	0	0	0	0	0	667	15
II	495	0	0	0	0	0	495	11
III	712	0	0	0	0	0	712	16
IV	0	0	0	0	0	0	0	0

Maximum Axial Pile Load

Due to vert load 131.6 k
Due to lateral load #DIV/0! k

Job No. 182838 No.

HDR Computation

Project NCDOT - Coddle Creek Bridge | Computed KKM | Date 1/24/13

Subject Abutment Design | Checked | Date

Task Pile Design | Sheet | Of

Load Cases

Loads

Case	Vertical	Long	Trans	M_{Long}
D	1407	0	0	673
L	698	0	0	582
EP_V	446	0	0	-1597
EP_H	0	595	0	5619
EP_{LLS}	37	72	0	826
W	0	23	14	402
WL	0	2	7	80
LF	0	209	0	4598
F	0	0.0	0.0	0

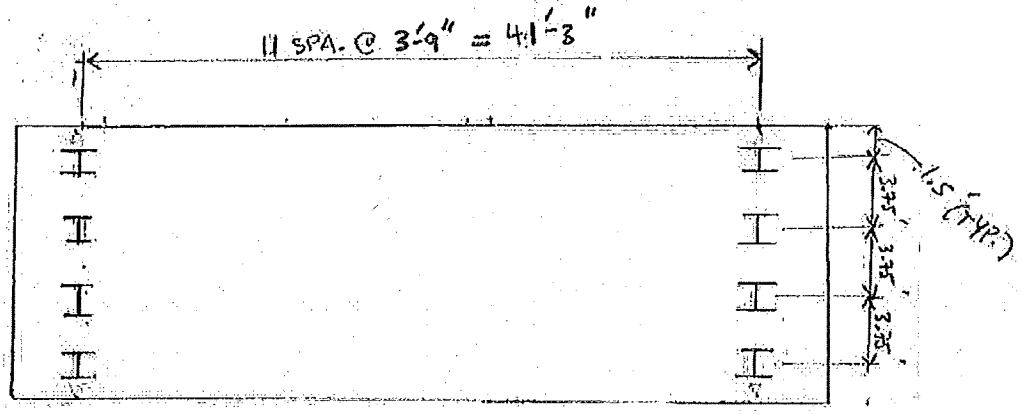
Group Load Combos (ASD - AREMA Table 8-2-4)

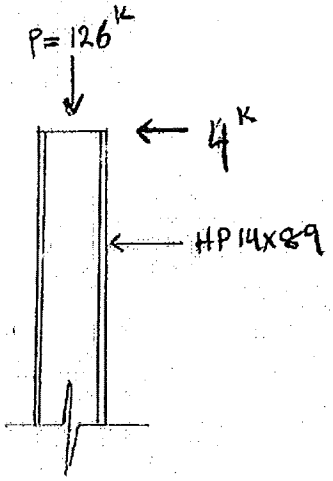
Group	I	II	III	IV
D	1.0	0.80	0.80	0.0
L	1.0	0	0.80	0.0
EP_V	1.0	0.80	0.80	0.0
EP_H	1.0	0.80	0.80	0.0
EP_{LLS}	1.0	0	0.80	0.0
W	0	0.80	0.40	0.0
WL	0	0	0.80	0.0
LF	0	0	0.80	0.0
F	0	0	0.80	0.0

Group Load Combo	P_{Total}	V_{Long}	V_{Trans}	M_{Long}
I	2588	667	0	6103
II	1482	495	11	4077
III	2070	712	11	8785
IV	0	0	0	0

HDR

Project: NCDOT CODDLE CREEK		Computed: KKM	Date: 1/17/13
Subject: PIER DESIGN		Checked:	Date:
Task: PIER LOADS		Page:	of:
Job #: 182838		No:	





126K = 63 TON, SAY 65 TONS/PILE ALLOWABLE

Job No. | No.

HDR Computation

HDR

Project	NCDOT - Coddle Creek Bridge		Computed	DCL	Date 1/24/13
Subject	Pier Design		Checked		Date
Task	Pile Design		Sheet		Of

Determine No. of Piles

Check Piles w/o Moments

Pile Axial Capacity =	150 k	assumed - ASD
Total Load =	3520 k	
Pile Lateral Capacity =	36.4 k	due to batter
Total Load =	182 k	
Min. No. of Piles =	23.5	
=	24.0	

Check Piles w/ Moments (and Transverse Demand)

No. of Piles =	48	Max Transverse Load =	55 k
Transverse Spacing =	3.75 ft	Transverse Demand =	2.0 PILES BATTERED TRANS
$\sum d^2$	843.75 ft^2		

Group Load Combo	P_{total} (kip)	M_{long} (k-ft)	Vert Load/Pile from P (k)	Max Vert Load from M_{Long}/Pile (k)	Min Vert Load from M_{Long}/Pile (k)	Max Total Vert Load/Pile (k)	Min Total Vert Load/Pile (k)	Max Pile Axial Capacity (k)	Max Pile Vert Capacity (k)	Min Pile Axial Capacity (k)	Max Pile Vert Capacity (k)	
I	0	0	0	0	0	0.0	0.0	150	146	-200	-194	OK
II	0	0	0	0	0	0	0.0	150	146	-200	-194	OK
III	3520	7337	73	49	-49	122	24.4	150	146	-200	-194	OK
IV	0	0	0	0	0	0	0.0	150	146	-200	-194	OK

Check Pile Batter

No. of Piles =	48				
Longitudinal Batter =	3 :12		Lateral Bending Allowable =	0	k/pile
=	0 :12	(First Row)	No. of Battered Piles =	0	(First Row Longitudinal)
=	0 :12	(Second Row)	=	0	(Second Row Longitudinal)
=	0 :12	(Third Row)	=	0	(Third Row Longitudinal)
=	0 :12	(Fourth Row)	=	0	(Fourth Row Longitudinal)
=	0 :12	(Fifth Row)	=	0	(Fifth Row Longitudinal)

Group Load Combo	V_{long} (k-ft)	First Row Resistance (k)	Second Row Resistance (k)	Third Row Resistance (k)	Fourth Row Resistance (k)	Total Resistance	Additional Resistance Required	Lateral Resistance/Pile
I	0	0	0	0	0	0	0	0
II	0	0	0	0	0	0	0	0
III	182	0	0	0	0	0	182	4
IV	0	0	0	0	0	0	0	0

Maximum Axial Pile Load

Due to vert load	126.0	k
Due to lateral load	#DIV/0!	k

Moment in Pile Cap

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. EB1-A	STATION 10281+67	OFFSET 29 ft LT	ALIGNMENT MAIN TRK #1 — 0 HR. 13.0
COLLAR ELEV. 541.0 ft	TOTAL DEPTH 36.0 ft	NORTHING 582,659	EASTING 1,520,031 — 24 HR. 15.5
DRILL RIG/HAMMER EFF./DATE F&R988 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/20/12	COMP. DATE 08/20/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
545						BOC = 538.0, Pile Is ≈ 3.0' Below Existing Grades				
	541.0	0.0								541.0 GROUND SURFACE 0.0
540			2	3	4	7 (9)		M		ROADWAY EMBANKMENT Brown silty fine to coarse SAND (A-2-4)
	537.5	3.5								
535			3	3	3	6 (8)		M		
	532.5	8.5								
530			2	2	2	4 (5)		M		
	527.5	13.5								529.0 12.0
525			2	1	3	4 (5)	SS-4	23%		RESIDUAL Brown and gray fine to coarse sandy SILT (A-4(0))
	522.5	18.5								* Some rock fragments from 18.5 to 20 feet 18.(
520			6	22	21	43 (58)		W		
	517.5	23.5								
515			21	46	45	(100) 91		W		
	512.5	28.5								512.0 29.0 29.
510			29	51	49/0.4	100/0.9				WEATHERED ROCK Tan and brown (GRANITE)
	507.5	33.5								
505	505.0	36.0	70	30/0.2		100/0.7				505.0 36.0
			60/0.0			60/0.0				Boring Terminated with Standard Penetration Test Refusal at Elevation 505.0 ft On CRYSTALLINE ROCK (GRANITE)

1) Driller indicated approximately 5 inches of Surficial Organic Laden soil.

Tip EL ≈ 511.0'

L = BOC - Tip EL + 1.0 Embed

= 538.0 - 511.0 + 1.0 = 28'

Anticipated Length = 28'

Ave Pile Length = 30'

SPT Corrected for hammer efficiency

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/29/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral	
SITE DESCRIPTION P-5208A Haydock to Junker Double Track				GROUND WTR (ft)
BORING NO. EB1-B	STATION 10281+63	OFFSET 1 ft LT	ALIGNMENT MAIN TRK #1	0 HR. 18.0
COLLAR ELEV. 549.0 ft	TOTAL DEPTH 42.5 ft	NORTHING 582,687	EASTING 1,520,029	24 HR. 12.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers		HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/21/12	COMP. DATE 08/21/12	SURFACE WATER DEPTH N/A	

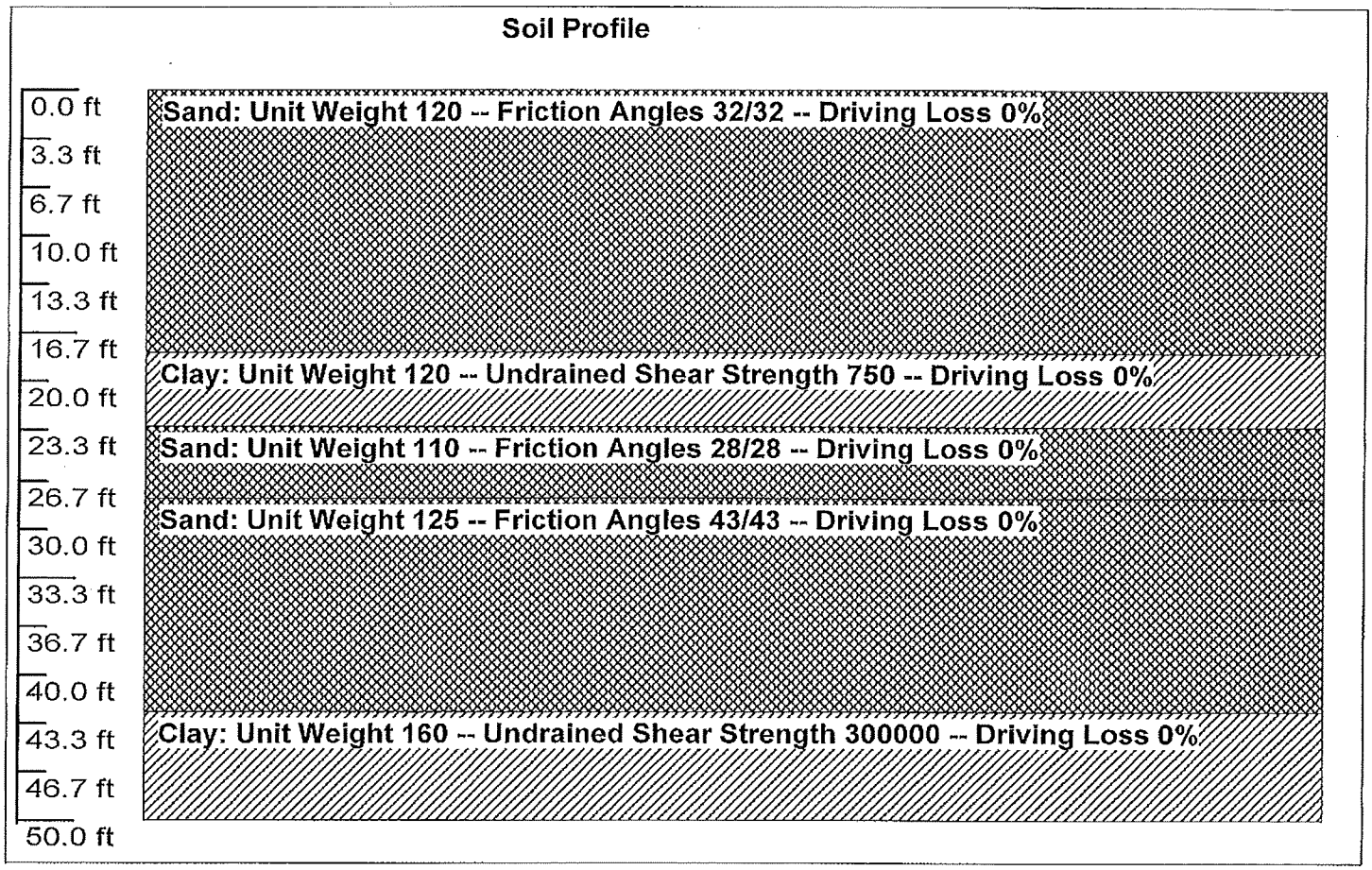
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
550						Boc = 538.0' Pile is ≈11.0' Below Ex Grades				
	549.0	0.0	2	3	5	8 (11)		M		549.0 GROUND SURFACE 0.0 **ROADWAY EMBANKMENT** Brown, tan, and orange silty fine to coarse SAND (A-2-4), trace to some gravel
545	545.5	3.5	5	5	5	10 (13) N_{AV}=11 γ=120 ϕ=32		M		* Wood encountered from 13.5 to 15 feet
540	540.5	8.5	5	4	4	8 (11)		M		
535	535.5	13.5	4	4	4	8 (11)		M		531.0 18.0
530	530.5	18.5	4	4	3	7 (9) N=9 γ=120 S_u=750	SS-9	28%		**ALLUVIAL** Brown and gray sandy CLAY (A-6(10))
525	525.5	23.5	0	1	1	2 (3) N=3 γ=110 ϕ=28		W		526.0 23.0 Gray and tan silty fine to coarse SAND (A-2-4)
520	520.5	28.5	16	25	37	(64) 62 γ=125 ϕ=43		W		521.0 28.0 **RESIDUAL** Gray and tan silty fine to coarse SAND (A-2-4)
515	515.5	33.5	10	30	70/0.2	Ignore 100/0.7 N=92				515.0 34.0 **WEATHERED ROCK** Tan and brown (GRANITE)
510	510.5	38.5	22	30	54	(100) 84		M		511.0 38.0 **RESIDUAL** Tan and brown silty fine to coarse SAND (A-2-4)
	506.5	42.5	60/0.0			60/0.0				506.5 42.5 Boring Terminated with Standard Penetration Test Refusal at Elevation 506.5 ft On CRYSTALLINE ROCK (GRANITE) 1) Driller indicated approximately 4 inches of Surficial Organic Laden soil.

USE EB1-B for Analysis

SPT Corrected for hammer efficiency

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/29/13

Filename: F:\BRANCH63\DRIVEN\H2J\EB1-B.DVN



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: F:\BRANCH63\DRIVEN\H2J\EB1-B.DVN
Project Name: H2J - End Bent 1 Project Date: 01/29/2013
Project Client: HDR
Computed By: M. Walko
Project Manager: R. Kral

PILE INFORMATION

Pile Type: H Pile - HP14X89
Top of Pile: 11.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	12.00 ft
	- Driving/Restrike	12.00 ft
	- Ultimate:	12.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	18.00 ft	0.00%	120.00 pcf	31.5/31.5	Nordlund
2	Cohesive	5.00 ft	0.00%	120.00 pcf	750.00 psf	T-79 Steel
3	Cohesionless	5.00 ft	0.00%	110.00 pcf	28.1/28.1	Nordlund
4	Cohesionless	14.50 ft	0.00%	125.00 pcf	43.0/43.0	Nordlund
5	Cohesive	7.50 ft	0.00%	160.00 pcf	300000.00 psf	T-79 Steel

Pile will Not Penetrate far into Crystalline Rock

ULTIMATE - SUMMARY OF CAPACITIES

	Depth	Skin Friction	End Bearing	Total Capacity
	0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
	9.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
Boc →	10.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
	11.00 ft	0.00 Kips	4.84 Kips	4.84 Kips
	11.99 ft	2.75 Kips	4.84 Kips	7.58 Kips
	12.01 ft	2.80 Kips	4.84 Kips	7.64 Kips
	17.99 ft	22.19 Kips	4.84 Kips	27.03 Kips
	18.01 ft	22.26 Kips	1.22 Kips	23.48 Kips
	22.99 ft	37.88 Kips	1.22 Kips	39.10 Kips
	23.01 ft	37.94 Kips	2.41 Kips	40.36 Kips
	27.99 ft	54.28 Kips	2.41 Kips	56.69 Kips
	28.01 ft	54.42 Kips	100.87 Kips	155.29 Kips
Top of CR →	37.01 ft	166.73 Kips	122.82 Kips	289.54 Kips
	42.49 ft	247.06 Kips	122.82 Kips	369.87 Kips
	42.51 ft	247.27 Kips	489.38 Kips	736.64 Kips
	49.99 ft	292.08 Kips	489.38 Kips	781.45 Kips

Design Load = 70 ton/pile = 2(70 ton/pile) = 140 ton/pile (Required Bearing Capacity)

By inspection, pile will Refuse on Crystalline Rock at a depth of Approx. 42.5 feet below existing grades (Tip EL = 506.5')

L = Boc - Tip EL + 1.0 Embed into Cap

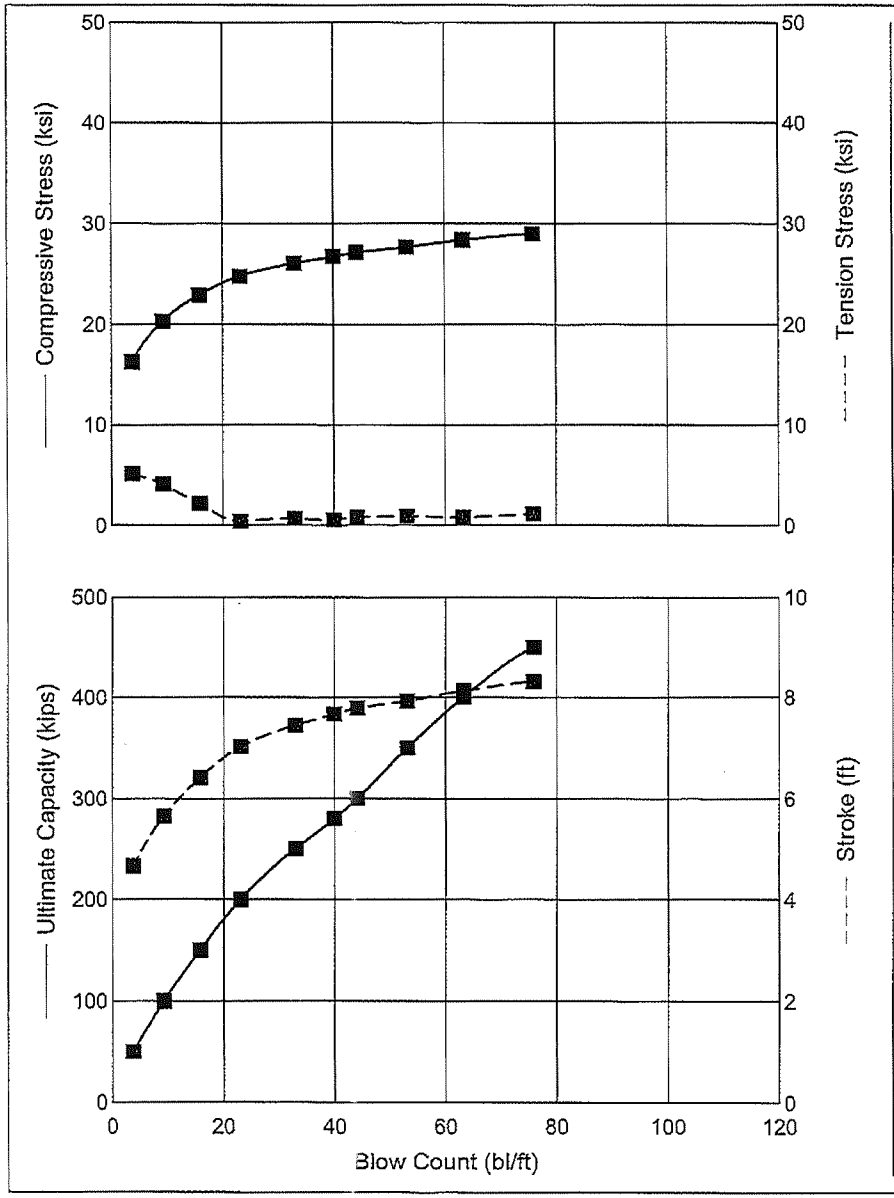
= 538 - 506.5 + 1.0 = 32.5 feet, Anticipated Pile Length = 33 feet

Ave. Pile Length = 35' feet

For Preliminary WEAP = $\frac{247^k}{280^k} \cong 88\%$ Skin Friction

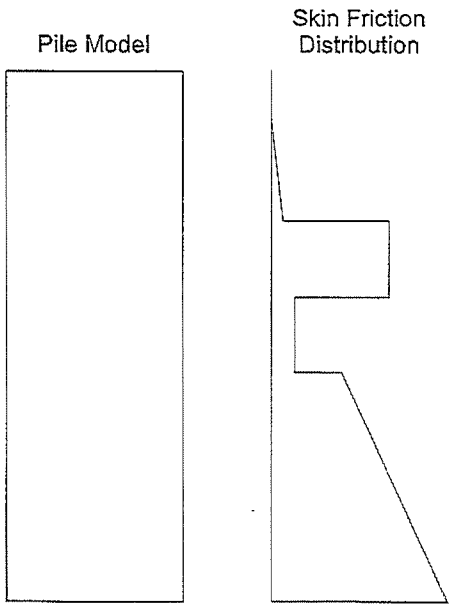
Froehling & Robertson, Inc.
H2J EB1-B

29-Jan-2013
GRLWEAP Version 2010



DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1500 (100%)	psi
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.040	in ← hard rock
Skin Damping	0.083	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	35.00	ft
Pile Penetration	32.00	ft
Pile Top Area	26.20	in2



Res. Shaft = 88 %
(Proportional)

Froehling & Robertson, Inc.
H2J EB1-B

29-Jan-2013
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
50.0	16.23	5.15	3.8	4.65	21.17
100.0	20.32	4.13	9.3	5.64	18.17
150.0	22.89	2.21	15.9	6.41	16.94
200.0	24.77	0.41	23.2	7.02	16.33
250.0	26.05	0.70	33.0	7.44	15.99
280.0	26.71 < 45 ok	0.59	30 < 40.0 < 180 ok	7.66	15.86
300.0	27.13	0.85	44.2	7.79	15.84
350.0	27.67	0.95	53.2	7.93	15.39
400.0	28.36	0.85	63.3	8.13	15.64
450.0	29.00	1.18	75.9	8.32	15.84

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: E:\GRLWEAP\BRANCH 63\P-5208A (H2J)\H2J EB1-B.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2003.GW
Hammer File Version: 2003 (3/21/2012)

Input File Contents

H2J EB1-B

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
6	0	40	0	1	0	0	0	0	0	88	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size		Pile Type
32.170	32.170	203.680	14.690		H Pile

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
1.900	227.000	530.0	2.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	CI	CoR	ROut
35.000	26.20	30000.0	492.000	4.759	0	0.850	0.010

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 19-32	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
4.00	129.10	12.60	11.76	10.61	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
0.75	25.30	12.60	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
15.50	124.70	157.70	0.002	0.002	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1500.00	1350.00	1215.00	1094.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.6100	0.8000	1500.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.100	0.040	0.083	0.150	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Dpth	Dpth						
0.00	0.00	32.00	32.00	0.00	0.00	0.00	0.00	0.00	0.0
7.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
32.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
32.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
35.00	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Rult

50.0	100.0	150.0	200.0	250.0	280.0	300.0	350.0	400.0	450.0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

H2J EB1-B

Hammer Model: D 19-32 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		20585.7			

HAMMER OPTIONS:

Hammer File ID No.	40	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.76			
Rated Stroke	(ft)	10.61	Efficiency		0.800
Maximum Pressure	(psi)	1500.00	Actual Pressure	(psi)	1500.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

H2J EB1-B 01/29/2013
Froehling & Robertson, Inc. GRLWEAP Version 2010

PILE PROFILE:

Toe Area	(in2)	203.680	Pile Type		H Pile
Pile Size	(inch)	14.690			

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	26.20	30000.	492.0	4.8	0	16807.	46.8
35.0	26.20	30000.	492.0	4.8	0	16807.	46.8

Wave Travel Time 2L/c (ms) 4.165

Pile and Soil Model — Total Capacity Rut (kips) 50.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.285	20586	0.010	0.000	0.85	0.0	0.083	0.100	3.18	4.8	26.2
2	0.285	20586	0.000	0.000	1.00	0.2	0.083	0.100	6.36	4.8	26.2
3	0.285	20586	0.000	0.000	1.00	0.4	0.083	0.100	9.55	4.8	26.2
4	0.285	20586	0.000	0.000	1.00	5.4	0.083	0.100	12.73	4.8	26.2
5	0.285	20586	0.000	0.000	1.00	4.8	0.083	0.100	15.91	4.8	26.2
6	0.285	20586	0.000	0.000	1.00	1.2	0.083	0.100	19.09	4.8	26.2
7	0.285	20586	0.000	0.000	1.00	3.5	0.083	0.100	22.27	4.8	26.2
8	0.285	20586	0.000	0.000	1.00	5.4	0.083	0.100	25.45	4.8	26.2
9	0.285	20586	0.000	0.000	1.00	6.5	0.083	0.100	28.64	4.8	26.2
10	0.285	20586	0.000	0.000	1.00	7.7	0.083	0.100	31.82	4.8	26.2
11	0.285	20586	0.000	0.000	1.00	8.9	0.083	0.100	35.00	4.8	26.2
Toe						6.0	0.150	0.040			

3.133 kips total unreduced pile weight (g= 32.17 ft/s2)
3.133 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

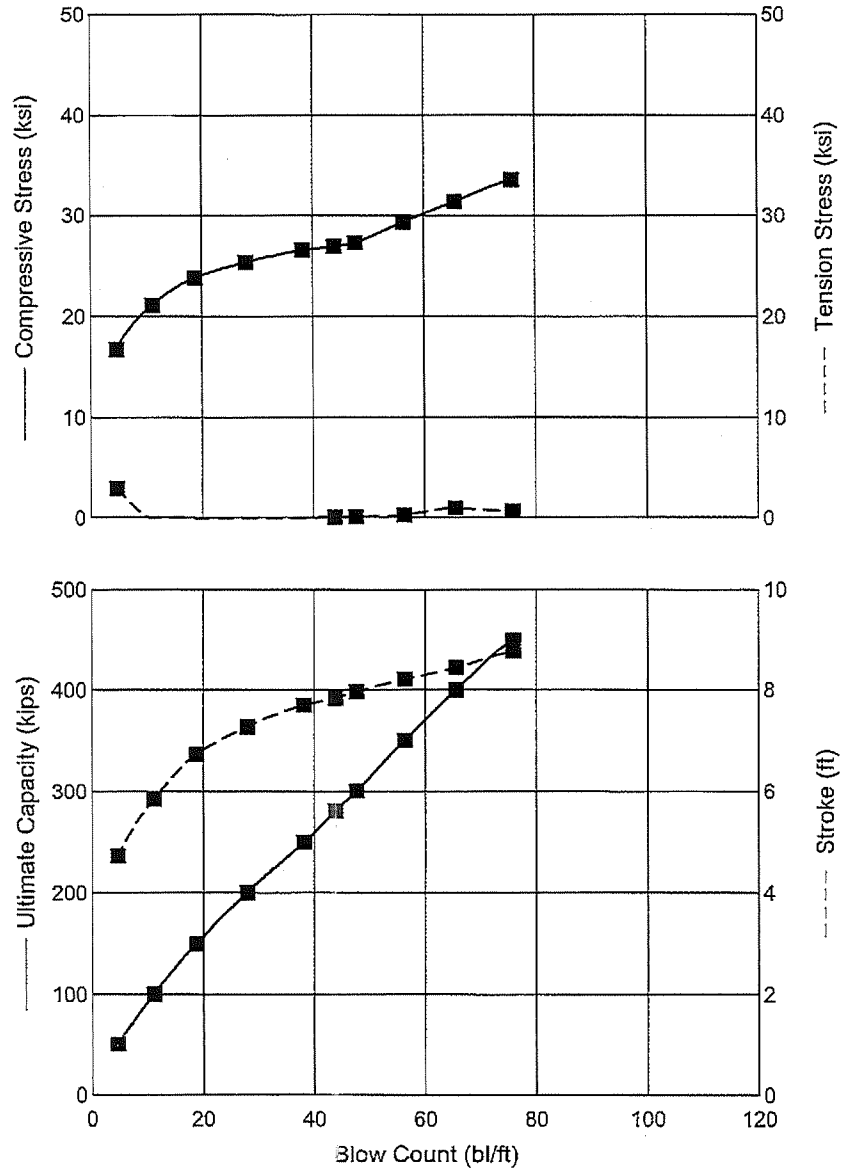
Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	32.00	Pile Damping Fact.(k/ft/s)	0.935
% Shaft Resistance	88		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170 32.170	
Output Segment Generation: Automatic			

H2J EB1-B 01/29/2013
Froehling & Robertson, Inc. GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
50.0	3.8	4.65	4.62	-5.15	7	5	16.23	4	3	21.2	55.0
100.0	9.3	5.64	5.69	-4.13	7	5	20.32	4	2	18.2	49.6
150.0	15.9	6.41	6.42	-2.21	3	6	22.89	4	2	16.9	46.6
200.0	23.2	7.02	6.98	-0.41	4	45	24.77	4	2	16.3	44.7
250.0	33.0	7.44	7.42	-0.70	4	39	26.05	4	2	16.0	43.4
280.0	40.0	7.66	7.65	-0.59	4	35	26.71	4	2	15.9	42.7
300.0	44.2	7.79	7.78	-0.85	4	34	27.13	4	2	15.8	42.4
350.0	53.2	7.93	7.98	-0.95	4	33	27.67	4	2	15.4	41.9
400.0	63.3	8.13	8.17	-0.85	4	29	28.37	4	2	15.6	41.4
450.0	75.9	8.32	8.35	-1.18	4	27	29.00	4	2	15.8	41.0

Froehling & Robertson, Inc.
H2J EB1-B

31-Jan-2013
GRLWEAP Version 2010



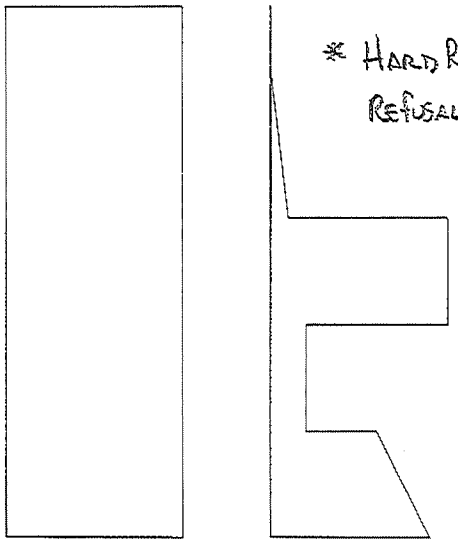
DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1500 (100%)	psi
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.040	in
Skin Damping	0.083	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	25.00	ft
Pile Penetration	22.00	ft
Pile Top Area	26.20	in2

HARD Rock ←

Pile Model

Skin Friction Distribution



* HARD Rock/Shallow Refusal Scenario

Res. Shaft = 25 %
(Proportional)

Froehling & Robertson, Inc.
H2J EB1-B

31-Jan-2013
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
50.0	16.73	2.97	4.7	4.72	20.69
100.0	21.12	0.00	11.2	5.84	17.79
150.0	23.78	0.00	18.9	6.72	16.77
200.0	25.33	0.00	28.0	7.27	15.94
250.0	26.55	0.00	38.2	7.70	15.64
280.0	26.95 $< 45^{ok}$	0.07	$30 < 43.9 < 180^{ok}$	7.84	15.51
300.0	27.28	0.10	47.7	7.96	15.48
350.0	29.35	0.29	56.4	8.21	15.55
400.0	31.41	0.99	65.6	8.44	15.82
450.0	33.56	0.72	75.9	8.77	16.27

Check to see driving stresses if Hard Rock/Shallow Refusal Conditions occur.

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: E:\GRLWEAP\BRANCH 63\P-5208A (H2J)\H2J EB1-B SHALLOW REFUSAL.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2003.GW
Hammer File Version: 2003 (3/21/2012)

Input File Contents

H2J EB1-B

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
6	0	40	0	1	0	0	0	0	0	25	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size		Pile Type
32.170	32.170	203.680	14.690		H Pile

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
1.900	227.000	530.0	2.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	CI	CoR	ROut
25.000	26.20	30000.0	492.000	4.759	0	0.850	0.010

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 19-32	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
4.00	129.10	12.60	11.76	10.61	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
0.75	25.30	12.60	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
15.50	124.70	157.70	0.002	0.002	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1500.00	1350.00	1215.00	1094.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.6100	0.8000	1500.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.100	0.040	0.083	0.150	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Dpth	Dpth						
0.00	0.00	22.00	22.00	0.00	0.00	0.00	0.00	0.00	0.0
7.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Rult

50.0	100.0	150.0	200.0	250.0	280.0	300.0	350.0	400.0	450.0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

H2J EB1-B

Hammer Model: D 19-32 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		20960.0			

HAMMER OPTIONS:

Hammer File ID No.	40	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.76			
Rated Stroke	(ft)	10.61	Efficiency		0.800
Maximum Pressure	(psi)	1500.00	Actual Pressure	(psi)	1500.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

PILE PROFILE:

Toe Area	(in2)	203.680	Pile Type	H Pile
Pile Size	(inch)	14.690		

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	26.20	30000.	492.0	4.8	0	16807.	46.8
25.0	26.20	30000.	492.0	4.8	0	16807.	46.8

Wave Travel Time 2L/c (ms) 2.975

Pile and Soil Model — Total Capacity Rut (kips) 50.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.280	20960	0.010	0.000	0.85	0.0	0.083	0.100	3.12	4.8	26.2
2	0.280	20960	0.000	0.000	1.00	0.1	0.083	0.100	6.25	4.8	26.2
3	0.280	20960	0.000	0.000	1.00	0.3	0.083	0.100	9.38	4.8	26.2
4	0.280	20960	0.000	0.000	1.00	3.2	0.083	0.100	12.50	4.8	26.2
5	0.280	20960	0.000	0.000	1.00	3.2	0.083	0.100	15.62	4.8	26.2
6	0.280	20960	0.000	0.000	1.00	0.7	0.083	0.100	18.75	4.8	26.2
7	0.280	20960	0.000	0.000	1.00	1.9	0.083	0.100	21.88	4.8	26.2
8	0.280	20960	0.000	0.000	1.00	3.2	0.083	0.100	25.00	4.8	26.2
Toe						37.5	0.150	0.040			

2.238 kips total unreduced pile weight (g= 32.17 ft/s2)
2.238 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	22.00	Pile Damping Fact.(k/ft/s)	0.935
% Shaft Resistance	25		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170 32.170	
Output Segment Generation: Automatic			

H2J EB1-B 01/31/2013
Froehling & Robertson, Inc. GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
50.0	4.7	4.72	4.69	-2.97	4	4	16.73	4	3	20.7	54.6
100.0	11.2	5.84	5.87	0.00	1	0	21.12	4	2	17.8	48.7
150.0	18.9	6.72	6.67	0.00	1	0	23.78	4	2	16.8	45.6
200.0	28.0	7.27	7.26	0.00	1	0	25.33	4	2	15.9	43.8
250.0	38.2	7.70	7.70	0.00	1	0	26.55	4	2	15.6	42.6
280.0	43.9	7.84	7.87	-0.07	4	47	26.95	4	2	15.5	42.2
300.0	47.7	7.96	7.98	-0.10	4	47	27.28	4	2	15.5	41.9
350.0	56.4	8.21	8.20	-0.29	4	27	29.35	8	3	15.5	41.3
400.0	65.6	8.44	8.45	-0.99	4	42	31.41	8	3	15.8	40.7
450.0	75.9	8.77	8.72	-0.72	4	40	33.56	8	3	16.3	40.1

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris	
SITE DESCRIPTION P-5208A Haydock to Junker Double Track				GROUND WTR (ft)
BORING NO. EB2-A	STATION 10283+75	OFFSET 8 ft LT	ALIGNMENT MAIN TRK #1	0 HR. 43.0
COLLAR ELEV. 562.3 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,636	EASTING 1,519,823	24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers		HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 09/07/12	COMP. DATE 09/07/12	SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
						Boc = 550.0', Pile is ≈ 12.3' Below Ex. Grade				ELEV. (ft) / DEPTH (ft)
565	562.3	0.0								562.3 GROUND SURFACE 0.0
560			5	12	18	30 (40)		D		ARTIFICIAL FILL Gray ABC Stone
	558.8	3.5								
555			8	9	5	14 (19) IGNORE ABC		D		553.8 8.5
	553.8	8.5								Brown fine to coarse sandy CLAY (A-6) with intermittent ABC stone layers
550			1	3	4	7 (9)		M		548.8 13.5
	548.8	13.5								RESIDUAL Tan, orange, and brown fine to coarse sandy SILT (A-4(0))
545			0	1	2	3 (4)		M		
	543.8	18.5								
540			3	3	2	5 (7)	SS-32	22%		539.3 23.0
	538.8	23.5								Tan, orange, gray, and white silty fine to coarse SAND (A-2-4)
535			8	12	17	29 (39)		M		
	533.8	28.5								
530			14	20	28	48 (65)		M		
	528.8	33.5								528.8 33.5
525			51	49/0.2		100/0.7				WEATHERED ROCK Tan and gray (GRANITE)
	523.8	38.5								Tip EL = 527.8'
520			61	39/0.0		100/0.5				L = Boc - Tip EL + 1.0 Embed into Cap
	518.8	43.5								= 550 - 527.8 + 1.0 = 23.2'
515			69	31/0.0		100/0.5				Anticipated Pile Length = 24'
	513.8	48.5								Ave Pile Length = 25'
510			46	54/0.3		100/0.8				509.3 53.0
	508.8	53.5								RESIDUAL Tan and gray silty fine to coarse SAND (A-2-4)
505			11	13	51	64		M		503.8 58.5
	503.8	58.5	100/0.4			100/0.4				WEATHERED ROCK Tan and gray (GRANITE)
	501.3	61.0	60/0.0			60/0.0				501.3 61.0
500										CRYSTALLINE ROCK Gray, white, and pink (GRANITE)
495										496.3 66.0
										CRYSTALLINE ROCK Gray, white, and pink (GRANITE)
490										SPT Corrected for hammer efficiency.
485										USE EB 2-B for Analysis

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/29/13

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

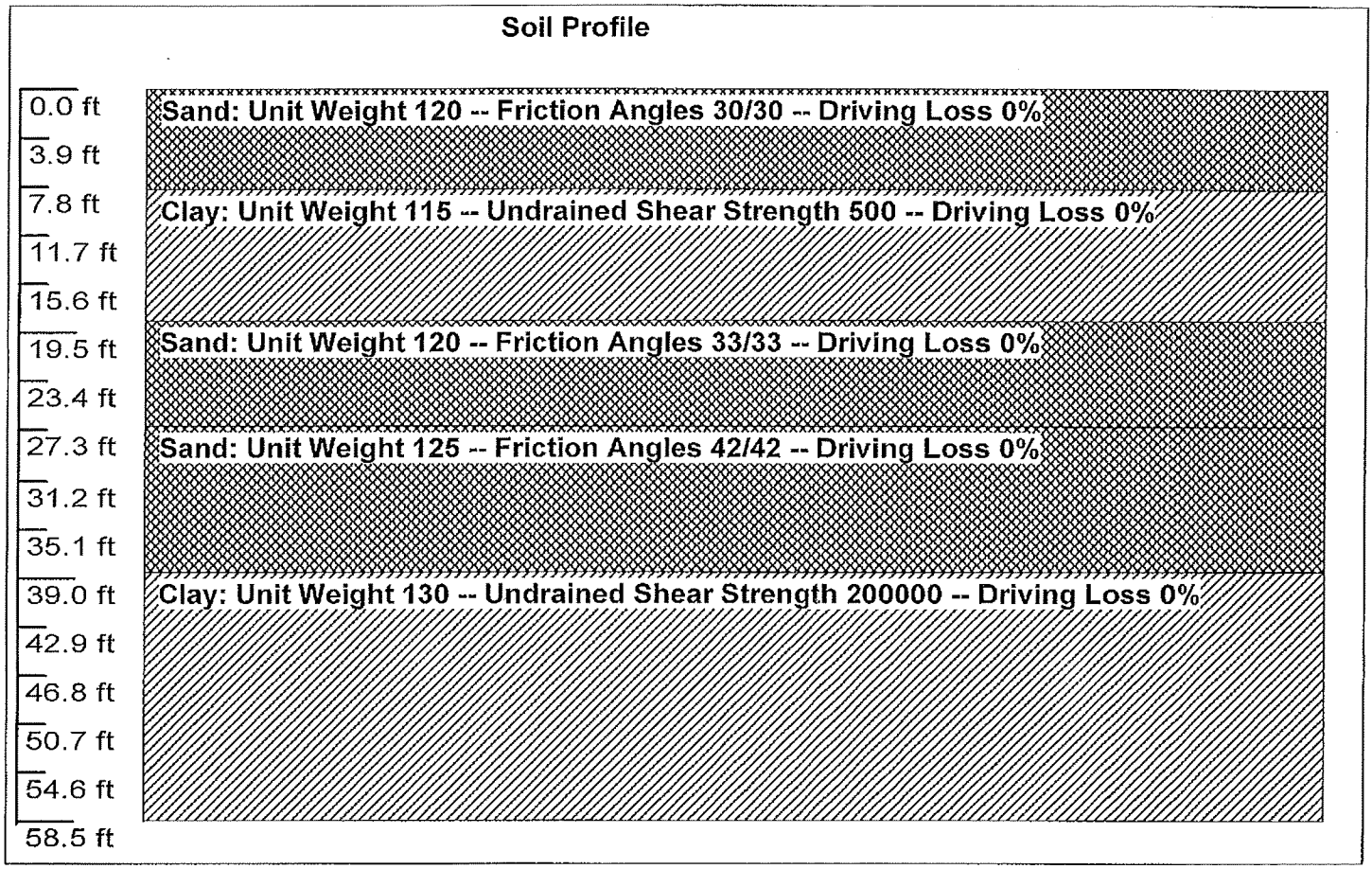
SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris	
SITE DESCRIPTION P-5208A Haydock to Junker Double Track				GROUND WTR (ft)
BORING NO. EB2-B	STATION 10283+83	OFFSET 10 ft RT	ALIGNMENT MAIN TRK #1	0 HR. 43.0
COLLAR ELEV. 563.0 ft	TOTAL DEPTH 81.0 ft	NORTHING 582,652	EASTING 1,519,812	24 HR. 23.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers		HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 09/04/12	COMP. DATE 09/05/12	SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
						BOC = 550', Pile is ≈ 13.0' Below Ex. Grd.				
565	563.0	0.0								GROUND SURFACE 0.0
			8	10	8	18 Ignore ABC		D		ARTIFICIAL FILL Gray ABC Stone 2.0
560	559.5	3.5								Tan and gray silty fine to coarse SAND (A-2-4), some gravel
			3	4	1	5 (7) γ=120 Φ=30		M		
555	554.5	8.5								555.0 8.0 8
			2	1	1	2 (3) N=4 γ=115 Su=500		M		Brown and gray silty CLAY (A-7-6(9)), trace gravel
550	549.5	13.5					BOC			
			2	1	3	4 (5)	SS-44	25%		
545	544.5	18.5								544.5 18.5 18.5
			3	5	6	11 (15) N=23 γ=120		M		RESIDUAL Tan, orange, and brown silty fine to coarse SAND (A-2-4(0))
540	539.5	23.5						▼		
			6	10	13	23 (31) Φ=33		M		27.0
535	534.5	28.5								
			14	14	26	40 (54) N=68 γ=125	SS-47	8%		
530	529.5	33.5								
			23	27	34	Φ=42 61 (82)		M		
525	524.5	38.5								524.5 38.5 38.5
			47	53/0.3		100/0.8				WEATHERED ROCK Tan, brown, and orange (GRANITE)
520	519.5	43.5								* Hard rock lens from 40.5 to 43 feet
			100/0.2			100/0.2				SPT Corrected for hammer efficiency
515	514.5	48.5								
			100/0.4			100/0.4				
510	509.5	53.5								
			32	63/0.3		100/0.8				
505	504.5	58.5								504.5 58.5
			60/0.1			60/0.1				CRYSTALLINE ROCK Tan, brown, and orange (GRANITE)
	502.0	61.0	60/0.0			60/0.0				502.0 61.0 CRYSTALLINE ROCK Gray, pink, and white (GRANITE)
500										
495										
490										
485										

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/29/13

Filename: F:\BRANCH63\DRIVEN\H2J\EB2-B.DVN



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: F:\BRANCH63\DRIVEN\H2J\EB2-B.DVN
Project Name: H2J - End Bent 2 Project Date: 01/29/2013
Project Client: HDR
Computed By: M. Walko
Project Manager: R. Kral

PILE INFORMATION

Pile Type: H Pile - HP14X89
Top of Pile: 13.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	23.00 ft
	- Driving/Restrike	23.00 ft
	- Ultimate:	23.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.00 ft	0.00%	120.00 pcf	30.3/30.3	Nordlund
2	Cohesive	10.50 ft	0.00%	115.00 pcf	500.00 psf	T-79 Steel
3	Cohesionless	8.50 ft	0.00%	120.00 pcf	33.4/33.4	Nordlund
4	Cohesionless	11.50 ft	0.00%	125.00 pcf	42.5/42.5	Nordlund
5	Cohesive	20.00 ft	0.00%	130.00 pcf	200000.00 psf	T-79 Steel

Pile will not penetrate far into weathered Rock

ULTIMATE - SUMMARY OF CAPACITIES

	Depth	Skin Friction	End Bearing	Total Capacity
	0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
	7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
	8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
BOC →	12.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
	13.00 ft	0.00 Kips	0.82 Kips	0.82 Kips
	17.01 ft	8.04 Kips	0.82 Kips	8.85 Kips
	18.49 ft	11.10 Kips	0.82 Kips	11.92 Kips
	18.51 ft	11.17 Kips	10.62 Kips	21.79 Kips
	22.99 ft	37.24 Kips	10.62 Kips	47.86 Kips
	23.01 ft	37.37 Kips	10.62 Kips	47.99 Kips
	26.99 ft	64.18 Kips	10.62 Kips	74.80 Kips
	27.01 ft	64.39 Kips	109.13 Kips	173.53 Kips
	36.01 ft	203.07 Kips	114.75 Kips	317.82 Kips
Top of WR →	38.49 ft	245.55 Kips	114.75 Kips	360.30 Kips
	38.51 ft	245.78 Kips	326.25 Kips	572.03 Kips
	47.51 ft	298.86 Kips	326.25 Kips	625.11 Kips
	56.51 ft	353.61 Kips	326.25 Kips	679.86 Kips
	58.49 ft	365.47 Kips	326.25 Kips	691.72 Kips

Design Load = 70 ton/pile = 2(70 ton/pile) = 140 ton/pile (Required Bearing Capacity)

By inspection, pile will Refuse in Weathered Rock At A depth of Approx 38.5 feet below existing grades. Assume 1-foot into WR (39.5') Tip EL = 523.5'

L = Boc - Tip EL + 1.0 Embed into Cap

= 550 - 523.5 + 1.0 = 27.5', Anticipated Pile Length = 28 feet

Ave Pile Length = 30 feet

For Preliminary WEAP $\frac{245^{K}}{280^{K}} \approx 88\%$ Skin Friction

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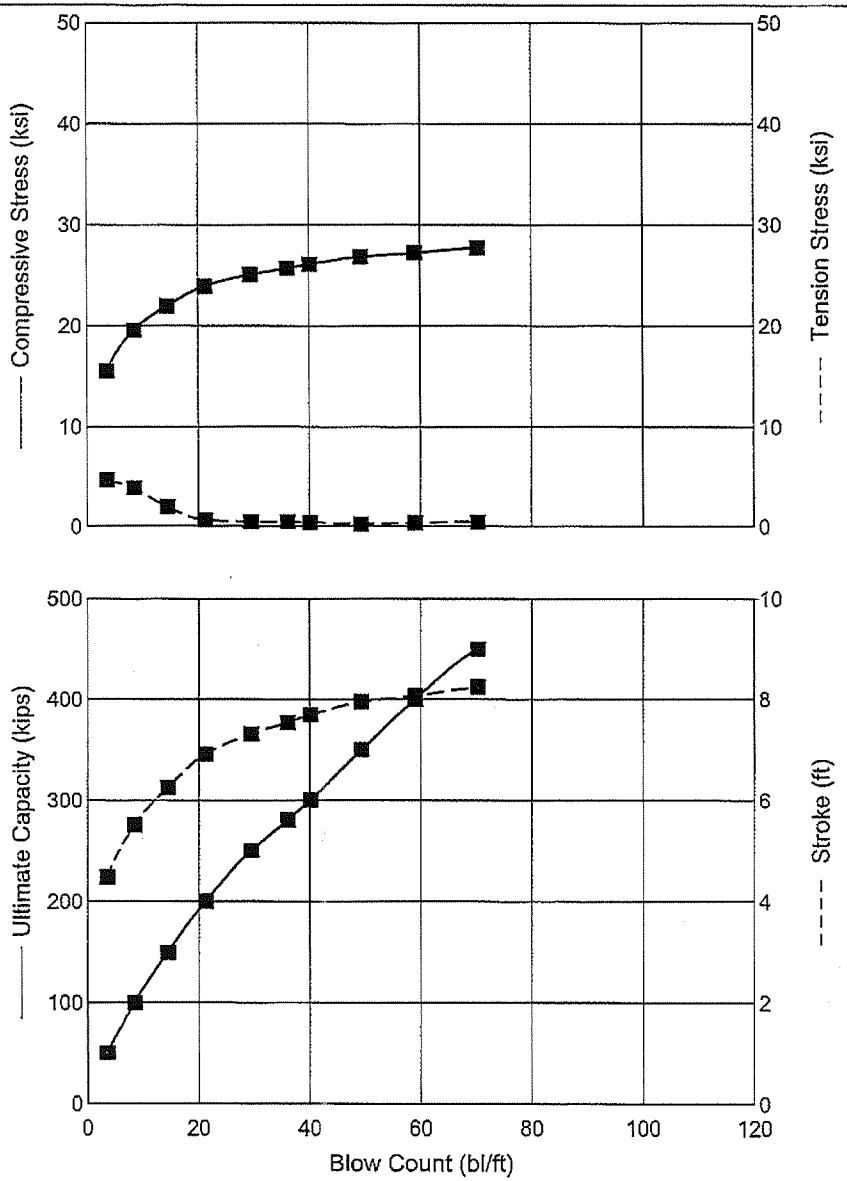
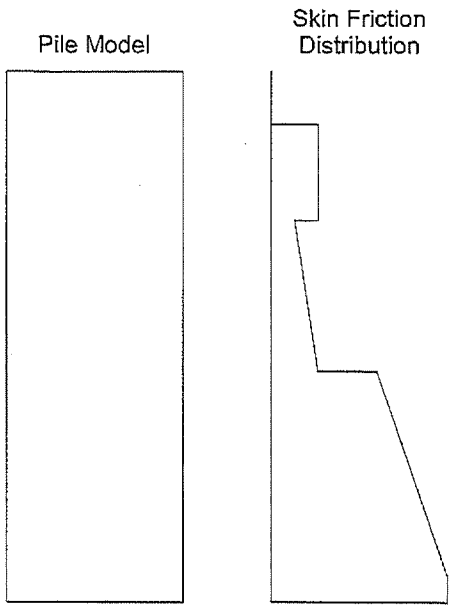
H2J EB2-B

29-Jan-2013
GRLWEAP Version 2010



DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1500 (100%)	psi
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.118	in
Skin Damping	0.065	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	30.00	ft
Pile Penetration	27.00	ft
Pile Top Area	26.20	in2



Res. Shaft = 88 %
(Proportional)

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29-Jan-2013
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
50.0	15.54	4.65	3.6	4.48	21.50
100.0	19.56	3.89	8.5	5.51	18.66
150.0	21.97	2.02	14.5	6.25	17.19
200.0	23.91	0.65	21.3	6.91	16.54
250.0	25.07	0.48	29.5	7.31	16.08
280.0	25.70 < 45 ok	0.44	30 < 36.1 < 180 ok	7.53	15.85
300.0	26.12	0.40	40.2	7.69	15.92
350.0	26.87	0.26	49.4	7.95	15.81
400.0	27.24	0.38	59.1	8.07	15.45
450.0	27.77	0.48	70.4	8.24	15.69

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: E:\GRLWEAP\BRANCH 63\P-5208A (H2J)\H2J EB2-B.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2003.GW
Hammer File Version: 2003 (3/21/2012)

Input File Contents

H2J EB2-B

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
6	0	40	0	1	0	0	0	0	0	88	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size		Pile Type
32.170	32.170	203.680	14.690		H Pile

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
1.900	227.000	530.0	2.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	CI	CoR	ROut
30.000	26.20	30000.0	492.000	4.759	0	0.850	0.010

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 19-32	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
4.00	129.10	12.60	11.76	10.61	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
0.75	25.30	12.60	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
15.50	124.70	157.70	0.002	0.002	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1500.00	1350.00	1215.00	1094.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.6100	0.8000	1500.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.100	0.118	0.065	0.150	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Dpth	Dpth						
0.00	0.40	27.00	27.00	0.00	0.00	0.00	0.00	0.00	0.0
5.50	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5.50	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14.00	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25.50	1.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25.50	1.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27.00	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27.00	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Rult

50.0	100.0	150.0	200.0	250.0	280.0	300.0	350.0	400.0	450.0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

H2J EB2-B

Hammer Model: D 19-32 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		19650.0			

HAMMER OPTIONS:

Hammer File ID No.	40	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.76			
Rated Stroke	(ft)	10.61	Efficiency		0.800
Maximum Pressure	(psi)	1500.00	Actual Pressure	(psi)	1500.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

H2J EB2-B 01/29/2013
Froehling & Robertson, Inc. GRLWEAP Version 2010

PILE PROFILE:

Toe Area	(in2)	203.680	Pile Type	H Pile
Pile Size	(inch)	14.690		

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	26.20	30000.	492.0	4.8	0	16807.	46.8
30.0	26.20	30000.	492.0	4.8	0	16807.	46.8

Wave Travel Time 2L/c (ms) 3.570

Pile and Soil Model — Total Capacity Rut (kips) 50.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.298	19650	0.010	0.000	0.85	0.3	0.065	0.100	3.33	4.8	26.2
2	0.298	19650	0.000	0.000	1.00	2.8	0.065	0.100	6.67	4.8	26.2
3	0.298	19650	0.000	0.000	1.00	2.3	0.065	0.100	10.00	4.8	26.2
4	0.298	19650	0.000	0.000	1.00	2.1	0.065	0.100	13.33	4.8	26.2
5	0.298	19650	0.000	0.000	1.00	2.8	0.065	0.100	16.67	4.8	26.2
6	0.298	19650	0.000	0.000	1.00	6.5	0.065	0.100	20.00	4.8	26.2
7	0.298	19650	0.000	0.000	1.00	8.0	0.065	0.100	23.33	4.8	26.2
8	0.298	19650	0.000	0.000	1.00	9.1	0.065	0.100	26.67	4.8	26.2
9	0.298	19650	0.000	0.000	1.00	10.3	0.065	0.100	30.00	4.8	26.2
Toe						6.0	0.150	0.118			

2.686 kips total unreduced pile weight (g= 32.17 ft/s2)
2.686 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	27.00	Pile Damping Fact.(k/ft/s)	0.935
% Shaft Resistance	88		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170 32.170	
Output Segment Generation: Automatic			

H2J EB2-B 01/29/2013
Froehling & Robertson, Inc. GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	Stroke (ft) up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
50.0	3.6	4.48	4.45	-4.65	5	5	15.54	2	2	21.5	56.0
100.0	8.5	5.51	5.50	-3.89	6	5	19.56	2	2	18.7	50.3
150.0	14.5	6.25	6.27	-2.01	6	4	21.96	2	2	17.2	47.2
200.0	21.3	6.91	6.85	-0.65	4	24	23.91	2	2	16.5	45.0
250.0	29.5	7.31	7.27	-0.48	4	36	25.07	2	2	16.1	43.8
280.0	36.1	7.53	7.53	-0.44	5	35	25.70	2	2	15.9	43.1
300.0	40.2	7.69	7.67	-0.40	2	33	26.12	2	2	15.9	42.6
350.0	49.4	7.95	7.95	-0.26	2	31	26.87	2	2	15.8	41.9
400.0	59.1	8.07	8.13	-0.38	2	29	27.24	2	2	15.5	41.6
450.0	70.4	8.24	8.31	-0.48	2	26	27.77	2	2	15.7	41.1

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

SHEET

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. B1-A	STATION 10282+14	OFFSET 21 ft LT	ALIGNMENT MAIN TRK #1 — 0 HR. 5.0
COLLAR ELEV. 538.8 ft	TOTAL DEPTH 51.5 ft	NORTHING 582,657	EASTING 1,519,983 — 24 HR. 10.0
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/21/12	COMP. DATE 08/24/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	ELEV. (ft)	DEPTH (ft)
540						BOF = 526.0 Pile is ≈ 12.8' Below Ex Grade.						
	538.8	0.0								GROUND SURFACE	538.8	0.0
			1	2	1	3 (4) γ=120 Su=250		M		ROADWAY EMBANKMENT Dark brown fine to coarse sandy CLAY (A-6), trace gravel		
535	535.3	3.5									535.3	3.5
			3	4	5	9 (12) γ=120 Φ=33°		D		Tan and brown silty fine sand (A-2-4)		
530	530.3	8.5									530.8	8.0
			0	0	0	0 (1) γ=105 Φ=28 BOF	SS-16	34%		ALLUVIAL Brown and gray fine to coarse sandy SILT (A-4(0))		
											526.8	12.0
525	525.3	13.5					0'			Gray silty CLAY (A-7-6) with organic odor		
			0	0	3	3 (4) γ=120 Su=250		M				
							5.2'				520.8	18.0
520	520.3	18.5										
			35	21	23	44 (59) SCOUR	7.0'	M		RESIDUAL Brown, tan, and black silty fine to coarse SAND (A-2-4(0))	519	
						N=45 γ=125						
515	515.3	23.5										
			8	9	15	24 (32) Φ=40°	SS-19	16%				
510	510.3	28.5					16.2'				509.8	29.0
			28	43	57/0.6	100/1.0	18.7'			WEATHERED ROCK Brown and tan (GRANITE)	507.3	31.5
	507.3	31.5	60/0.0			60/0.0						
505						γ=130 Su=200K γ=160 Su=300K				CRYSTALLINE ROCK Gray, pink, and white (GRANITE)		
500											497.3	41.5
495										CRYSTALLINE ROCK Gray, pink, and white (GRANITE)		
490											487.3	51.5
										Boring Terminated at Elevation 487.3 ft In CRYSTALLINE ROCK (GRANITE)		

1) Driller indicated approximately 3 inches of Surficial Organic Laden soil.

Pile will Refuse in WR* 508.8'
L = Bot - Tip EL + 1.0 Embed in Cap
= 526 - 508.8 + 1.0 = 18.2'
Anticipated Pile Length = 19'
Ave Pile Length = 20'
USE B1-A for Analyses
*Lateral will control *

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/29/13

SHEET

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 50000.1.STR03T1B	TIP P-5208A	COUNTY Cabarrus	GEOLOGIST R. Kral / J. Harris
SITE DESCRIPTION P-5208A Haydock to Junker Double Track			GROUND WTR (ft)
BORING NO. B1-B	STATION 10282+31	OFFSET 6 ft LT	ALIGNMENT MAIN TRK #1 — 0 HR. 11.0
COLLAR ELEV. 538.4 ft	TOTAL DEPTH 51.5 ft	NORTHING 582,668	EASTING 1,519,964 — 24 HR. 8.5
DRILL RIG/HAMMER EFF./DATE F&R968 CME-550X 81% 12/28/2011		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Boyce	START DATE 08/23/12	COMP. DATE 08/23/12	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
						BOF = 526.0 Pile is ≈ 12.4' Below Ex Grade				
540	538.4	0.0								538.4 GROUND SURFACE 0.0
			1	1	3	4 (3)		M		ROADWAY EMBANKMENT Dark brown silty fine SAND (A-2-4), trace gravel
535	534.9	3.5	3	3	3	6 (B)		W		533.4 5.0 5.0
530	529.9	8.5	0	0	0	0 (1) 526 BOF	SS-23	45%		ALLUVIAL Gray and black silty CLAY (A-7-6(18)) with organic odor 526 15.0
525	524.9	13.5	11	9	7	16 (22) 519.5 Cav		W		520.4 18.0 18.5
520	519.9	18.5	27	34	45	79 (100)	SS-25	9%		519 RESIDUAL Brown, orange, and gray silty fine to coarse SAND (A-2-4(0))
515	514.9	23.5	37	63/0.4		100/0.9				514.9 23.5 23.5
510	509.9	28.5	36	28	72/0.3	100/0.8				WEATHERED ROCK Brown and tan (GRANITE)
	506.9	31.5	60/0.0			60/0.0				506.9 31.5 31.5
505										CRYSTALLINE ROCK Gray, green, and pink (GRANITE)
500										
495										496.9 41.5 CRYSTALLINE ROCK Pink, gray, and white (GRANITE)
490										
										486.9 51.5

Pile will Refuse in WR ≈ 513.9'

L = Boc - Tip EL + 1.0 Embed in Cap

= 526 - 513.9 + 1.0 = 13.1'

Anticipated Pile Length = 14'

Ave Pile Length = 15'

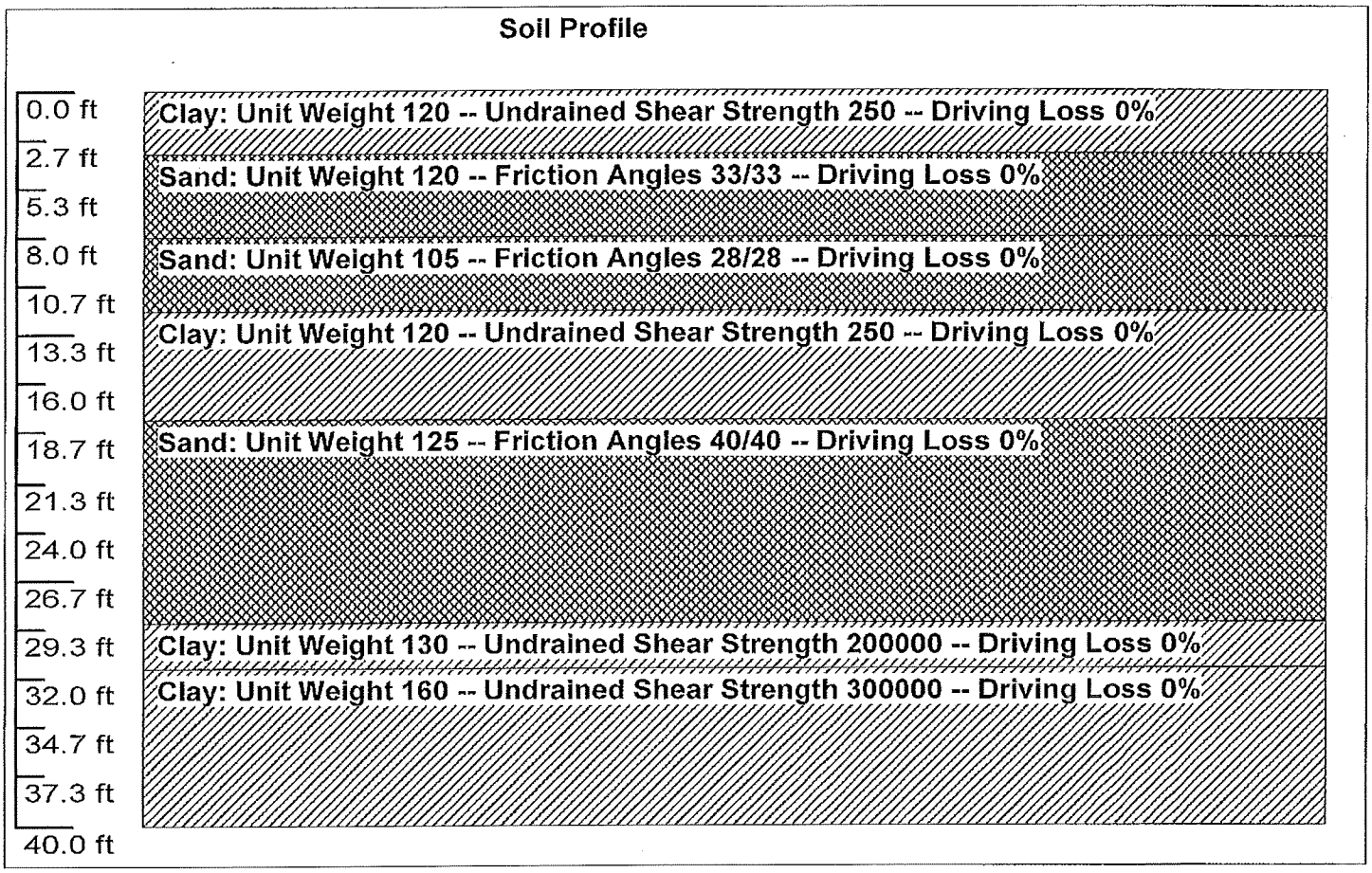
* Lateral will Control *

Boring Terminated with Standard Penetration Test Refusal at Elevation 486.9 ft in CRYSTALLINE ROCK (GRANITE)

1) Driller indicated approximately 4 inches of Surficial Organic Laden soil.

NCDOT BORE SINGLE 63P-0090 HADOCK TO JUNKER.GPJ NC_DOT.GDT 1/29/13

Filename: F:\BRANCH63\DRIVEN\H2J\B1-A.DVN



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: F:\BRANCH63\DRIVEN\H2J\B1-A.DVN
Project Name: H2J Bent 1 - B1-A Project Date: 01/30/2013
Project Client: HDR
Computed By: M. Walko
Project Manager: R. Kral

PILE INFORMATION

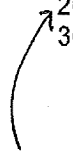
Pile Type: H Pile - HP14X89
Top of Pile: 12.80 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	10.00 ft
	- Driving/Restrike	10.00 ft
	- Ultimate:	10.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.50 ft	0.00%	120.00 pcf	250.00 psf	T-79 Steel
2	Cohesionless	4.50 ft	0.00%	120.00 pcf	32.6/32.6	Nordlund
3	Cohesionless	4.00 ft	0.00%	105.00 pcf	28.1/28.1	Nordlund
4	Cohesive	6.00 ft	0.00%	120.00 pcf	250.00 psf	T-79 Steel
5	Cohesionless	11.00 ft	0.00%	125.00 pcf	40.5/40.5	Nordlund
6	Cohesive	2.50 ft	0.00%	130.00 pcf	200000.00 psf	T-79 Steel
7	Cohesive	8.50 ft	0.00%	160.00 pcf	300000.00 psf	T-79 Steel



Pile will not penetrate far into weathered Rock

ULTIMATE - SUMMARY OF CAPACITIES

	Depth	Skin Friction	End Bearing	Total Capacity
	0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
	3.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
	3.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
	7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
	8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
	9.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
	10.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
	11.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
	12.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
BOC →	12.79 ft	0.00 Kips	0.00 Kips	0.00 Kips
	12.80 ft	0.00 Kips	0.41 Kips	0.41 Kips
	17.99 ft	5.97 Kips	0.41 Kips	6.37 Kips
	18.01 ft	6.05 Kips	39.52 Kips	45.57 Kips
	27.01 ft	85.15 Kips	53.42 Kips	138.57 Kips
Top of WR →	28.99 ft	105.72 Kips	56.48 Kips	162.21 Kips
	29.01 ft	105.88 Kips	326.25 Kips	432.13 Kips
	31.49 ft	117.98 Kips	326.25 Kips	444.23 Kips
	31.51 ft	118.08 Kips	489.38 Kips	607.46 Kips
	39.99 ft	164.05 Kips	489.38 Kips	653.43 Kips

Design Load = 65 tons/pile ∴ 2(65 ton/pile) = 130 tons/pile (Required Bearing Capacity)

By inspection, pile will refuse in the weathered rock at a depth of ≈ 29 feet below Ex. grade. Assume 1 foot of penetration into WR (Tip EL ≈ 508.8')

L = Boc - Tip EL + 1.0 Embed into Cap

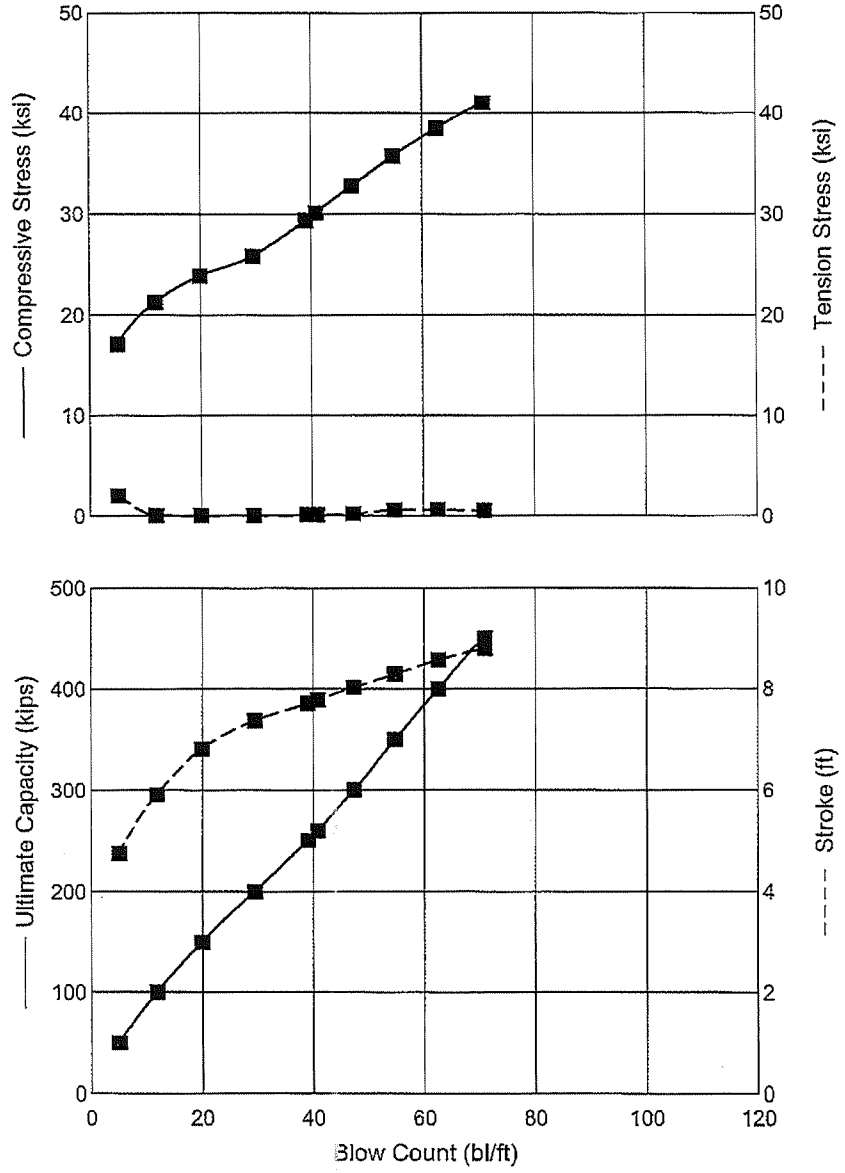
= 526.0 - 508.8 + 1.0 = 18.2' ; Anticipated Pile Length = 19 feet

Ave. Pile Length = 20 feet

For Preliminary Weap for Pile Excavation, Assume 1% Skin Friction

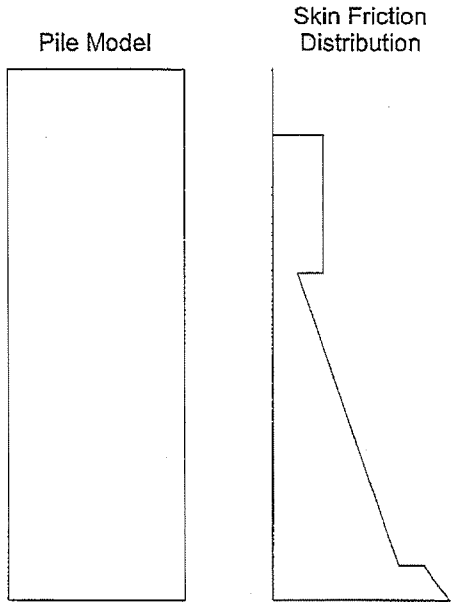
Froehling & Robertson, Inc.
H2J Bent 1 B1-A w/ Pile Excavation

31-Jan-2013
GRLWEAP Version 2010



DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1500 (100%)	psi
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.040	in ← Hard Rock
Skin Damping	0.084	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	20.00	ft
Pile Penetration	17.50	ft
Pile Top Area	26.20	in2



Res. Shaft = 1 % ← Pile Exc.
(Proportional) Minimal Skin Friction

Froehling & Robertson, Inc.
H2J Bent 1 B1-A w/ Pile Excavation

31-Jan-2013
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
50.0	17.08	2.03	5.1	4.74	20.51
100.0	21.27	0.08	11.9	5.91	17.68
150.0	23.84	0.07	20.0	6.81	16.49
200.0	25.84	0.08	29.5	7.37	15.66
250.0	29.35	0.12	39.1	7.71	15.24
260.0	30.11 $< 45^{ok}$	0.14	$30 < 40.9 < 180^{ok}$	7.78	15.24
300.0	32.78	0.21	47.4	8.03	15.29
350.0	35.72	0.59	54.8	8.29	15.48
400.0	38.48	0.64	62.6	8.57	15.66
450.0	40.98	0.56	71.0	8.79	15.88

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: E:\GRLWEAP\BRANCH 63\P-5208A (H2J)\H2J B1-A PILE EXCAVATION.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2003.GW
Hammer File Version: 2003 (3/21/2012)

Input File Contents

H2J Bent 1 B1-A w/ Pile Excavation

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
6	0	40	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size		Pile Type
32.170	32.170	203.680	14.690		H Pile

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
1.900	227.000	530.0	2.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	CI	CoR	ROut
20.000	26.20	30000.0	492.000	4.759	0	0.850	0.010

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 19-32	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
4.00	129.10	12.60	11.76	10.61	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
0.75	25.30	12.60	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
15.50	124.70	157.70	0.002	0.002	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1500.00	1350.00	1215.00	1094.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.6100	0.8000	1500.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.100	0.040	0.084	0.150	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Dpth	Dpth						
0.00	0.23	17.50	17.50	0.00	0.00	0.00	0.00	0.00	0.0
5.20	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5.20	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16.20	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16.20	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.50	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.50	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
20.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Rult									
50.0	100.0	150.0	200.0	250.0	260.0	300.0	350.0	400.0	450.0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

H2J Bent 1 B1-A w/ Pile Excavation

Hammer Model: D 19-32 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		19650.0			

HAMMER OPTIONS:

Hammer File ID No.	40	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.76			
Rated Stroke	(ft)	10.61	Efficiency		0.800
Maximum Pressure	(psi)	1500.00	Actual Pressure	(psi)	1500.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

H2J Bent 1 B1-A w/ Pile Excavation 01/31/2013
Froehling & Robertson, Inc. GRLWEAP Version 2010

PILE PROFILE:

Toe Area	(in2)	203.680	Pile Type	H Pile
Pile Size	(inch)	14.690		

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	26.20	30000.	492.0	4.8	0	16807.	46.8
20.0	26.20	30000.	492.0	4.8	0	16807.	46.8

Wave Travel Time 2L/c (ms) 2.380

Pile and Soil Model Total Capacity Rut (kips) 50.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.298	19650	0.010	0.000	0.85	0.0	0.084	0.100	3.33	4.8	26.2
2	0.298	19650	0.000	0.000	1.00	0.1	0.084	0.100	6.67	4.8	26.2
3	0.298	19650	0.000	0.000	1.00	0.1	0.084	0.100	10.00	4.8	26.2
4	0.298	19650	0.000	0.000	1.00	0.1	0.084	0.100	13.33	4.8	26.2
5	0.298	19650	0.000	0.000	1.00	0.1	0.084	0.100	16.67	4.8	26.2
6	0.298	19650	0.000	0.000	1.00	0.2	0.084	0.100	20.00	4.8	26.2
Toe						49.5	0.150	0.040			

1.790 kips total unreduced pile weight (g= 32.17 ft/s2)
1.790 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	17.50	Pile Damping Fact.(k/ft/s)	0.935
% Shaft Resistance	1		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170 32.170	
Output Segment Generation: Automatic			

H2J Bent 1 B1-A w/ Pile Excavation 01/31/2013
Froehling & Robertson, Inc. GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
50.0	5.1	4.74	4.71	-2.03	3	4	17.08	1	2	20.5	54.4
100.0	11.9	5.91	5.93	-0.08	5	49	21.27	3	2	17.7	48.5
150.0	20.0	6.81	6.77	-0.07	5	39	23.84	3	2	16.5	45.3
200.0	29.5	7.37	7.37	-0.08	5	49	25.84	6	3	15.7	43.5
250.0	39.1	7.71	7.76	-0.12	4	44	29.35	6	3	15.2	42.5
260.0	40.9	7.78	7.82	-0.14	4	43	30.11	6	3	15.2	42.4
300.0	47.4	8.03	8.02	-0.21	5	26	32.78	6	3	15.3	41.8
350.0	54.8	8.29	8.27	-0.60	4	22	35.72	6	3	15.5	41.1
400.0	62.6	8.57	8.53	-0.64	4	22	38.48	6	3	15.7	40.5
450.0	71.0	8.79	8.74	-0.56	6	22	40.98	6	3	15.9	40.1

SINCE 1881

FROEHLING & ROBERTSON, INC.

Engineering • Environmental • Geotechnical

SHEET NO. 1 OF 1

JOB P-5208A HZJ Bridge

DATE 2/2013

COMPUTATIONS FOR Lateral Stability - Bent 1

BY MJW CHKD

Model Soil & Rock conditions with Boring B1-A due to deeper Rock Line.

Depth (Ft)		Elev (Ft)
0	POF = 526	526.0
7.0'	Scour (Per HDR)	519.0
	γ = 125	
	Sand ϕ = 40 K = 125	
16.2		509.8
	γ = 130	
	WR C = 8000 ε = .004	
	K = 2000	
18.7		507.3
	$\bar{\gamma}$ = 120 (Ave)	
	CR q_u = 3500 (Ave)	
30.0		496.0

Loads Provided By HDR: Axial = 126 k
Lateral = 4 k

"Free-End" δ = 0.85", 1st Neg = 16.17' (EL = 509.8)
Max Neg = 17.43' (EL = 508.6)

"Fixed End" δ = 0.07" 1st Neg = 18.06' (EL = 507.9)
Max Neg = 18.69' (EL = 507.3)

Say Point of Fixity (POF) = 507.5'

Min Tip: 1.5 B below 1st Neg ≈ 505'
1.0 B below Max Neg ≈ 506'

Say Min Tip for Lateral Stability = El. 505'
Min Tip for Axial Capacity = El. 509' (1' into WR)

∴ Lateral Controls ⇒ Min Tip = El 505'

Form No. 502
Revised 05/2008

Bent 1 - Boring B1-A

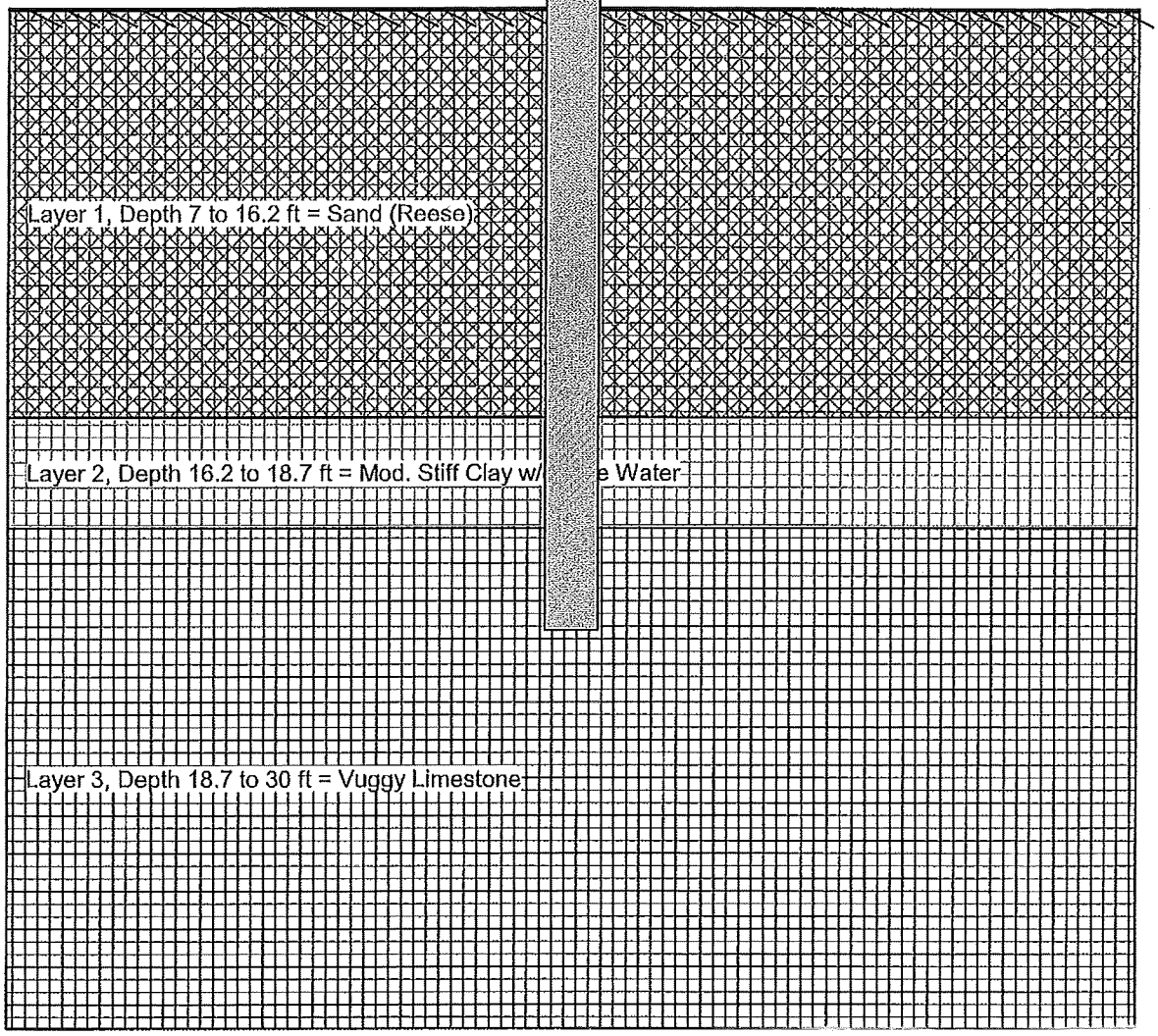
BOF = 526'

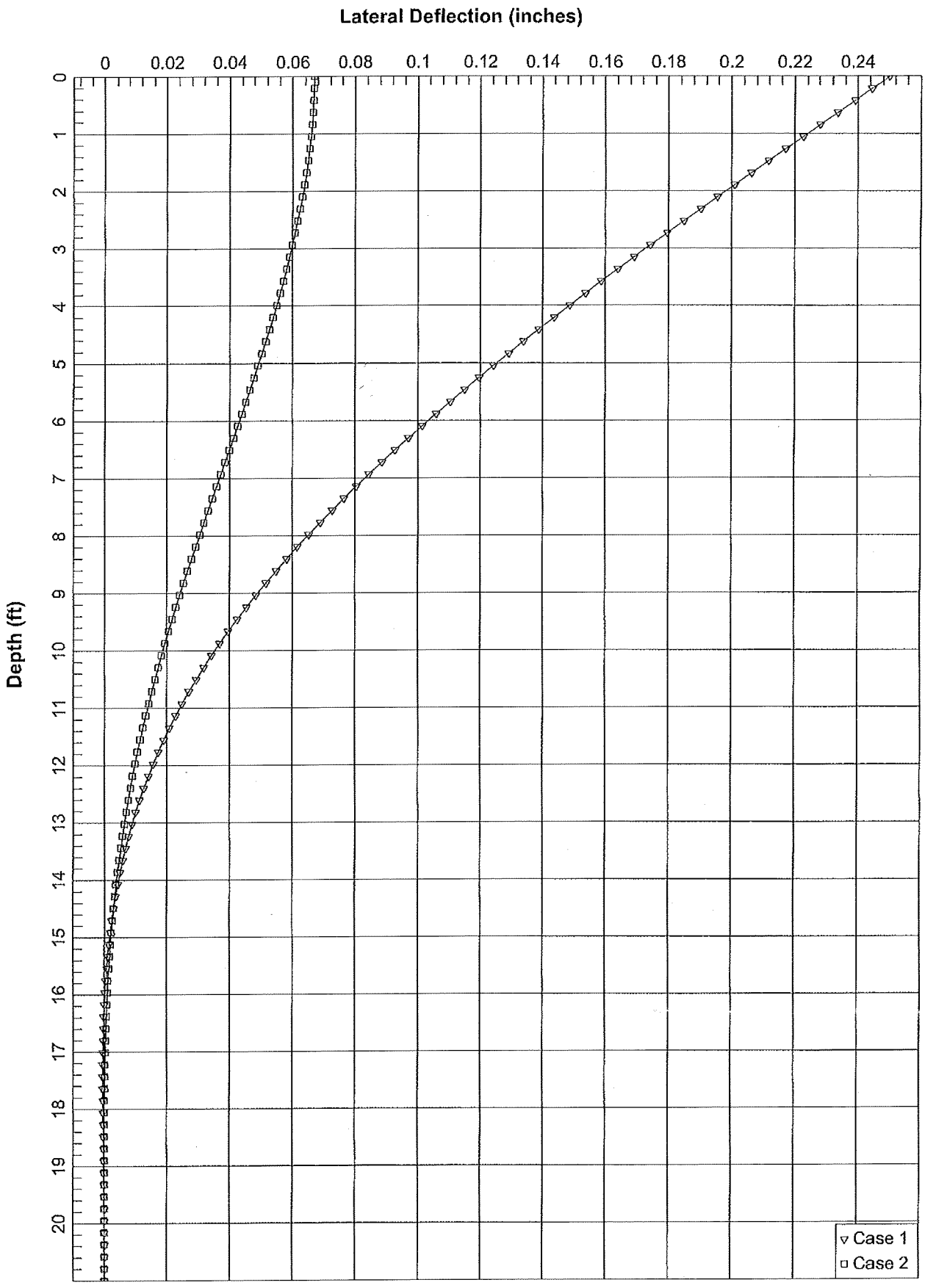
FREE END $\delta = 0.25''$ POF = 508'

FIXED END $\delta = 0.07''$ POF = 507.5'

MIN TIP = 505' (Extending into CR)

Scour = 519'




Lateral Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1
Case 2

LPile Plus for Windows, Version 2012-06.034

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

This copy of LPile is licensed to:

testt
test

Serial Number of Security Device: 293783516
Company Name Stored in Security Device: Froehling & Robertson, Inc.

Files Used for Analysis

Path to file locations: E:\Lpile 2012\Branch63\H2J\
Name of input data file: Bent 1 Boring B1-A.lp6d
Name of output report file: Bent 1 Boring B1-A.lp6o
Name of plot output file: Bent 1 Boring B1-A.lp6p
Name of runtime messeage file: Bent 1 Boring B1-A.lp6r

Date and Time of Analysis

Date: February 1, 2013 Time: 9:37:03

Problem Title

Project Name: H2J Bridge Bent 1

Job Number: 63P-0090

Client: HDR

Engineer: M. Walko

Description: Bent 1 Boring B1-A

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear moment-curvature and nominal moment capacity for section types with nonlinear properties.

Computation Options:
- Analysis does not use p-y multipliers (individual pile or shaft only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix values
- Report pile response for full length of pile
- Analysis assumes no loading by soil movements acting on pile
- No p-y curves to be computed and reported for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 21.00 ft

Depth of ground surface below top of pile = 7.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	14.6950000
2	21.000000	14.6950000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile	
Cross-sectional Shape	=	Strong H-Pile	
Section Length	=	21.00000000	ft
Flange Width	=	14.69500000	in
Section Depth	=	13.83000000	in
Flange Thickness	=	0.61500000	in
Web Thickness	=	0.61500000	in
Section Area	=	26.10000000	Sq. in
Moment of Inertia	=	904.00000000	in^4
Elastic Modulus	=	29000000.	lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	7.00000 ft
Distance from top of pile to bottom of layer	=	16.20000 ft
Effective unit weight at top of layer	=	125.00000 pcf
Effective unit weight at bottom of layer	=	125.00000 pcf
Friction angle at top of layer	=	40.00000 deg.
Friction angle at bottom of layer	=	40.00000 deg.
Subgrade k at top of layer	=	125.00000 pci
Subgrade k at bottom of layer	=	125.00000 pci

Layer 2 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	16.20000 ft
Distance from top of pile to bottom of layer	=	18.70000 ft
Effective unit weight at top of layer	=	130.00000 pcf
Effective unit weight at bottom of layer	=	130.00000 pcf
Undrained cohesion at top of layer	=	8000.00000 psf
Undrained cohesion at bottom of layer	=	8000.00000 psf
Epsilon-50 at top of layer	=	0.00400
Epsilon-50 at bottom of layer	=	0.00400
Subgrade k at top of layer	=	2000.00000 pci
Subgrade k at bottom of layer	=	2000.00000 pci

Layer 3 is strong rock (vuggy limestone)

Distance from top of pile to top of layer	=	18.70000 ft
Distance from top of pile to bottom of layer	=	30.00000 ft
Effective unit weight at top of layer	=	170.00000 pcf
Effective unit weight at bottom of layer	=	170.00000 pcf
Uniaxial compressive strength at top of layer	=	3500.00000 psi
Uniaxial compressive strength at bottom of layer	=	3500.00000 psi

(Depth of lowest soil layer extends 9.00 ft below pile tip)

**** Warning - Possible Input Data Error ****

Values entered for effective unit weights of soil were outside
the limits of 0.011574 pci (20 pcf) or 0.0810019 pci (140 pcf)
This data may be erroneous. Please check your data.

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	Strain Factor kpy Epsilon 50 pci
1	Sand (Reese, et al.)	7.000	125.000	--	40.000	--	--
	125.000						
		16.200	125.000	--	40.000	--	--
	125.000						
2	Stiff Clay w/o Free Water, using k	16.200	130.000	8000.000	--	--	
0.00400	2000.000						
		18.700	130.000	8000.000	--	--	
0.00400	2000.000						
3	Vuggy Limestone	18.700	170.000	--	--	3500.000	--
	--						
		30.000	170.000	--	--	3500.000	--
	--						

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 4000.00000 lbs	M = 0.0000 in-lbs	126000.	No
2	2	V = 4000.00000 lbs	S = 0.0000 in/in	126000.	No

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 4000.000 lbs
Applied moment at pile head = 0.000 in-lbs
Axial thrust load on pile head = 126000.000 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2501	7.562E-06	4000.0000	-0.002179	4827.5862	2.622E+10	0.000	0.000	0.000
0.210	0.2446	10772.	4000.0000	-0.002178	4915.1369	2.622E+10	0.000	0.000	0.000
0.420	0.2391	21543.	4000.0000	-0.002177	5002.6849	2.622E+10	0.000	0.000	0.000
0.630	0.2336	32314.	4000.0000	-0.002174	5090.2275	2.622E+10	0.000	0.000	0.000
0.840	0.2281	43084.	4000.0000	-0.002170	5177.7621	2.622E+10	0.000	0.000	0.000
1.050	0.2227	53852.	4000.0000	-0.002166	5265.2861	2.622E+10	0.000	0.000	0.000
1.260	0.2172	64619.	4000.0000	-0.002160	5352.7967	2.622E+10	0.000	0.000	0.000
1.470	0.2118	75384.	4000.0000	-0.002153	5440.2912	2.622E+10	0.000	0.000	0.000
1.680	0.2064	86147.	4000.0000	-0.002146	5527.7671	2.622E+10	0.000	0.000	0.000
1.890	0.2010	96907.	4000.0000	-0.002137	5615.2216	2.622E+10	0.000	0.000	0.000
2.100	0.1956	107664.	4000.0000	-0.002127	5702.6520	2.622E+10	0.000	0.000	0.000
2.310	0.1902	118417.	4000.0000	-0.002116	5790.0557	2.622E+10	0.000	0.000	0.000
2.520	0.1849	129168.	4000.0000	-0.002104	5877.4301	2.622E+10	0.000	0.000	0.000
2.730	0.1796	139914.	4000.0000	-0.002091	5964.7724	2.622E+10	0.000	0.000	0.000
2.940	0.1744	150656.	4000.0000	-0.002077	6052.0800	2.622E+10	0.000	0.000	0.000
3.150	0.1692	161393.	4000.0000	-0.002062	6139.3503	2.622E+10	0.000	0.000	0.000
3.360	0.1640	172125.	4000.0000	-0.002046	6226.5805	2.622E+10	0.000	0.000	0.000
3.570	0.1588	182852.	4000.0000	-0.002029	6313.7680	2.622E+10	0.000	0.000	0.000
3.780	0.1538	193574.	4000.0000	-0.002011	6400.9101	2.622E+10	0.000	0.000	0.000
3.990	0.1487	204290.	4000.0000	-0.001992	6488.0042	2.622E+10	0.000	0.000	0.000
4.200	0.1437	214999.	4000.0000	-0.001972	6575.0477	2.622E+10	0.000	0.000	0.000
4.410	0.1388	225702.	4000.0000	-0.001951	6662.0378	2.622E+10	0.000	0.000	0.000
4.620	0.1339	236398.	4000.0000	-0.001928	6748.9719	2.622E+10	0.000	0.000	0.000
4.830	0.1291	247087.	4000.0000	-0.001905	6835.8473	2.622E+10	0.000	0.000	0.000
5.040	0.1243	257768.	4000.0000	-0.001881	6922.6615	2.622E+10	0.000	0.000	0.000
5.250	0.1196	268441.	4000.0000	-0.001856	7009.4118	2.622E+10	0.000	0.000	0.000
5.460	0.1149	279106.	4000.0000	-0.001829	7096.0954	2.622E+10	0.000	0.000	0.000
5.670	0.1104	289763.	4000.0000	-0.001802	7182.7098	2.622E+10	0.000	0.000	0.000
5.880	0.1058	300411.	4000.0000	-0.001774	7269.2523	2.622E+10	0.000	0.000	0.000
6.090	0.1014	311049.	4000.0000	-0.001744	7355.7203	2.622E+10	0.000	0.000	0.000
6.300	0.0971	321678.	4000.0000	-0.001714	7442.1111	2.622E+10	0.000	0.000	0.000
6.510	0.0928	332297.	4000.0000	-0.001682	7528.4222	2.622E+10	0.000	0.000	0.000
6.720	0.0886	342907.	4000.0000	-0.001650	7614.6508	2.622E+10	0.000	0.000	0.000
6.930	0.0845	353505.	4000.0000	-0.001617	7700.7943	2.622E+10	0.000	0.000	0.000
7.140	0.0804	364093.	3982.9476	-0.001582	7786.8502	2.622E+10	-13.5336	424.0352	0.000
7.350	0.0765	374584.	3920.0066	-0.001547	7872.1171	2.622E+10	-36.4195	1199.9131	0.000
7.560	0.0726	384832.	3797.2416	-0.001510	7955.4114	2.622E+10	-61.0131	2116.8000	0.000
7.770	0.0689	394681.	3620.1300	-0.001473	8035.4611	2.622E+10	-79.5517	2910.6000	0.000
7.980	0.0652	404013.	3399.1076	-0.001434	8111.3068	2.622E+10	-95.8629	3704.4000	0.000
8.190	0.0616	412723.	3139.6686	-0.001395	8182.1044	2.622E+10	-110.0411	4498.2000	0.000
8.400	0.0582	420722.	2847.0661	-0.001355	8247.1199	2.622E+10	-122.1831	5292.0000	0.000
8.610	0.0548	427933.	2526.3064	-0.001314	8305.7245	2.622E+10	-132.3881	6085.8000	0.000
8.820	0.0516	434290.	2182.1431	-0.001273	8357.3899	2.622E+10	-140.7573	6879.6000	0.000
9.030	0.0484	439739.	1819.0735	-0.001231	8401.6824	2.622E+10	-147.3932	7673.4000	0.000
9.240	0.0454	444239.	1441.3345	-0.001188	8438.2582	2.622E+10	-152.3997	8467.2000	0.000
9.450	0.0424	447758.	1052.9002	-0.001145	8466.8577	2.622E+10	-155.8815	9261.0000	0.000
9.660	0.0396	450273.	657.4806	-0.001102	8487.3004	2.622E+10	-157.9436	10055.	0.000
9.870	0.0369	451772.	258.5208	-0.001059	8499.4792	2.622E+10	-158.6912	10849.	0.000
10.080	0.0342	452248.	-140.7987	-0.001015	8503.3552	2.622E+10	-158.2290	11642.	0.000
10.290	0.0317	451707.	-537.5602	-0.000972	8498.9520	2.622E+10	-156.6611	12436.	0.000
10.500	0.0294	450156.	-929.1067	-0.000929	8486.3508	2.622E+10	-154.0901	13230.	0.000
10.710	0.0271	447614.	-1313.0384	-0.000885	8465.6847	2.622E+10	-150.6176	14024.	0.000

10.920	0.0249	444101.	-1687.2085	-0.000843	8437.1334	2.622E+10	-146.3428	14818.	0.000
11.130	0.0228	439645.	-2049.7178	-0.000800	8400.9186	2.622E+10	-141.3630	15611.	0.000
11.340	0.0209	434278.	-2398.9089	-0.000758	8357.2983	2.622E+10	-135.7728	16405.	0.000
11.550	0.0190	428036.	-2733.3592	-0.000717	8306.5624	2.622E+10	-129.6640	17199.	0.000
11.760	0.0172	420957.	-3051.8735	-0.000676	8249.0278	2.622E+10	-123.1251	17993.	0.000
11.970	0.0156	413084.	-3353.4754	-0.000636	8185.0337	2.622E+10	-116.2415	18787.	0.000
12.180	0.0140	404459.	-3637.3989	-0.000596	8114.9374	2.622E+10	-109.0946	19580.	0.000
12.390	0.0126	395130.	-3903.0782	-0.000558	8039.1098	2.622E+10	-101.7621	20374.	0.000
12.600	0.0112	385142.	-4150.1385	-0.000520	7957.9319	2.622E+10	-94.3175	21168.	0.000
12.810	0.009963	374544.	-4378.3849	-0.000484	7871.7902	2.622E+10	-86.8304	21962.	0.000
13.020	0.008789	363382.	-4587.7919	-0.000448	7781.0739	2.622E+10	-79.3656	22756.	0.000
13.230	0.007703	351706.	-4778.4918	-0.000414	7686.1711	2.622E+10	-71.9836	23549.	0.000
13.440	0.006702	339562.	-4950.7639	-0.000381	7587.4656	2.622E+10	-64.7403	24343.	0.000
13.650	0.005783	326996.	-5105.0221	-0.000349	7485.3343	2.622E+10	-57.6868	25137.	0.000
13.860	0.004944	314054.	-5241.8032	-0.000318	7380.1445	2.622E+10	-50.8696	25931.	0.000
14.070	0.004180	300779.	-5361.7550	-0.000289	7272.2511	2.622E+10	-44.3302	26725.	0.000
14.280	0.003490	287214.	-5465.6240	-0.000260	7161.9950	2.622E+10	-38.1055	27518.	0.000
14.490	0.002868	273398.	-5554.2435	-0.000233	7049.7009	2.622E+10	-32.2274	28312.	0.000
14.700	0.002314	259369.	-5628.5207	-0.000208	6935.6755	2.622E+10	-26.7229	29106.	0.000
14.910	0.001822	245162.	-5689.4256	-0.000183	6820.2065	2.622E+10	-21.6143	29900.	0.000
15.120	0.001389	230811.	-5737.9776	-0.000161	6703.5611	2.622E+10	-16.9191	30694.	0.000
15.330	0.001012	216345.	-5775.2346	-0.000139	6585.9851	2.622E+10	-12.6500	31487.	0.000
15.540	0.000688	201792.	-5802.2803	-0.000119	6467.7026	2.622E+10	-8.8148	32281.	0.000
15.750	0.000413	187177.	-5820.2123	-0.000100	6348.9150	2.622E+10	-5.4170	33075.	0.000
15.960	0.000183	172522.	-5830.1310	-8.300E-05	6229.8014	2.622E+10	-2.4550	33869.	0.000
16.170	-5.607E-06	157846.	-5833.1271	-6.712E-05	6110.5183	2.622E+10	0.0771	34663.	0.000
16.380	-0.000156	143165.	-5811.7636	-5.266E-05	5991.2000	2.622E+10	16.8780	273275.	0.000
16.590	-0.000271	128588.	-5751.7486	-3.960E-05	5872.7173	2.622E+10	30.7530	285976.	0.000
16.800	-0.000355	114202.	-5659.9549	-2.793E-05	5755.7901	2.622E+10	42.0991	298677.	0.000
17.010	-0.000412	100079.	-5542.8067	-1.763E-05	5641.0074	2.622E+10	50.8757	311377.	0.000
17.220	-0.000444	86277.	-5406.7514	-8.671E-06	5528.8259	2.622E+10	57.1047	324078.	0.000
17.430	-0.000455	72835.	-5258.1081	-1.023E-06	5419.5704	2.622E+10	60.8662	336779.	0.000
17.640	-0.000449	59777.	-5102.9240	5.350E-06	5313.4384	2.622E+10	62.2958	349480.	0.000
17.850	-0.000428	47113.	-4946.8386	1.049E-05	5210.5069	2.622E+10	61.5814	362181.	0.000
18.060	-0.000396	34838.	-4794.9559	1.443E-05	5110.7422	2.622E+10	58.9604	374881.	0.000
18.270	-0.000356	22937.	-4651.7215	1.720E-05	5014.0122	2.622E+10	54.7176	387582.	0.000
18.480	-0.000310	11383.	-4520.8065	1.885E-05	4920.1006	2.622E+10	49.1832	400283.	0.000
18.690	-0.000261	140.0880	-4404.9934	1.941E-05	4828.7248	2.622E+10	42.7320	412984.	0.000
18.900	-0.000212	-10831.	-3416.9968	1.889E-05	4915.6178	2.622E+10	741.3923	8820000.	0.000
19.110	-0.000166	-17094.	-1752.8615	1.755E-05	4966.5188	2.622E+10	579.3501	8820000.	0.000
19.320	-0.000123	-19677.	-478.8121	1.578E-05	4987.5125	2.622E+10	431.8002	8820000.	0.000
19.530	-8.598E-05	-19517.	444.4309	1.390E-05	4986.2143	2.622E+10	300.9324	8820000.	0.000
19.740	-5.332E-05	-17445.	1058.7359	1.212E-05	4969.3786	2.622E+10	186.6113	8820000.	0.000
19.950	-2.488E-05	-14188.	1403.5878	1.060E-05	4942.9068	2.622E+10	87.0807	8820000.	0.000
20.160	1.202E-07	-10378.	1512.7796	9.422E-06	4911.9369	2.622E+10	-0.4205	8820000.	0.000
20.370	2.261E-05	-6570.0537	1412.5546	8.607E-06	4880.9861	2.622E+10	-79.1231	8820000.	0.000
20.580	4.350E-05	-3264.2805	1121.0177	8.135E-06	4854.1175	2.622E+10	-152.2554	8820000.	0.000
20.790	6.361E-05	-925.2905	648.6743	7.933E-06	4835.1068	2.622E+10	-222.6203	8820000.	0.000
21.000	8.349E-05	0.000	0.000	7.889E-06	4827.5862	2.622E+10	-292.2006	4410000.	0.000

1st Neg

509.8'

508.6'

MAX Neg

PoF ≈ 508'

Tip ≈ 505'

* The above values of total stress are combined axial and bending stress.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.2500575 inches
Computed slope at pile head	=	-0.0021788 radians
Maximum bending moment	=	452248. inch-lbs
Maximum shear force	=	-5833.1270574 lbs
Depth of maximum bending moment	=	120.9600000 inches below pile head
Depth of maximum shear force	=	194.0400000 inches below pile head
Number of iterations	=	6
Number of zero deflection points	=	2

Bent 1 Boring B1-A.lp6o
Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 4000.000 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 126000.000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0668	-336172.	4000.0000	0.000	7559.9106	2.622E+10	0.000	0.000	0.000
0.210	0.0668	-326087.	4000.0000	-3.183E-05	7477.9410	2.622E+10	0.000	0.000	0.000
0.420	0.0666	-315991.	4000.0000	-6.269E-05	7395.8906	2.622E+10	0.000	0.000	0.000
0.630	0.0664	-305887.	4000.0000	-9.258E-05	7313.7617	2.622E+10	0.000	0.000	0.000
0.840	0.0662	-295773.	4000.0000	-0.000121	7231.5570	2.622E+10	0.000	0.000	0.000
1.050	0.0658	-285650.	4000.0000	-0.000149	7149.2789	2.622E+10	0.000	0.000	0.000
1.260	0.0654	-275518.	4000.0000	-0.000176	7066.9299	2.622E+10	0.000	0.000	0.000
1.470	0.0649	-265378.	4000.0000	-0.000202	6984.5126	2.622E+10	0.000	0.000	0.000
1.680	0.0644	-255229.	4000.0000	-0.000227	6902.0294	2.622E+10	0.000	0.000	0.000
1.890	0.0638	-245073.	4000.0000	-0.000251	6819.4830	2.622E+10	0.000	0.000	0.000
2.100	0.0631	-234910.	4000.0000	-0.000275	6736.8757	2.622E+10	0.000	0.000	0.000
2.310	0.0624	-224739.	4000.0000	-0.000297	6654.2102	2.622E+10	0.000	0.000	0.000
2.520	0.0616	-214561.	4000.0000	-0.000318	6571.4889	2.622E+10	0.000	0.000	0.000
2.730	0.0608	-204377.	4000.0000	-0.000338	6488.7144	2.622E+10	0.000	0.000	0.000
2.940	0.0599	-194187.	4000.0000	-0.000357	6405.8891	2.622E+10	0.000	0.000	0.000
3.150	0.0590	-183990.	4000.0000	-0.000375	6323.0158	2.622E+10	0.000	0.000	0.000
3.360	0.0580	-173788.	4000.0000	-0.000392	6240.0967	2.622E+10	0.000	0.000	0.000
3.570	0.0570	-163581.	4000.0000	-0.000409	6157.1346	2.622E+10	0.000	0.000	0.000
3.780	0.0560	-153369.	4000.0000	-0.000424	6074.1319	2.622E+10	0.000	0.000	0.000
3.990	0.0549	-143152.	4000.0000	-0.000438	5991.0911	2.622E+10	0.000	0.000	0.000
4.200	0.0538	-132931.	4000.0000	-0.000451	5908.0148	2.622E+10	0.000	0.000	0.000
4.410	0.0526	-122705.	4000.0000	-0.000464	5824.9056	2.622E+10	0.000	0.000	0.000
4.620	0.0514	-112476.	4000.0000	-0.000475	5741.7659	2.622E+10	0.000	0.000	0.000
4.830	0.0502	-102244.	4000.0000	-0.000485	5658.5983	2.622E+10	0.000	0.000	0.000
5.040	0.0490	-92008.	4000.0000	-0.000495	5575.4053	2.622E+10	0.000	0.000	0.000
5.250	0.0477	-81770.	4000.0000	-0.000503	5492.1895	2.622E+10	0.000	0.000	0.000
5.460	0.0464	-71529.	4000.0000	-0.000510	5408.9535	2.622E+10	0.000	0.000	0.000
5.670	0.0452	-61285.	4000.0000	-0.000517	5325.6997	2.622E+10	0.000	0.000	0.000
5.880	0.0438	-51040.	4000.0000	-0.000522	5242.4306	2.622E+10	0.000	0.000	0.000
6.090	0.0425	-40794.	4000.0000	-0.000527	5159.1490	2.622E+10	0.000	0.000	0.000
6.300	0.0412	-30546.	4000.0000	-0.000530	5075.8572	2.622E+10	0.000	0.000	0.000
6.510	0.0399	-20297.	4000.0000	-0.000532	4992.5578	2.622E+10	0.000	0.000	0.000
6.720	0.0385	-10048.	4000.0000	-0.000534	4909.2534	2.622E+10	0.000	0.000	0.000
6.930	0.0372	201.7445	4000.0000	-0.000534	4829.2259	2.622E+10	0.000	0.000	0.000
7.140	0.0358	10451.	3990.5235	-0.000534	4912.5328	2.622E+10	-7.5211	529.2000	0.000
7.350	0.0345	20653.	3958.2447	-0.000532	4995.4489	2.622E+10	-18.0970	1323.0000	0.000
7.560	0.0331	30739.	3900.3759	-0.000530	5077.4257	2.622E+10	-27.8305	2116.8000	0.000
7.770	0.0318	40647.	3819.0309	-0.000526	5157.9585	2.622E+10	-36.7290	2910.6000	0.000
7.980	0.0305	50321.	3716.3003	-0.000522	5236.5855	2.622E+10	-44.8031	3704.4000	0.000
8.190	0.0292	59709.	3594.2448	-0.000517	5312.8874	2.622E+10	-52.0663	4498.2000	0.000
8.400	0.0279	68764.	3454.8872	-0.000511	5386.4872	2.622E+10	-58.5349	5292.0000	0.000
8.610	0.0266	77446.	3300.2061	-0.000504	5457.0487	2.622E+10	-64.2278	6085.8000	0.000
8.820	0.0253	85717.	3132.1291	-0.000496	5524.2758	2.622E+10	-69.1666	6879.6000	0.000
9.030	0.0241	93547.	2952.5267	-0.000487	5587.9117	2.622E+10	-73.3750	7673.4000	0.000
9.240	0.0229	100907.	2763.2066	-0.000478	5647.7372	2.622E+10	-76.8791	8467.2000	0.000
9.450	0.0217	107777.	2565.9085	-0.000468	5703.5695	2.622E+10	-79.7067	9261.0000	0.000
9.660	0.0205	114137.	2362.2994	-0.000457	5755.2611	2.622E+10	-81.8878	10055.	0.000
9.870	0.0194	119973.	2153.9694	-0.000446	5802.6978	2.622E+10	-83.4535	10849.	0.000
10.080	0.0183	125276.	1942.4281	-0.000434	5845.7973	2.622E+10	-84.4365	11642.	0.000
10.290	0.0172	130038.	1729.1011	-0.000422	5884.5076	2.622E+10	-84.8706	12436.	0.000
10.500	0.0162	134258.	1515.3279	-0.000409	5918.8050	2.622E+10	-84.7906	13230.	0.000

10.710	0.0151	137935.	1302.3595	-0.000396	5948.6927	2.622E+10	-84.2319	14024.	0.000
10.920	0.0142	141074.	1091.3569	-0.000383	5974.1986	2.622E+10	-83.2305	14818.	0.000
11.130	0.0132	143679.	883.3899	-0.000369	5995.3736	2.622E+10	-81.8226	15611.	0.000
11.340	0.0123	145760.	679.4370	-0.000355	6012.2898	2.622E+10	-80.0448	16405.	0.000
11.550	0.0114	147329.	480.3848	-0.000341	6025.0382	2.622E+10	-77.9332	17199.	0.000
11.760	0.0106	148398.	287.0289	-0.000327	6033.7277	2.622E+10	-75.5239	17993.	0.000
11.970	0.009772	148983.	100.0742	-0.000312	6038.4822	2.622E+10	-72.8528	18787.	0.000
12.180	0.009003	149100.	-79.8631	-0.000298	6039.4395	2.622E+10	-69.9547	19580.	0.000
12.390	0.008270	148769.	-252.2547	-0.000284	6036.7491	2.622E+10	-66.8640	20374.	0.000
12.600	0.007573	148009.	-416.6574	-0.000269	6030.5706	2.622E+10	-63.6143	21168.	0.000
12.810	0.006912	146841.	-572.7112	-0.000255	6021.0721	2.622E+10	-60.2379	21962.	0.000
13.020	0.006286	145285.	-720.1362	-0.000241	6008.4279	2.622E+10	-56.7661	22756.	0.000
13.230	0.005696	143364.	-858.7303	-0.000227	5992.8177	2.622E+10	-53.2292	23549.	0.000
13.440	0.005140	141101.	-988.3653	-0.000214	5974.4246	2.622E+10	-49.6557	24343.	0.000
13.650	0.004619	138519.	-1108.9836	-0.000200	5953.4335	2.622E+10	-46.0731	25137.	0.000
13.860	0.004131	135639.	-1220.5950	-0.000187	5930.0300	2.622E+10	-42.5073	25931.	0.000
14.070	0.003676	132486.	-1323.2721	-0.000174	5904.3988	2.622E+10	-38.9825	26725.	0.000
14.280	0.003253	129081.	-1417.1471	-0.000162	5876.7227	2.622E+10	-35.5215	27518.	0.000
14.490	0.002861	125446.	-1502.4071	-0.000149	5847.1812	2.622E+10	-32.1452	28312.	0.000
14.700	0.002500	121603.	-1579.2903	-0.000138	5815.9494	2.622E+10	-28.8732	29106.	0.000
14.910	0.002168	117574.	-1648.0816	-0.000126	5783.1972	2.622E+10	-25.7230	29900.	0.000
15.120	0.001865	113377.	-1709.1081	-0.000115	5749.0881	2.622E+10	-22.7107	30694.	0.000
15.330	0.001589	109033.	-1762.7350	-0.000104	5713.7786	2.622E+10	-19.8504	31487.	0.000
15.540	0.001339	104559.	-1809.3611	-9.399E-05	5677.4176	2.622E+10	-17.1545	32281.	0.000
15.750	0.001115	99973.	-1849.4145	-8.416E-05	5640.1452	2.622E+10	-14.6339	33075.	0.000
15.960	0.000915	95291.	-1883.3482	-7.477E-05	5602.0927	2.622E+10	-12.2976	33869.	0.000
16.170	0.000738	90529.	-1911.6356	-6.584E-05	5563.3818	2.622E+10	-10.1527	34663.	0.000
16.380	0.000583	85699.	-2004.1089	-5.737E-05	5524.1244	2.622E+10	-63.2388	273275.	0.000
16.590	0.000449	80464.	-2147.9855	-4.939E-05	5481.5817	2.622E+10	-50.9489	285976.	0.000
16.800	0.000334	74904.	-2262.0978	-4.192E-05	5436.3894	2.622E+10	-39.6164	298677.	0.000
17.010	0.000238	69090.	-2349.0202	-3.500E-05	5389.1336	2.622E+10	-29.3696	311377.	0.000
17.220	0.000158	63087.	-2411.6063	-2.864E-05	5340.3449	2.622E+10	-20.3018	324078.	0.000
17.430	9.332E-05	56954.	-2452.9008	-2.288E-05	5290.4926	2.622E+10	-12.4717	336779.	0.000
17.640	4.257E-05	50739.	-2476.0544	-1.770E-05	5239.9825	2.622E+10	-5.9042	349480.	0.000
17.850	4.116E-06	44486.	-2484.2390	-1.312E-05	5189.1550	2.622E+10	-0.5916	362181.	0.000
18.060	-2.356E-05	38227.	-2480.5674	-9.147E-06	5138.2860	2.622E+10	3.5056	374881.	0.000
18.270	-4.199E-05	31989.	-2468.0138	-5.773E-06	5087.5884	2.622E+10	6.4576	387582.	0.000
18.480	-5.266E-05	25792.	-2449.3381	-2.995E-06	5037.2162	2.622E+10	8.3644	400283.	0.000
18.690	-5.708E-05	19647.	-2427.0117	-8.116E-07	4987.2693	2.622E+10	9.3550	412984.	0.000
18.900	-5.675E-05	13560.	-2164.9615	7.844E-07	4937.8004	2.622E+10	198.6214	8820000.	0.000
19.110	-5.313E-05	8734.7177	-1680.3959	1.856E-06	4898.5799	2.622E+10	185.9545	8820000.	0.000
19.320	-4.739E-05	5089.8400	-1237.0817	2.520E-06	4868.9552	2.622E+10	165.8822	8820000.	0.000
19.530	-4.043E-05	2498.2254	-849.7869	2.885E-06	4847.8912	2.622E+10	141.4946	8820000.	0.000
19.740	-3.285E-05	805.0820	-526.6175	3.044E-06	4834.1297	2.622E+10	114.9890	8820000.	0.000
19.950	-2.509E-05	-157.8596	-271.1022	3.075E-06	4828.8693	2.622E+10	87.8009	8820000.	0.000
20.160	-1.736E-05	-563.2257	-83.9324	3.040E-06	4832.1640	2.622E+10	60.7465	8820000.	0.000
20.370	-9.763E-06	-582.8098	35.6620	2.985E-06	4832.3231	2.622E+10	34.1697	8820000.	0.000
20.580	-2.311E-06	-385.3847	88.9055	2.939E-06	4830.7185	2.622E+10	8.0870	8820000.	0.000
20.790	5.048E-06	-136.5920	76.8323	2.914E-06	4828.6964	2.622E+10	-17.6689	8820000.	0.000
21.000	1.237E-05	0.000	0.000	2.907E-06	4827.5862	2.622E+10	-43.3091	4410000.	0.000

1st Neg

507.9' → 18.060

507.3' → 18.690

Max Neg

19 ≈ 507.5'

ip = 505'

* The above values of total stress are combined axial and bending stress.

Output Summary for Load Case No. 2:

Pile-head deflection	=	0.0667913 inches
Computed slope at pile head	=	0.000000 radians
Maximum bending moment	=	-336172. inch-lbs
Maximum shear force	=	4000.0000001 lbs
Depth of maximum bending moment	=	0.000000 inches below pile head
Depth of maximum shear force	=	20.1600000 inches below pile head
Number of iterations	=	6
Number of zero deflection points	=	2

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	1	V = 4000.0000	M = 0.000	126000.	0.25005751	452248.	-5833.1271	-0.00217876
2	2	V = 4000.0000	S = 0.000	126000.	0.06679126	-336172.	4000.0000	0.00000000

The analysis ended normally.

SINCE 1881

FROEHLING & ROBERTSON, INC.

Engineering • Environmental • Geotechnical

SHEET NO. _____ OF _____

JOB P-5208A

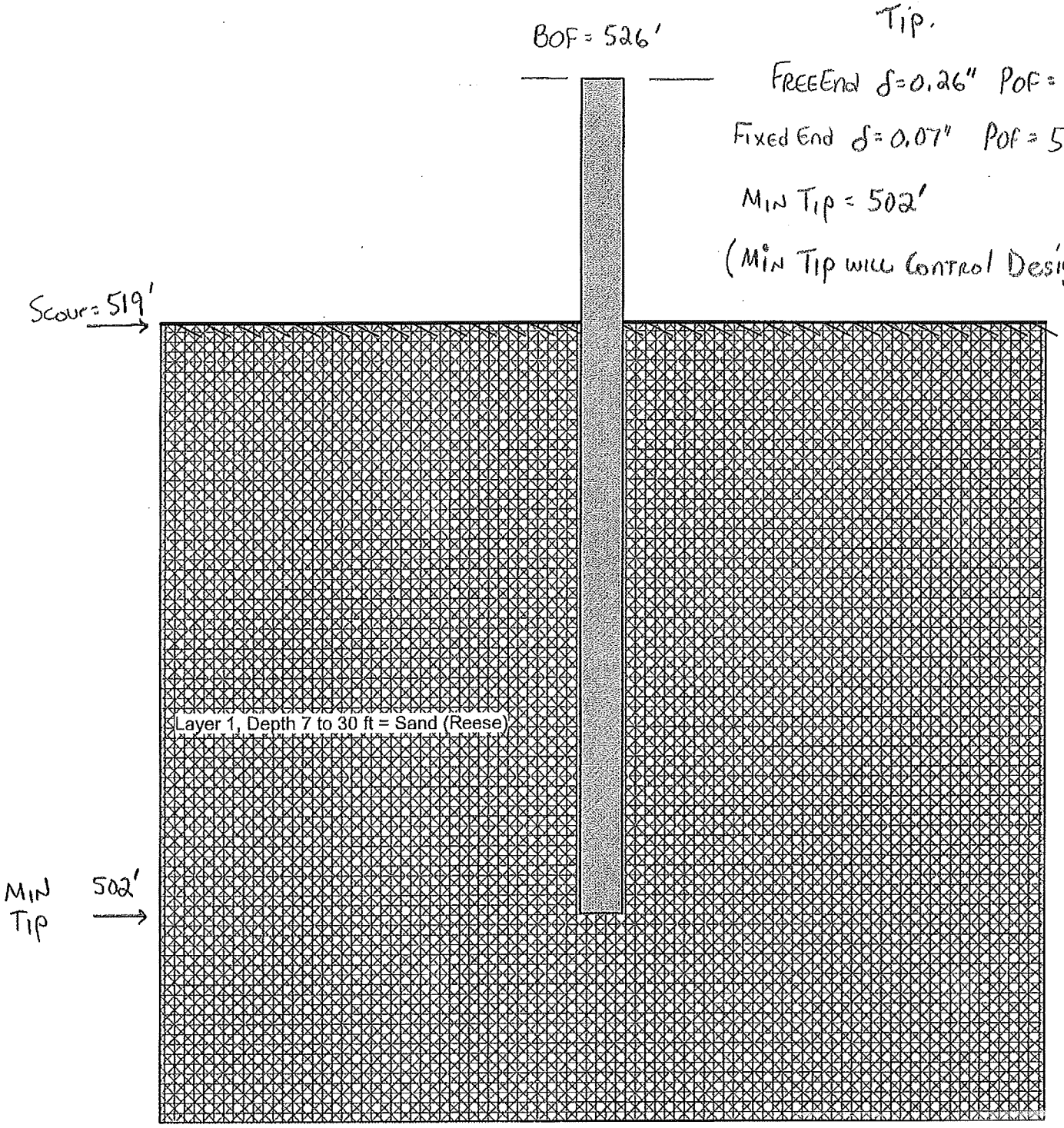
DATE 2/2013

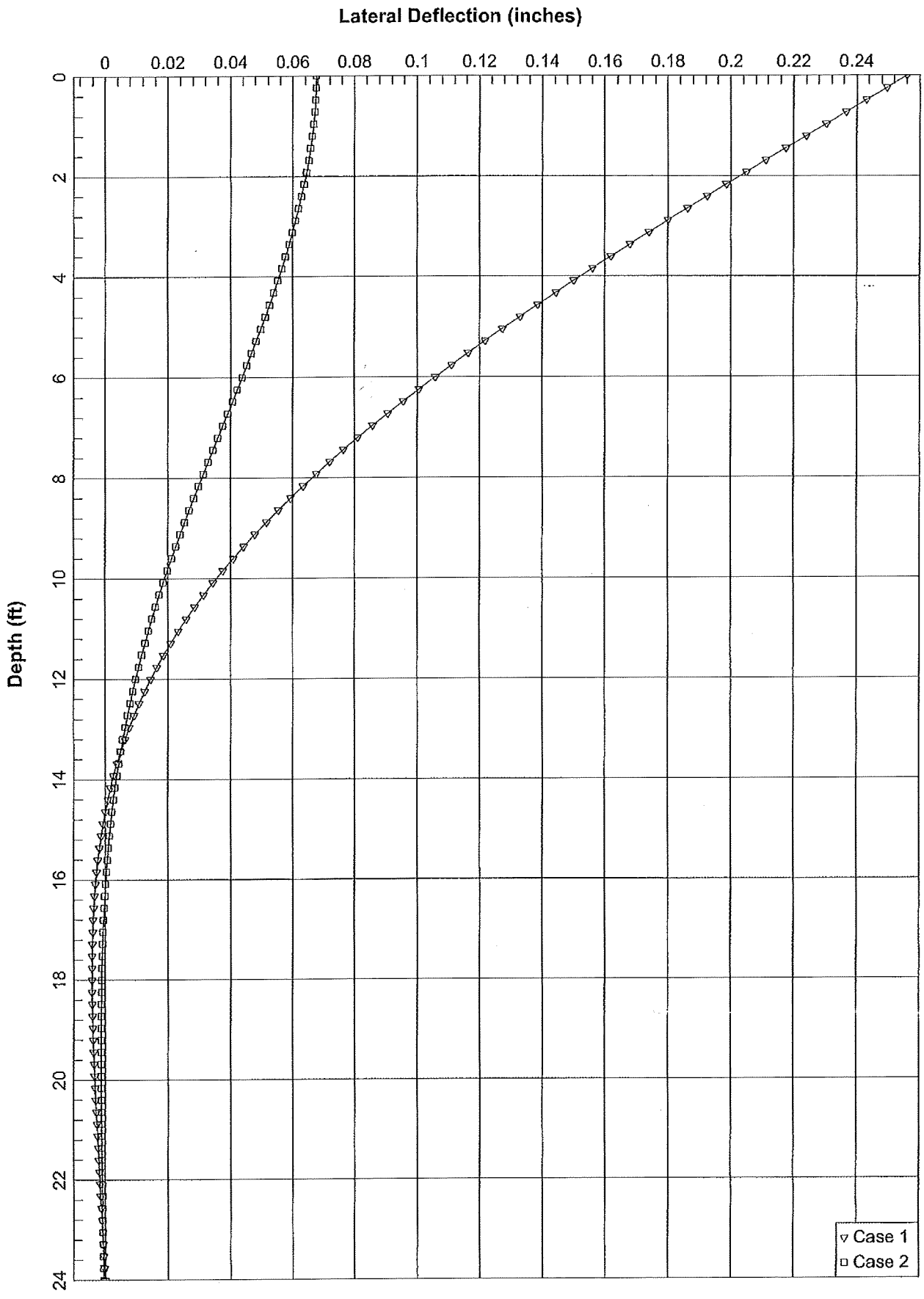
COMPUTATIONS FOR Bent 2 Analysis

BY MW CHKD _____

- Due to the inaccessibility of our drilling equipment at the Bent 2 boring locations, F&R utilized the borings from Bent 1 and End Bent 2 and developed an assumed soil profile for Bent 2 to be used for our analysis and also in estimating pile excavation quantities.
- Based on our analysis, the lateral will control the design. We have assumed a "worst-case" scenario where weathered rock was not encountered to be used to calculate the minimum tip elevation.

Bent 2 - Assume Worst Case w/o WR or CR to estimate MIN Tip.




Lateral Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
Case 1
Case 2

LPile Plus for Windows, Version 2012-06.034

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

This copy of LPile is licensed to:

testt
test

Serial Number of Security Device: 293783516
Company Name Stored in Security Device: Froehling & Robertson, Inc.

Files Used for Analysis

Path to file locations: E:\Lpile 2012\Branch63\H2J\
Name of input data file: Bent 2 Worst Case Scenario.lp6d
Name of output report file: Bent 2 Worst Case Scenario.lp6o
Name of plot output file: Bent 2 Worst Case Scenario.lp6p
Name of runtime messeage file: Bent 2 Worst Case Scenario.lp6r

Date and Time of Analysis

Date: January 31, 2013 Time: 15:59:07

Problem Title

Project Name: H2J Bridge Bent 2

Job Number: 63P-0090

Client: HDR

Engineer: M. Walko

Description: Bent 2 Worst Case Soil Conditions

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear moment-curvature and nominal moment capacity for section types with nonlinear properties.

Computation Options:
- Analysis does not use p-y multipliers (individual pile or shaft only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix values
- Report pile response for full length of pile
- Analysis assumes no loading by soil movements acting on pile
- No p-y curves to be computed and reported for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 24.00 ft

Depth of ground surface below top of pile = 7.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	14.6950000
2	24.000000	14.6950000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile	
Cross-sectional Shape	=	Strong H-Pile	
Section Length	=	24.00000000	ft
Flange Width	=	14.69500000	in
Section Depth	=	13.83000000	in
Flange Thickness	=	0.61500000	in
Web Thickness	=	0.61500000	in
Section Area	=	26.10000000	Sq. in
Moment of Inertia	=	904.00000000	in^4
Elastic Modulus	=	29000000.	lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 1 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	7.00000 ft
Distance from top of pile to bottom of layer	=	30.00000 ft
Effective unit weight at top of layer	=	125.00000 pcf
Effective unit weight at bottom of layer	=	125.00000 pcf
Friction angle at top of layer	=	40.00000 deg.
Friction angle at bottom of layer	=	40.00000 deg.
Subgrade k at top of layer	=	125.00000 pci
Subgrade k at bottom of layer	=	125.00000 pci

(Depth of lowest soil layer extends 6.00 ft below pile tip)

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	7.000	125.000	40.000	125.000
		30.000	125.000	40.000	125.000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 4000.00000 lbs	M = 0.0000 in-lbs	126000.	No
2	2	V = 4000.00000 lbs	S = 0.0000 in/in	126000.	No

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

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Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 4000.000 lbs
Applied moment at pile head = 0.000 in-lbs
Axial thrust load on pile head = 126000.000 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2560	3.860E-06	4000.0000	-0.002227	4827.5862	2.622E+10	0.000	0.000	0.000
0.240	0.2496	12328.	4000.0000	-0.002226	4927.7866	2.622E+10	0.000	0.000	0.000
0.480	0.2432	24656.	4000.0000	-0.002224	5027.9830	2.622E+10	0.000	0.000	0.000
0.720	0.2368	36983.	4000.0000	-0.002221	5128.1714	2.622E+10	0.000	0.000	0.000
0.960	0.2304	49308.	4000.0000	-0.002216	5228.3478	2.622E+10	0.000	0.000	0.000
1.200	0.2240	61631.	4000.0000	-0.002210	5328.5082	2.622E+10	0.000	0.000	0.000
1.440	0.2177	73952.	4000.0000	-0.002203	5428.6487	2.622E+10	0.000	0.000	0.000
1.680	0.2113	86270.	4000.0000	-0.002194	5528.7652	2.622E+10	0.000	0.000	0.000
1.920	0.2050	98584.	4000.0000	-0.002184	5628.8537	2.622E+10	0.000	0.000	0.000
2.160	0.1987	110894.	4000.0000	-0.002172	5728.9103	2.622E+10	0.000	0.000	0.000
2.400	0.1925	123201.	4000.0000	-0.002159	5828.9310	2.622E+10	0.000	0.000	0.000
2.640	0.1863	135502.	4000.0000	-0.002145	5928.9118	2.622E+10	0.000	0.000	0.000
2.880	0.1802	147797.	4000.0000	-0.002130	6028.8486	2.622E+10	0.000	0.000	0.000
3.120	0.1740	160087.	4000.0000	-0.002113	6128.7376	2.622E+10	0.000	0.000	0.000
3.360	0.1680	172371.	4000.0000	-0.002094	6228.5747	2.622E+10	0.000	0.000	0.000
3.600	0.1620	184647.	4000.0000	-0.002075	6328.3560	2.622E+10	0.000	0.000	0.000
3.840	0.1560	196917.	4000.0000	-0.002054	6428.0774	2.622E+10	0.000	0.000	0.000
4.080	0.1501	209178.	4000.0000	-0.002032	6527.7350	2.622E+10	0.000	0.000	0.000
4.320	0.1443	221431.	4000.0000	-0.002008	6627.3248	2.622E+10	0.000	0.000	0.000
4.560	0.1386	233675.	4000.0000	-0.001983	6726.8429	2.622E+10	0.000	0.000	0.000
4.800	0.1329	245910.	4000.0000	-0.001957	6826.2853	2.622E+10	0.000	0.000	0.000
5.040	0.1273	258135.	4000.0000	-0.001929	6925.6480	2.622E+10	0.000	0.000	0.000
5.280	0.1218	270350.	4000.0000	-0.001900	7024.9271	2.622E+10	0.000	0.000	0.000
5.520	0.1164	282554.	4000.0000	-0.001869	7124.1186	2.622E+10	0.000	0.000	0.000
5.760	0.1110	294747.	4000.0000	-0.001838	7223.2185	2.622E+10	0.000	0.000	0.000
6.000	0.1058	306928.	4000.0000	-0.001805	7322.2229	2.622E+10	0.000	0.000	0.000
6.240	0.1006	319097.	4000.0000	-0.001770	7421.1279	2.622E+10	0.000	0.000	0.000
6.480	0.0956	331253.	4000.0000	-0.001735	7519.9295	2.622E+10	0.000	0.000	0.000
6.720	0.0906	343395.	4000.0000	-0.001698	7618.6237	2.622E+10	0.000	0.000	0.000
6.960	0.0858	355525.	4000.0000	-0.001659	7717.2067	2.622E+10	0.000	0.000	0.000

7.200	0.0811	367640.	3971.3165	-0.001619	7815.6745	2.622E+10	-19.9191	707.4772	0.000
7.440	0.0765	379575.	3874.7154	-0.001578	7912.6803	2.622E+10	-47.1650	1776.0657	0.000
7.680	0.0720	391103.	3701.0513	-0.001536	8006.3835	2.622E+10	-73.4351	2937.6000	0.000
7.920	0.0676	402008.	3460.9040	-0.001492	8095.0094	2.622E+10	-93.3338	3974.4000	0.000
8.160	0.0634	412121.	3167.6522	-0.001448	8177.2129	2.622E+10	-110.3132	5011.2000	0.000
8.400	0.0593	421304.	2829.4960	-0.001402	8251.8461	2.622E+10	-124.5174	6048.0000	0.000
8.640	0.0553	429437.	2454.2151	-0.001355	8317.9485	2.622E+10	-136.0943	7084.8000	0.000
8.880	0.0515	436424.	2049.1582	-0.001308	8374.7370	2.622E+10	-145.1952	8121.6000	0.000
9.120	0.0478	442189.	1621.2349	-0.001259	8421.5957	2.622E+10	-151.9738	9158.4000	0.000
9.360	0.0442	446676.	1176.9094	-0.001211	8458.0658	2.622E+10	-156.5856	10195.	0.000
9.600	0.0408	449847.	722.1962	-0.001161	8483.8350	2.622E+10	-159.1874	11232.	0.000
9.840	0.0375	451679.	262.6585	-0.001112	8498.7269	2.622E+10	-159.9360	12269.	0.000
10.080	0.0344	452167.	-196.5919	-0.001062	8502.6903	2.622E+10	-158.9879	13306.	0.000
10.320	0.0314	451318.	-650.8917	-0.001013	8495.7891	2.622E+10	-156.4980	14342.	0.000
10.560	0.0286	449152.	-1096.0211	-0.000963	8478.1913	2.622E+10	-152.6196	15379.	0.000
10.800	0.0259	445703.	-1528.1975	-0.000914	8450.1591	2.622E+10	-147.5029	16416.	0.000
11.040	0.0233	441013.	-1944.0660	-0.000865	8412.0386	2.622E+10	-141.2947	17453.	0.000
11.280	0.0209	435134.	-2340.6890	-0.000817	8364.2499	2.622E+10	-134.1379	18490.	0.000
11.520	0.0186	428124.	-2715.5330	-0.000770	8307.2773	2.622E+10	-126.1705	19526.	0.000
11.760	0.0165	420051.	-3066.4550	-0.000723	8241.6602	2.622E+10	-117.5253	20563.	0.000
12.000	0.0144	410986.	-3391.6861	-0.000677	8167.9840	2.622E+10	-108.3296	21600.	0.000
12.240	0.0126	401006.	-3689.8149	-0.000633	8086.8716	2.622E+10	-98.7042	22637.	0.000
12.480	0.0108	390192.	-3959.7688	-0.000589	7998.9752	2.622E+10	-88.7638	23674.	0.000
12.720	0.009163	378626.	-4200.7953	-0.000547	7904.9683	2.622E+10	-78.6158	24710.	0.000
12.960	0.007647	366393.	-4412.4419	-0.000506	7805.5388	2.622E+10	-68.3610	25747.	0.000
13.200	0.006247	353578.	-4594.5352	-0.000467	7701.3821	2.622E+10	-58.0927	26784.	0.000
13.440	0.004958	340267.	-4747.1603	-0.000429	7593.1946	2.622E+10	-47.8970	27821.	0.000
13.680	0.003778	326545.	-4870.6394	-0.000392	7481.6678	2.622E+10	-37.8524	28858.	0.000
13.920	0.002700	312496.	-4965.5104	-0.000357	7367.4833	2.622E+10	-28.0302	29894.	0.000
1ST Neg 14.160	0.001722	298203.	-5032.5057	-0.000323	7251.3080	2.622E+10	-18.4943	30931.	0.000
14.400	0.000838	283744.	-5072.5310	-0.000291	7133.7893	2.622E+10	-9.3011	31968.	0.000
14.640	4.365E-05	269196.	-5086.6449	-0.000261	7015.5515	2.622E+10	-0.5002	33005.	0.000
511.1' → 14.880	-0.000665	254634.	-5076.0385	-0.000232	6897.1929	2.622E+10	7.8658	34042.	0.000
15.120	-0.001294	240127.	-5042.0156	-0.000205	6779.2820	2.622E+10	15.7612	35078.	0.000
15.360	-0.001847	225741.	-4985.9742	-0.000179	6662.3558	2.622E+10	23.1564	36115.	0.000
15.600	-0.002328	211538.	-4909.3884	-0.000155	6546.9176	2.622E+10	30.0282	37152.	0.000
15.840	-0.002742	197576.	-4813.7910	-0.000133	6433.4352	2.622E+10	36.3589	38189.	0.000
16.080	-0.003094	183907.	-4700.7578	-0.000112	6322.3399	2.622E+10	42.1365	39226.	0.000
16.320	-0.003387	170581.	-4571.8918	-9.255E-05	6214.0257	2.622E+10	47.3538	40262.	0.000
16.560	-0.003627	157640.	-4428.8098	-7.452E-05	6108.8485	2.622E+10	52.0086	41299.	0.000
16.800	-0.003817	145125.	-4273.1294	-5.789E-05	6007.1265	2.622E+10	56.1028	42336.	0.000
17.040	-0.003960	133069.	-4106.4570	-4.261E-05	5909.1395	2.622E+10	59.6420	43373.	0.000
17.280	-0.004062	121503.	-3930.3775	-2.863E-05	5815.1302	2.622E+10	62.6355	44410.	0.000
17.520	-0.004125	110451.	-3746.4447	-1.589E-05	5725.3041	2.622E+10	65.0956	45446.	0.000
508.2' → 17.760	-0.004153	99935.	-3556.1734	-4.333E-06	5639.8307	2.622E+10	67.0372	46483.	0.000
18.000	-0.004150	89970.	-3361.0321	6.098E-06	5558.8441	2.622E+10	68.4775	47520.	0.000
MAX Neg 18.240	-0.004118	80571.	-3162.4373	1.547E-05	5482.4448	2.622E+10	69.4355	48557.	0.000
18.480	-0.004061	71743.	-2961.7486	2.383E-05	5410.7004	2.622E+10	69.9316	49594.	0.000
18.720	-0.003981	63494.	-2760.2650	3.126E-05	5343.6472	2.622E+10	69.9875	50630.	0.000
Of ≈ 509.5' 18.960	-0.003881	55822.	-2559.2226	3.781E-05	5281.2917	2.622E+10	69.6253	51667.	0.000
19.200	-0.003763	48725.	-2359.7923	4.356E-05	5223.6118	2.622E+10	68.8679	52704.	0.000
ρ = 502' 19.440	-0.003630	42198.	-2163.0796	4.855E-05	5170.5589	2.622E+10	67.7381	53741.	0.000
19.680	-0.003484	36230.	-1970.1246	5.286E-05	5122.0588	2.622E+10	66.2585	54778.	0.000
19.920	-0.003326	30811.	-1781.9026	5.654E-05	5078.0139	2.622E+10	64.4512	55814.	0.000
20.160	-0.003158	25926.	-1599.3265	5.966E-05	5038.3039	2.622E+10	62.3378	56851.	0.000
20.400	-0.002982	21556.	-1423.2484	6.227E-05	5002.7880	2.622E+10	59.9387	57888.	0.000
20.640	-0.002799	17683.	-1254.4629	6.442E-05	4971.3059	2.622E+10	57.2735	58925.	0.000
20.880	-0.002611	14283.	-1093.7105	6.618E-05	4943.6791	2.622E+10	54.3602	59962.	0.000
21.120	-0.002418	11335.	-941.6815	6.758E-05	4919.7124	2.622E+10	51.2155	60998.	0.000
21.360	-0.002222	8810.3631	-799.0202	6.869E-05	4899.1948	2.622E+10	47.8548	62035.	0.000
21.600	-0.002022	6682.5464	-666.3293	6.954E-05	4881.9004	2.622E+10	44.2916	63072.	0.000
21.840	-0.001821	4921.8358	-544.1747	7.018E-05	4867.5897	2.622E+10	40.5379	64109.	0.000
22.080	-0.001618	3497.1668	-433.0902	7.064E-05	4856.0104	2.622E+10	36.6040	65146.	0.000
22.320	-0.001414	2375.9670	-333.5824	7.096E-05	4846.8975	2.622E+10	32.4987	66182.	0.000
22.560	-0.001209	1524.2293	-246.1348	7.118E-05	4839.9748	2.622E+10	28.2288	67219.	0.000
22.800	-0.001004	906.5721	-171.2130	7.131E-05	4834.9546	2.622E+10	23.8002	68256.	0.000
23.040	-0.000799	486.2867	-109.2686	7.139E-05	4831.5386	2.622E+10	19.2168	69293.	0.000

23.280	-0.000593	225.3739	-60.7427	7.143E-05	4829.4180	2.622E+10	14.4817	70330.	0.000
23.520	-0.000387	84.5694	-26.0696	7.144E-05	4828.2736	2.622E+10	9.5968	71366.	0.000
23.760	-0.000182	23.3612	-5.6794	7.145E-05	4827.7761	2.622E+10	4.5631	72403.	0.000
24.000	2.428E-05	0.000	0.000	7.145E-05	4827.5862	2.622E+10	-0.6190	36720.	0.000

* The above values of total stress are combined axial and bending stress.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.2560040 inches
Computed slope at pile head = -0.0022271 radians
Maximum bending moment = 452167. inch-lbs
Maximum shear force = -5086.6449323 lbs
Depth of maximum bending moment = 120.9600000 inches below pile head
Depth of maximum shear force = 175.6800000 inches below pile head
Number of iterations = 6
Number of zero deflection points = 2

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 4000.000 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 126000.000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0676	-338105.	4000.0000	0.000	7575.6208	2.622E+10	0.000	0.000	0.000
0.240	0.0675	-326578.	4000.0000	-3.651E-05	7481.9341	2.622E+10	0.000	0.000	0.000
0.480	0.0674	-315038.	4000.0000	-7.175E-05	7388.1417	2.622E+10	0.000	0.000	0.000
0.720	0.0671	-303486.	4000.0000	-0.000106	7294.2472	2.622E+10	0.000	0.000	0.000
0.960	0.0667	-291921.	4000.0000	-0.000138	7200.2543	2.622E+10	0.000	0.000	0.000
1.200	0.0663	-280345.	4000.0000	-0.000170	7106.1669	2.622E+10	0.000	0.000	0.000
1.440	0.0658	-268758.	4000.0000	-0.000200	7011.9886	2.622E+10	0.000	0.000	0.000
1.680	0.0651	-257160.	4000.0000	-0.000229	6917.7232	2.622E+10	0.000	0.000	0.000
1.920	0.0644	-245552.	4000.0000	-0.000257	6823.3745	2.622E+10	0.000	0.000	0.000
2.160	0.0637	-233934.	4000.0000	-0.000283	6728.9463	2.622E+10	0.000	0.000	0.000
2.400	0.0628	-222307.	4000.0000	-0.000308	6634.4423	2.622E+10	0.000	0.000	0.000
2.640	0.0619	-210670.	4000.0000	-0.000332	6539.8662	2.622E+10	0.000	0.000	0.000
2.880	0.0609	-199026.	4000.0000	-0.000354	6445.2219	2.622E+10	0.000	0.000	0.000
3.120	0.0599	-187373.	4000.0000	-0.000375	6350.5130	2.622E+10	0.000	0.000	0.000
3.360	0.0587	-175713.	4000.0000	-0.000395	6255.7435	2.622E+10	0.000	0.000	0.000
3.600	0.0576	-164046.	4000.0000	-0.000414	6160.9170	2.622E+10	0.000	0.000	0.000
3.840	0.0564	-152373.	4000.0000	-0.000431	6066.0374	2.622E+10	0.000	0.000	0.000
4.080	0.0551	-140693.	4000.0000	-0.000448	5971.1085	2.622E+10	0.000	0.000	0.000
4.320	0.0538	-129008.	4000.0000	-0.000462	5876.1339	2.622E+10	0.000	0.000	0.000
4.560	0.0524	-117318.	4000.0000	-0.000476	5781.1175	2.622E+10	0.000	0.000	0.000
4.800	0.0510	-105623.	4000.0000	-0.000488	5686.0631	2.622E+10	0.000	0.000	0.000
5.040	0.0496	-93924.	4000.0000	-0.000499	5590.9745	2.622E+10	0.000	0.000	0.000
5.280	0.0482	-82221.	4000.0000	-0.000509	5495.8555	2.622E+10	0.000	0.000	0.000
5.520	0.0467	-70514.	4000.0000	-0.000517	5400.7098	2.622E+10	0.000	0.000	0.000
5.760	0.0452	-58805.	4000.0000	-0.000524	5305.5413	2.622E+10	0.000	0.000	0.000
6.000	0.0437	-47094.	4000.0000	-0.000530	5210.3537	2.622E+10	0.000	0.000	0.000
6.240	0.0421	-35381.	4000.0000	-0.000535	5115.1509	2.622E+10	0.000	0.000	0.000
6.480	0.0406	-23666.	4000.0000	-0.000538	5019.9366	2.622E+10	0.000	0.000	0.000
6.720	0.0390	-11950.	4000.0000	-0.000540	4924.7146	2.622E+10	0.000	0.000	0.000

6.960	0.0375	-234.0795	4000.0000	-0.000540	4829.4888	2.622E+10	0.000	0.000	0.000
7.200	0.0359	11482.	3984.4813	-0.000540	4920.9096	2.622E+10	-10.7769	864.0000	0.000
7.440	0.0344	23108.	3936.2972	-0.000538	5015.4053	2.622E+10	-22.6842	1900.8000	0.000
7.680	0.0328	34546.	3855.4193	-0.000535	5108.3642	2.622E+10	-33.4810	2937.6000	0.000
7.920	0.0313	45704.	3745.0277	-0.000530	5199.0548	2.622E+10	-43.1799	3974.4000	0.000
8.160	0.0298	56502.	3608.2580	-0.000525	5286.8196	2.622E+10	-51.7991	5011.2000	0.000
8.400	0.0283	66868.	3448.1872	-0.000518	5371.0741	2.622E+10	-59.3612	6048.0000	0.000
8.640	0.0268	76739.	3267.8202	-0.000510	5451.3052	2.622E+10	-65.8937	7084.8000	0.000
8.880	0.0253	86061.	3070.0766	-0.000501	5527.0691	2.622E+10	-71.4282	8121.6000	0.000
9.120	0.0239	94787.	2857.7795	-0.000491	5597.9898	2.622E+10	-76.0003	9158.4000	0.000
9.360	0.0225	102878.	2633.6441	-0.000480	5663.7562	2.622E+10	-79.6493	10195.	0.000
9.600	0.0211	110305.	2400.2682	-0.000469	5724.1198	2.622E+10	-82.4174	11232.	0.000
9.840	0.0198	117044.	2160.1235	-0.000456	5778.8914	2.622E+10	-84.3498	12269.	0.000
10.080	0.0185	123078.	1915.5484	-0.000443	5827.9387	2.622E+10	-85.4941	13306.	0.000
10.320	0.0172	128399.	1668.7413	-0.000429	5871.1826	2.622E+10	-85.8998	14342.	0.000
10.560	0.0160	133002.	1421.7559	-0.000415	5908.5939	2.622E+10	-85.6178	15379.	0.000
10.800	0.0149	136889.	1176.4975	-0.000400	5940.1902	2.622E+10	-84.7005	16416.	0.000
11.040	0.0137	140069.	934.7197	-0.000385	5966.0320	2.622E+10	-83.2007	17453.	0.000
11.280	0.0126	142553.	698.0235	-0.000369	5986.2195	2.622E+10	-81.1716	18490.	0.000
11.520	0.0116	144357.	467.8567	-0.000353	6000.8887	2.622E+10	-78.6664	19526.	0.000
11.760	0.0106	145504.	245.5143	-0.000338	6010.2077	2.622E+10	-75.7380	20563.	0.000
12.000	0.009658	146016.	32.1405	-0.000322	6014.3738	2.622E+10	-72.4383	21600.	0.000
12.240	0.008756	145922.	-171.2689	-0.000306	6013.6091	2.622E+10	-68.8183	22637.	0.000
12.480	0.007899	145252.	-363.8631	-0.000290	6008.1578	2.622E+10	-64.9277	23674.	0.000
12.720	0.007088	144037.	-544.9319	-0.000274	5998.2823	2.622E+10	-60.8145	24710.	0.000
12.960	0.006323	142311.	-713.9008	-0.000258	5984.2603	2.622E+10	-56.5250	25747.	0.000
13.200	0.005603	140112.	-870.3255	-0.000242	5966.3816	2.622E+10	-52.1033	26784.	0.000
13.440	0.004927	137474.	-1013.8855	-0.000227	5944.9449	2.622E+10	-47.5912	27821.	0.000
13.680	0.004294	134437.	-1144.3775	-0.000212	5920.2554	2.622E+10	-43.0283	28858.	0.000
13.920	0.003704	131037.	-1261.7085	-0.000198	5892.6215	2.622E+10	-38.4516	29894.	0.000
14.160	0.003156	127313.	-1365.8882	-0.000183	5862.3530	2.622E+10	-33.8954	30931.	0.000
14.400	0.002648	123302.	-1457.0215	-0.000170	5829.7581	2.622E+10	-29.3916	31968.	0.000
14.640	0.002179	119043.	-1535.3007	-0.000156	5795.1419	2.622E+10	-24.9689	33005.	0.000
14.880	0.001747	114572.	-1600.9973	-0.000144	5758.8039	2.622E+10	-20.6537	34042.	0.000
15.120	0.001352	109926.	-1654.4546	-0.000131	5721.0363	2.622E+10	-16.4694	35078.	0.000
15.360	0.000992	105138.	-1696.0793	-0.000119	5682.1228	2.622E+10	-12.4367	36115.	0.000
15.600	0.000665	100243.	-1726.3341	-0.000108	5642.3369	2.622E+10	-8.5736	37152.	0.000
15.840	0.000369	95273.	-1745.7295	-9.735E-05	5601.9405	2.622E+10	-4.8955	38189.	0.000
16.080	0.000104	90258.	-1754.8168	-8.715E-05	5561.1832	2.622E+10	-1.4152	39226.	0.000
16.320	-0.000133	85228.	-1754.1807	-7.752E-05	5520.3012	2.622E+10	1.8569	40262.	0.000
16.560	-0.000343	80210.	-1744.4326	-6.843E-05	5479.5168	2.622E+10	4.9127	41299.	0.000
16.800	-0.000527	75230.	-1726.2034	-5.989E-05	5439.0376	2.622E+10	7.7465	42336.	0.000
17.040	-0.000688	70311.	-1700.1378	-5.190E-05	5399.0563	2.622E+10	10.3546	43373.	0.000
17.280	-0.000826	65475.	-1666.8884	-4.444E-05	5359.7502	2.622E+10	12.7353	44410.	0.000
17.520	-0.000944	60742.	-1627.1099	-3.750E-05	5321.2815	2.622E+10	14.8887	45446.	0.000
17.760	-0.001042	56130.	-1581.4542	-3.109E-05	5283.7968	2.622E+10	16.8166	46483.	0.000
18.000	-0.001123	51655.	-1530.5661	-2.516E-05	5247.4276	2.622E+10	18.5224	47520.	0.000
18.240	-0.001187	47332.	-1475.0785	-1.973E-05	5212.2904	2.622E+10	20.0107	48557.	0.000
18.480	-0.001236	43173.	-1415.6094	-1.476E-05	5178.4868	2.622E+10	21.2874	49594.	0.000
18.720	-0.001272	39189.	-1352.7580	-1.023E-05	5146.1043	2.622E+10	22.3594	50630.	0.000
18.960	-0.001295	35389.	-1287.1024	-6.136E-06	5115.2165	2.622E+10	23.2348	51667.	0.000
19.200	-0.001307	31780.	-1219.1967	-2.446E-06	5085.8836	2.622E+10	23.9220	52704.	0.000
19.440	-0.001309	28368.	-1149.5695	8.573E-07	5058.1531	2.622E+10	24.4302	53741.	0.000
19.680	-0.001302	25157.	-1078.7223	3.797E-06	5032.0604	2.622E+10	24.7692	54778.	0.000
19.920	-0.001287	22152.	-1007.1281	6.396E-06	5007.6293	2.622E+10	24.9490	55814.	0.000
20.160	-0.001265	19352.	-935.2309	8.676E-06	4984.8730	2.622E+10	24.9796	56851.	0.000
20.400	-0.001237	16758.	-863.4454	1.066E-05	4963.7945	2.622E+10	24.8714	57888.	0.000
20.640	-0.001204	14371.	-792.1568	1.237E-05	4944.3872	2.622E+10	24.6346	58925.	0.000
20.880	-0.001166	12187.	-721.7212	1.383E-05	4926.6359	2.622E+10	24.2790	59962.	0.000
21.120	-0.001124	10203.	-652.4666	1.506E-05	4910.5175	2.622E+10	23.8145	60998.	0.000
21.360	-0.001079	8417.4538	-584.6930	1.608E-05	4896.0013	2.622E+10	23.2504	62035.	0.000
21.600	-0.001032	6823.9591	-518.6747	1.692E-05	4883.0497	2.622E+10	22.5956	63072.	0.000
21.840	-0.000982	5417.6095	-454.6608	1.759E-05	4871.6193	2.622E+10	21.8585	64109.	0.000
22.080	-0.000930	4192.3469	-392.8773	1.812E-05	4861.6606	2.622E+10	21.0467	65146.	0.000
22.320	-0.000878	3141.4868	-333.5292	1.852E-05	4853.1195	2.622E+10	20.1673	66182.	0.000
22.560	-0.000824	2257.7772	-276.8018	1.882E-05	4845.9369	2.622E+10	19.2267	67219.	0.000
22.800	-0.000769	1533.4516	-222.8636	1.903E-05	4840.0497	2.622E+10	18.2304	68256.	0.000

1st Neg

09.7' →

06.6' →

MAX NEG

Pof ≈ 508'

ip = 502'

23.040	-0.000714	960.2752	-171.8680	1.916E-05	4835.3911	2.622E+10	17.1832	69293.	0.000
23.280	-0.000659	529.5845	-123.9563	1.924E-05	4831.8905	2.622E+10	16.0889	70330.	0.000
23.520	-0.000603	232.3200	-79.2595	1.929E-05	4829.4744	2.622E+10	14.9506	71366.	0.000
23.760	-0.000548	59.0523	-37.9013	1.930E-05	4828.0662	2.622E+10	13.7705	72403.	0.000
24.000	-0.000492	0.000	0.000	1.931E-05	4827.5862	2.622E+10	12.5499	36720.	0.000

* The above values of total stress are combined axial and bending stress.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.0675627 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = -338105. inch-lbs
Maximum shear force = 4000.0000001 lbs
Depth of maximum bending moment = 0.000000 inches below pile head
Depth of maximum shear force = 25.9200000 inches below pile head
Number of iterations = 6
Number of zero deflection points = 1

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	1	V = 4000.0000	M = 0.000	126000.	0.25600403	452167.	-5086.6449	-0.00222707
2	2	V = 4000.0000	S = 0.000	126000.	0.06756269	-338105.	4000.0000	0.00000000

The analysis ended normally.

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SHEET NO. 1 OF 2

JOB P-5208A

DATE 2/2013

COMPUTATIONS FOR Pile Exc. Quantity Est.

BY MWJ CHKD

* USE Assumed Soil Profile to estimate pile EXCAVATION QUANTITIES for Bent 2.

BENT 1 (48 piles) BOF = 526' MIN TIP = 505'

(LT) ∴ Soil ≅ 526 - 510 = 16'
WR ≅ 510 - 507 = 3' (use ½ WR as "In Soil", ½ WR as "Not in Soil")
CR ≅ 507 - 505 = 2'

In Soil = 24(16) + 24(1.5) = 420'
Not In Soil = 24(2) + 24(1.5) = 84'

(RT) Soil ≅ 526 - 515 = 11'
WR ≅ 515 - 507 = 8' (4' In Soil, 4' Not In Soil)
CR ≅ 507 - 505 = 2'

In Soil = 24(11) + 24(4) = 360'
Not In Soil = 24(4) + 24(2) = 144'

Total for Bent 1:

In Soil = 780'

Not In Soil = 228'

Form No. 502
Revised 05/2008

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SHEET NO. 2 OF 2

JOB P-5208A DATE 2/2013

COMPUTATIONS FOR Pile Exc. Quantity Est. BY MW CHKD

Bent 2 (48 Piles) BOF = 526' MIN TIP = 502'

(LT) Soil: 526 - 520 = 6'
WR: 520 - 504 = 16' (8' IN SOIL, 8' NOT IN SOIL)
CR: 504 - 502 = 2'

IN SOIL = 24(6) + 24(8) = 336'
NOT IN SOIL = 24(8) + 24(2) = 240'

(RT) Soil: 526 - 520 = 6'
WR: 520 - 506 = 14' (7' IN SOIL, 7' NOT IN SOIL)
CR: 506 - 502 = 4'

IN SOIL = 24(6) + 24(7) = 312'
NOT IN SOIL = 24(7) + 24(4) = 264'

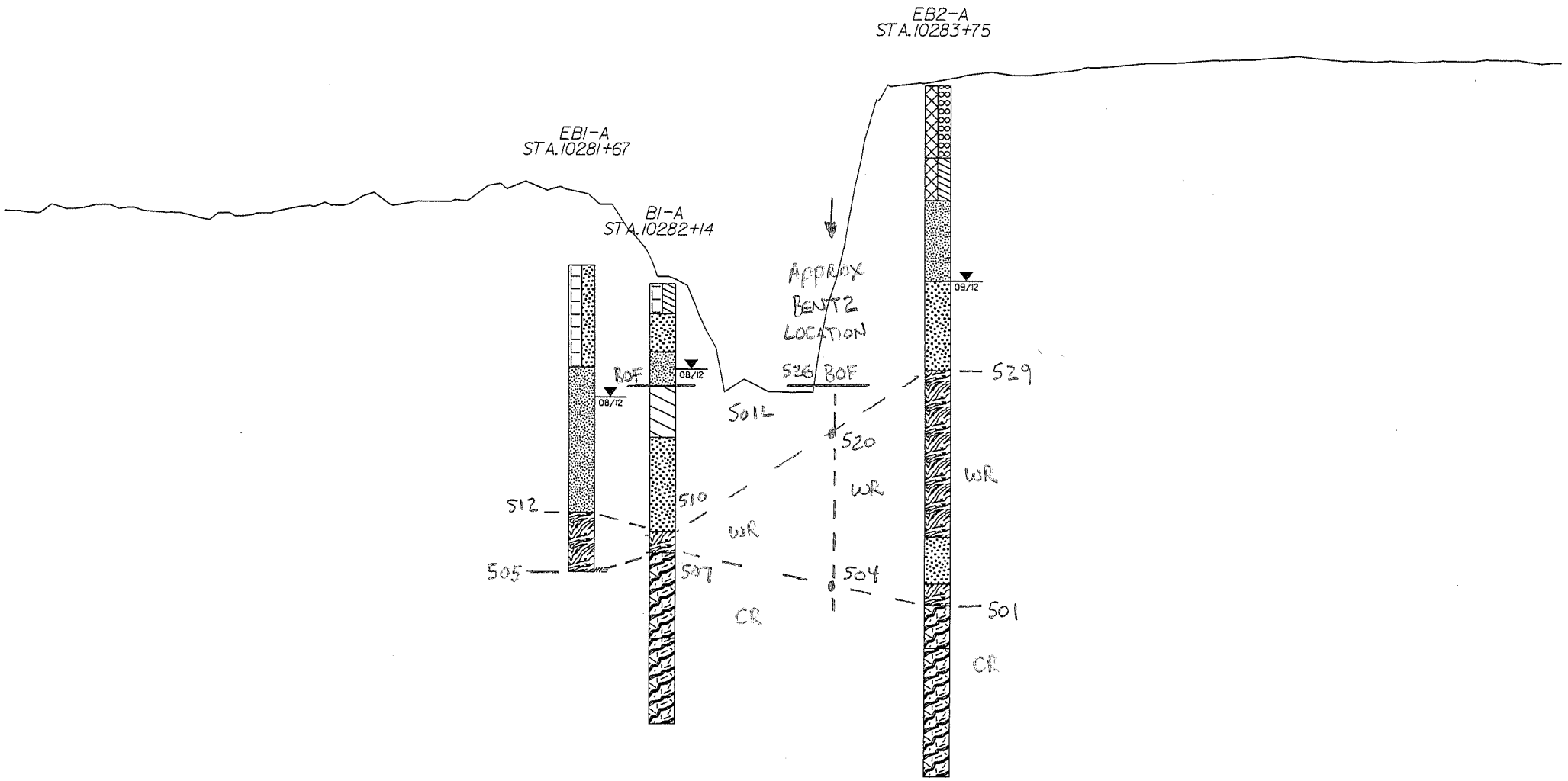
TOTAL For Bent 2:

IN SOIL = 648'

NOT IN SOIL = 504'

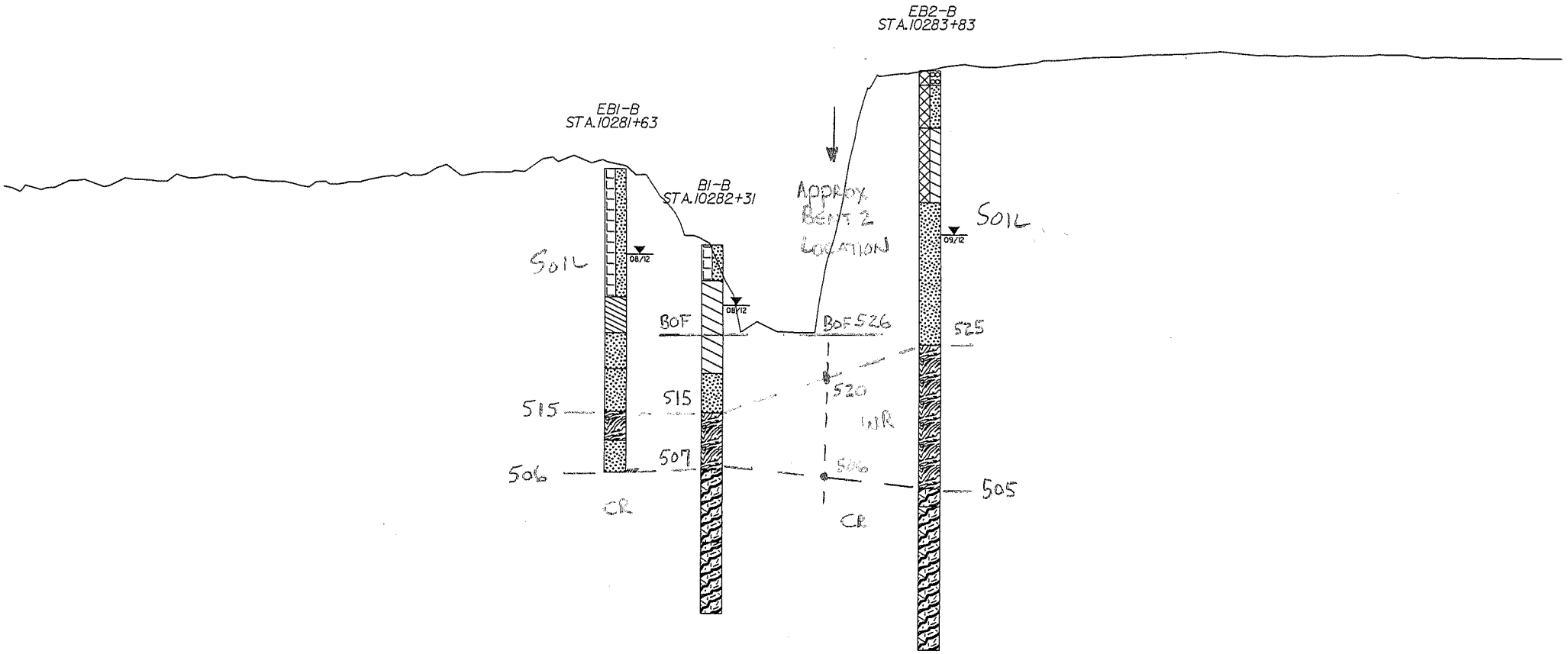
Soil Profile for Pile Excavation Qty

Bent 2 (Lt)



Soil Profile for Pile Excavation Qty

Bent 2 (Rt)



APPENDIX E

SPECIAL PROVISIONS

PILES (1-17-12)

Revise the *Standard Specifications* as follows:

Replace Section 450 with the following:

SECTION 450
PILES

450-1 DESCRIPTION

Furnish and drive bearing piles as shown on the plans and as directed by the Engineer to the required bearing and penetration. Furnish, weld, and attach steel pile points, pipe pile plates, pile tips and splicers; provide collars, hardware, concrete, reinforcing steel, and all other materials; furnish all equipment, preauger through embankments, install piles vertically or on a batter; galvanize, cut off, splice, and build up piles; place concrete and reinforcing steel; construct pile trestles; furnish and place temporary bracing; remove any obstructions; wrap, bolt, or fasten timber fender piles; and abandon, remove, replace, and restrike or redrive piles as necessary.

450-2 MATERIALS

Refer to Division 10.

Item	Section
Portland Cement Concrete	1000
Reinforcing Steel	1070
Timber, Steel and Prestressed Concrete Piles	1084-1
Steel Pipe Pile Plates	1072

450-3 PREPARATION FOR DRIVING

If applicable, completely excavate for the cap and/or footing before installing piles. If applicable and unless noted otherwise on the plans, construct the embankment to the bottom of cap or footing elevation for a horizontal distance of 50 ft (15 m) from any pile except where fill slopes are within 50 ft (15 m) of a pile. If preaugering through an embankment is necessary before driving prestressed concrete piles, submit the preaugering and pile installation methods with the proposed pile driving methods and equipment for approval.

450-4 DETERMINATION OF PILE LENGTH

The estimated total pile lengths per structure shown on the plans are for bid purposes only. Determine pile lengths and furnish piling of sufficient length to obtain the required bearing and penetration and the required embedment into the cap or footing as shown on the plans. As an option and at no cost to the Department, make investigations as necessary to determine the required pile lengths.

450-5 DRIVING EQUIPMENT

Submit the proposed pile driving methods and equipment including the pile driving hammer, hammer cushion, pile helmet and cushion, if any. Do not submit more than two pile driving hammers per pile type per submittal. Submit this information for approval at least 20 working days before driving piles. All equipment is subject to satisfactory field performance.

Drive bearing piles with approved driving equipment using steam, air, or diesel hammers. Use pile driving hammers with an energy that will not overstress the piles during driving and provide the required driving resistance at blows per foot ranging from 36 to 96, unless otherwise approved. Use a variable energy hammer to drive prestressed concrete piles.

Operate steam, air, or diesel hammers at the length of stroke and number of blows per minute required by the Engineer. Operate air and steam hammers within 10% of the manufacturer's rated speed in blows per minute or the rate approved by the Engineer.

Provide plant and equipment for air or steam hammers with sufficient capacity to maintain, under working conditions, the volume and pressure specified by the manufacturer. Equip the plant and equipment with accurate pressure gauges that are easily accessible. Use striking parts of air and steam hammers that weigh at least 1/3 the weight of the pile helmet and pile, with a minimum weight of 2,750 lb (1,250 kg).

Equip open-end (single acting) diesel hammers with a graduated scale (jump stick) extending above the ram cylinder, graduated rings or grooves on the ram, or an electric sound activated remote measuring instrument to allow the Engineer to visually determine hammer stroke at all times during pile driving operations.

Equip closed-end (double acting) diesel hammers with a calibrated bounce chamber pressure gauge, in good working order, mounted near ground level and easily read by the Engineer. Also, provide a current calibrated chart or graph equating bounce chamber pressure and gauge hose length to equivalent energy for the closed-end diesel hammer used. Submit this chart or graph with the proposed pile driving methods and equipment required above.

Protect and hold pile heads in position with an approved pile helmet. Make sure that the pile helmet closely fits the top of the pile and extends down the sides of the pile a sufficient distance to hold the pile in position. Protect the heads of concrete and timber piles from direct impact with an approved pile cushion. Provide collars or bands to protect timber piles against splitting or brooming where required.

450-6 ACCURACY OF DRIVING

Drive piles so that the axial alignment is within 1/4" (6 mm) per foot from the vertical or batter shown on the plans. Horizontally, keep the pile within 3" (75 mm) of the plan location longitudinally and transversely. Maintain pile embedment in the cap or footing to within 3" (75 mm) more or 2" (50 mm) less than that shown on the plans. No additional payment is made for increased cap or footing dimensions necessary due to piles driven out of position.

450-7 CONSTRUCTION METHODS

(A) General

Unless approved otherwise or directed by the Engineer, do not drive piles within 50 ft (15 m) of cast-in-place concrete until the concrete attains an age of at least 3 curing days. When approved by the Engineer, the Contractor may use vibratory hammers to install the initial portions of steel piles. The Engineer will approve the depth of pile installation with the vibratory hammer. Do not use vibratory hammers to install prestressed concrete piles.

The Engineer will inspect the capblock before beginning each pile driving project and periodically throughout the duration of the project, depending on driving conditions as

determined by the Engineer. Expose the hammer cushion for inspection as directed by the Engineer. Replace or repair any hammer cushion that is less than 25% of the original thickness.

Do not exceed the allowable pile driving stresses during the entire driving time. Allowable pile driving stresses are defined in the *AASHTO Standard Specifications for Highway Bridges*. Drive piles to the required tip elevation or penetration into natural ground, whichever is lower, in a continuous operation unless stopped due to exceeding the maximum blow count or the allowable pile driving stresses, insufficient pile length, or other reasons approved by the Engineer. Once the required embedment is achieved, the Engineer may require the Contractor to stop driving and wait before restriking to allow for soil setup.

Use a pile cushion made of pine plywood with a 4" (100 mm) minimum thickness for driving prestressed concrete piles. When using a pile cushion, provide a new cushion for each pile unless otherwise approved. Replace the pile cushion if, during the driving of any pile, the cushion is either compressed more than one-half the original thickness or begins to burn.

Redrive any pile raised or moved laterally by the driving of adjacent piles.

(B) Timber Piles

Store and handle timber piles by methods that do not damage the pile. Take care to avoid breaking the surface of treated piles. Do not use cant-hooks, dogs, or pike-poles. Treat cuts or breaks in the surface of treated piles in an approved manner.

Cut off the tops of all piles at the elevation shown on the plans. Except where a cast-in-place concrete cap or footing is constructed, cut off piles to a plane that provides true bearing on every pile without the use of shims. Withdraw any pile damaged during driving operations, driven out of its proper location or below the cut-off grade and replace with a new pile, or otherwise correct as directed by the Engineer.

Thoroughly brush-coat the sawn surface of all timber piles not encased in concrete with 3 applications of approved preservative treatment and then cover with a coat of hot roofing pitch or other approved hot bituminous material. Place a sheet of galvanized iron or aluminum upon each pile head, bend it down over the sides of the pile, neatly trim and firmly secure to the pile with large headed galvanized roofing nails. Use sheets of iron that are 24 gauge and 24" (600 mm) by 24" (600 mm) in size. If using aluminum, use the same size as specified for galvanized iron sheets with a minimum thickness of 0.032" (0.81 mm).

(C) Prestressed Concrete Piles

Handle, transport, and store prestressed concrete piles by methods that do not damage the pile and support the piles at the pick-up points shown on the plans or along their full length. Replace piles damaged in handling or driving unless they are repaired to an acceptable condition.

When driving or cutting off piles below the elevation shown on the plans, build up the pile section to the plan elevation as shown on the plans unless otherwise directed by the Engineer.

Cut off piles not driven to grade perpendicular to the axis of the pile by means that do not result in spalling or other damage to the pile. Use steel pile tips with prestressed concrete piles when shown on the plans. Use pile splicers for splicing steel pile tips. Contact the Materials and Tests Unit for a list of approved pile splicers. Submit pile splicer specifications with the manufacturer's attachment detail to the Engineer for approval before installation.

(D) Steel Piles

Handle and store steel piles by methods that do not damage the pile. Store the piles above ground upon platforms, blocks, or other supports and keep the piles free from dirt, grease, and other foreign matter, and protect insofar as is practicable from corrosion. Do not damage coatings on steel piles. Protect coatings when driving piles through templates in an approved manner.

When shown on the plans, galvanize steel piles in accordance with Section 1076. Prepare the pile surface and provide materials in accordance with the applicable portions of this section.

Use pile points for steel piles when shown on the plans or as directed by the Engineer. Contact the Materials and Tests Unit for a list of approved pile points. Weld pile points to piles in accordance with the manufacturers' details as approved by the Engineer. The minimum weld length is twice the width of the flange.

Furnish plates for pipe piles when shown on the plans or as directed by the Engineer. Weld plates to the bottom of pipe piles as shown on the plans. Use pipe pile plates with a thickness as shown on the plans and that meets the requirements of ASTM A709, Grade 50.

Cut off piles at the required elevations along a plane normal to the axis of the pile. Use approved methods for cutting off piles.

Use welded butt splices for steel piles as shown on the plans. Do not use more than 3 pieces (2 splices) of steel pile in making up one full-length pile.

(E) Redriving Piles

Once the required pile embedment has been achieved, the Contractor may choose to or the Engineer may require restriking or redriving piles. If the Contractor chooses to stop driving and then restrike or redrive piles, no payment will be made for restrikes or redrives. If the Engineer requires the Contractor to stop driving and then restrike or redrive piles, the payment will be made in accordance with Article 450-9. When the Engineer requires restrikes or redrives, the Engineer will determine the time to wait after stopping driving and the number of restrikes or redrives. However, the maximum number of restrikes or redrives per pile during any 48 hour period will not exceed three. The minimum time separation between redrives required by the Engineer is 4 hours.

Use the same approved pile driving methods, equipment and compressed pile cushion from the previous drive to restrike or redrive the pile unless the cushion is unacceptable due to deterioration, in which case use another acceptable cushion. Do not use a cold diesel hammer for a restrike or redrive, unless in the opinion of the Engineer, it is impractical to do otherwise. In general, warm up the hammer by applying at least 20

blows to a previously driven pile or timber mats on the ground.

450-8 PENETRATION AND WAVE EQUATION

When no tip elevation is shown on the plans, drive piles to the required bearing capacity and a penetration of at least 10 ft (3 m) into natural ground unless otherwise directed by the Engineer. When a tip elevation is shown on the plans, drive piles to the required bearing capacity and the specified tip elevation. When noted on the plans, drive piles to additional capacity to account for downdrag or negative skin friction and scour.

Natural ground within an area of new embankment is defined as the bottom of the embankment or bottom of footing on piles, whichever is lower.

The Engineer will use the wave equation analysis to evaluate the suitability of the proposed pile driving methods and equipment to evaluate pile driving stresses and estimate the driving resistance in order to achieve the required bearing capacity. The required driving resistance in blows per foot or any equivalent set is based upon the bearing capacity shown on the plans with a minimum safety factor of 2 plus any additional capacity to account for downdrag or negative skin friction and scour, when applicable. The Engineer will provide the required driving resistance based upon the wave equation analysis and pile driving analyzer results, if applicable, using the approved pile driving methods and equipment.

Stop driving piles when practical refusal is reached, unless otherwise directed by the Engineer. Practical refusal is defined as 180 blows per foot (0.3 m) or any equivalent set.

450-9 MEASUREMENT AND PAYMENT

Piles (Treated Timber Piles, _____ *Prestressed Concrete Piles,* _____ *Steel Piles or* _____ *Galvanized Steel Piles)* will be measured and paid as the actual number of linear feet (meters) of piles incorporated into the completed and accepted structure. This quantity is measured as the length of pile before driving minus any pile cut-offs. No payment will be made for pile cut-offs or cutting off piles. However, once the required bearing and penetration has been achieved, the Contractor may drive the remaining portion of a pile to grade in lieu of cutting off the pile provided the remaining portion does not exceed 5 ft (1.5 m) and the pile can be driven without damaging the pile or reaching the maximum blow count or practical refusal. When this occurs, the additional length of pile driven will be measured as described above.

For prestressed concrete piles that are built up, the quantity of piles to be paid for will also include the actual number of linear feet (meters) added to the original pile length by the build-up. Steel pile tips are not included in the quantity of prestressed concrete piles. No payment will be made for steel pile tips or pile splicers and any associated hardware or welding. The cost for these items will be considered incidental to the cost of the prestressed concrete pile.

Pile points will be measured and paid for per each for the actual number of pile points incorporated into the completed and accepted structure.

Pipe pile plates will be measured and paid for per each for the actual number of plates incorporated into the completed and accepted structure.

Pile redrives will be measured and paid for per each as the actual number of restrikes or redrives required by the Engineer. No payment will be made for restrikes or redrives when the Contractor chooses to restrike or redrive piles.

No payment will be made for any defective or rejected piles or any piles driven for falsework, bracing, or temporary work bridges.

The prices and payments will be full compensation for all items required to provide bearing piles including but not limited to those items contained in Article 450-1.

Payment will be made under:

Pay Item	**Pay Unit**
____ Prestressed Concrete Piles	Linear Foot
____ Steel Piles	Linear Foot
____ Galvanized Steel Piles	Linear Foot
Steel Pile Points	Each
Pipe Pile Plates	Each
Pile Redrives	Each

PILE EXCAVATION (1-17-12)

1.0 GENERAL

This special provision governs installing piles using pile excavation in accordance with the plans and as directed by the Engineer. Pile excavation is necessary when piles cannot be installed to the required bearing capacity and tip elevation with conventional driving equipment due to vibration concerns or the presence of rock, boulders, debris or very dense soils. Install piles in accordance with Section 450 of the Standard Specifications and this provision.

2.0 PILE EXCAVATION

Perform pile excavation to the required elevation shown on the plans or otherwise required by the Engineer. Excavate a hole with a diameter that will result in at least 3 in (75 mm) of clearance around the entire pile. Use equipment of adequate capacity and capable of drilling through soil and non-soil including rock, boulders, debris, man-made objects and any other materials encountered. Blasting is not permitted to advance the excavation. Blasting for core removal is only permitted when approved by the Engineer. Dispose of drilling spoils in accordance with Section 802 of the Standard Specifications and as directed by the Engineer. Drilling spoils consist of all excavated material including water removed from the excavation either by pumping or drilling tools.

If unstable, caving or sloughing soils are anticipated or encountered, the Engineer may require the Contractor to stabilize the excavation with steel casing. Steel casing may be either the sectional type or one continuous corrugated or non-corrugated piece. Steel casings should consist of clean watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill. Use steel casings with an outside diameter equal to the hole size and a minimum wall thickness of 1/4 in (7 mm).

3.0 CONCRETE PLACEMENT

Before placing concrete, center the pile in the excavation and drive to the required bearing capacity and specified tip elevation, if applicable, as shown on the plans or as directed by the Engineer. Check the water inflow rate in the excavation after any pumps have been removed. If the inflow rate is less than 6 in (150 mm) per half hour, remove any water and free fall the concrete into the excavation. Ensure that concrete flows completely around the pile. If the water inflow rate is greater than 6 in (150 mm) per half hour, propose a concrete placement procedure to the Engineer. The Engineer shall approve the concrete placement procedure before placing concrete.

Fill the excavation with Class A concrete in accordance with Section 1000 of the Standard Specifications except as modified herein. Provide concrete with a slump of 6 to 8 in (150 to 200 mm). Use an approved high-range water reducer to achieve this slump. Place concrete in a continuous manner and remove all casings.

4.0 MEASUREMENT AND PAYMENT

A. Method of Measurement

1. Pile Excavation in Soil

The quantity of "Pile Excavation in Soil" to be paid for will be the linear feet (meters) of pile excavation exclusive of the linear feet (meters) of "Pile Excavation Not in Soil" computed from elevations and dimensions as shown on the plans or from revised dimensions authorized by the Engineer.

2. Pile Excavation Not in Soil

The quantity of "Pile Excavation Not in Soil" to be paid for will be the linear feet (meters) of pile excavation in non-soil as determined by the Engineer. Non-soil is defined as material that cannot be cut with a rock auger and requires excavation by coring, air tools, hand removal or other acceptable methods. Top of non-soil elevation is that elevation where the rock auger penetration rate is less than 2 in (50 mm) per 5 minutes of drilling at full crowd force and coring, air tools, etc. are used to advance the excavation. For pay purposes, after non-soil is encountered, earth seams, rock fragments and voids in the excavation less than 3 ft (0.9 m) in total length will be considered "Pile Excavation Not in Soil". If the non-soil is discontinuous, payment will revert to "Pile Excavation in Soil" at the elevation where non-soil is no longer encountered.

B. Basis of Payment

1. Pile Excavation in Soil

Payment will be made at the contract unit price per linear foot (meter) for "Pile Excavation in Soil". Such payment will include, but is not limited to, furnishing all labor, tools, equipment, materials including concrete complete and in place and all incidentals necessary to excavate and complete the work as described in this provision. The cost for the pile will be paid for separately in accordance with the Standard Specifications and will not be part of the unit bid price for "Pile Excavation in Soil".

2. Pile Excavation Not in Soil

Payment will be made at the contract unit price per linear foot (meter) for "Pile Excavation Not in Soil". Such payment will include, but is not limited to, furnishing all labor, tools, equipment, materials including concrete complete and in place and all incidentals necessary to excavate and complete the work as described in this provision. The cost for the pile will be paid for separately in accordance with the Standard Specifications and will not be part of the unit bid price for "Pile Excavation Not in Soil".

SINCE

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