ECS Southeast, LLP

Bridge Foundation Design Recommendations

Bridge No. 269 on SR 1599 (Big Peak Creek Road) over Peak Creek

Project No: BP11.R007.3
Project ID: SF-040269
Ashe County, North Carolina

ECS Project No. 09:29663

May 26, 2023

May 26, 2023

Mr. Jason Griscom, P.E.
STV Engineers, Inc.
900 W. Trade Street, Suite 715
Charlotte, North Carolina 28202

ECS Project No.:09:29663

Reference: Bridge Foundation Design Recommendations
Bridge No. 269 on SR 1599 (Big Peak Creek Road) over Peak Creek
Project No: BP.11.R007.3
Project ID: SF-040269
County: Ashe

Dear Mr. Griscom:

ECS Southeast, LLP (ECS) is pleased to submit the Bridge Foundation Design Recommendations Report associated with design and construction of Bridge No. 269 on SR 1599 (Big Peak Creek Road) over Peak Creek in Ashe County, North Carolina. This work was performed in general accordance with our Proposal No. 09-28283P dated July 15, 2021.

Our design is based on project information and structure loads provided to us by STV. This report contains the foundation recommendations, the Structure Subsurface Investigation report prepared by ECS, and supporting calculations.

ECS Southeast, LLP appreciates the opportunity to assist you during this phase of the project. If you have questions concerning this report, please contact our office at 704-525-5152.

Respectfully,

ECS SOUTHEAST, LLP

NORTH CAROLINA PROFESSIONAL SEAL 026917 ENGINEER MICHAEL J. WALKO

5/26/2023

DocuSigned by:
Kelly de Montbrun
7BDD9975E22C480...

Kelly N. de Montbrun, P.E.
Senior Project Engineer
KdeMontbrun@ecslimited.com

DocuSigned by:
Michael J. Walko
78222AC7F82F4D7...

Michael J. Walko, P.E.
Principal Engineer
MWalko@ecslimited.com
NC Registration No. 026917

FOUNDATION RECOMMENDATIONS

WBS NO. BP11.R007.3

DESCRIPTION Bridge No. 269 on SR 1599 (Big Peak Creek Road) Over Peak Creek

T.I.P. NO. N/A

COUNTY Ashe

STATION 15+50.00 -L-

	INITIALS	DATE
DESIGN	MJW	05/22/23
CHECK	KND	05/22/23
REVISED		

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 026917 ENGINEER MICHAEL J. WALKO

5/26/2023

DocuSigned by:
Michael J. Walko
78222AC7F82F4D7...
SIGNATURE

	STATION	FOUNDATION TYPE	FACTORED LOAD	MISCELLANEOUS DETAILS
END BENT NO. 1	15+13.73 -L-	Cap on HP 14X73 Steel Piles	100 Tons/Pile	Average Bottom of Cap Elevation = 2,624.5 ft +/- Average Pile Length = 30 ft (LT), 25 ft (RT) 6 Vertical Piles @ 7'-8" Spacing Wing Wall 1 - 3 Vertical (HP 12x53) Piles @ 7'-8" Spacing Wing Wall 2 - 3 Vertical (HP 12x53) Piles @ 7'-8" Spacing
END BENT NO. 2	15+86.30 -L-	Cap on HP 14X73 Steel Piles	100 Tons/Pile	Average Bottom of Cap Elevation = 2,622.7 ft +/- Average Pile Length = 15 ft (LT), 20 ft (RT) 5 Vertical Piles @ 9'-6" Spacing

(SEE NOTES ON PLANS AND COMMENTS ON FOLLOWING PAGES)

WBS No: BP11.R007.3 **County:** Ashe

FOUNDATION RECOMMENDATION COMMENTS

1) A PRECAST CONCRETE PANEL WALL WILL BE USED AS A VERTICAL FACE AT END BENT NO. 1.

2) CLASS II RIP RAP WILL BE USED FOR SCOUR PROTECTION AT END BENT NO. 2.

3) TYPE II BRIDGE APPROACH FILL (STANDARD DETAIL 422.02) SHOULD BE USED AT END BENT NO. 1 AND END BENT NO. 2.

4) NO WAITING PERIOD IS REQUIRED AT EITHER END BENT PRIOR TO CONSTRUCTION.

5) AVERAGE PILE LENGTHS ARE BASED ON PLUMB PILES FROM THE BOTTOM OF CAP ELEVATION TO THE ANTICIPATED TIP ELEVATION, ROUNDED UP TO THE NEAREST 5 FEET.

6) DRILLED-IN PILES ARE RQUIRED FOR END BENT NO. 1. EXCAVATE HOLES TO A TIP ELEVATION NO HIGHTER THAN 2,598 FT (LT) AND 2,603 FT (RT) WITH A PENETRATION OF AT LEAST 5 FT INTO CRYSTALLINE ROCK. FOR PILE EXCAVATION, SEE SECTION 450 OF THE STANDARD SPECIFICATIONS.

7) END BENT NO. 1 AND END BENT NO. 2 ABUTMENT PILES WILL BE HP 14X73. END BENT NO. 1 WING WALL PILES WILL BE HP 12X53.

SUMMARY OF PILE INFORMATION/INSTALLATION

(Blank entries indicate item is not applicable to structure)

End Bent/ Bent No, Pile(s) #(-#) (e.g., "Bent 1, Piles 1-5")	Factored Resistance per Pile TONS	Pile Cut-Off (Top of Pile) Elevation FT	Estimated Pile Length per Pile FT	Scour Critical Elevation FT	Driven Piles			Predrilling for Piles*			Drilled-In Piles		
					Min Pile Tip (Tip No Higher Than) Elev FT	Required Driving Resistance (RDR)** per Pile TONS	Total Pile Redrives Quantity EACH	Predrilling Length per Pile Lin FT	Predrilling Elevation (Elev Not To Predrill Below) FT	Maximum Predrilling Dia INCHES	Pile Excavation (Bottom of Hole) Elev FT	Pile Exc Not In Soil per Pile Lin FT	Pile Exc In Soil per Pile Lin FT
End Bent No. 1, Piles 4-6	100	See Substructure Plans	30	2611							2598.0	6.0	21.0
End Bent No. 1, Piles 7-9	100		25	2611							2603.0	9.0	13.0
Wing Wall 1, Piles 1-3			30								2598.0	6.0	23.0
Wing Wall 2, Piles 10-12			25								2603.0	9.0	15.0
End Bent No. 2, Piles 1-3	100		15			170							
End Bent No. 2, Piles 4-5	100		20			170							

**Predrilling for Piles is required for end bents/bents with a predrilling length and at the Contractor's option for end bents/bents with predrilling information but no predrilling length.

$$^{**}RDR = \frac{Factored\ Resistance + Factored\ Downdrag\ Load + Factored\ Dead\ Load}{Dynamic\ Resistance\ Factor} + Nominal\ Downdrag\ Resistance + \frac{Nominal\ Scour\ Resistance}{Scour\ Resistance\ Factor}$$

SUMMARY OF PDA/PILE ORDER LENGTHS

(Blank entries indicate item is not applicable to structure)

Pile Driving Analyzer (PDA)				Pile Order Lengths	
End Bent/ Bent No	PDA Testing Required? YES or MAYBE	PDA Test Pile Length FT	Total PDA Testing Quantity EACH	End Bent/ Bent No(s)	Pile Order Length Basis* EST or PDA
End Bent No. 2, Piles 1-5	MAYBE	25	1		

*EST = Pile order lengths from estimated pile lengths; PDA = Pile order lengths based on PDA testing. For groups of end bents/bents with pile order lengths based on PDA testing, the first end bent/bent no. listed for each group is the representative end bent/bent with the PDA.

PILE DESIGN INFORMATION

(Blank entries indicate item is not applicable to structure)

End Bent/ Bent No, Pile(s) #(-#) (e.g., "Bent 1, Piles 1-5")	Factored Axial Load per Pile TONS	Factored Downdrag Load per Pile TONS	Factored Dead Load* per Pile TONS	Dynamic Resistance Factor	Nominal Downdrag Resistance per Pile TONS	Nominal Scour Resistance per Pile TONS	Scour Resistance Factor (Default = 1.00)
End Bent No. 1	97			0.60			1.00
End Bent No. 2	97			0.60			1.00

*Factored Dead Load is factored weight of pile above the ground line.

SUMMARY OF PILE ACCESSORIES

(Blank entries indicate item is not applicable to structure)

End Bent/ Bent No, Pile(s) #(-#) (e.g., "Bent 1, Piles 1-5")	Pipe Pile Plates Required? YES or MAYBE	Steel Pile Points			Steel Pile Tips Required? YES
		Pipe Pile Cutting Shoes Required? YES	Pipe Pile Conical Points Required? YES	H-Pile Points Required? YES	
End Bent No. 2, Piles 1-5				YES	
TOTAL QTY:				5	

PROJECT NO. BP11.R007.3

Ashe COUNTY

STATION: 15+50.00 -L-

NOTES:

1. The Pile Foundation Tables are based on the bridge substructure design and foundation recommendations sealed by a North Carolina Professional Engineer Michael J. Walko (NC# 026917) on 05-26-2023.
2. Total Pile Driving Equipment Setup quantity (not shown in Pile Foundation Tables) equals the number of driven piles, i.e., the number of piles with a Required Driving Resistance.
3. The Engineer will determine the need for PDA Testing when PDA's may be required.
4. For Piles, see Piles Provision and Section 450 of the Standard Specifications.
5. Concrete is required to fill holes for pile excavation at End Bent No. 1.
6. Drilled-in piles are required for End Bent No. 1. Abutment Piles and Wing Wall Piles should be installed a minimum of 5 feet into Crystalline Rock.

NORTH CAROLINA PROFESSIONAL SEAL 029429 ENGINEER JASON T. GRISCOM

SIGNATURE DATE

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

PILE FOUNDATION TABLES

REVISIONS

NO.	BY:	DATE:	NO.	BY:	DATE:
1			3		
2			4		

SHEET NO.

TOTAL SHEETS

SUBSURFACE INVENTORY REPORT

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	SF-040269	1	8

PROJECT: BP11.R007.1 REFERENCE: SF-040269

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

STRUCTURE SUBSURFACE INVESTIGATION

COUNTY *ASHE*

PROJECT DESCRIPTION *BRIDGE NO. 269 ON SR 1599 (BIG PEAK CREEK ROAD) OVER PEAK CREEK*

SITE DESCRIPTION *-L- STA. 15+50*

CONTENTS

PERSONNEL

A. BLACKMORE

HPC DRILLING

INVESTIGATED BY *ECS SOUTHEAST, LLP*

DRAWN BY *K. DE MONTBRUN, P.E.*

CHECKED BY *M. WALKO, P.E.*

SUBMITTED BY *ECS SOUTHEAST, LLP*

DATE *MAY 2023*

Prepared in the Office of:

ECS SOUTHEAST, LLP
1812 CENTER PARK DRIVE, SUITE D
CHARLOTTE, NC 28217
(704) 525-5152 [PHONE]
(704) 357-0023 [FAX]
NC REGISTERED ENGINERING FIRM # F-1078

CAUTION NOTICE

THE SUBSURFACE INFORMATION AND THE SUBSURFACE INVESTIGATION ON WHICH IT IS BASED WERE MADE FOR THE PURPOSE OF STUDY, PLANNING AND DESIGN, AND NOT FOR CONSTRUCTION OR PAY PURPOSES. THE VARIOUS FIELD BORING LOGS, ROCK CORES AND SOIL TEST DATA AVAILABLE MAY BE REVIEWED OR INSPECTED IN RALEIGH BY CONTACTING THE N. C. DEPARTMENT OF TRANSPORTATION, GEOTECHNICAL ENGINEERING UNIT AT (919) 707-6850. THE SUBSURFACE PLANS AND REPORTS, FIELD BORING LOGS, ROCK CORES AND SOIL TEST DATA ARE NOT PART OF THE CONTRACT.

GENERAL SOIL AND ROCK STRATA DESCRIPTIONS AND INDICATED BOUNDARIES ARE BASED ON A GEOTECHNICAL INTERPRETATION OF ALL AVAILABLE SUBSURFACE DATA AND MAY NOT NECESSARILY REFLECT THE ACTUAL SUBSURFACE CONDITIONS BETWEEN BORINGS OR BETWEEN SAMPLED STRATA WITHIN THE BOREHOLE. THE LABORATORY SAMPLE DATA AND THE IN SITU (IN-PLACE) TEST DATA CAN BE RELIED ON ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE STANDARD TEST METHOD. THE OBSERVED WATER LEVELS OR SOIL MOISTURE CONDITIONS INDICATED IN THE SUBSURFACE INVESTIGATIONS ARE AS RECORDED AT THE TIME OF THE INVESTIGATION. THESE WATER LEVELS OR SOIL MOISTURE CONDITIONS MAY VARY CONSIDERABLY WITH TIME ACCORDING TO CLIMATIC CONDITIONS INCLUDING TEMPERATURES, PRECIPITATION AND WIND, AS WELL AS OTHER NON-CLIMATIC FACTORS.

THE BIDDER OR CONTRACTOR IS CAUTIONED THAT DETAILS SHOWN ON THE SUBSURFACE PLANS ARE PRELIMINARY ONLY AND IN MANY CASES THE FINAL DESIGN DETAILS ARE DIFFERENT. FOR BIDDING AND CONSTRUCTION PURPOSES, REFER TO THE CONSTRUCTION PLANS AND DOCUMENTS FOR FINAL DESIGN INFORMATION ON THIS PROJECT. THE DEPARTMENT DOES NOT WARRANT OR GUARANTEE THE SUFFICIENCY OR ACCURACY OF THE INVESTIGATION MADE, NOR THE INTERPRETATIONS MADE, OR OPINION OF THE DEPARTMENT AS TO THE TYPE OF MATERIALS AND CONDITIONS TO BE ENCOUNTERED. THE BIDDER OR CONTRACTOR IS CAUTIONED TO MAKE SUCH INDEPENDENT SUBSURFACE INVESTIGATIONS AS HE DEEMS NECESSARY TO SATISFY HIMSELF AS TO CONDITIONS TO BE ENCOUNTERED ON THE PROJECT. THE CONTRACTOR SHALL HAVE NO CLAIM FOR ADDITIONAL COMPENSATION OR FOR AN EXTENSION OF TIME FOR ANY REASON RESULTING FROM THE ACTUAL CONDITIONS ENCOUNTERED AT THE SITE DIFFERING FROM THOSE INDICATED IN THE SUBSURFACE INFORMATION.

NOTES:

1. THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N. C. DEPARTMENT OF TRANSPORTATION AS ACCURATE NOR IS IT CONSIDERED PART OF THE PLANS, SPECIFICATIONS OR CONTRACT FOR THE PROJECT.
2. BY HAVING REQUESTED THIS INFORMATION, THE CONTRACTOR SPECIFICALLY WAIVES ANY CLAIMS FOR INCREASED COMPENSATION OR EXTENSION OF TIME BASED ON DIFFERENCES BETWEEN THE CONDITIONS INDICATED HEREIN AND THE ACTUAL CONDITIONS AT THE PROJECT SITE.

NORTH CAROLINA PROFESSIONAL SEAL 045442 ENGINEER KELLY DE MONTBRUN

DocuSigned by:
kelly de Montbrun 5/12/2023
7BDD9975E22C480...
SIGNATURE DATE

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

PROJECT REFERENCE NO.	SHEET NO.
SF-040269	2

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

SUBSURFACE INVESTIGATION

SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS
(PAGE 1 OF 2)

SOIL DESCRIPTION

SOIL IS CONSIDERED 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 THE STANDARD PENETRATION TEST (AASHTO T 206, ASTM D1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY INCLUDE THE FOLLOWING: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. FOR 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 #40 #200	50 MX 30 MX 15 MX	50 MX 25 MX	51 MN 10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN	GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
MATERIAL PASSING #40 LL PI	— 6 MX		— NP	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
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 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 RESISTENCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH ($TONS/FT^2$)
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 4 4 TO 10 10 TO 30 30 TO 50 > 50	N/A
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	< 2 2 TO 4 4 TO 8 8 TO 15 15 TO 30 > 30	< 0.25 0.25 TO 0.5 0.5 TO 1.0 1 TO 2 2 TO 4 > 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) PL — PLASTIC LIMIT	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
OM — OPTIMUM MOISTURE SL — SHRINKAGE LIMIT	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NON PLASTIC	0-5	VERY LOW
SLIGHTLY PLASTIC	6-15	SLIGHT
MODERATELY PLASTIC	16-25	MEDIUM
HIGHLY PLASTIC	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.
UNIFORMLY GRADED - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE.
GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLE SIZES 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 WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LL < 31
MODERATELY COMPRESSIBLE	LL = 31 - 50
HIGHLY COMPRESSIBLE	LL > 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL	
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE	1 - 10%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE	10 - 20%
MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME	20 - 35%
HIGHLY ORGANIC	> 10%	> 20%	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, DPT, DMT, VST, PMT — TEST BORING
- AUGER BORING
- CORE BORING
- MW — MONITORING WELL
- PIEZOMETER INSTALLATION
- SLOPE INDICATOR INSTALLATION
- CONE PENETROMETER TEST
- SOUNDING ROD
- TEST BORING WITH CORE
- SPT N-VALUE

RECOMMENDATION SYMBOLS

- UNDERCUT
- SHALLOW UNDERCUT
- UNCLASSIFIED EXCAVATION - UNSUITABLE WASTE
- UNCLASSIFIED EXCAVATION - ACCEPTABLE DEGRADABLE ROCK
- UNCLASSIFIED EXCAVATION - ACCEPTABLE, BUT NOT TO BE USED IN THE TOP 3 FEET OF EMBANKMENT OR BACKFILL

ABBREVIATIONS

AR - AUGER REFUSAL
BT - BORING TERMINATED
CL. - CLAY
CPT - CONE PENETRATION TEST
CSE. - COARSE
DMT - DILATOMETER TEST
DPT - DYNAMIC PENETRATION TEST
e - VOID RATIO
F - FINE
FOSS. - FOSSILIFEROUS
FRAC. - FRACTURED, FRACTURES
FRAGS. - FRAGMENTS
HI. - HIGHLY
MED. - MEDIUM
MICA. - MICACEOUS
MOD. - MODERATELY
NP - NON PLASTIC
ORG. - ORGANIC
PMT - PRESSUREMETER TEST
SAP. - SAPROLITIC
SD. - SAND, SANDY
SL. - SILT, SILTY
SLI. - SLIGHTLY
TCR - TRICONE REFUSAL
ω - MOISTURE CONTENT
V - VERY
VST - VANE SHEAR TEST
WEA. - WEATHERED
γ - UNIT WEIGHT
γ_d - DRY UNIT WEIGHT

SAMPLE ABBREVIATIONS

S - BULK
SS - SPLIT SPOON
ST - SHELBY TUBE
RS - ROCK
RT - RECOMPACTED TRIAXIAL
CBR - CALIFORNIA BEARING RATIO

EQUIPMENT USED ON SUBJECT PROJECT

DRILL UNITS:
- [ ] CME-45C
- [ ] CME-55
- [X] CME-550
- [ ] VANE SHEAR TEST
- [ ] 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 _____ [ ] -H _____
- [ ] -N _____

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

PROJECT REFERENCE NO.	SHEET NO.
SF-040269	2A

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

SUBSURFACE INVESTIGATION

SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS
(PAGE 2 OF 2)

ROCK DESCRIPTION

HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT REFUSAL IF TESTED. 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, WOULD YIELD SPT N VALUES > 100 BPF*
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE THAT ONLY MINOR VESTIGES OF ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, WOULD YIELD 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 FOOT
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 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, SUCH 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:

ELEVATION: FEET

NOTES:

FIAD = FILLED IN AFTER DRILLING

DESIGN FILES, .TIN AND .GPK FILE PROVIDED BY STV.

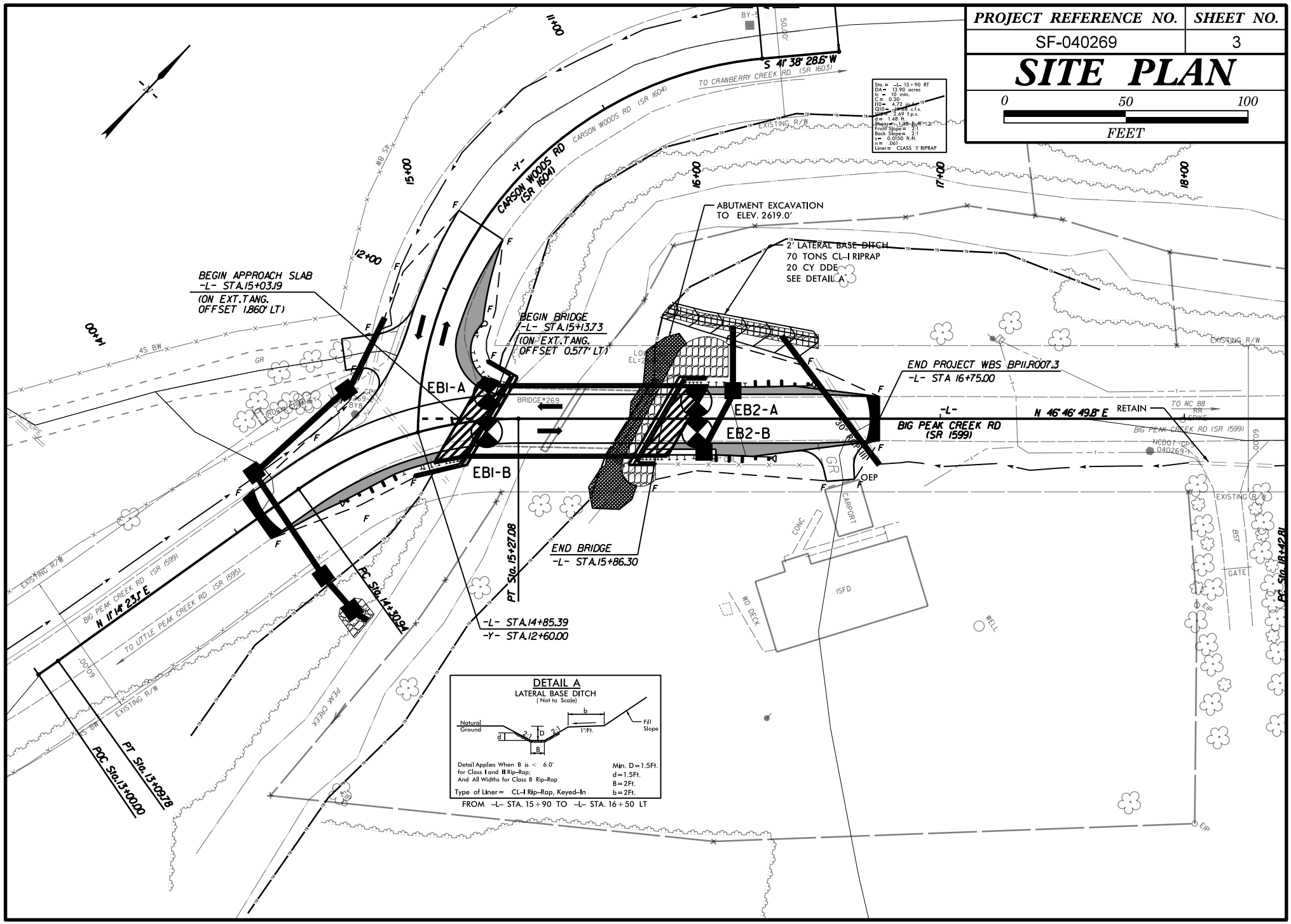
DATE: 8-15-14

PROJECT REFERENCE NO.	SHEET NO.
SF-040269	3

SITE PLAN

0 50 100

FEET



GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB1-A	**STATION** 15+16	**OFFSET** 11 ft LT	**ALIGNMENT** -L-	**0 HR.** 19.8
COLLAR ELEV. 2,627.2 ft	**TOTAL DEPTH** 24.2 ft	**NORTHING** 983,989	**EASTING** 1,312,305	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550X 84% 04/19/2022		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER J. Cain	**START DATE** 07/18/22	**COMP. DATE** 07/18/22	**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)
2630										
	2,627.2	0.0								2,627.2 GROUND SURFACE 0.0
	2,626.2	1.0	3	3	4	7		M		**ROADWAY EMBANKMENT** Soft to Medium Stiff, Brown-Gray, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
2625	2,623.7	3.5	2	2	3	5		M		
	2,621.2	6.0	2	3	5	8		M		
2620	2,618.7	8.5	3	1	1	2		W		
2615	2,614.2	13.0								2,614.2 13.0
	2,613.7	13.5	12	41	45	86		W		**RESIDUAL** Hard, Gray-Brown, Fine to Coarse Sandy SILT (A-4), with trace mica
2610	2,608.7	18.5	21	28	23	51		W		
2605	2,603.7	23.5								2,603.7 23.5
	2,603.1	24.1	100/0.2			100/0.2				2,603.1 24.1 **WEATHERED ROCK** Gray (AMPHIBOLITE)
	2,603.0	24.2	60/0.1			60/0.1				2,603.0 24.2 **CRYSTALLINE ROCK** Gray (AMPHIBOLITE) Boring Terminated with Standard Penetration Test Refusal at Elevation 2,603.0 ft In Crystalline Rock (AMPHIBOLITE)

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB1-B	**STATION** 15+14	**OFFSET** 5 ft RT	**ALIGNMENT** -L-	**0 HR.** 10.8
COLLAR ELEV. 2,627.3 ft	**TOTAL DEPTH** 19.4 ft	**NORTHING** 983,977	**EASTING** 1,312,315	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550X 84% 04/19/2022		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER J. Cain	**START DATE** 07/14/22	**COMP. DATE** 07/14/22	**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)
2630										
	2,627.3	0.0								2,627.3 GROUND SURFACE 0.0
	2,626.3	1.0								**ROADWAY EMBANKMENT**
2625			3	5	4	9		M		Medium Stiff to Very Stiff, Brown-Gray, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
	2,623.8	3.5	1	3	4	7		M		
	2,621.3	6.0								
2620			1	2	3	5		W		
	2,618.8	8.5	8	7	9	16		W		
2615										
	2,614.3	13.0								
	2,613.8	13.5	13	22	21	43		M		**RESIDUAL** Hard, Gray-Green, Fine to Coarse Sandy SILT (A-4), with some mica
	2,611.5	15.8								2,611.5 15.8
2610			70	30/0.2		100/0.7				**WEATHERED ROCK** Brown-Gray (AMPHIBOLITE)
	2,608.8	18.5								
	2,608.0	19.3	100/0.4			100/0.4				2,608.0 19.3
	2,607.9	19.4	60/0.1			60/0.1				2,607.9 19.4 **CRYSTALLINE ROCK** Gray (AMPHIBOLITE)

Boring Terminated with Standard Penetration Test Refusal at Elevation 2,607.9 ft In Crystalline Rock (AMPHIBOLITE)

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB2-A	**STATION** 16+00	**OFFSET** 7 ft LT	**ALIGNMENT** -L-	**0 HR.** 15.5
COLLAR ELEV. 2,627.4 ft	**TOTAL DEPTH** 17.4 ft	**NORTHING** 984,045	**EASTING** 1,312,369	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550X 84% 04/19/2022		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER J. Cain	**START DATE** 07/18/22	**COMP. DATE** 07/18/22	**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
2630										
										2,627.4 GROUND SURFACE 0.0
	2,626.4	1.0								**ROADWAY EMBANKMENT**
2625			3	2	2	4		M		Soft, Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
	2,623.9	3.5	1	1	1	2		M		
	2,621.4	6.0								2,621.9 5.5
2620			1	1	1	2		W		Soft, Brown, Fine to Coarse Sandy SILT (A-4)
	2,618.9	8.5								2,619.4 8.0
			1	WOH	1	1		Sat.		Very Soft, Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
2615										
	2,613.9	13.5	76	24/0.1		100/0.6				2,613.9 13.5 **WEATHERED ROCK** Gray (AMPHIBOLITE)
2610	2,610.0	17.4	60/0.0			60/0.0				2,610.0 17.4 Boring Terminated with Standard Penetration Test Refusal at Elevation 2,610.0 ft On Crystalline Rock (AMPHIBOLITE)

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB2-B	**STATION** 16+00	**OFFSET** 6 ft RT	**ALIGNMENT** -L-	**0 HR.** 12.3
COLLAR ELEV. 2,627.6 ft	**TOTAL DEPTH** 26.6 ft	**NORTHING** 984,036	**EASTING** 1,312,378	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550X 84% 04/19/2022		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER J. Cain	**START DATE** 07/14/22	**COMP. DATE** 07/14/22	**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)
2630											
										2,627.6 GROUND SURFACE	0.0
	2,626.6	1.0								**ROADWAY EMBANKMENT**	
2625			5	3	3	6		M		Medium Stiff, Red-Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments	
	2,624.1	3.5								2,624.6	3.0
			1	1	1	2		M		Soft, Black, Fine to Coarse Sandy SILT (A-4)	
	2,621.6	6.0								2,622.1	5.5
2620			1	2	1	3		W		Soft, Red-Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments	
	2,619.1	8.5									
			1	1	1	2		W			
2615											
	2,614.1	13.5								2,614.6	13.0
			4	8	9	17		M		**RESIDUAL** Very Stiff, Gray-Brown, Fine to Coarse Sandy SILT (A-4), with trace rock fragments	
2610											
	2,609.1	18.5								2,608.6	19.0
			21	40	60/0.2	100/0.7				**WEATHERED ROCK** Gray-Brown (AMPHIBOLITE)	
2605											
	2,604.1	23.5								2,604.6	23.0
			31	30	31	61		M		**RESIDUAL** Hard, Gray, Fine to Coarse Sandy SILT (A-4), with trace rock fragments	
	2,601.0	26.6								2,601.0	26.6
			60/0.0			60/0.0				Boring Terminated with Standard Penetration Test Refusal at Elevation 2,601.0 ft On Crystalline Rock (AMPHIBOLITE)	

SUPPORTING DOCUMENTATION

BRIDGE SURVEY & HYDRAULIC DESIGN REPORT

N. C. DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
HYDRAULICS UNIT
RALEIGH, N. C.

State Proj. Reference No. SF-040269 WBS Project No. BP11.R007.1 Proj. Station -L- 15+50

County ASHE Bridge Over PEAK CREEK Bridge Inv. No. 269

On Highway SR 1599 (BIG PEAK CREEK RD) Between NC-88 and SR 1604 (CARSON WOODS RD)

Recommended Structure 1@70' (24" CORED SLAB) BRIDGE, VERTICAL ABUTMENT ON THE BEGIN BRIDGE, 4' CAP W/1.5:1 SLOPING ABUTMENTS ON END BRIDGE SIDE, 3.5' VERTICAL CONCRETE BARRIER RAIL

Recommended Width of Roadway 27'-10" CLEAR ROADWAY Skew 120 DEGREES

Recommended Location is (Up, (At,) Down) Stream from Existing Crossing, AT EXISTING CROSSING

Longitude -81.33750 Latitude 36.43129

Statewide Tier ☐ Regional Tier ☐ Sub-Regional Tier ☒

Bench Mark is BM-2, -L- 21+96.58, 19.5' LT, IP AND CAP 040269 BL-6

Northing 984498 Easting 1312750 Elev. 2657.74 ft. Datum: NAVD 88

Temporary Crossing OFFSITE DETOUR

Designed by: PETER WALDRON, PE
STV ENGINEERS, INC. (LICENSE NO. F-0991)

Assisted by: EDWARD VANCE, PE

Date 7/6/2022

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 049506 PETER B. WALDRON
Peter B. Waldron
ENGINEER PETER B. WALDRON

STV 100 Years
STV Engineers, Inc.
900 West Trade St., Suite 715
Charlotte, NC 28202
NC License Number F-0991

QA Review by: DocuSigned by: Marc T. Shown 4B024AEC0A0B4C2... Date 07/06/2022

Drainage Area 11.6 SQ. MILES Source USGS STREAMSTATS

River Basin NEW Character RURAL REGION 2

Stream Classification (Such as Trout, High Quality Water, etc.) B, Tr, +

Data on Existing Structure STEEL DECK ON I-BEAMS (2@30'-4") W/VERTICAL TIMBER ABUTMENTS OAL=61'

Total Waterway Opening 372 s.f.
Waterway Opening Below 100yr. WS EL 372 s.f.

Debris Potential: Low X Moderate High

Data on Structures Up and Down Stream

US: PRESTRESSED CONC. CORED SLAB (040037) (1@31'-1", 1@61'-1", 1@31'-1") OAL=123'

DS: TIMBER DECK ON I-BEAMS (040115) (2@30'-4") OAL=61'

Design Control Elev. 2627.14 ft. (CORRECTED EFFECTIVE 100-YR WSEL @ RS 5051)

Gage Station No. N/A Period of Records N/A

Max. Discharge N/A c.f.s. Date N/A Frequency N/A

Historical Flood Information:

Date N/A Elev. N/A ft. Est. Freq. N/A yr. Source CHAD COX ASHE COUNTY BRIDGE MAINTENANCE SUPERVISOR Period of Knowledge yrs.

Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.

Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.

Historical Scour Info: General N/A ft. Contraction N/A ft. Local N/A ft.

Channel Slope 0.0085 ft/ft Source LiDAR Normal Water Surface Elev. 2617.4 (6302021) ft.

Manning's n: Left O.B. 0.08-0.13 Channel 0.048 Right O.B. 0.08-0.13 Source FIS\FIELD VERIFIED

Flood Study /Status LIMITED (ASHE CO. FIS 11/4/2009 PANEL: 3918)

Flood Study 100yr. Discharge 3477 c.f.s. WS Elev.: With Floodway 2628.02 ft. Without Floodway 2627.63 ft. @ River Station 5392

DESIGN DATA

Hydrological Method USE SIR 2009-5158 FOR DESIGN, USE FEMA FOR COMPLIANCE

Hydraulic Design Method HEC-RAS 6.0.0 (SF-040269 PEAK CREEK SR 1599)

Floods Evaluated:

@ River Station 5051	Freq. (yr.)	Q (c.f.s)	Elev. (ft.)	Backwater (ft.)	Bridge Opening Velocity (f.p.s.)
	10	1800	2623.4	0.2	6.9
	25	2400	2624.3	0.1	7.7
	50	2800	2624.9	0.0	8.0
	100	3477	2625.9	0.0	8.5
	500	4500	2627.9	0.4	9.5

Waterway Opening Provided Below Design W.S. Elev. 312 s.f., 100yr W.S. Elev. 409 s.f., Total 475 s.f.,

Average Channel Velocity (Design) 8.1 f.p.s. Average Overbank Velocity (Design) 1.9 f.p.s.

Computed Scour : General N/A ft. Contraction 0.8 ft. Local 3.7 ft.

State Floodway Compliance Type SFC TYPE A

INFORMATION TO BE SHOWN ON PLANS

HYDRAULIC DATA	
DESIGN DISCHARGE	= 2400 C.F.S.
FREQUENCY OF DESIGN FLOOD	= 25 YRS.
DESIGN HIGH WATER ELEVATION	= 2624.3'
DRAINAGE AREA	= 11.6 SQ. MI.
BASIC DISCHARGE (Q100)	= 3477 C.F.S.
BASIC HIGH WATER ELEVATION	= 2625.9'
OVERTOPPING FLOOD DATA	
OVERTOPPING DISCHARGE	= 5200 C.F.S.
FREQUENCY OF OVERTOPPING FLOOD	= 500+ YRS.
OVERTOPPING FLOOD ELEVATION	= 2629.1'

* 1A = 12.12 EXISTING ROADWAY APPROACH

WS EL Taken @ River Station 5051

ADDITIONAL INFORMATION AND COMPUTATIONS

USGS REGRESSION EQUATIONS — FEMA DISCHARGES

SIR 2009-5158 RURAL BLUE RIDGE

$Q_{10} = 288\ (11.6)^{0.736} = 1749$ SAY 1800 CFS

$Q_{25} = 398\ (11.6)^{0.724} = 2347$ SAY 2400 CFS

$Q_{50} = 479\ (11.6)^{0.718} = 2784$ SAY 2800 CFS

$Q_{100} = 575\ (11.6)^{0.713} = 3301$ SAY 3300 CFS $Q_{100} = 3477$ CFS

$Q_{500} = 794\ (11.6)^{0.704} = 4459$ SAY 4500 CFS

NOTE: USGS FLOWS USED FOR DESIGN; FEMA 100-yr DISCHARGE USED FOR DESIGN AND COMPLIANCE

SCOUR ANALYSIS

BED MATERIAL IS SAND, GRAVEL, & COBBLES. BANKS ARE SHALLOW, WELL VEGETATED, & STABLE.

(100-YEAR) CONTRACTION SCOUR:

$Y_2 = Y_1 [Q_2/Q_1]^{.97} [W_1/W_2]^{.61}$ $Y_2 = 7.78\,[3477.00/3298.56]^{.97}\,[45.85/45.85]^{0.69}$

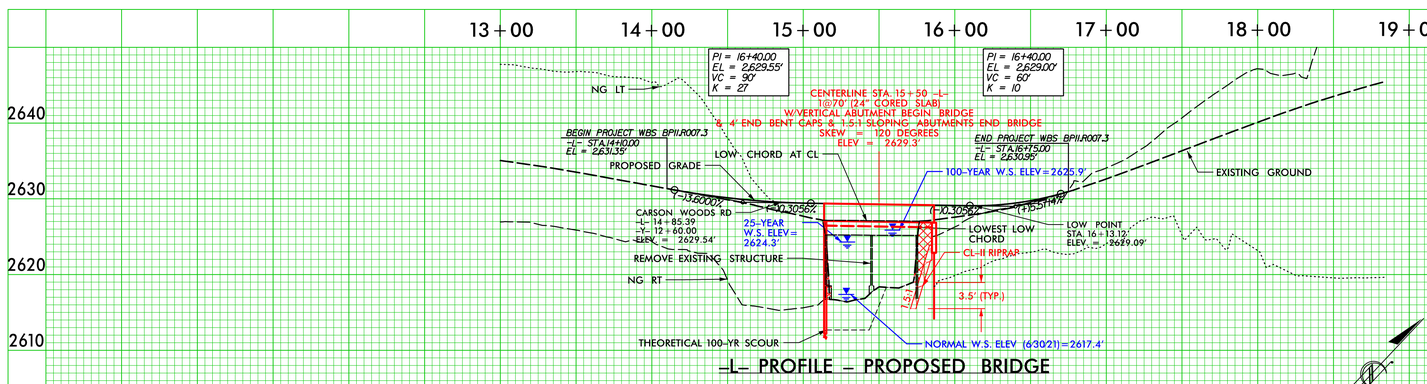
Ys = Y_2-Yo Ys = 8.14-7.32 = 0.82' SAY 0.8'

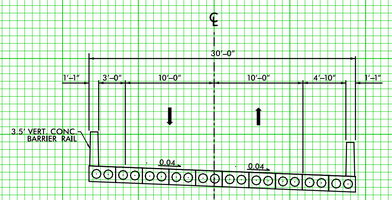
ABUTMENT SCOUR: 100yr. (NCHRP 24-20 EQUATION)

$Y_{MAX} = \alpha(Y_1) = \alpha(Y_1(q_2/q_1)^{.67})$ $Y_{MAX} = (Y_1) = 1.35[7.78(75.83/71.94)^{.67}]$

$Y_A = Y_{MAX} - Y_o$ $Y_A = 10.99 - 7.32 = 3.67'$ SAY 3.7'

*ACCORDING TO INFORMATION PROVIDED BY CHAD COX, NCDOT BRIDGE MAINTENANCE ENGINEER, THERE ARE NO INCIDENTS WITH OVERTOPPING





TYPICAL SECTION

NCDOT PERFORMANCE TABLE					
	FREQUENCY				
	10yr.	25yr.	50yr.	100yr.	500yr.
NATURAL	2623.2	2624.2	2624.9	2626.0	2627.5
EXISTING	2623.7	2626.0	2626.3	2627.1	2628.9
PROPOSED	2623.4	2624.3	2624.9	2625.9	2627.9
@SECTION 5051 34.3 FT. FROM US FACE OF BRIDGE					

FEMA PERFORMANCE TABLE	
	100yr.
DUPLICATE EFFECTIVE	2626.34 (RS 5020)
CORRECTED EFFECTIVE	2627.14
REVISED	2625.85
@SECTION 5051 34.3 FT. FROM US FACE OF BRIDGE	

SPREAD ANALYSIS
DA= 0.065
I= 4.0 in./hr.
C= 0.90
Q= 0.234 cfs
LONGITUDINAL SLOPE= 0.0031 ft/ft
CROSS SLOPE= 0.040 ft/ft
SHOULDER WIDTH= 4.833 FT.
SPREAD= 3.31 FT.

NO DECK DRAINS REQUIRED

End Bent Geometry and Loads (Cored Slabs)

Bridge Width	CS Unit Length	Factored Pile Reaction (kips)	Factored Pile Reaction (tons)
27'	25'-0"	106	53
	30'-0"	118	59
	35'-0"	126	63
	40'-0"	132	66
	45'-0"	140	70
	50'-0"	154	77
	55'-0"	162	81
	60'-0"	170	85
	65'-0"	178	89
	70'-0"	184	92
30'	25'-0"	110	55
	30'-0"	122	61
	35'-0"	132	66
	40'-0"	140	70
	45'-0"	148	74
	50'-0"	162	81
	55'-0"	170	85
	60'-0"	180	90
	65'-0"	188	94
	70'-0"	194	97
33'	25'-0"	92	46
	30'-0"	102	51
	35'-0"	110	55
	40'-0"	118	59
	45'-0"	122	61
	50'-0"	134	67
	55'-0"	142	71
	60'-0"	148	74
	65'-0"	156	78
	70'-0"	162	81
36'	25'-0"	96	48
	30'-0"	108	54
	35'-0"	116	58
	40'-0"	122	61
	45'-0"	130	65
	50'-0"	142	71
	55'-0"	148	74
	60'-0"	156	78
	65'-0"	164	82
	70'-0"	170	85
39'	25'-0"	100	50
	30'-0"	112	56
	35'-0"	120	60
	40'-0"	126	63
	45'-0"	136	68
	50'-0"	146	73
	55'-0"	154	77
	60'-0"	162	81
	65'-0"	170	85
	70'-0"	176	88

End Bent No. 1 = 6 piles
14x73 @ 7'-8"

End Bent No. 2 = 5 piles
14x73 @ 9'-6"

USE 100 ton/pile

For Wing Wall 1 & 2
USE 12x53 piles @ 7'-8"

Bridge Width	Skew	Cap Length	No. of Vertical Piles	Pile Spacing
27'	60/120	38'-2"	5	8'-6"
	75/105	34'-3"	5	7'-6"
	90	33'-0"	5	7'-6"
30'	60/120	41'-8"	~~5~~ 6	~~9'-6"~~ 7'-8"
	75/105	37'-4"	5	8'-3"
	90	36'-0"	5	8'-3"
33'	60/120	45'-2"	7	7'-0"
	75/105	40'-6"	7	6'-0"
	90	39'-0"	7	6'-0"
36'	60/120	48'-7"	7	7'-6"
	75/105	43'-7"	7	6'-6"
	90	42'-0"	7	6'-6"
39'	60/120	52'-0"	7	8'-0"
	75/105	46'-8"	7	7'-0"
	90	45'-0"	7	7'-0"

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB1-A	**STATION** 15+16	**OFFSET** 11 ft LT	**ALIGNMENT** -L-	**0 HR.** 19.8
COLLAR ELEV. 2,627.2 ft	**TOTAL DEPTH** 24.2 ft	**NORTHING** 983,989	**EASTING** 1,312,305	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550X 84% 04/19/2022		**DRILL METHOD** H.S. Augers	**HAMMER TYPE** Automatic	
DRILLER J. Cain	**START DATE** 07/18/22	**COMP. DATE** 07/18/22	**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)
2630						Boc = 2624.5				
	2,627.2	0.0								2,627.2 GROUND SURFACE 0.0
	2,626.2	1.0	3	3	4	7		M		**ROADWAY EMBANKMENT** Soft to Medium Stiff, Brown-Gray, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
2625	2,623.7	3.5	2	2	3	5		M		
	2,621.2	6.0	2	3	5	8		M		
2620	2,618.7	8.5	3	1	1	2		W		
						Scour = 2613				
2615	2,614.2	13.0								2,614.2 13.0
	2,613.7	13.5	12	41	45	86		W		**RESIDUAL** Hard, Gray-Brown, Fine to Coarse Sandy SILT (A-4), with trace mica
2610	2,608.7	18.5	21	28	23	51		W		
2605	2,603.7	23.5								2,603.7 23.5
	2,603.1	24.1	100/0.2			100/0.2				2,603.1 24.1
	2,603.0	24.2	60/0.1			60/0.1				2,603.0 24.2 **WEATHERED ROCK** Gray (AMPHIBOLITE) **CRYSTALLINE ROCK** Gray (AMPHIBOLITE) Boring Terminated with Standard Penetration Test Refusal at Elevation 2,603.0 ft In Crystalline Rock (AMPHIBOLITE)

Top of drilled hole/bottom of wall = 2613'

Tip 5' into Rock

Min Tip = 2598'

L = Boc - Tip El + 1.0 Embed

= 2624.5 - 2598 + 1 = 27.5'

Ave Pile Length = 30'

Est Qty (Abutment)

In Soil = 2624.5 - 2603.7 = 20.8'

Not In Soil = 2603.7 - 2598 = 5.7'

Est Qty (wing wall 1)

In Soil = 2626.2 - 2603.7 = 22.5'

Not In Soil = 2603.7 - 2598 = 5.7'

Ave Pile Length (Wing 1) = 30'

EB1-A 14x73

Boc = 2624.5

* used a lateral load of 5 kips to determine POF

1ST Neg = 22.3' (EL 2602.2)

Max Neg = 22.8' (EL 2601.7)

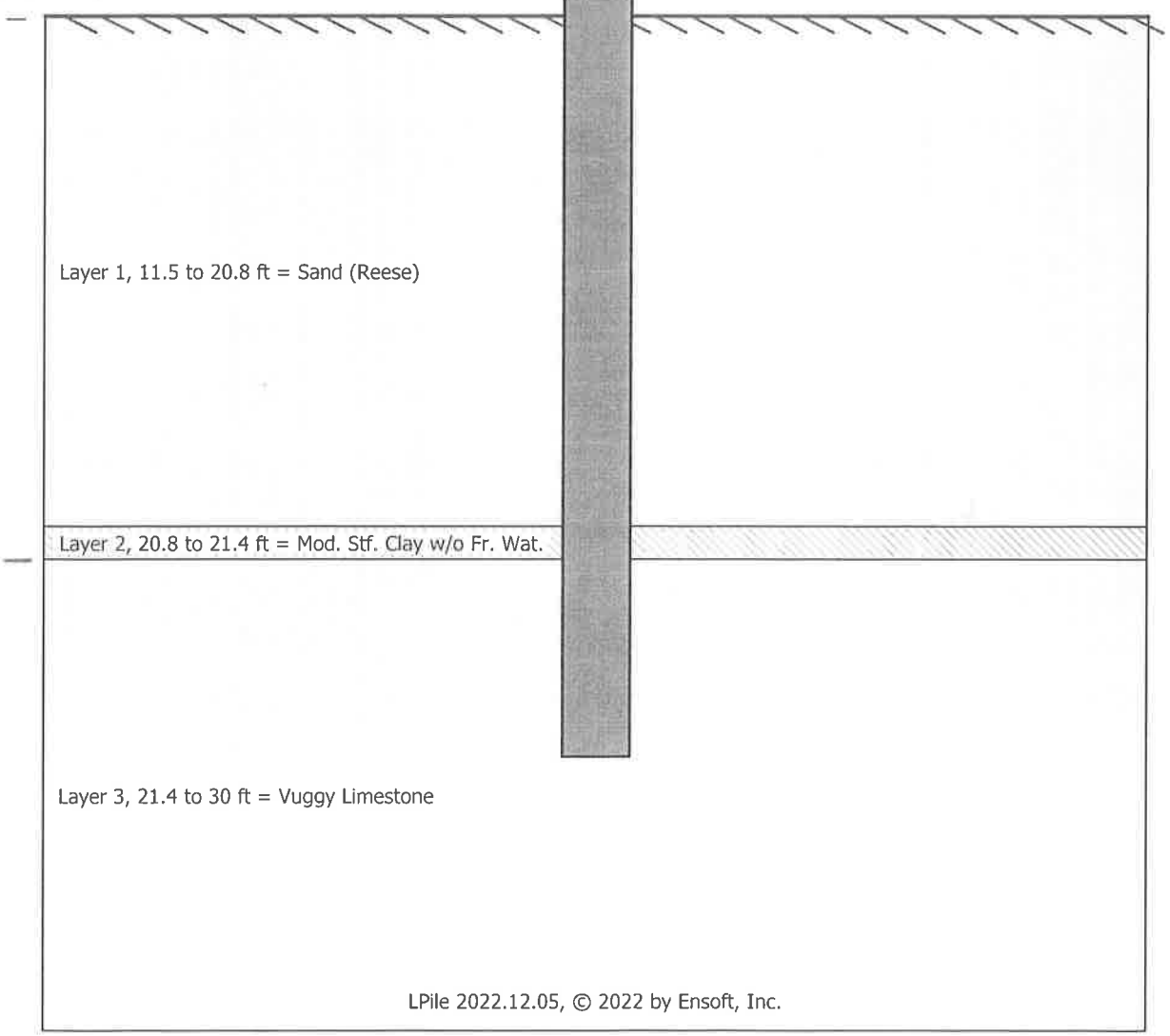
Say POF = 2601 Ft

Min Tip for Lateral = 2599 Ft

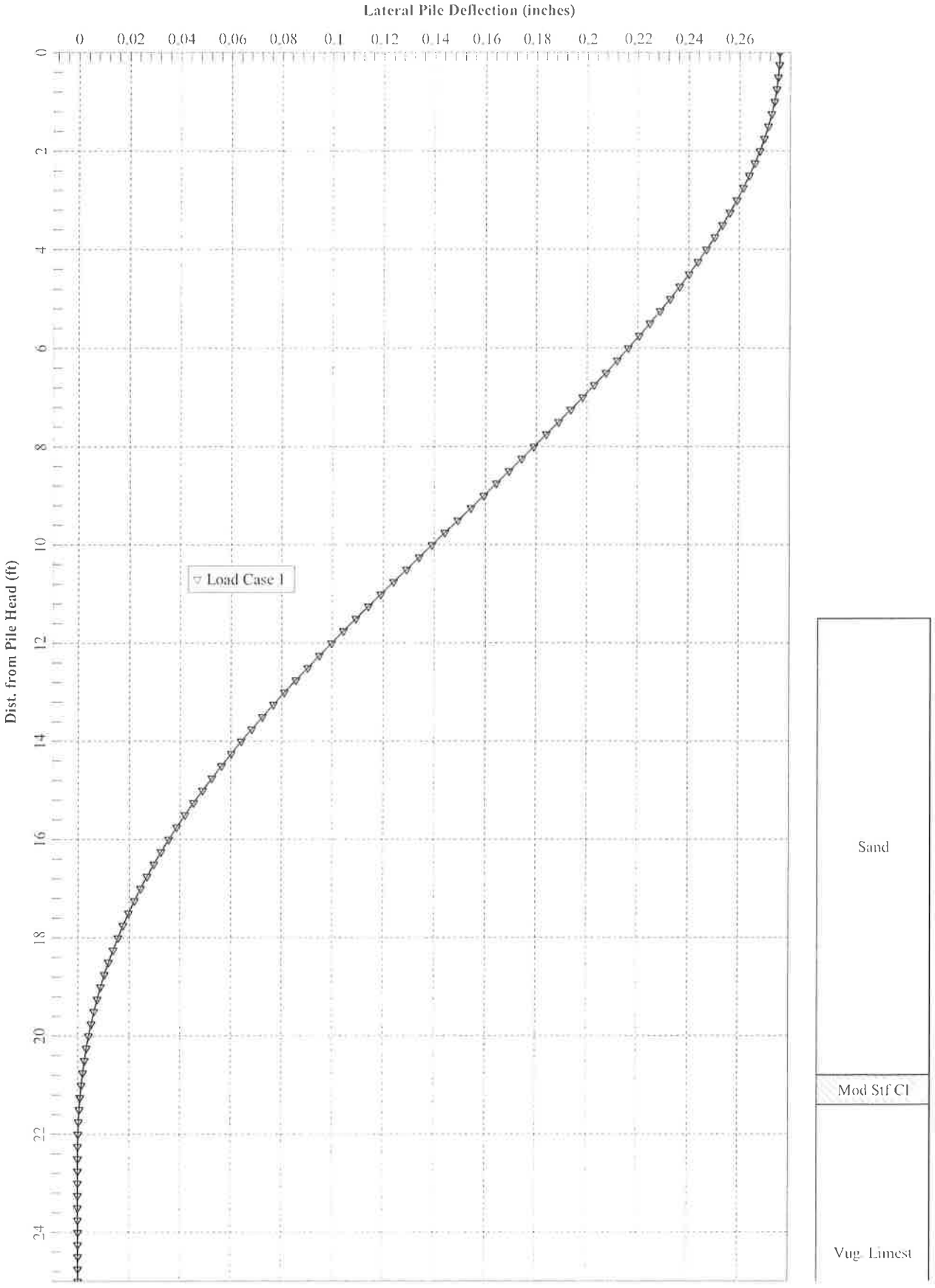
Recommend min 5' into Rock

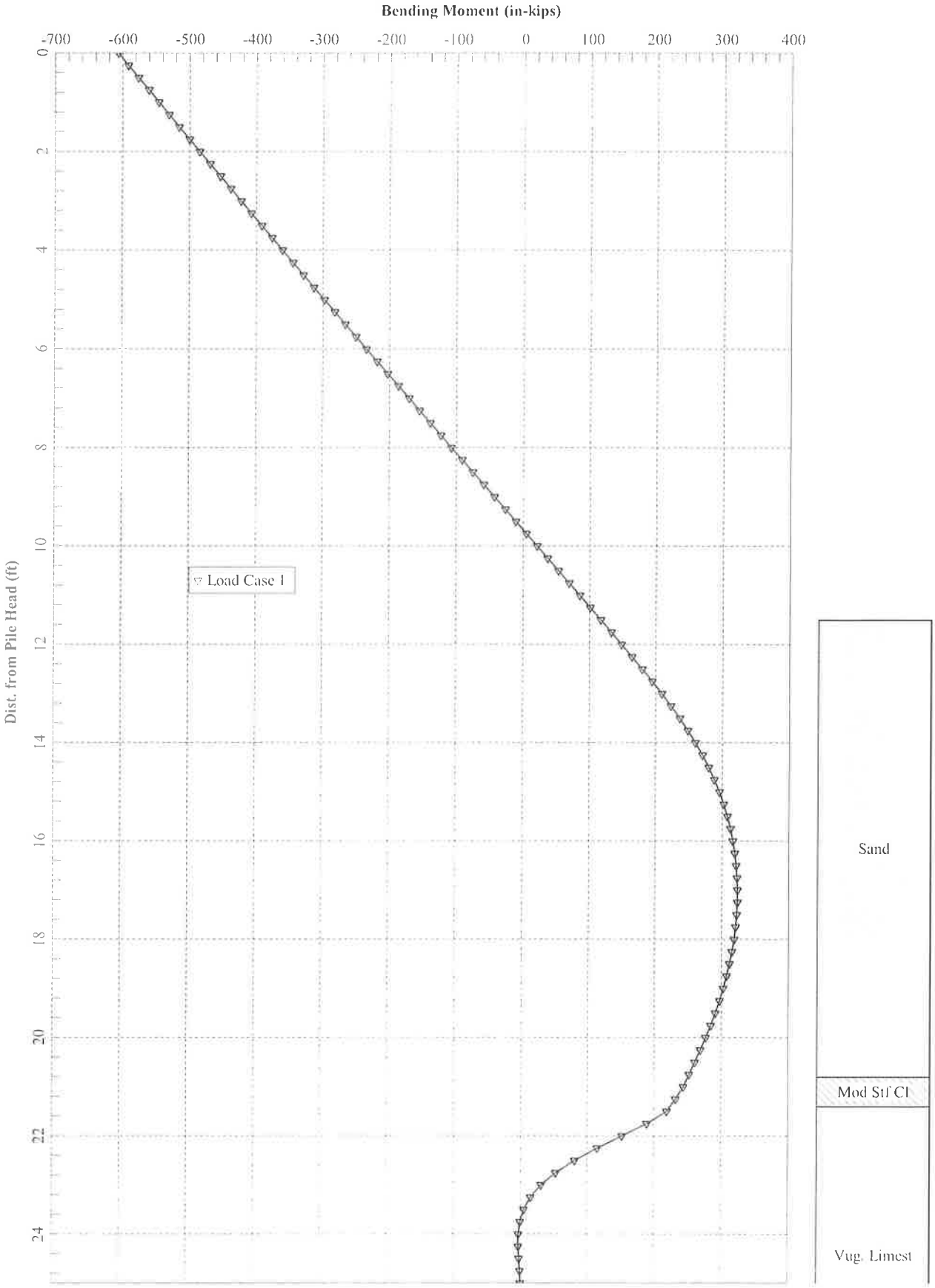
Tip Elev = 2598 Ft

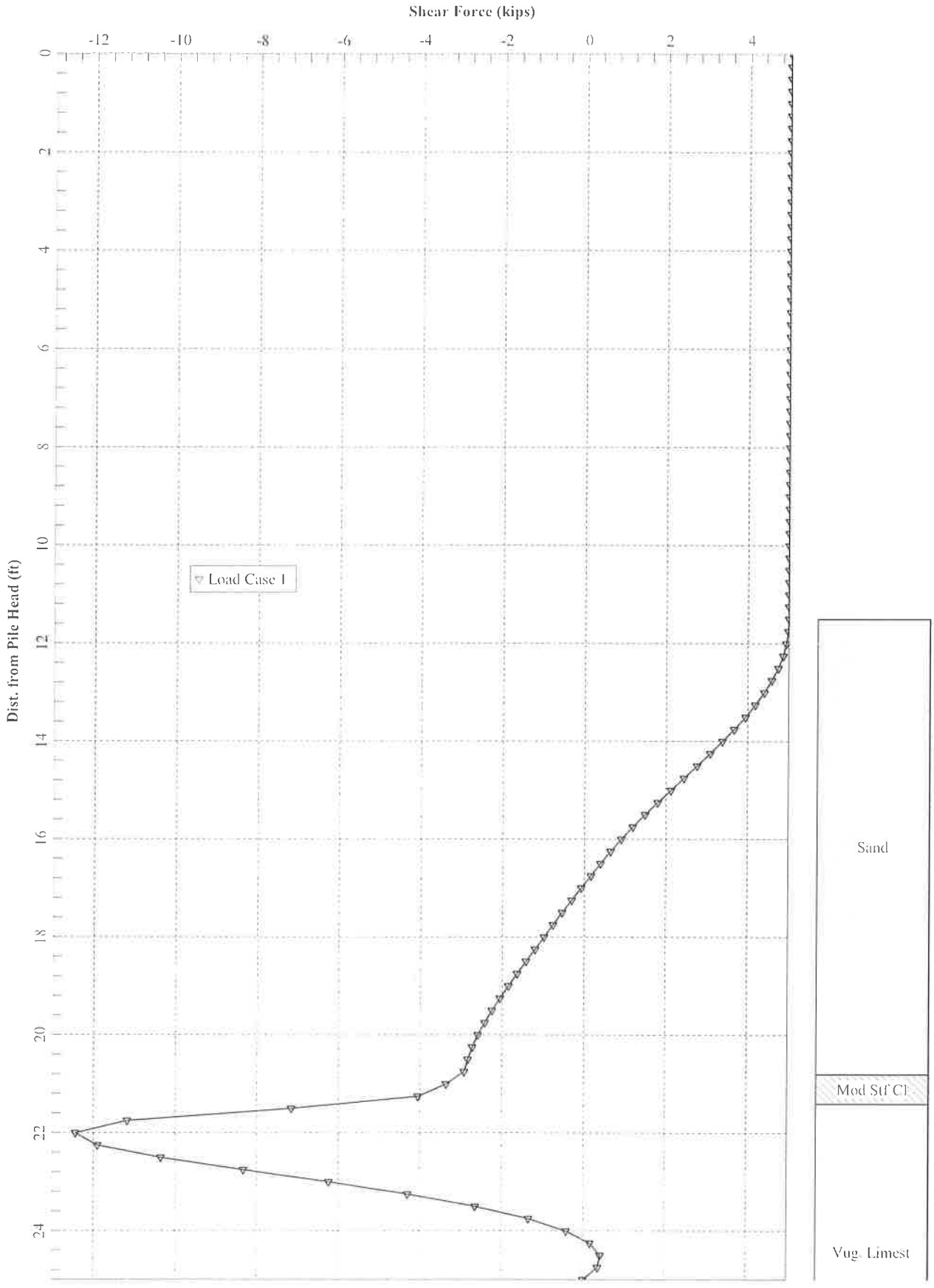
Bot of Wall/Scour = 2613



Rock @ 2603.1







LPile for Windows, Version 2022-12.005

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

This copy of LPile is being used by:

ECS Limited
ECS Southeast, LLP

Serial Number of Security Device: 562473626

This copy of LPile is licensed for exclusive use by:

ECS Carolinas, LLP, Charlotte, NC, USA

Use of this software by employees of ECS Carolinas, LLP
other than those of the office site in Charlotte, NC, USA
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\Users\mwalko\OneDrive - ECS Corporate Services\Home Dir\Working Files to Move to Sharepoint\Greensboro Projects\09-29663 Ashe Bridge 269 (BP11.R007)\Lateral Analysis\

Name of input data file:
EB1-A 14x73.lp12d

Name of output report file:
EB1-A 14x73.lp12o

Name of plot output file:
EB1-A 14x73.lp12p

Name of runtime message file:
EB1-A 14x73.lp12r

Date and Time of Analysis

Date: May 22, 2023 Time: 11:37:27

Problem Title

Project Name: Ashe Bridge 269

Job Number: 09-29663

Client: STV

Engineer: ECS

Description: EB1-A

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- 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
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 25.000 ft
Depth of ground surface below top of pile = 11.5000 ft

Pile diameters 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. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.5850
2	25.000	14.5850

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile
Cross-sectional Shape = Strong H-Pile
Length of section = 25.000000 ft
Flange Width = 14.585000 in
Section Depth = 13.610000 in
Flange Thickness = 0.505000 in
Web Thickness = 0.505000 in
Section Area = 21.400000 sq. in
Moment of Inertia = 729.000000 in^4
Elastic Modulus = 29000000. psi

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 = 11.500000 ft
Distance from top of pile to bottom of layer = 20.800000 ft
Effective unit weight at top of layer = 57.600000 pcf
Effective unit weight at bottom of layer = 57.600000 pcf
Friction angle at top of layer = 36.000000 deg.
Friction angle at bottom of layer = 36.000000 deg.
Subgrade k at top of layer = 125.000000 pci
Subgrade k at bottom of layer = 125.000000 pci

Layer 2 is stiff clay with user-defined k-value

Distance from top of pile to top of layer = 20.800000 ft
Distance from top of pile to bottom of layer = 21.400000 ft
Effective unit weight at top of layer = 100.000000 pcf
Effective unit weight at bottom of layer = 100.000000 pcf
Undrained cohesion at top of layer = 8000. psf
Undrained cohesion at bottom of layer = 8000. psf
Epsilon-50 at top of layer = 0.004000
Epsilon-50 at bottom of layer = 0.004000
Subgrade k at top of layer = 2000. pci
Subgrade k at bottom of layer = 2000. pci

Layer 3 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 21.400000 ft
Distance from top of pile to bottom of layer = 30.000000 ft
Effective unit weight at top of layer = 160.000000 pcf
Effective unit weight at bottom of layer = 160.000000 pcf
Uniaxial compressive strength at top of layer = 4500. psi
Uniaxial compressive strength at bottom of layer = 4500. psi

(Depth of the lowest soil layer extends 5.000 ft below the pile tip)

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

Values entered for effective unit weight of rock were outside the limits of
50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 160.00 pcf

This data may be erroneous. Please check your data.

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	E50 or krm	kpy pci
1	Sand	11.5000	57.6000	--	36.0000	--	--	125.0000
	(Reese, et al.)	20.8000	57.6000	--	36.0000	--	--	125.0000
2	Stiff Clay w/o	20.8000	100.0000	8000.	--	--	0.00400	2000.
	Free Water, using k	21.4000	100.0000	8000.	--	--	0.00400	2000.
3	Strong Rock	21.4000	160.0000	--	--	4500.	--	--
	(Vuggy Limestone)	30.0000	160.0000	--	--	4500.	--	--

Static 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 = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	2	V = 5000. lbs	S = 0.0000 in/in	200000.	No	Yes

V = shear force applied normal to pile axis

M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

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

---

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf Above ft	Same Layer Type As Layer Above Rock Layer	Layer is Rock or is Below lbs	F0 Integral for Layer lbs	F1 Integral for Layer
1	11.5000	0.00	N.A.	No	0.00	56476.
2	20.8000	1.7278	No	No	56476.	25573.
3	21.4000	9.9000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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

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

Shear force at pile head = 5000.0 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 200000.0 lbs

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

Depth	Deflect.	Bending	Shear	Slope	Total	Bending	Soil Res.	Soil Spr.	Distrib.

X feet	y inches	Moment in-lbs	Force lbs	S radians	Stress psi*	Stiffness lb-in^2	p lb/inch	Es*H lb/inch	Lat. Load lb/inch
0.00	0.2757	-606517.	5000.	0.00	15413.	2.11E+10	0.00	0.00	0.00
0.2500	0.2755	-591491.	5000.	-8.50E-05	15263.	2.11E+10	0.00	0.00	0.00
0.5000	0.2752	-576415.	5000.	-1.68E-04	15112.	2.11E+10	0.00	0.00	0.00
0.7500	0.2745	-561290.	5000.	-2.49E-04	14961.	2.11E+10	0.00	0.00	0.00
1.0000	0.2737	-546117.	5000.	-3.27E-04	14809.	2.11E+10	0.00	0.00	0.00
1.2500	0.2726	-530897.	5000.	-4.04E-04	14657.	2.11E+10	0.00	0.00	0.00
1.5000	0.2712	-515632.	5000.	-4.78E-04	14504.	2.11E+10	0.00	0.00	0.00
1.7500	0.2697	-500324.	5000.	-5.50E-04	14351.	2.11E+10	0.00	0.00	0.00
2.0000	0.2679	-484973.	5000.	-6.20E-04	14197.	2.11E+10	0.00	0.00	0.00
2.2500	0.2660	-469580.	5000.	-6.88E-04	14043.	2.11E+10	0.00	0.00	0.00
2.5000	0.2638	-454147.	5000.	-7.53E-04	13889.	2.11E+10	0.00	0.00	0.00
2.7500	0.2615	-438676.	5000.	-8.16E-04	13734.	2.11E+10	0.00	0.00	0.00
3.0000	0.2589	-423168.	5000.	-8.78E-04	13579.	2.11E+10	0.00	0.00	0.00
3.2500	0.2562	-407623.	5000.	-9.37E-04	13423.	2.11E+10	0.00	0.00	0.00
3.5000	0.2533	-392044.	5000.	-9.93E-04	13268.	2.11E+10	0.00	0.00	0.00
3.7500	0.2502	-376431.	5000.	-0.00105	13111.	2.11E+10	0.00	0.00	0.00
4.0000	0.2470	-360787.	5000.	-0.00110	12955.	2.11E+10	0.00	0.00	0.00
4.2500	0.2436	-345111.	5000.	-0.00115	12798.	2.11E+10	0.00	0.00	0.00
4.5000	0.2401	-329406.	5000.	-0.00120	12641.	2.11E+10	0.00	0.00	0.00
4.7500	0.2364	-313673.	5000.	-0.00124	12484.	2.11E+10	0.00	0.00	0.00
5.0000	0.2326	-297914.	5000.	-0.00129	12326.	2.11E+10	0.00	0.00	0.00
5.2500	0.2287	-282129.	5000.	-0.00133	12168.	2.11E+10	0.00	0.00	0.00
5.5000	0.2247	-266320.	5000.	-0.00137	12010.	2.11E+10	0.00	0.00	0.00
5.7500	0.2205	-250488.	5000.	-0.00140	11852.	2.11E+10	0.00	0.00	0.00
6.0000	0.2163	-234635.	5000.	-0.00144	11693.	2.11E+10	0.00	0.00	0.00
6.2500	0.2119	-218763.	5000.	-0.00147	11534.	2.11E+10	0.00	0.00	0.00
6.5000	0.2074	-202871.	5000.	-0.00150	11375.	2.11E+10	0.00	0.00	0.00
6.7500	0.2029	-186962.	5000.	-0.00153	11216.	2.11E+10	0.00	0.00	0.00
7.0000	0.1983	-171037.	5000.	-0.00155	11057.	2.11E+10	0.00	0.00	0.00
7.2500	0.1936	-155098.	5000.	-0.00158	10897.	2.11E+10	0.00	0.00	0.00
7.5000	0.1888	-139146.	5000.	-0.00160	10738.	2.11E+10	0.00	0.00	0.00
7.7500	0.1840	-123181.	5000.	-0.00162	10578.	2.11E+10	0.00	0.00	0.00
8.0000	0.1791	-107206.	5000.	-0.00163	10418.	2.11E+10	0.00	0.00	0.00
8.2500	0.1742	-91222.	5000.	-0.00165	10258.	2.11E+10	0.00	0.00	0.00
8.5000	0.1692	-75231.	5000.	-0.00166	10098.	2.11E+10	0.00	0.00	0.00
8.7500	0.1642	-59233.	5000.	-0.00167	9938.	2.11E+10	0.00	0.00	0.00
9.0000	0.1592	-43229.	5000.	-0.00168	9778.	2.11E+10	0.00	0.00	0.00
9.2500	0.1542	-27222.	5000.	-0.00168	9618.	2.11E+10	0.00	0.00	0.00
9.5000	0.1491	-11213.	5000.	-0.00168	9458.	2.11E+10	0.00	0.00	0.00
9.7500	0.1441	4797.	5000.	-0.00168	9394.	2.11E+10	0.00	0.00	0.00
10.0000	0.1390	20807.	5000.	-0.00168	9554.	2.11E+10	0.00	0.00	0.00
10.2500	0.1340	36815.	5000.	-0.00168	9714.	2.11E+10	0.00	0.00	0.00
10.5000	0.1290	52819.	5000.	-0.00167	9874.	2.11E+10	0.00	0.00	0.00
10.7500	0.1240	68820.	5000.	-0.00166	10034.	2.11E+10	0.00	0.00	0.00
11.0000	0.1190	84814.	5000.	-0.00165	10194.	2.11E+10	0.00	0.00	0.00
11.2500	0.1141	100801.	5000.	-0.00164	10354.	2.11E+10	0.00	0.00	0.00
11.5000	0.1092	116780.	5000.	-0.00162	10514.	2.11E+10	0.00	0.00	0.00
11.7500	0.1043	132749.	4985.	-0.00161	10674.	2.11E+10	-9.969	286.6395	0.00
12.0000	0.09955	148617.	4938.	-0.00159	10832.	2.11E+10	-21.119	636.4362	0.00
12.2500	0.09482	164282.	4857.	-0.00156	10989.	2.11E+10	-32.931	1042.	0.00
12.5000	0.09017	179636.	4741.	-0.00154	11143.	2.11E+10	-44.948	1495.	0.00
12.7500	0.08559	194571.	4588.	-0.00151	11292.	2.11E+10	-56.516	1981.	0.00
13.0000	0.08110	208981.	4402.	-0.00148	11436.	2.11E+10	-67.492	2497.	0.00
13.2500	0.07669	222765.	4185.	-0.00145	11574.	2.11E+10	-77.119	3017.	0.00
13.5000	0.07238	235836.	3941.	-0.00142	11705.	2.11E+10	-85.953	3563.	0.00
13.7500	0.06817	248114.	3672.	-0.00139	11828.	2.11E+10	-93.412	4111.	0.00
14.0000	0.06407	259530.	3383.	-0.00135	11942.	2.11E+10	-99.254	4648.	0.00
14.2500	0.06007	270030.	3077.	-0.00131	12047.	2.11E+10	-104.264	5207.	0.00

14.5000	0.05619	279569.	2760.	-0.00127	12142.	2.11E+10	-107.133	5720.	0.00
14.7500	0.05243	288120.	2437.	-0.00123	12228.	2.11E+10	-108.233	6193.	0.00
15.0000	0.04879	295673.	2115.	-0.00119	12304.	2.11E+10	-106.961	6576.	0.00
15.2500	0.04528	302237.	1797.	-0.00115	12369.	2.11E+10	-104.639	6932.	0.00
15.5000	0.04190	307835.	1487.	-0.00111	12425.	2.11E+10	-102.292	7324.	0.00
15.7500	0.03865	312485.	1186.	-0.00106	12472.	2.11E+10	-97.905	7600.	0.00
16.0000	0.03553	316227.	902.2597	-0.00102	12509.	2.11E+10	-91.546	7730.	0.00
16.2500	0.03254	319119.	639.8774	-9.72E-04	12538.	2.11E+10	-83.376	7686.	0.00
16.5000	0.02970	321233.	395.5525	-9.27E-04	12559.	2.11E+10	-79.508	8032.	0.00
16.7500	0.02698	322604.	157.0294	-8.81E-04	12573.	2.11E+10	-79.508	8840.	0.00
17.0000	0.02441	323233.	-80.436	-8.35E-04	12579.	2.11E+10	-78.802	9685.	0.00
17.2500	0.02197	323124.	-314.737	-7.89E-04	12578.	2.11E+10	-77.398	10568.	0.00
17.5000	0.01967	322291.	-543.803	-7.44E-04	12570.	2.11E+10	-75.313	11485.	0.00
17.7500	0.01751	320754.	-768.770	-6.98E-04	12554.	2.11E+10	-74.665	12792.	0.00
18.0000	0.01549	318516.	-992.415	-6.53E-04	12532.	2.11E+10	-74.431	14420.	0.00
18.2500	0.01360	315582.	-1215.	-6.08E-04	12503.	2.11E+10	-73.688	16261.	0.00
18.5000	0.01184	311958.	-1434.	-5.63E-04	12466.	2.11E+10	-72.425	18352.	0.00
18.7500	0.01022	307655.	-1648.	-5.19E-04	12423.	2.11E+10	-70.635	20741.	0.00
19.0000	0.00872	302691.	-1857.	-4.76E-04	12374.	2.11E+10	-68.315	23490.	0.00
19.2500	0.00736	297086.	-2057.	-4.33E-04	12318.	2.11E+10	-65.465	26677.	0.00
19.5000	0.00613	290866.	-2249.	-3.92E-04	12255.	2.11E+10	-62.089	30410.	0.00
19.7500	0.00501	284063.	-2429.	-3.51E-04	12187.	2.11E+10	-58.198	34831.	0.00
20.0000	0.00402	276712.	-2593.	-3.11E-04	12114.	2.11E+10	-51.266	38250.	0.00
20.2500	0.00315	268875.	-2732.	-2.72E-04	12035.	2.11E+10	-41.303	39375.	0.00
20.5000	0.00239	260645.	-2843.	-2.35E-04	11953.	2.11E+10	-32.229	40500.	0.00
20.7500	0.00174	252102.	-2927.	-1.98E-04	11868.	2.11E+10	-24.126	41625.	0.00
21.0000	0.00120	243320.	-3373.	-1.63E-04	11780.	2.11E+10	-273.051	684000.	0.00
21.2500	7.60E-04	232060.	-4049.	-1.29E-04	11667.	2.11E+10	-177.830	702000.	0.00
21.5000	4.21E-04	219180.	-7158.	-9.74E-05	11538.	2.11E+10	-1895.	1.35E+07	0.00
21.7500	1.76E-04	189227.	-11186.	-6.84E-05	11239.	2.11E+10	-790.082	1.35E+07	0.00
22.0000	1.06E-05	152146.	-12443.	-4.42E-05	10868.	2.11E+10	-47.669	1.35E+07	0.00
22.2500	-8.96E-05	114624.	-11909.	-2.53E-05	10492.	2.11E+10	403.2766	1.35E+07	0.00
22.5000	-1.41E-04	80721.	-10352.	-1.14E-05	10153.	2.11E+10	634.6365	1.35E+07	0.00
22.7500	-1.58E-04	52523.	-8333.	-1.96E-06	9871.	2.11E+10	711.3584	1.35E+07	0.00
23.0000	-1.53E-04	30723.	-6235.	3.95E-06	9653.	2.11E+10	687.4614	1.35E+07	0.00
23.2500	-1.34E-04	15107.	-4297.	7.20E-06	9497.	2.11E+10	604.7081	1.35E+07	0.00
23.5000	-1.10E-04	4933.	-2650.	8.62E-06	9395.	2.11E+10	493.0135	1.35E+07	0.00
23.7500	-8.26E-05	-804.970	-1353.	8.92E-06	9354.	2.11E+10	371.8691	1.35E+07	0.00
24.0000	-5.61E-05	-3196.	-416.803	8.63E-06	9378.	2.11E+10	252.2667	1.35E+07	0.00
24.2500	-3.08E-05	-3316.	169.7776	8.17E-06	9379.	2.11E+10	138.7867	1.35E+07	0.00
24.5000	-7.04E-06	-2187.	425.4471	7.78E-06	9368.	2.11E+10	31.6595	1.35E+07	0.00
24.7500	1.58E-05	-772.798	366.0194	7.57E-06	9354.	2.11E+10	-71.278	1.35E+07	0.00
25.0000	3.84E-05	0.00	0.00	7.52E-06	9346.	2.11E+10	-172.735	6750000.	0.00

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

Output Summary for Load Case No. 1:

Pile-head deflection = 0.27566428 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = -606517. inch-lbs
Maximum shear force = -12443. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 22.00000000 feet below pile head
Number of iterations = 10
Number of zero deflection points = 2
Pile deflection at ground = 0.10917830 inches

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Load lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	5000.	S, rad	0.00	200000.	0.2757	0.00	-12443.	-606517.

Maximum pile-head deflection = 0.2756642845 inches
Maximum pile-head rotation = -0.0000000000 radians = -0.000000 deg.

The analysis ended normally.

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB1-B	**STATION** 15+14	**OFFSET** 5 ft RT	**ALIGNMENT** -L-	**0 HR.** 10.8
COLLAR ELEV. 2,627.3 ft	**TOTAL DEPTH** 19.4 ft	**NORTHING** 983,977	**EASTING** 1,312,315	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550X 84% 04/19/2022		**DRILL METHOD** H.S. Augers	**HAMMER TYPE** Automatic	
DRILLER J. Cain	**START DATE** 07/14/22	**COMP. DATE** 07/14/22	**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)
2630						Boc = 2624.5				
	2,627.3	0.0								GROUND SURFACE
2625	2,626.3	1.0	3	5	4	9		M		**ROADWAY EMBANKMENT** Medium Stiff to Very Stiff, Brown-Gray, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
	2,623.8	3.5	1	3	4	7		M		
	2,621.3	6.0	1	2	3	5		W		
2620	2,618.8	8.5	8	7	9	16		W		
2615						Scour = 2613				
	2,614.3	13.0								
	2,613.8	13.5	13	22	21	43		M		**RESIDUAL** Hard, Gray-Green, Fine to Coarse Sandy SILT (A-4), with some mica
	2,611.5	15.8	70	30/0.2		100/0.7				**WEATHERED ROCK** Brown-Gray (AMPHIBOLITE)
2610	2,608.8	18.5	100/0.4			100/0.4				
	2,608.0	19.3	60/0.1			60/0.1				
	2,607.9	19.4								**CRYSTALLINE ROCK** Gray (AMPHIBOLITE)

Boring Terminated with Standard Penetration Test Refusal at Elevation 2,607.9 ft In Crystalline Rock (AMPHIBOLITE)

Top of drilled hole/bottom of wall = 2613'

Tip 5' into Rock

min Tip = 2603'

L = Boc - Tip Elev + 1.0 Embed

= 2624.5 - 2603 + 1 = 22.5'

Ave Pile Length = 25'

Est Qty (Abutment)

In Soil = 2624.5 - 2611.5 = 13.0'

Not In Soil = 2611.5 - 2603 = 8.5'

Est Qty (Wingwall 2)

In Soil = 26262 - 2611.5 = 14.7'

Not In Soil = 2611.5 - 2603 = 8.5

Ave Pile Length (wing 2) = 25'

EB1-B

BOC = 2624.5

* Used a lateral load of 5 kips to determine POF

1ST Neg = 17.0' (EL 2607.5)

Max Neg = 17.8' (EL 2606.7)

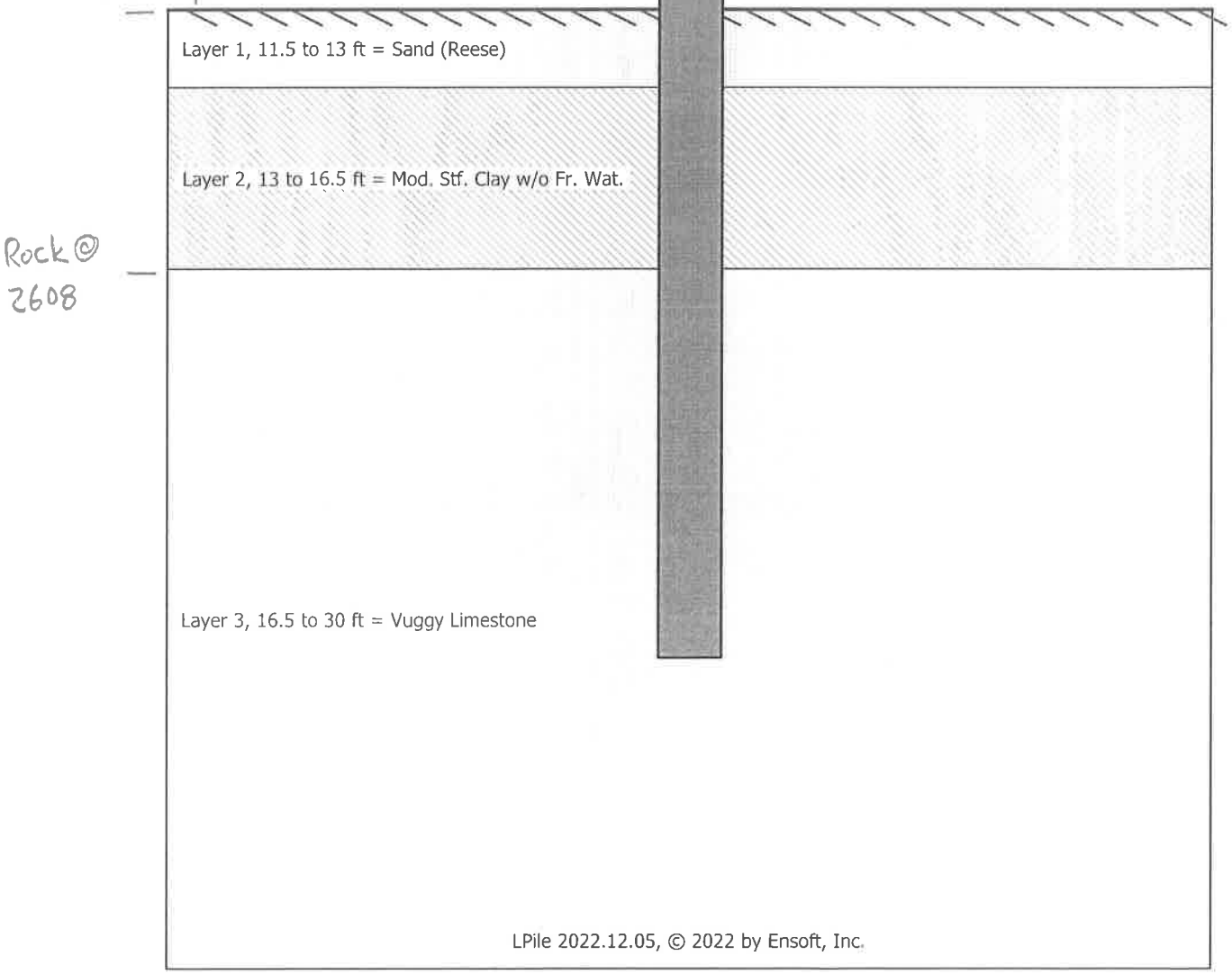
Say POF = 2607 Ft

Min Tip For Lateral = 2605 Ft (3' into Rock)

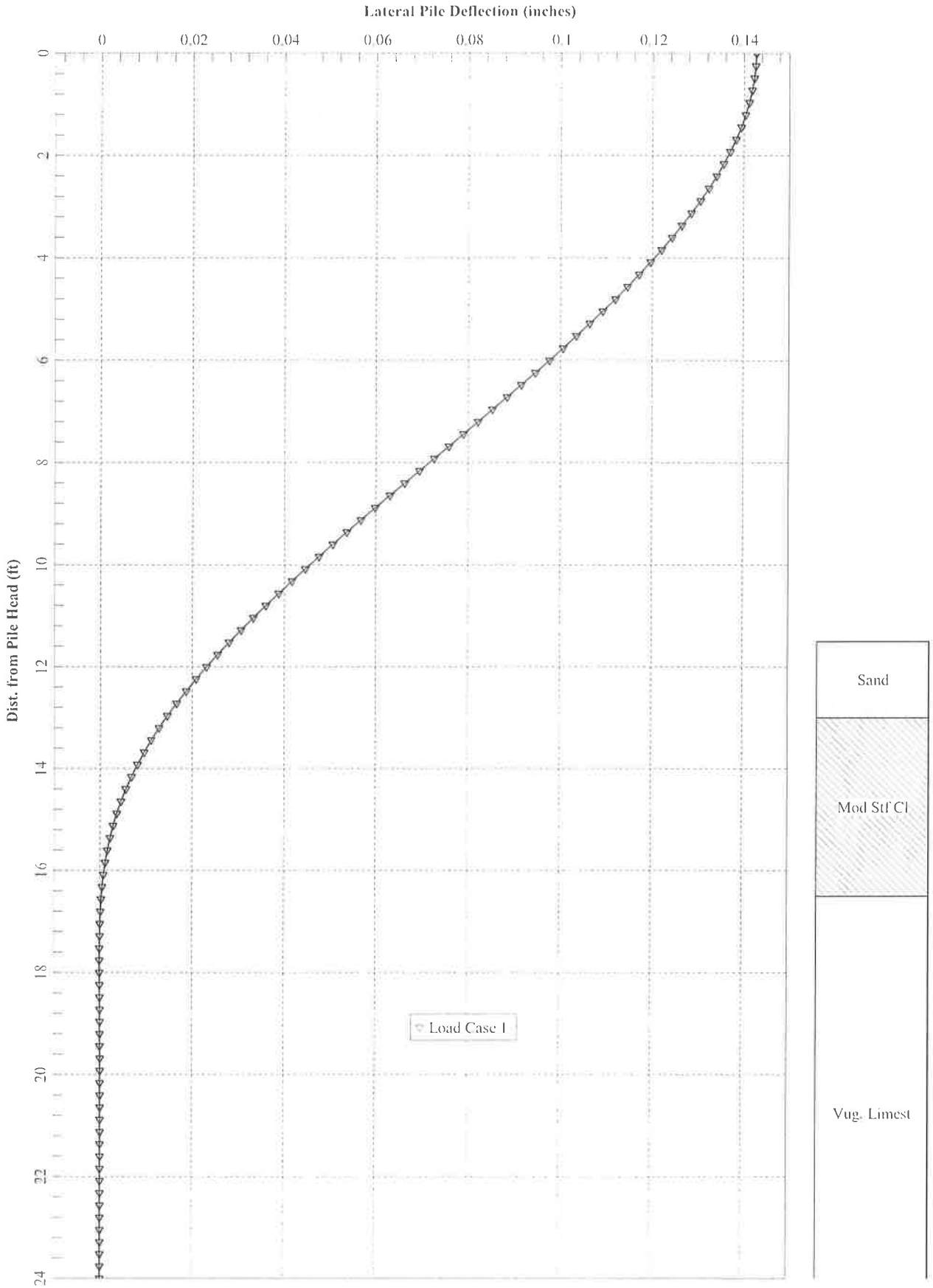
• Recommend min 5' into Rock

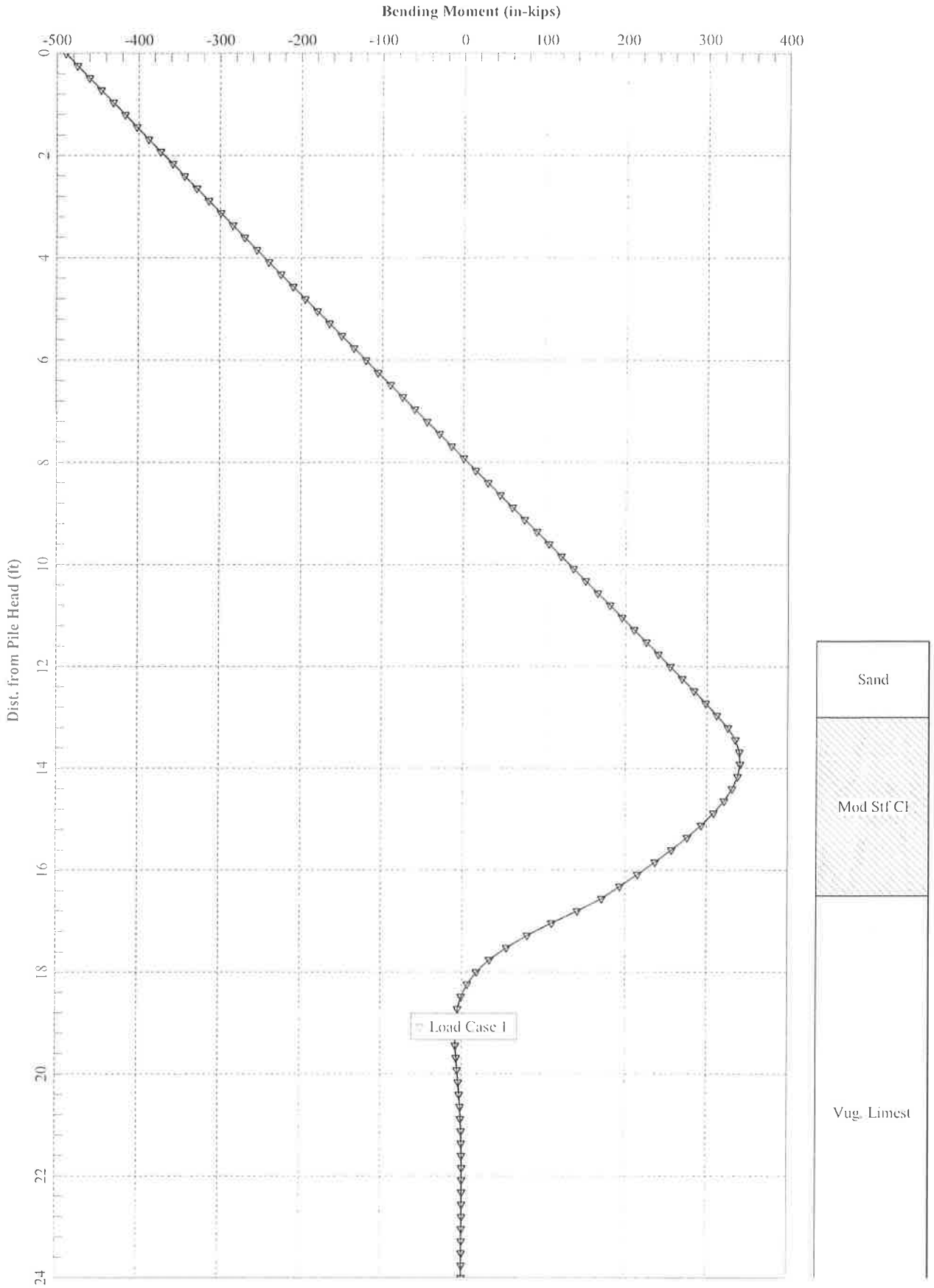
Tip Elev = 2603 Ft

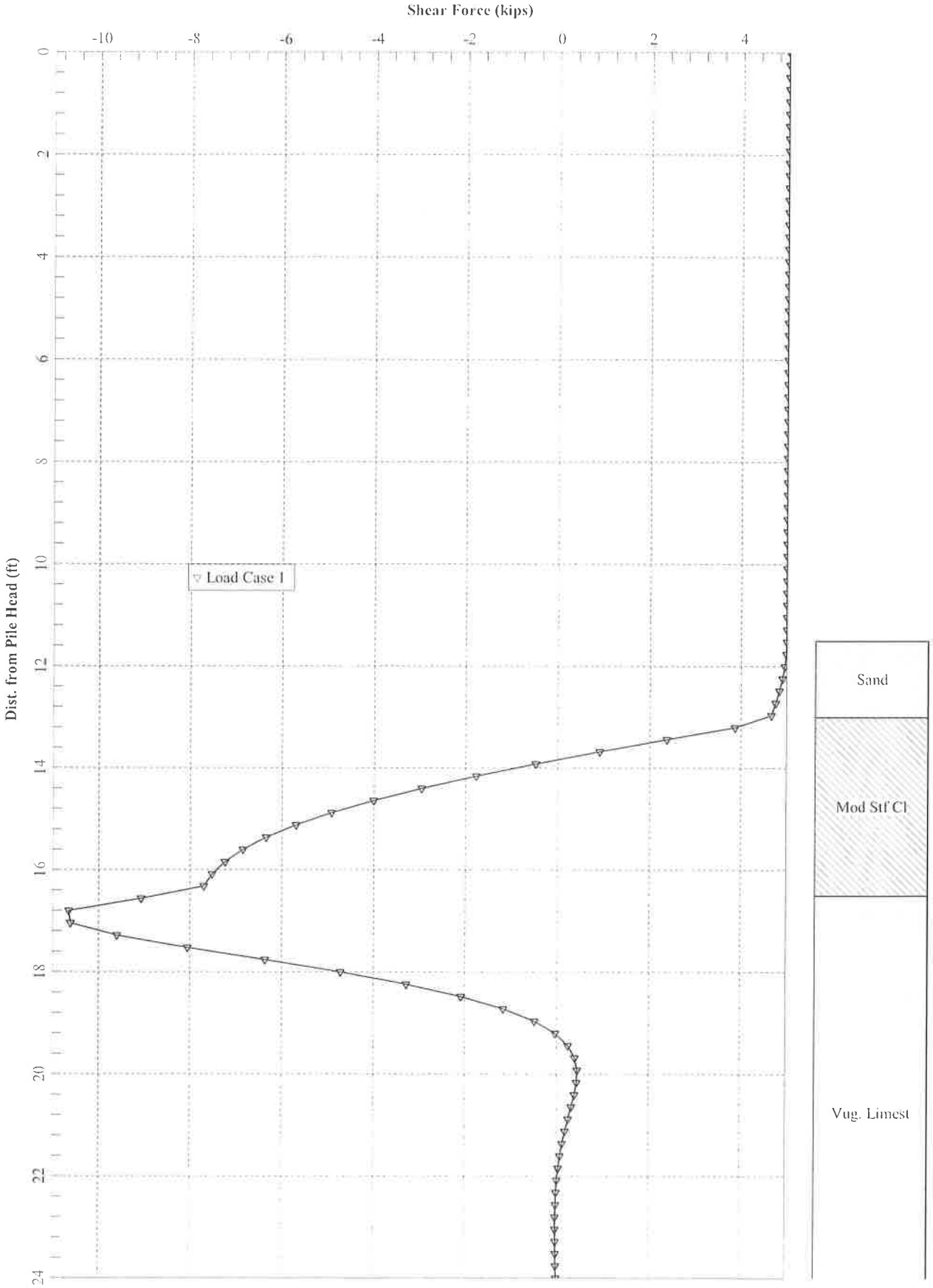
Bot of Wall/Scour = 2613



Rock @ 2608







LPile for Windows, Version 2022-12.005

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

This copy of LPile is being used by:

ECS Limited
ECS Southeast, LLP

Serial Number of Security Device: 562473626

This copy of LPile is licensed for exclusive use by:

ECS Carolinas, LLP, Charlotte, NC, USA

Use of this software by employees of ECS Carolinas, LLP
other than those of the office site in Charlotte, NC, USA
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\Users\mwalko\OneDrive - ECS Corporate Services\Home Dir\Working Files to Move to Sharepoint\Greensboro Projects\09-29663 Ashe Bridge 269 (BP11.R007)\Lateral Analysis\

Name of input data file:
EB1-B 14x73.lp12d

Name of output report file:
EB1-B 14x73.lp12o

Name of plot output file:
EB1-B 14x73.lp12p

Name of runtime message file:
EB1-B 14x73.lp12r

Date and Time of Analysis

Date: May 22, 2023 Time: 10:22:20

Problem Title

Project Name: Ashe Bridge 269

Job Number: 09-29663

Client: STV

Engineer: ECS

Description: EB1-B

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- 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
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 24.000 ft
Depth of ground surface below top of pile = 11.5000 ft

Pile diameters 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. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.5850
2	24.000	14.5850

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile

Cross-sectional Shape	= Strong H-Pile
Length of section	= 24.000000 ft
Flange Width	= 14.585000 in
Section Depth	= 13.610000 in
Flange Thickness	= 0.505000 in
Web Thickness	= 0.505000 in
Section Area	= 21.400000 sq. in
Moment of Inertia	= 729.000000 in^4
Elastic Modulus	= 29000000. psi

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	= 11.500000 ft
Distance from top of pile to bottom of layer	= 13.000000 ft
Effective unit weight at top of layer	= 57.600000 pcf
Effective unit weight at bottom of layer	= 57.600000 pcf
Friction angle at top of layer	= 36.000000 deg.
Friction angle at bottom of layer	= 36.000000 deg.
Subgrade k at top of layer	= 125.000000 pci
Subgrade k at bottom of layer	= 125.000000 pci

Layer 2 is stiff clay with user-defined k-value

Distance from top of pile to top of layer	= 13.000000 ft
Distance from top of pile to bottom of layer	= 16.500000 ft
Effective unit weight at top of layer	= 100.000000 pcf
Effective unit weight at bottom of layer	= 100.000000 pcf
Undrained cohesion at top of layer	= 8000. psf
Undrained cohesion at bottom of layer	= 8000. psf
Epsilon-50 at top of layer	= 0.004000
Epsilon-50 at bottom of layer	= 0.004000
Subgrade k at top of layer	= 2000. pci
Subgrade k at bottom of layer	= 2000. pci

Layer 3 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 16.500000 ft
Distance from top of pile to bottom of layer = 25.000000 ft
Effective unit weight at top of layer = 160.000000 pcf
Effective unit weight at bottom of layer = 160.000000 pcf
Uniaxial compressive strength at top of layer = 4500. psi
Uniaxial compressive strength at bottom of layer = 4500. psi

(Depth of the lowest soil layer extends 1.000 ft below the pile tip)

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

Values entered for effective unit weight of rock were outside the limits of
50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 160.00 pcf

This data may be erroneous. Please check your data.

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	E50 or krm	kpy pci
1	Sand	11.5000	57.6000	--	36.0000	--	--	125.0000
	(Reese, et al.)	13.0000	57.6000	--	36.0000	--	--	125.0000
2	Stiff Clay w/o	13.0000	100.0000	8000.	--	--	0.00400	2000.
	Free Water, using k	16.5000	100.0000	8000.	--	--	0.00400	2000.
3	Strong Rock	16.5000	160.0000	--	--	4500.	--	--
	(Vuggy Limestone)	25.0000	160.0000	--	--	4500.	--	--

Static 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 = 1

Load No	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	2	V = 5000. lbs	S = 0.0000 in/in	200000.	No	Yes

V = shear force applied normal to pile axis

M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

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

---

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf Above ft	Same Layer Type As Layer Above Rock Layer	Layer is Rock or is Below lbs	F0 Integral for Layer lbs	F1 Integral for Layer
1	11.5000	0.00	N.A.	No	0.00	1073.
2	13.0000	0.03668	No	No	1073.	148201.
3	16.5000	5.0000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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

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

Shear force at pile head = 5000.0 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 200000.0 lbs

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

Depth	Deflect.	Bending	Shear	Slope	Total	Bending	Soil Res.	Soil Spr.	Distrib.

X	y	Moment	Force	S	Stress	Stiffness	p	Es*H	Lat. Load
feet	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/inch	lb/inch	lb/inch
0.00	0.1427	-489248.	5000.	0.00	14240.	2.11E+10	0.00	0.00	0.00
0.2400	0.1426	-474829.	5000.	-6.57E-05	14096.	2.11E+10	0.00	0.00	0.00
0.4800	0.1423	-460372.	5000.	-1.29E-04	13951.	2.11E+10	0.00	0.00	0.00
0.7200	0.1418	-445880.	5000.	-1.91E-04	13806.	2.11E+10	0.00	0.00	0.00
0.9600	0.1412	-431352.	5000.	-2.51E-04	13661.	2.11E+10	0.00	0.00	0.00
1.2000	0.1404	-416791.	5000.	-3.09E-04	13515.	2.11E+10	0.00	0.00	0.00
1.4400	0.1394	-402197.	5000.	-3.64E-04	13369.	2.11E+10	0.00	0.00	0.00
1.6800	0.1383	-387571.	5000.	-4.18E-04	13223.	2.11E+10	0.00	0.00	0.00
1.9200	0.1370	-372915.	5000.	-4.70E-04	13076.	2.11E+10	0.00	0.00	0.00
2.1600	0.1356	-358230.	5000.	-5.20E-04	12929.	2.11E+10	0.00	0.00	0.00
2.4000	0.1340	-343516.	5000.	-5.68E-04	12782.	2.11E+10	0.00	0.00	0.00
2.6400	0.1323	-328776.	5000.	-6.13E-04	12635.	2.11E+10	0.00	0.00	0.00
2.8800	0.1305	-314010.	5000.	-6.57E-04	12487.	2.11E+10	0.00	0.00	0.00
3.1200	0.1285	-299219.	5000.	-6.99E-04	12339.	2.11E+10	0.00	0.00	0.00
3.3600	0.1264	-284404.	5000.	-7.39E-04	12191.	2.11E+10	0.00	0.00	0.00
3.6000	0.1243	-269568.	5000.	-7.76E-04	12042.	2.11E+10	0.00	0.00	0.00
3.8400	0.1220	-254710.	5000.	-8.12E-04	11894.	2.11E+10	0.00	0.00	0.00
4.0800	0.1196	-239832.	5000.	-8.46E-04	11745.	2.11E+10	0.00	0.00	0.00
4.3200	0.1171	-224936.	5000.	-8.77E-04	11596.	2.11E+10	0.00	0.00	0.00
4.5600	0.1145	-210021.	5000.	-9.07E-04	11447.	2.11E+10	0.00	0.00	0.00
4.8000	0.1119	-195091.	5000.	-9.35E-04	11297.	2.11E+10	0.00	0.00	0.00
5.0400	0.1091	-180144.	5000.	-9.60E-04	11148.	2.11E+10	0.00	0.00	0.00
5.2800	0.1063	-165184.	5000.	-9.84E-04	10998.	2.11E+10	0.00	0.00	0.00
5.5200	0.1035	-150211.	5000.	-0.00101	10848.	2.11E+10	0.00	0.00	0.00
5.7600	0.1005	-135226.	5000.	-0.00102	10699.	2.11E+10	0.00	0.00	0.00
6.0000	0.09757	-120231.	5000.	-0.00104	10549.	2.11E+10	0.00	0.00	0.00
6.2400	0.09455	-105226.	5000.	-0.00106	10398.	2.11E+10	0.00	0.00	0.00
6.4800	0.09148	-90213.	5000.	-0.00107	10248.	2.11E+10	0.00	0.00	0.00
6.7200	0.08838	-75192.	5000.	-0.00108	10098.	2.11E+10	0.00	0.00	0.00
6.9600	0.08525	-60166.	5000.	-0.00109	9948.	2.11E+10	0.00	0.00	0.00
7.2000	0.08209	-45135.	5000.	-0.00110	9797.	2.11E+10	0.00	0.00	0.00
7.4400	0.07892	-30101.	5000.	-0.00110	9647.	2.11E+10	0.00	0.00	0.00
7.6800	0.07574	-15064.	5000.	-0.00111	9496.	2.11E+10	0.00	0.00	0.00
7.9200	0.07255	-25.749	5000.	-0.00111	9346.	2.11E+10	0.00	0.00	0.00
8.1600	0.06936	15012.	5000.	-0.00111	9496.	2.11E+10	0.00	0.00	0.00
8.4000	0.06617	30049.	5000.	-0.00110	9646.	2.11E+10	0.00	0.00	0.00
8.6400	0.06300	45084.	5000.	-0.00110	9797.	2.11E+10	0.00	0.00	0.00
8.8800	0.05985	60115.	5000.	-0.00109	9947.	2.11E+10	0.00	0.00	0.00
9.1200	0.05671	75141.	5000.	-0.00108	10097.	2.11E+10	0.00	0.00	0.00
9.3600	0.05361	90161.	5000.	-0.00107	10248.	2.11E+10	0.00	0.00	0.00
9.6000	0.05055	105174.	5000.	-0.00106	10398.	2.11E+10	0.00	0.00	0.00
9.8400	0.04752	120179.	5000.	-0.00104	10548.	2.11E+10	0.00	0.00	0.00
10.0800	0.04454	135175.	5000.	-0.00102	10698.	2.11E+10	0.00	0.00	0.00
10.3200	0.04162	150160.	5000.	-0.00101	10848.	2.11E+10	0.00	0.00	0.00
10.5600	0.03875	165133.	5000.	-9.84E-04	10998.	2.11E+10	0.00	0.00	0.00
10.8000	0.03595	180093.	5000.	-9.60E-04	11147.	2.11E+10	0.00	0.00	0.00
11.0400	0.03322	195039.	5000.	-9.35E-04	11297.	2.11E+10	0.00	0.00	0.00
11.2800	0.03057	209970.	5000.	-9.07E-04	11446.	2.11E+10	0.00	0.00	0.00
11.5200	0.02800	224884.	4999.	-8.78E-04	11595.	2.11E+10	-0.518	53.2829	0.00
11.7600	0.02551	239777.	4988.	-8.46E-04	11744.	2.11E+10	-7.130	804.8945	0.00
12.0000	0.02312	254591.	4958.	-8.12E-04	11893.	2.11E+10	-14.056	1751.	0.00
12.2400	0.02083	269269.	4907.	-7.77E-04	12039.	2.11E+10	-21.010	2904.	0.00
12.4800	0.01865	283752.	4838.	-7.39E-04	12184.	2.11E+10	-27.415	4234.	0.00
12.7200	0.01658	297984.	4754.	-6.99E-04	12327.	2.11E+10	-30.337	5270.	0.00
12.9600	0.01462	311942.	4665.	-6.58E-04	12466.	2.11E+10	-32.022	6307.	0.00
13.2000	0.01279	325610.	3867.	-6.14E-04	12603.	2.11E+10	-521.787	117504.	0.00
13.4400	0.01108	334924.	2373.	-5.69E-04	12696.	2.11E+10	-516.050	134093.	0.00
13.6800	0.00951	339932.	913.0022	-5.23E-04	12746.	2.11E+10	-497.542	150682.	0.00

13.9200	0.00807	340786.	-478.311	-4.77E-04	12755.	2.11E+10	-468.648	167270.	0.00
14.1600	0.00676	337726.	-1775.	-4.31E-04	12724.	2.11E+10	-431.694	183859.	0.00
14.4000	0.00559	331059.	-2956.	-3.85E-04	12658.	2.11E+10	-388.907	200448.	0.00
14.6400	0.00454	321141.	-4010.	-3.41E-04	12558.	2.11E+10	-342.379	217037.	0.00
14.8800	0.00362	308357.	-4926.	-2.98E-04	12430.	2.11E+10	-294.039	233626.	0.00
15.1200	0.00283	293110.	-5703.	-2.57E-04	12278.	2.11E+10	-245.629	250214.	0.00
15.3600	0.00214	275803.	-6343.	-2.18E-04	12105.	2.11E+10	-198.685	266803.	0.00
15.6000	0.00157	256827.	-6852.	-1.82E-04	11915.	2.11E+10	-154.526	283392.	0.00
15.8400	0.00110	236548.	-7239.	-1.48E-04	11712.	2.11E+10	-114.247	299981.	0.00
16.0800	7.16E-04	215303.	-7516.	-1.18E-04	11500.	2.11E+10	-78.713	316570.	0.00
16.3200	4.20E-04	193389.	-7700.	-8.97E-05	11280.	2.11E+10	-48.565	333158.	0.00
16.5600	1.99E-04	171057.	-9062.	-6.49E-05	11057.	2.11E+10	-897.402	1.30E+07	0.00
16.8000	4.61E-05	141267.	-10653.	-4.36E-05	10759.	2.11E+10	-207.610	1.30E+07	0.00
17.0400	-5.17E-05	109745.	-10617.	-2.65E-05	10444.	2.11E+10	232.7724	1.30E+07	0.00
17.2800	-1.07E-04	80145.	-9591.	-1.36E-05	10148.	2.11E+10	479.3980	1.30E+07	0.00
17.5200	-1.30E-04	54514.	-8059.	-4.40E-06	9891.	2.11E+10	584.5268	1.30E+07	0.00
17.7600	-1.32E-04	33728.	-6363.	1.61E-06	9683.	2.11E+10	593.4095	1.30E+07	0.00
18.0000	-1.21E-04	17861.	-4727.	5.13E-06	9524.	2.11E+10	542.7445	1.30E+07	0.00
18.2400	-1.02E-04	6495.	-3282.	6.78E-06	9411.	2.11E+10	460.5450	1.30E+07	0.00
18.4800	-8.15E-05	-1052.	-2091.	7.16E-06	9356.	2.11E+10	366.8790	1.30E+07	0.00
18.7200	-6.11E-05	-5556.	-1166.	6.71E-06	9401.	2.11E+10	275.0710	1.30E+07	0.00
18.9600	-4.29E-05	-7778.	-492.240	5.80E-06	9424.	2.11E+10	193.0727	1.30E+07	0.00
19.2000	-2.77E-05	-8398.	-34.493	4.70E-06	9430.	2.11E+10	124.8074	1.30E+07	0.00
19.4400	-1.59E-05	-7982.	248.0017	3.58E-06	9426.	2.11E+10	71.3694	1.30E+07	0.00
19.6800	-7.12E-06	-6974.	396.8890	2.56E-06	9416.	2.11E+10	32.0246	1.30E+07	0.00
19.9200	-1.11E-06	-5699.	450.1936	1.70E-06	9403.	2.11E+10	4.9925	1.30E+07	0.00
20.1600	2.66E-06	-4383.	440.1353	1.01E-06	9390.	2.11E+10	-11.977	1.30E+07	0.00
20.4000	4.71E-06	-3165.	392.3464	4.97E-07	9377.	2.11E+10	-21.209	1.30E+07	0.00
20.6400	5.52E-06	-2123.	326.0167	1.36E-07	9367.	2.11E+10	-24.853	1.30E+07	0.00
20.8800	5.50E-06	-1288.	254.5923	-9.58E-08	9359.	2.11E+10	-24.747	1.30E+07	0.00
21.1200	4.97E-06	-656.910	186.7453	-2.28E-07	9352.	2.11E+10	-22.369	1.30E+07	0.00
21.3600	4.18E-06	-211.693	127.4192	-2.87E-07	9348.	2.11E+10	-18.830	1.30E+07	0.00
21.6000	3.32E-06	77.3562	78.8225	-2.97E-07	9347.	2.11E+10	-14.918	1.30E+07	0.00
21.8400	2.48E-06	242.6659	41.2965	-2.75E-07	9348.	2.11E+10	-11.142	1.30E+07	0.00
22.0800	1.73E-06	315.5406	14.0277	-2.37E-07	9349.	2.11E+10	-7.795	1.30E+07	0.00
22.3200	1.11E-06	323.7385	-4.403	-1.93E-07	9349.	2.11E+10	-5.004	1.30E+07	0.00
22.5600	6.19E-07	290.4021	-15.621	-1.51E-07	9349.	2.11E+10	-2.786	1.30E+07	0.00
22.8000	2.40E-07	233.9366	-21.187	-1.16E-07	9348.	2.11E+10	-1.080	1.30E+07	0.00
23.0400	-4.74E-08	168.4961	-22.435	-8.83E-08	9347.	2.11E+10	0.2131	1.30E+07	0.00
23.2800	-2.69E-07	104.8098	-20.388	-6.97E-08	9347.	2.11E+10	1.2085	1.30E+07	0.00
23.5200	-4.49E-07	51.1394	-15.741	-5.90E-08	9346.	2.11E+10	2.0189	1.30E+07	0.00
23.7600	-6.09E-07	14.2109	-8.889	-5.46E-08	9346.	2.11E+10	2.7390	1.30E+07	0.00
24.0000	-7.63E-07	0.00	0.00	-5.36E-08	9346.	2.11E+10	3.4341	6480000.	0.00

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

Output Summary for Load Case No. 1:

Pile-head deflection = 0.14265822 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = -489248. inch-lbs
Maximum shear force = -10653. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 16.80000000 feet below pile head
Number of iterations = 6
Number of zero deflection points = 3
Pile deflection at ground = 0.02820991 inches

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Pile-head Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	5000.	S, rad	0.00	200000.	0.1427	0.00	-10653.	-489248.

Maximum pile-head deflection = 0.1426582184 inches
Maximum pile-head rotation = 0.0000000000 radians = 0.000000 deg.

The analysis ended normally.

GEOTECHNICAL BORING REPORT
BORE LOG

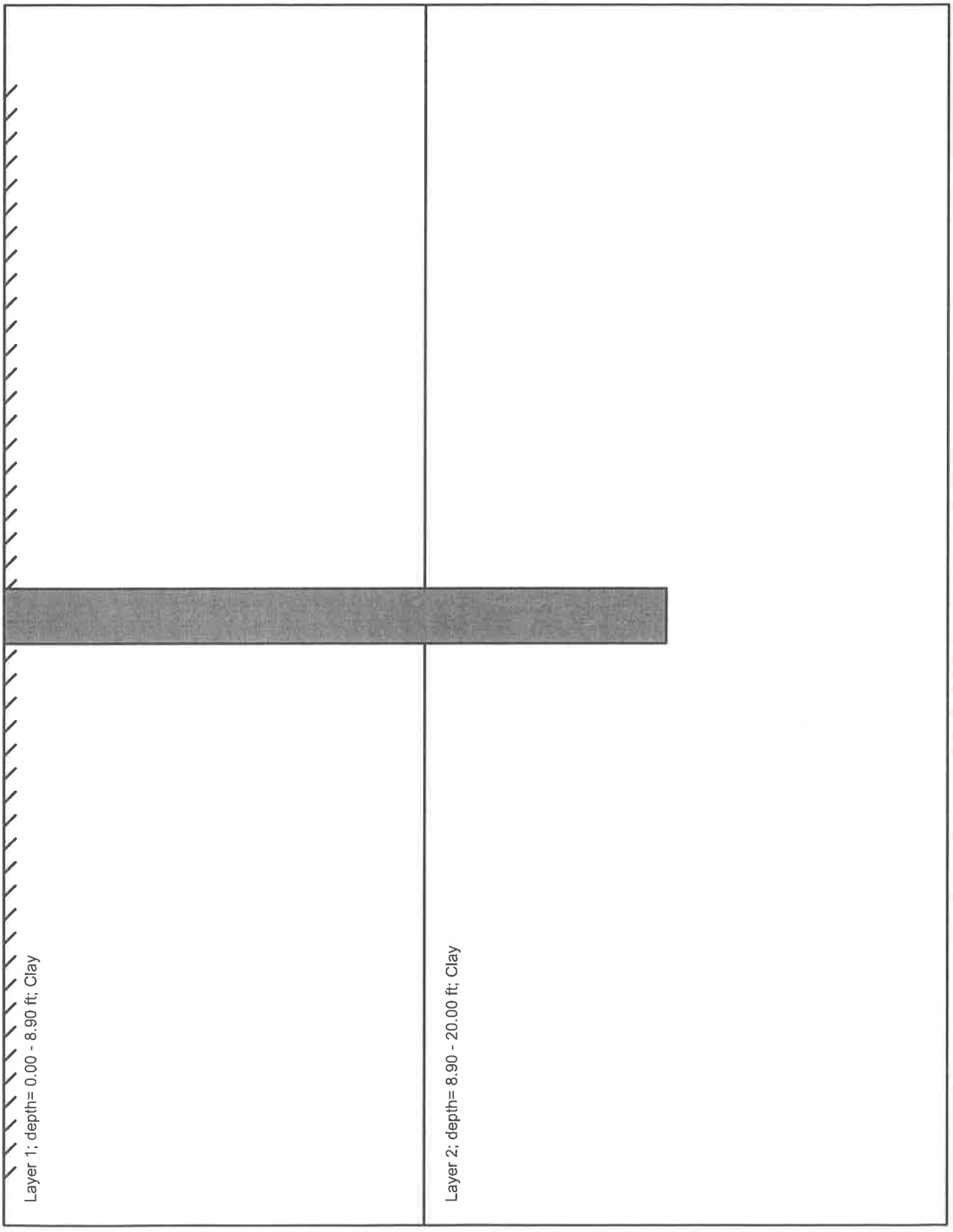
WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB2-A	**STATION** 16+00	**OFFSET** 7 ft LT	**ALIGNMENT** -L-	**0 HR.** 15.5
COLLAR ELEV. 2,627.4 ft	**TOTAL DEPTH** 17.4 ft	**NORTHING** 984,045	**EASTING** 1,312,369	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550 92% 11/02/2016		**DRILL METHOD** H.S. Augers	**HAMMER TYPE** Automatic	
DRILLER J. Cain	**START DATE** 07/18/22	**COMP. DATE** 07/18/22	**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
2630						BOC ≈ 2622.7				
										2,627.4 GROUND SURFACE 0.0
	2,626.4	1.0	3	2	2	4		M		**ROADWAY EMBANKMENT** Soft, Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
2625	2,623.9	3.5	1	1	1	2 BOC	0	M		
	2,621.4	6.0	1	1	1	2 N Scour = 3		W		2,621.9 5.5 Soft, Brown, Fine to Coarse Sandy SILT (A-4)
2620	2,618.9	8.5	1	WOH	1	1 γ = 105 C = 250		Sat.		2,619.4 8.0 Very Soft, Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
2615										
	2,613.9	13.5	76	24/0.1		WR 100/0.6	8.9			2,613.9 13.5 **WEATHERED ROCK** Gray (AMPHIBOLITE)
2610	2,610.0	17.4	60/0.0			60/0.0				2,610.0 17.4 Boring Terminated with Standard Penetration Test Refusal at Elevation 2,610.0 ft On Crystalline Rock (AMPHIBOLITE)

Assume pile will Refuse 1-2' into WR for a tip elevation of 2612 ft

No Scour @ EB-2

Bridge 269
EB-2(LT)



```
=============================================================================

            APILE for Windows, Version 2019.9.6

            Serial Number :  562476398

            A Program for Analyzing the Axial Capacity
            and Short-term Settlement of Driven Piles
                  under Axial Loading.
            (c) Copyright ENSOFT, Inc., 1987-2019
                All Rights Reserved

=============================================================================

   This program is licensed to :

   ECS Carolinas, LLP
   Charlotte, NC, USA

   Path to file locations      : C:\Users\mwalko\OneDrive - ECS Corporate Services\Home Dir\Working Files to Move to Sharepoint\Greensboro
Projects\09-29663 Ashe Bridge 269 (BP11.R007)\Axial Analysis\
   Name of input data file     : EB2-A (14x73).ap9d
   Name of output file         : EB2-A (14x73).ap9o
   Name of plot output file    : EB2-A (14x73).ap9p

   -----------------------------------------------------------------------
                  Time and Date of Analysis
   -----------------------------------------------------------------------

         Date:  May 22, 2023     Time:  07:13:28


1
      **********************
      * INPUT INFORMATION *
      **********************



      Ashe Bridge 269

      DESIGNER   : ECS

      JOB NUMBER : 09-29663


      METHOD FOR UNIT LOAD TRANSFERS :

      - FHWA (Federal Highway Administration)
        Unfactored Unit Side Friction and Unit Side Resistance are used.


      COMPUTATION METHOD(S) FOR PILE CAPACITY :

      - FHWA (Federal Highway Administration)


      TYPE OF LOADING :
```

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 21.40 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 14.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 56.40 IN.
- TIP AREA OF PILE = 21.40 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	105.00	0.00	8.00**
8.90	CLAY	0.80*	105.00	0.00	8.00**
8.90	CLAY	0.80*	100.00	0.00	8.00**
20.00	CLAY	0.80*	100.00	0.00	8.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.25	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.25	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

LRFD FACTOR LRFD FACTOR

DEPTH FT.	ON UNIT FRICTION	ON UNIT BEARING
0.00	1.000	1.000
8.90	1.000	1.000
8.90	1.000	1.000
20.00	1.000	1.000

Factored Load = 100 tons/pile

By inspection, pile should refuse ≈ 1-2 feet into WR for a tip elevation of 2612 Ft.

1

****
* COMPUTATION RESULT *
****

L = Boc-Tip EL + 2.0 Embed into Cap
= 2622.7 - 2612 + 2.0 = 12.7 Ft

****
* FED. HWY. METHOD *
****

Ave Pile Length = 15 Ft; Pile Pen = 10.7 Ft

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP	
0.00	0.0	0.2	0.2	
1.00	0.0	0.2	0.2	
2.00	0.4	0.2	0.6	
3.00	1.1	0.3	1.4	
4.00	1.8	0.3	2.1	
5.00	2.5	0.3	2.8	
6.00	3.2	0.3	3.6	
7.00	3.9	1.2	5.1	
8.00	4.7	4.7	9.4	
9.00	5.4	8.2	13.6	
10.00	11.0	11.7	22.7	Top of WR = 2613.9
11.00	21.5	15.2	36.7	
12.00	32.0	16.0	48.1	
13.00	42.5	16.0	58.6	Est Tip = 2612
14.00	53.0	16.0	69.1	

Drive Piles to: $\frac{100 \text{ ton}}{0.6} = 166.7$ ton

Round up to 170 ton (340^k) RDR

WEAP = $\frac{21^k}{340^k}$ = 6% Skin Friction

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

****
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING *
****

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.2872E-01
			0.0000E+00	0.5565E-01

		0.0000E+00	0.1023E+00
		0.0000E+00	0.1436E+00
		0.0000E+00	0.1795E+00
		0.0000E+00	0.3591E+00
		0.0000E+00	0.5386E+00
		0.0000E+00	0.8976E+00
		0.0000E+00	0.3591E+01
2	10	0.4475E+01	
		0.0000E+00	0.0000E+00
		0.3174E+00	0.2872E-01
		0.5291E+00	0.5565E-01
		0.7936E+00	0.1023E+00
		0.9523E+00	0.1436E+00
		0.1058E+01	0.1795E+00
		0.9523E+00	0.3591E+00
		0.9523E+00	0.5386E+00
		0.9523E+00	0.8976E+00
		0.9523E+00	0.3591E+01
3	10	0.8858E+01	
		0.0000E+00	0.0000E+00
		0.3216E+00	0.2872E-01
		0.5360E+00	0.5565E-01
		0.8040E+00	0.1023E+00
		0.9648E+00	0.1436E+00
		0.1072E+01	0.1795E+00
		0.9648E+00	0.3591E+00
		0.9648E+00	0.5386E+00
		0.9648E+00	0.8976E+00
		0.9648E+00	0.3591E+01
4	10	0.8900E+01	
		0.0000E+00	0.0000E+00
		0.3204E+00	0.2872E-01
		0.5339E+00	0.5565E-01
		0.8009E+00	0.1023E+00
		0.9611E+00	0.1436E+00
		0.1068E+01	0.1795E+00
		0.9611E+00	0.3591E+00
		0.9611E+00	0.5386E+00
		0.9611E+00	0.8976E+00
		0.9611E+00	0.3591E+01
5	10	0.1448E+02	
		0.0000E+00	0.0000E+00
		0.4650E+01	0.2872E-01
		0.7750E+01	0.5565E-01
		0.1163E+02	0.1023E+00
		0.1395E+02	0.1436E+00
		0.1550E+02	0.1795E+00
		0.1395E+02	0.3591E+00
		0.1395E+02	0.5386E+00
		0.1395E+02	0.8976E+00
		0.1395E+02	0.3591E+01
6	10	0.1996E+02	
		0.0000E+00	0.0000E+00
		0.4650E+01	0.2872E-01
		0.7750E+01	0.5565E-01
		0.1163E+02	0.1023E+00
		0.1395E+02	0.1436E+00
		0.1550E+02	0.1795E+00
		0.1395E+02	0.3591E+00
		0.1395E+02	0.5386E+00
		0.1395E+02	0.8976E+00

0.1395E+02 0.3591E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.1003E+01	0.8976E-02
0.2006E+01	0.1795E-01
0.4012E+01	0.3591E-01
0.8025E+01	0.2334E+00
0.1204E+02	0.7540E+00
0.1444E+02	0.1311E+01
0.1605E+02	0.1795E+01
0.1605E+02	0.2693E+01
0.1605E+02	0.3591E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.6722E-01	0.1150E-03	0.1118E-01	0.1000E-03
0.6722E+00	0.1150E-02	0.1118E+00	0.1000E-02
0.3361E+01	0.5748E-02	0.5588E+00	0.5000E-02
0.6722E+01	0.1150E-01	0.1118E+01	0.1000E-01
0.1345E+02	0.2299E-01	0.2235E+01	0.2000E-01
0.2880E+02	0.5638E-01	0.4299E+01	0.5000E-01
0.3850E+02	0.8849E-01	0.4908E+01	0.8000E-01
0.4458E+02	0.1098E+00	0.5315E+01	0.1000E+00
0.5951E+02	0.2131E+00	0.7347E+01	0.2000E+00
0.5761E+02	0.5129E+00	0.1008E+02	0.5000E+00
0.5977E+02	0.8135E+00	0.1224E+02	0.8000E+00
0.6063E+02	0.1014E+01	0.1310E+02	0.1000E+01
0.6358E+02	0.2015E+01	0.1605E+02	0.2000E+01

WEAP Parameter Calculation

Bent #: EB2-A

		Toe Quake	Shaft Quake
Pile Type:	HP 14X73	**0.12**	**0.10**

Subsurface Conditions: Loose/Soft or Submerged

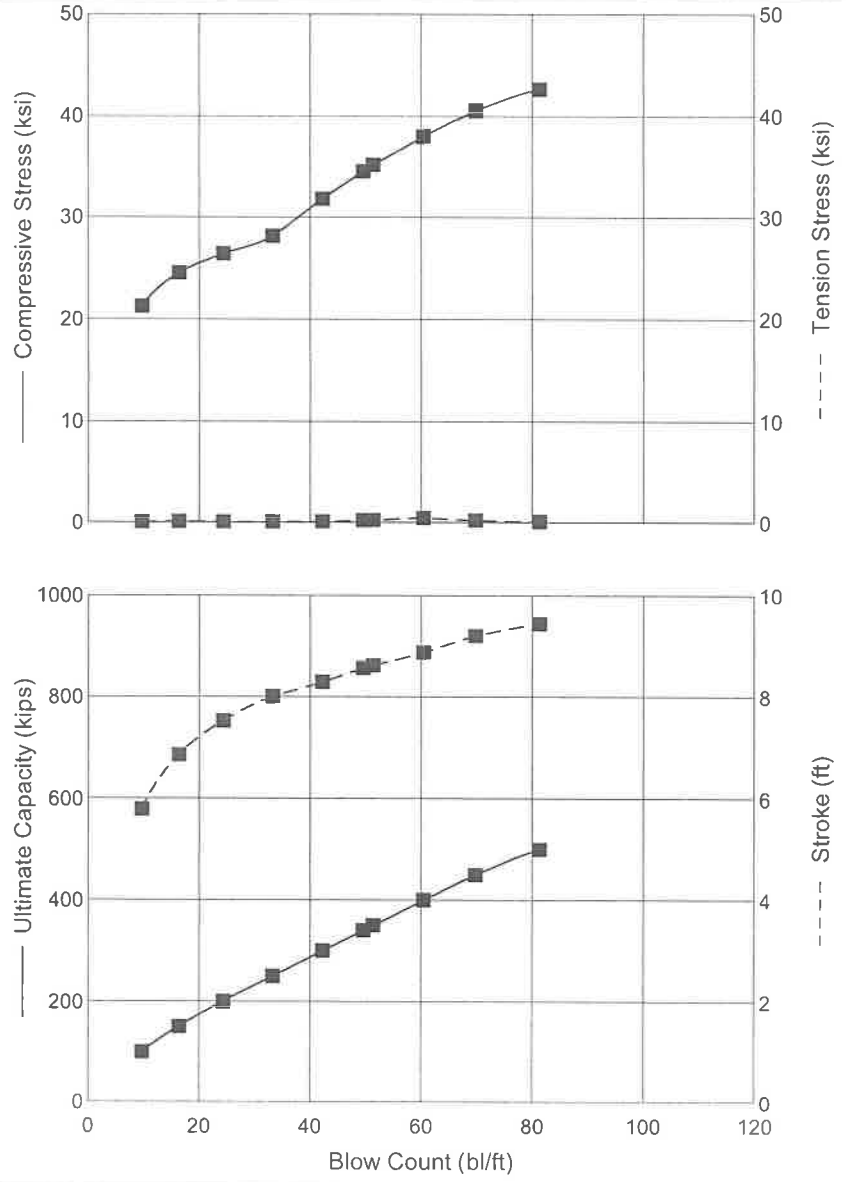
Layer #	Top	Bottom	Navg	Soil Type	Shaft Damping
1	2622.7	2613.9	3	Clay	0.30
2	2613.9	2612.0	100	WR	0.10
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
					0.26

Toe Damping
0.10

Length of Pile 10.7

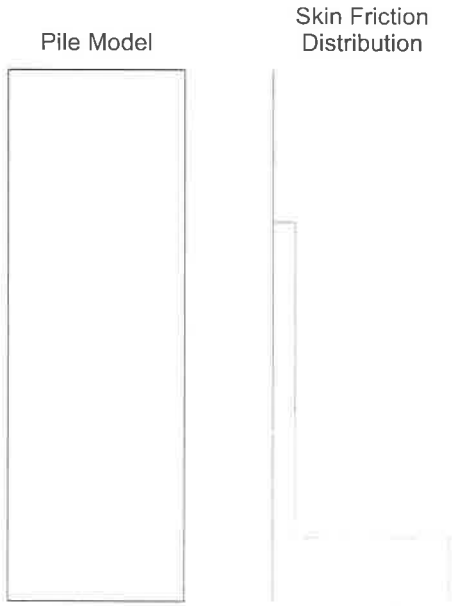
ECS Carolinas LLP
Bridge 269 - EB2-A

22-May-2023
GRLWEAP Version 2010



DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1580 (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	0.120	in
Skin Damping	0.260	sec/ft
Toe Damping	0.100	sec/ft
Pile Length	15.00	ft
Pile Penetration	10.70	ft
Pile Top Area	21.40	in2



Res. Shaft = 6 %
(Proportional)

ECS Carolinas LLP
Bridge 269 - EB2-A

22-May-2023
GRLWEAP Version 2010

	Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
	100.0	21.29	0.06	9.7	5.79	19.90
	150.0	24.53	0.10	16.4	6.85	18.62
	200.0	26.43	0.09	24.4	7.52	17.72
	250.0	28.19	0.08	33.3	8.00	17.29
	300.0	31.85	0.12	42.3	8.29	16.95
→	340.0	34.58	0.23	49.6	8.56	16.96
	350.0	35.21	0.27	51.4	8.62	16.97
	400.0	37.97	0.47	60.4	8.88	17.20
	450.0	40.51	0.24	69.8	9.21	17.59
	500.0	42.64	0.10	81.3	9.45	17.82

Pile can be driven to 340 k w/o overstressing

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 stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others 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: C:\USERS\MWALKO\ONEDRIVE - ECS CORPORATE SERVICES\HOME DIR\WORKING FILES TO MOVE TO SHAREPOINT\GREENSBORO PROJECTS\09-29663 ASHE BRIDGE 269 (BP11.R007)\WEAP\EB2-A 14X73 DELMAG D19-32.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
Hammer File Version: 2003 (12/4/2015)

Input File Contents

Bridge 269 - EB2-A

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	6	1	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size	Pile Type
32.170	32.170	198.500	14.580	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
15.000	21.40	30000.0	492.000	4.699	0	0.850	0.010

FFatique	F0	0-Bottom
0	0.000	0.000

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	0.0020	0.0020	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1580.00	1420.00	1280.00	1150.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.6100	0.8000	1580.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.100	0.120	0.260	0.100	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	10.70	10.70	0.00	0.00	0.00	0.00	0.00	0.0
8.90	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8.90	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10.70	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10.70	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14.90	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
15.00	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Rult

100.0	150.0	200.0	250.0	300.0	340.0	350.0	400.0	450.0	500.0

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

Bridge 269 - EB2-A

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	140046.6	1.000	0.0100	
3	0.800	140046.6	1.000	0.0100	
4	0.800	140046.6	1.000	0.0100	
5	0.800	140046.6	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		17833.3			

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)	1580.00	Actual Pressure	(psi)	1580.00
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)	198.500	Pile Type		H Pile
Pile Size	(inch)	14.580			

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	21.40	30000.	492.0	4.7	0	16807.	38.2
15.0	21.40	30000.	492.0	4.7	0	16807.	38.2

Wave Travel Time 2L/c (ms) 1.785

Pile and Soil Model — Total Capacity Rut (kips) 100.0

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	0.219	17833	0.010	0.000	0.85	0.0	0.260	0.100	3.00	4.7	21.4
2	0.219	17833	0.000	0.000	1.00	0.5	0.260	0.100	6.00	4.7	21.4
3	0.219	17833	0.000	0.000	1.00	0.8	0.260	0.100	9.00	4.7	21.4
5	0.219	17833	0.000	0.000	1.00	3.8	0.260	0.100	15.00	4.7	21.4
Toe						94.0	0.100	0.120			

1.097 kips total unreduced pile weight (g= 32.17 ft/s2)
1.097 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)	10.70	Pile Damping Fact.(k/ft/s)	0.764
% Shaft Resistance	6		
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			

Rut= 100.0, Rtoe = 94.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	455.5	0.00	21.29	11.21	1.379	19.90
2	0.0	454.3	0.00	21.23	12.47	1.375	19.83
3	-0.5	440.5	-0.02	20.58	14.19	1.370	19.62
4	-1.1	393.9	-0.05	18.41	15.35	1.365	19.35
5	-1.3	308.1	-0.06	14.40	16.10	1.359	19.21

(Eq) Strokes Analyzed and Last Return (ft):
10.61 5.12 5.99 5.79 5.83

Max. Combustion Pressure 1580.0 psi

Rut= 150.0, Rtoe= 141.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	525.0	0.00	24.53	12.84	0.883	18.62
2	-1.3	524.7	-0.06	24.52	13.56	0.876	18.51
3	-1.9	511.4	-0.09	23.90	15.25	0.868	18.28
4	-2.2	462.3	-0.10	21.60	15.98	0.860	17.98
5	-2.1	403.6	-0.10	18.86	15.91	0.852	17.81

(Eq) Strokes Analyzed and Last Return (ft):
10.61 6.39 6.85 6.79

Max. Combustion Pressure 1580.0 psi

Rut= 200.0, Rtoe= 188.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	565.7	0.00	26.44	13.75	0.653	17.72
2	-1.3	565.7	-0.06	26.43	14.23	0.642	17.57
3	-1.8	552.7	-0.08	25.83	15.73	0.631	17.29
4	-2.0	503.6	-0.09	23.53	16.28	0.621	16.95
5	-1.9	510.0	-0.09	23.83	15.22	0.610	16.74

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.27 7.52 7.48

Max. Combustion Pressure 1580.0 psi

Rut= 250.0, Rtoe= 235.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	594.0	0.00	27.76	14.38	0.533	17.29
2	-1.3	594.3	-0.06	27.77	14.71	0.520	17.08
3	-1.8	581.6	-0.08	27.18	15.95	0.506	16.73
4	-1.8	554.4	-0.08	25.91	16.42	0.493	16.33
5	-1.8	603.3	-0.08	28.19	14.79	0.479	16.06

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.90 8.00 8.00

Max. Combustion Pressure 1580.0 psi

Rut= 300.0, Rtoe = 282.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	610.4	0.00	28.52	14.73	0.467	16.95
2	-2.0	611.7	-0.09	28.58	14.95	0.451	16.67
3	-2.6	598.3	-0.12	27.96	15.96	0.435	16.25
4	-2.5	627.9	-0.12	29.34	16.29	0.419	15.78
5	-2.4	681.7	-0.11	31.85	14.26	0.402	15.46

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.29 8.35

Max. Combustion Pressure 1580.0 psi

Rut= 340.0, Rtoe= 319.6 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	624.9	0.00	29.20	15.05	0.435	16.96
2	-3.7	626.5	-0.17	29.28	15.20	0.417	16.61
3	-5.0	613.0	-0.23	28.65	16.06	0.398	16.11
4	-4.6	683.7	-0.22	31.95	16.26	0.379	15.57
5	-4.4	739.9	-0.20	34.58	13.86	0.361	15.18

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.56 8.60

Max. Combustion Pressure 1580.0 psi

Rut= 350.0, Rtoe= 329.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	628.1	0.00	29.35	15.12	0.429	16.97
2	-4.4	630.0	-0.20	29.44	15.25	0.410	16.60
3	-5.8	616.1	-0.27	28.79	16.07	0.390	16.08
4	-5.2	696.7	-0.24	32.56	16.23	0.371	15.52
5	-5.0	753.4	-0.24	35.21	13.75	0.352	15.11

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.62 8.65

Max. Combustion Pressure 1580.0 psi

Rut= 400.0, Rtoe= 376.0 kips, Time Inc. =0.072 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	671.1	0.00	31.36	15.44	0.409	17.20
2	-8.0	660.9	-0.37	30.89	15.49	0.385	16.66
3	-10.1	646.1	-0.47	30.19	16.12	0.362	15.98
4	-9.5	754.6	-0.44	35.26	16.18	0.339	15.30
5	-8.7	812.5	-0.41	37.97	13.32	0.317	14.80

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.88 8.89

Max. Combustion Pressure 1580.0 psi

Rut= 450.0, Rtoe = 423.0 kips, Time Inc. =0.068 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	750.1	0.00	35.05	15.82	0.398	17.59
2	-4.5	730.7	-0.21	34.15	15.80	0.371	16.92
3	-5.2	709.0	-0.24	33.13	16.26	0.343	16.03
4	-4.1	806.8	-0.19	37.70	16.14	0.316	15.19
5	-3.3	867.0	-0.16	40.51	12.91	0.291	14.57

(Eq) Strokes Analyzed and Last Return (ft):
10.61 9.21 9.17

Max. Combustion Pressure 1580.0 psi

Rut= 500.0, Rtoe= 470.0 kips, Time Inc. =0.064 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	817.9	0.00	38.22	16.09	0.388	17.82
2	-2.2	791.6	-0.10	36.99	16.00	0.358	17.00
3	-1.5	765.8	-0.07	35.79	16.32	0.326	15.92
4	0.0	850.6	0.00	39.75	16.05	0.295	14.87
5	0.0	912.5	0.00	42.64	12.47	0.266	14.12

(Eq) Strokes Analyzed and Last Return (ft):
10.61 9.45 9.43

Max. Combustion Pressure 1580.0 psi

Bridge 269 - EB2-A 05/22/2023
ECS Carolinas LLP 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
100.0	9.7	5.79	5.83	-0.06	5	35	21.29	1	2	19.9	48.9
150.0	16.4	6.85	6.79	-0.10	4	48	24.53	1	2	18.6	45.2
200.0	24.4	7.52	7.48	-0.09	4	40	26.44	1	2	17.7	43.2
250.0	33.3	8.00	8.00	-0.08	4	35	28.19	5	3	17.3	41.8
300.0	42.3	8.29	8.35	-0.12	3	29	31.85	5	3	17.0	41.0
340.0	49.6	8.56	8.60	-0.23	3	27	34.58	5	3	17.0	40.4
350.0	51.4	8.62	8.65	-0.27	3	26	35.21	5	3	17.0	40.3
400.0	60.4	8.88	8.89	-0.47	3	24	37.97	5	3	17.2	39.7
450.0	69.8	9.21	9.17	-0.24	3	24	40.51	5	3	17.6	39.1
500.0	81.3	9.45	9.43	-0.10	2	39	42.64	5	3	17.8	38.6

GEOTECHNICAL BORING REPORT
BORE LOG

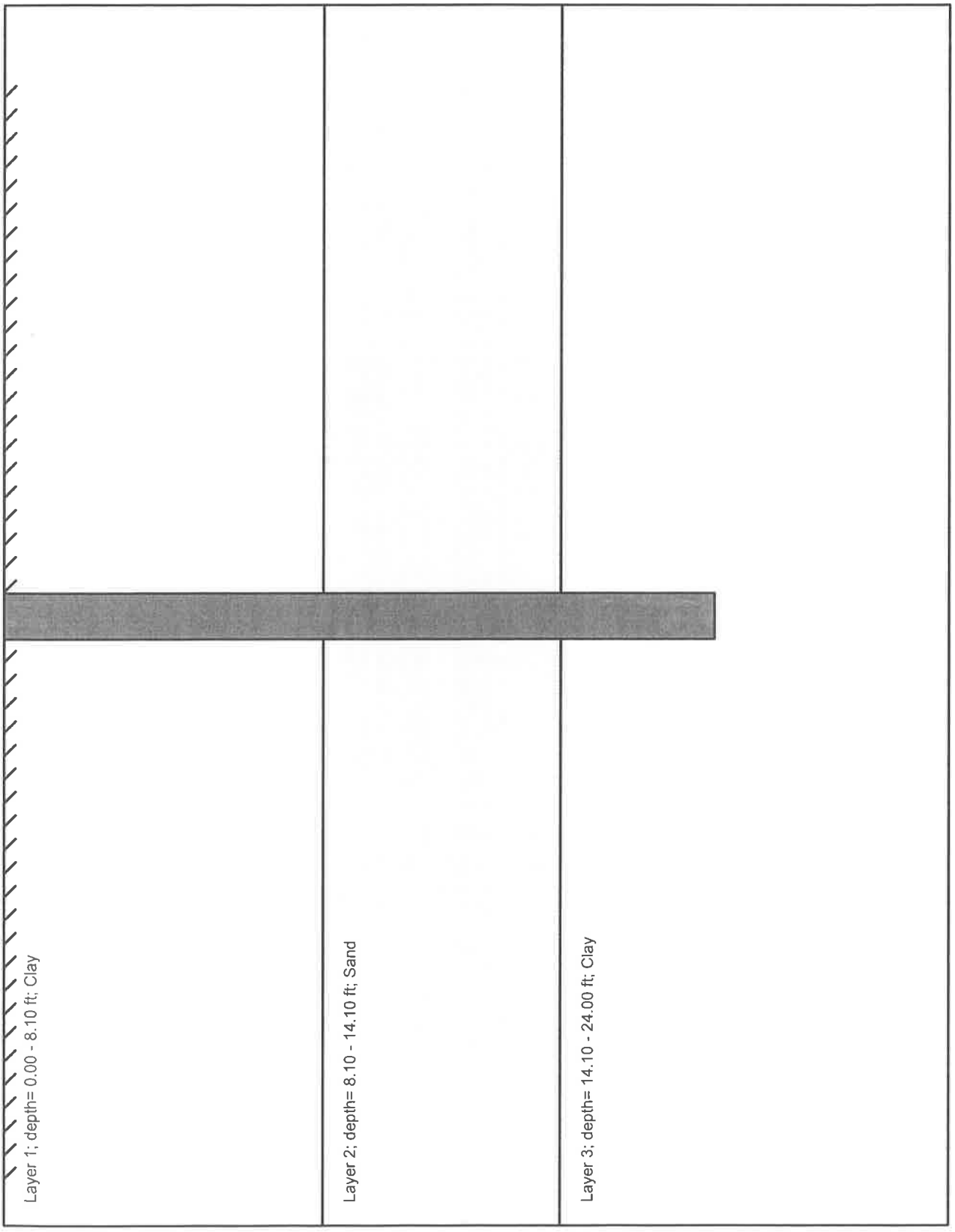
WBS BP11.R007.1	**TIP** SF-040269	**COUNTY** ASHE	**GEOLOGIST** A. Blackmore	
SITE DESCRIPTION Bridge No. 269 on SR 1599 over Peak Creek				**GROUND WTR (ft)**
BORING NO. EB2-B	**STATION** 16+00	**OFFSET** 6 ft RT	**ALIGNMENT** -L-	**0 HR.** 12.3
COLLAR ELEV. 2,627.6 ft	**TOTAL DEPTH** 26.6 ft	**NORTHING** 984,036	**EASTING** 1,312,378	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE HPC2473 CME-550 92% 11/02/2016		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER J. Cain	**START DATE** 07/14/22	**COMP. DATE** 07/14/22	**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
2630						Boc: 2622.7				
										2,627.6 GROUND SURFACE 0.0
	2,626.6	1.0	5	3	3	6		M		**ROADWAY EMBANKMENT** Medium Stiff, Red-Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
2625	2,624.1	3.5	1	1	1	2 Boc	0	M		2,624.6 3.0 Soft, Black, Fine to Coarse Sandy SILT (A-4)
	2,621.6	6.0	1	2	1	3 $N_{corr}=4$ $\gamma=105$		W		2,622.1 5.5 Soft, Red-Brown, Fine to Coarse Sandy CLAY (A-6), with trace rock fragments
2620	2,619.1	8.5	1	1	1	2 $C=400$		W		
2615							8.1			
	2,614.1	13.5	4	8	9	17 $N_{corr}=25$ $\gamma=120$ $\phi=32$		M		2,614.6 13.0 **RESIDUAL** Very Stiff, Gray-Brown, Fine to Coarse Sandy SILT (A-4), with trace rock fragments
2610	2,609.1	18.5	21	40	60/0.2	WR 100/0.7	14.1			2,608.6 ▽ 19.0
2605	2,604.1	23.5	31	30	31	61 1		M		2,604.6 23.0 **WEATHERED ROCK** Gray-Brown (AMPHIBOLITE) **RESIDUAL** Hard, Gray, Fine to Coarse Sandy SILT (A-4), with trace rock fragments
	2,601.0	26.6	60/0.0			60/0.0				2,601.0 26.6 Boring Terminated with Standard Penetration Test Refusal at Elevation 2,601.0 ft On Crystalline Rock (AMPHIBOLITE)

Assume pile will refuse or Achieve RDR Approx 1-2' into WR for an est. tip elevation of 2607 Ft

No Scour @ EB-2

Bridge 269
EB-2 (RT)



==========

APILE for Windows, Version 2019.9.6

Serial Number : 562476398

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

==========

This program is licensed to :

ECS Carolinas, LLP
Charlotte, NC, USA

Path to file locations : C:\Users\mwalko\OneDrive - ECS Corporate Services\Home Dir\Working Files to Move to Sharepoint\Greensboro Projects\09-29663 Ashe Bridge 269 (BP11.R007)\Axial Analysis\
Name of input data file : EB2-B (14x73).ap9d
Name of output file : EB2-B (14x73).ap9o
Name of plot output file : EB2-B (14x73).ap9p

Time and Date of Analysis

Date: May 22, 2023 Time: 07:16:20

1

****
* INPUT INFORMATION *
****

Ashe Bridge 269

DESIGNER : ECS

JOB NUMBER : 09-29663

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 21.40 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 18.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 56.40 IN.
- TIP AREA OF PILE = 21.40 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	105.00	0.00	8.00**
8.10	CLAY	0.80*	105.00	0.00	8.00**
8.10	SAND	0.80*	120.00	32.00	28.00**
14.10	SAND	0.80*	120.00	32.00	28.00**
14.10	CLAY	0.80*	100.00	0.00	8.00**
24.00	CLAY	0.80*	100.00	0.00	8.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.40	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.40	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	8.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	8.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

Factored Load = 100 tons/pile

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
8.10	1.000	1.000
8.10	1.000	1.000
14.10	1.000	1.000
14.10	1.000	1.000
24.00	1.000	1.000

By inspection, pile should refuse ≈ 1-2' into WR for a tip elevation of 2607 Ft

L = Boc - Tip EL + 2.0 Embed into Cap
= 2622.7 - 2607 + 2.0 = 17.7 Ft

1

****
* COMPUTATION RESULT *
****

Ave Pile Length = 20 Ft Pile Pen = 15.7 Ft

****
* FED. HWY. METHOD *
****

Drive Piles to: $\frac{100\text{ ton}}{0.6}$ = 166.7 ton

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP	
0.00	0.0	0.3	0.3	
1.00	0.0	0.3	0.3	
2.00	0.5	0.4	0.9	
3.00	1.6	0.5	2.1	
4.00	2.6	0.5	3.1	
5.00	3.7	0.5	4.2	
6.00	4.7	0.5	5.2	
7.00	5.7	0.7	6.4	
8.00	6.8	1.4	8.3	
9.00	7.9	2.3	10.2	
10.00	9.4	3.2	12.6	
11.00	11.4	4.2	15.6	
12.00	13.7	4.6	18.3	
13.00	16.2	5.1	21.3	
14.00	18.9	6.5	25.4	Top of WR = 2608.6
15.00	21.8	7.8	29.6	
16.00	42.1	9.1	51.2	Est Tip = 2607
17.00	79.7	10.4	90.1	
18.00	117.3	10.7	128.0	

RDR = 170 ton (340 k)

WEAP = $\frac{42\text{ k}}{340\text{ k}}$ = 12% Skin Friction

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

****
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING *

****

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.2872E-01
			0.0000E+00	0.5565E-01
			0.0000E+00	0.1023E+00
			0.0000E+00	0.1436E+00
			0.0000E+00	0.1795E+00
			0.0000E+00	0.3591E+00
			0.0000E+00	0.5386E+00
			0.0000E+00	0.8976E+00
			0.0000E+00	0.3591E+01
2	10	0.4075E+01		
			0.0000E+00	0.0000E+00
			0.4627E+00	0.2872E-01
			0.7711E+00	0.5565E-01
			0.1157E+01	0.1023E+00
			0.1388E+01	0.1436E+00
			0.1542E+01	0.1795E+00
			0.1388E+01	0.3591E+00
			0.1388E+01	0.5386E+00
			0.1388E+01	0.8976E+00
			0.1388E+01	0.3591E+01
3	10	0.8058E+01		
			0.0000E+00	0.0000E+00
			0.4829E+00	0.2872E-01
			0.8048E+00	0.5565E-01
			0.1207E+01	0.1023E+00
			0.1449E+01	0.1436E+00
			0.1610E+01	0.1795E+00
			0.1449E+01	0.3591E+00
			0.1449E+01	0.5386E+00
			0.1449E+01	0.8976E+00
			0.1449E+01	0.3591E+01
4	10	0.8100E+01		
			0.0000E+00	0.0000E+00
			0.4820E+00	0.2872E-01
			0.8033E+00	0.5565E-01
			0.1205E+01	0.1023E+00
			0.1446E+01	0.1436E+00
			0.1607E+01	0.1795E+00
			0.1607E+01	0.3591E+00
			0.1607E+01	0.5386E+00
			0.1607E+01	0.8976E+00
			0.1607E+01	0.3591E+01
5	10	0.1113E+02		
			0.0000E+00	0.0000E+00
			0.9708E+00	0.2872E-01
			0.1618E+01	0.5565E-01
			0.2427E+01	0.1023E+00
			0.2912E+01	0.1436E+00
			0.3236E+01	0.1795E+00
			0.3236E+01	0.3591E+00
			0.3236E+01	0.5386E+00
			0.3236E+01	0.8976E+00
			0.3236E+01	0.3591E+01

6	10	0.1406E+02	
		0.0000E+00	0.0000E+00
		0.1256E+01	0.2872E-01
		0.2093E+01	0.5565E-01
		0.3139E+01	0.1023E+00
		0.3767E+01	0.1436E+00
		0.4185E+01	0.1795E+00
		0.4185E+01	0.3591E+00
		0.4185E+01	0.5386E+00
		0.4185E+01	0.8976E+00
		0.4185E+01	0.3591E+01
7	10	0.1410E+02	
		0.0000E+00	0.0000E+00
		0.1260E+01	0.2872E-01
		0.2099E+01	0.5565E-01
		0.3149E+01	0.1023E+00
		0.3779E+01	0.1436E+00
		0.4199E+01	0.1795E+00
		0.3779E+01	0.3591E+00
		0.3779E+01	0.5386E+00
		0.3779E+01	0.8976E+00
		0.3779E+01	0.3591E+01
8	10	0.1908E+02	
		0.0000E+00	0.0000E+00
		0.1667E+02	0.2872E-01
		0.2778E+02	0.5565E-01
		0.4167E+02	0.1023E+00
		0.5000E+02	0.1436E+00
		0.5556E+02	0.1795E+00
		0.5000E+02	0.3591E+00
		0.5000E+02	0.5386E+00
		0.5000E+02	0.8976E+00
		0.5000E+02	0.3591E+01
9	10	0.2396E+02	
		0.0000E+00	0.0000E+00
		0.1667E+02	0.2872E-01
		0.2778E+02	0.5565E-01
		0.4167E+02	0.1023E+00
		0.5000E+02	0.1436E+00
		0.5556E+02	0.1795E+00
		0.5000E+02	0.3591E+00
		0.5000E+02	0.5386E+00
		0.5000E+02	0.8976E+00
		0.5000E+02	0.3591E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.6688E+00	0.8976E-02
0.1338E+01	0.1795E-01
0.2675E+01	0.3591E-01
0.5350E+01	0.2334E+00
0.8025E+01	0.7540E+00
0.9630E+01	0.1311E+01
0.1070E+02	0.1795E+01
0.1070E+02	0.2693E+01
0.1070E+02	0.3591E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1336E+00	0.1397E-03	0.7450E-02	0.1000E-03
0.1336E+01	0.1397E-02	0.7450E-01	0.1000E-02
0.6681E+01	0.6983E-02	0.3725E+00	0.5000E-02
0.1338E+02	0.1397E-01	0.7450E+00	0.1000E-01
0.2682E+02	0.2795E-01	0.1490E+01	0.2000E-01
0.5778E+02	0.6721E-01	0.2866E+01	0.5000E-01
0.7844E+02	0.1034E+00	0.3272E+01	0.8000E-01
0.9116E+02	0.1272E+00	0.3543E+01	0.1000E+00
0.1206E+03	0.2362E+00	0.4898E+01	0.2000E+00
0.1134E+03	0.5340E+00	0.6720E+01	0.5000E+00
0.1148E+03	0.8345E+00	0.8158E+01	0.8000E+00
0.1154E+03	0.1035E+01	0.8734E+01	0.1000E+01
0.1174E+03	0.2035E+01	0.1070E+02	0.2000E+01

WEAP Parameter Calculation

Bent #: EB2-B

		Toe Quake	Shaft Quake
Pile Type:	HP 14X73	**0.12**	**0.10**

Subsurface Conditions: Loose/Soft or Submerged

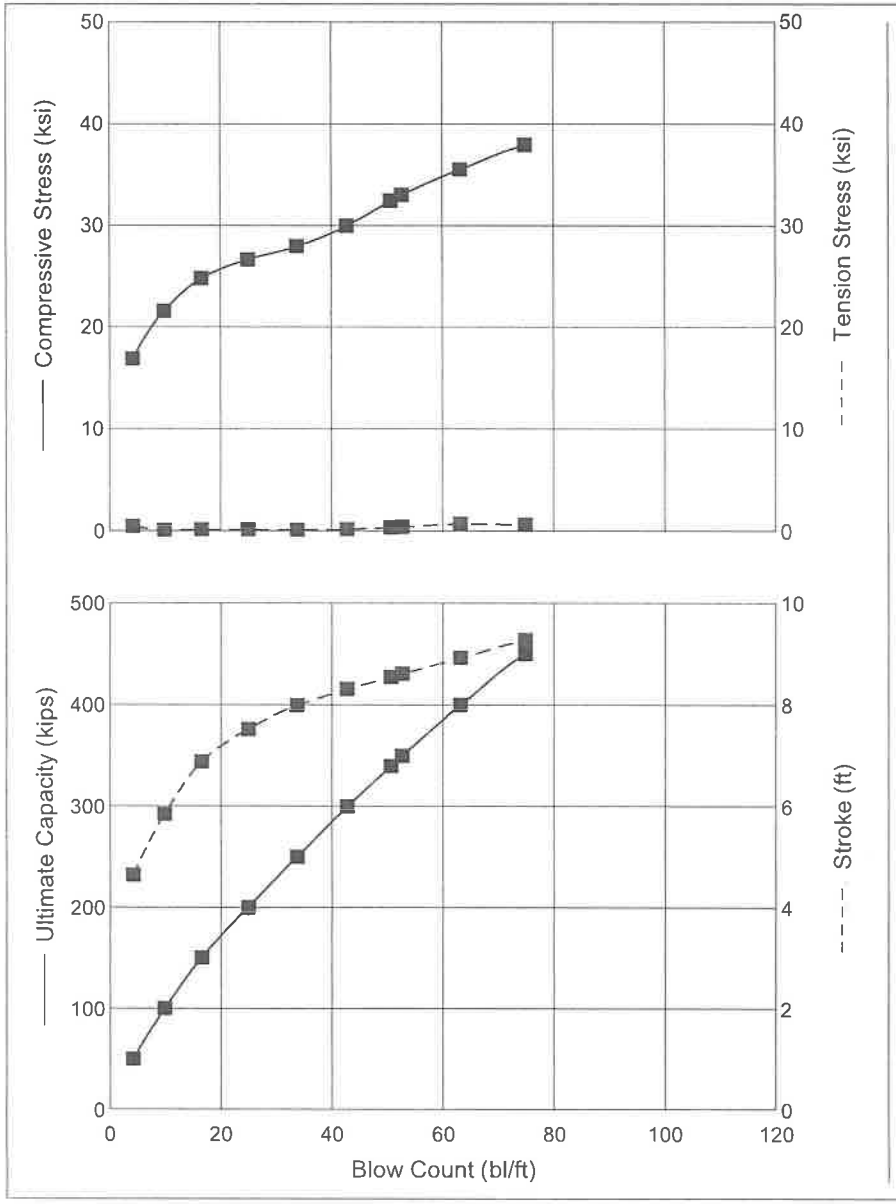
Layer #	Top	Bottom	Navg	Soil Type	Shaft Damping
1	2622.7	2614.6	4	Clay	0.30
2	2614.6	2608.6	25	Sand	0.15
3	2608.6	2607.0	100	WR	0.10
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
					0.22

Length of Pile	15.7

Toe Damping
0.10

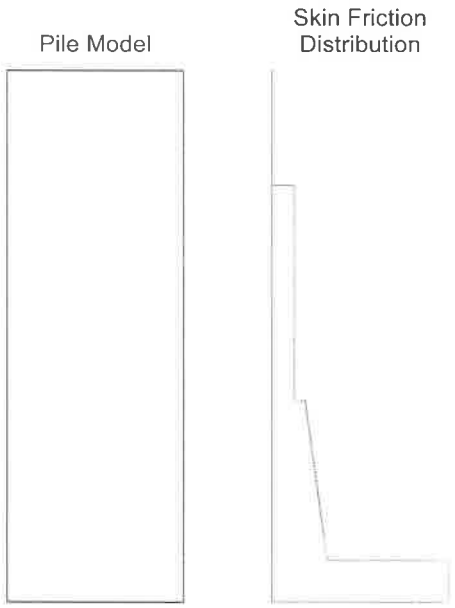
ECS Carolinas LLP
Bridge 269 - End Bent 2

22-May-2023
GRLWEAP Version 2010



DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1580 (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	0.120	in
Skin Damping	0.220	sec/ft
Toe Damping	0.100	sec/ft
Pile Length	20.00	ft
Pile Penetration	15.70	ft
Pile Top Area	21.40	in2



Res. Shaft = 12 %
(Proportional)

ECS Carolinas LLP
Bridge 269 - End Bent 2

22-May-2023
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	16.91	0.49	4.2	4.64	22.95
	100.0	21.56	0.12	9.9	5.84	19.71
	150.0	24.79	0.17	16.6	6.88	18.60
	200.0	26.65	0.18	25.0	7.52	17.72
	250.0	27.96	0.16	33.8	7.99	17.36
	300.0	30.01	0.21	42.8	8.31	17.18
→	340.0	32.44	0.39	50.7	8.55	17.17
	350.0	33.01	0.43	52.7	8.61	17.18
	400.0	35.56	0.75	63.2	8.92	17.45
	450.0	37.96	0.65	74.9	9.27	17.86

Pile can be driven to 340^{k} w/o overstressing

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 stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others 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: C:\USERS\MWALKO\ONEDRIVE - ECS CORPORATE SERVICES\HOME DIR\WORKING
FILES TO MOVE TO SHAREPOINT\GREENSBORO PROJECTS\09-29663 ASHE BRIDGE 269
(BP11.R007)\WEAP\EB2-B 14X73 DELMAG D19-32.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
 Hammer File Version:  2003 (12/4/2015)

                      Input File Contents
    Bridge 269 - End Bent 2
 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  12   1  0   0   0   0   0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size           Pile Type
    32.170    32.170   198.500    14.580              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     21.40   30000.0   492.000     4.699         0     0.850     0.010
 FFatique        F0  0-Bottom
        0     0.000     0.000
 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    0.0020    0.0020     1.250      0.00      0.00
     P atm        P1        P2        P3        P4        P5
     14.70   1580.00   1420.00   1280.00   1150.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
   10.6100    0.8000 1580.0000    0.0000    0.0000    0.0000    0.0100    0.0000
        Qs        Qt        Js        Jt        Qx        Jx      Rati      Dept
     0.100     0.120     0.220     0.100     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     15.70     15.70     0.00      0.00      0.00    0.00      0.00      0.0
    8.10     0.23      0.00      0.00     0.00      0.00      0.00    0.00      0.00      0.0
    8.10     0.28      0.00      0.00     0.00      0.00      0.00    0.00      0.00      0.0
   14.10     0.51      0.00      0.00     0.00      0.00      0.00    0.00      0.00      0.0
   14.10     1.61      0.00      0.00     0.00      0.00      0.00    0.00      0.00      0.0
   15.70     1.61      0.00      0.00     0.00      0.00      0.00    0.00      0.00      0.0
   15.70     1.61      0.00      0.00     0.00      0.00      0.00    0.00      0.00      0.0
   19.10     1.61      0.00      0.00     0.00      0.00      0.00    0.00      0.00      0.0
   20.00     1.61      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    300.0    340.0    350.0    400.0    450.0
```

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

Bridge 269 - End Bent 2

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	140046.6	1.000	0.0100	
3	0.800	140046.6	1.000	0.0100	
4	0.800	140046.6	1.000	0.0100	
5	0.800	140046.6	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		16050.0			

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)	1580.00	Actual Pressure	(psi)	1580.00
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)	198.500	Pile Type		H Pile
Pile Size	(inch)	14.580			

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	21.40	30000.	492.0	4.7	0	16807.	38.2
20.0	21.40	30000.	492.0	4.7	0	16807.	38.2

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	0.244	16050	0.010	0.000	0.85	0.0	0.220	0.100	3.33	4.7	21.4
2	0.244	16050	0.000	0.000	1.00	0.5	0.220	0.100	6.67	4.7	21.4
3	0.244	16050	0.000	0.000	1.00	0.7	0.220	0.100	10.00	4.7	21.4
4	0.244	16050	0.000	0.000	1.00	0.7	0.220	0.100	13.33	4.7	21.4
5	0.244	16050	0.000	0.000	1.00	1.1	0.220	0.100	16.67	4.7	21.4
6	0.244	16050	0.000	0.000	1.00	3.0	0.220	0.100	20.00	4.7	21.4
Toe						44.0	0.100	0.120			

1.462 kips total unreduced pile weight (g= 32.17 ft/s2)
1.462 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)	15.70	Pile Damping Fact.(k/ft/s)	0.764
% Shaft Resistance	12		
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			

Rut= 50.0, Rtoe = 44.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	361.2	0.00	16.88	11.81	2.986	22.95
2	-10.5	361.9	-0.49	16.91	12.27	2.984	22.84
3	-10.3	360.2	-0.48	16.83	12.77	2.982	22.52
4	0.0	349.5	0.00	16.33	13.22	2.979	22.12
5	0.0	309.6	0.00	14.47	14.44	2.977	21.55
6	0.0	220.0	0.00	10.28	15.25	2.974	21.20

(Eq) Strokes Analyzed and Last Return (ft):
10.61 3.88 4.89 4.51 4.64 4.60

Max. Combustion Pressure 1580.0 psi

Rut= 100.0, Rtoe= 88.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	459.0	0.00	21.45	11.28	1.359	19.71
2	-0.5	461.4	-0.03	21.56	11.26	1.354	19.59
3	-1.6	460.6	-0.07	21.53	11.63	1.348	19.28
4	-2.1	450.5	-0.10	21.05	13.62	1.342	18.90
5	-2.6	407.4	-0.12	19.04	15.12	1.337	18.38
6	-2.3	315.8	-0.11	14.76	16.27	1.331	18.05

(Eq) Strokes Analyzed and Last Return (ft):
10.61 5.17 6.05 5.84 5.89

Max. Combustion Pressure 1580.0 psi

Rut= 150.0, Rtoe= 132.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	526.6	0.00	24.61	12.89	0.880	18.60
2	-2.6	530.5	-0.12	24.79	12.84	0.872	18.44
3	-3.5	530.4	-0.16	24.78	12.88	0.864	18.11
4	-3.6	519.5	-0.17	24.28	14.46	0.856	17.70
5	-3.6	475.2	-0.17	22.20	15.67	0.847	17.16
6	-2.9	396.7	-0.14	18.54	15.96	0.839	16.82

(Eq) Strokes Analyzed and Last Return (ft):
10.61 6.43 6.88 6.82

Max. Combustion Pressure 1580.0 psi

Rut= 200.0, Rtoe = 176.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	565.4	0.00	26.42	13.77	0.656	17.72
2	-3.0	570.3	-0.14	26.65	13.70	0.644	17.51
3	-3.9	570.0	-0.18	26.63	13.69	0.632	17.11
4	-3.9	558.7	-0.18	26.11	14.81	0.620	16.65
5	-3.6	514.1	-0.17	24.03	15.89	0.609	16.08
6	-2.6	485.4	-0.12	22.68	14.94	0.597	15.70

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.30 7.52 7.51

Max. Combustion Pressure 1580.0 psi

Rut= 250.0, Rtoe= 220.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	592.4	0.00	27.68	14.38	0.545	17.36
2	-2.8	598.3	-0.13	27.96	14.29	0.531	17.09
3	-3.4	597.3	-0.16	27.91	14.22	0.516	16.63
4	-3.2	585.3	-0.15	27.35	15.01	0.502	16.09
5	-3.0	542.1	-0.14	25.33	15.93	0.487	15.45
6	-2.2	570.1	-0.10	26.64	14.47	0.472	15.02

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.90 7.99 7.99

Max. Combustion Pressure 1580.0 psi

Rut= 300.0, Rtoe= 264.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	610.6	0.00	28.53	14.79	0.484	17.18
2	-3.9	617.7	-0.18	28.86	14.66	0.467	16.83
3	-4.5	616.2	-0.21	28.79	14.56	0.449	16.26
4	-4.3	603.7	-0.20	28.21	15.11	0.432	15.64
5	-4.0	586.7	-0.19	27.42	15.80	0.415	14.94
6	-3.0	642.3	-0.14	30.01	13.90	0.398	14.45

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.31 8.34

Max. Combustion Pressure 1580.0 psi

Rut= 340.0, Rtoe = 299.2 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	623.9	0.00	29.15	15.08	0.456	17.17
2	-6.3	631.6	-0.30	29.51	14.93	0.435	16.71
3	-8.3	629.5	-0.39	29.42	14.78	0.415	16.05
4	-8.0	615.9	-0.38	28.78	15.20	0.394	15.33
5	-7.0	638.0	-0.33	29.82	15.69	0.374	14.54
6	-4.7	694.2	-0.22	32.44	13.43	0.354	13.98

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.55 8.59

Max. Combustion Pressure 1580.0 psi

Rut= 350.0, Rtoe= 308.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	627.0	0.00	29.30	15.14	0.450	17.18
2	-6.9	635.0	-0.32	29.67	14.99	0.428	16.69
3	-9.1	632.7	-0.43	29.56	14.83	0.407	16.00
4	-8.8	618.9	-0.41	28.92	15.22	0.386	15.26
5	-7.6	649.9	-0.35	30.37	15.68	0.365	14.44
6	-5.0	706.3	-0.23	33.01	13.35	0.345	13.87

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.61 8.65

Max. Combustion Pressure 1580.0 psi

Rut= 400.0, Rtoe= 352.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	648.5	0.00	30.30	15.52	0.432	17.45
2	-11.0	652.0	-0.51	30.47	15.34	0.406	16.81
3	-16.0	649.1	-0.75	30.33	15.14	0.380	15.91
4	-15.7	634.6	-0.73	29.65	15.40	0.355	15.01
5	-13.2	706.0	-0.62	32.99	15.64	0.331	14.08
6	-9.1	760.9	-0.42	35.56	12.91	0.308	13.41

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.92 8.93

Max. Combustion Pressure 1580.0 psi

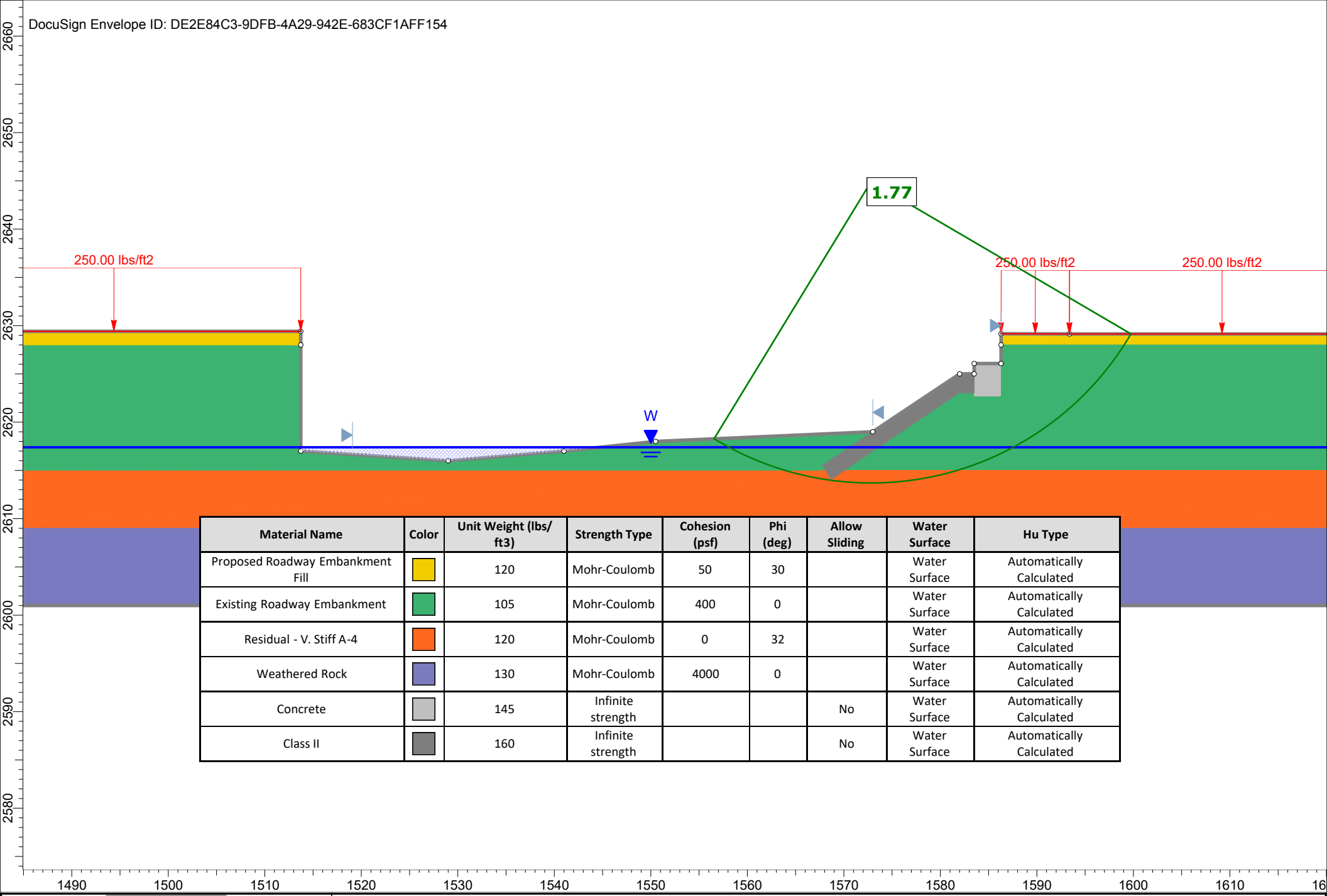
Rut= 450.0, Rtoe = 396.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	723.2	0.00	33.80	15.92	0.422	17.86
2	-9.4	680.5	-0.44	31.80	15.71	0.392	17.05
3	-13.1	666.7	-0.61	31.15	15.48	0.363	15.98
4	-13.9	655.7	-0.65	30.64	15.62	0.333	14.88
5	-12.6	757.1	-0.59	35.38	15.65	0.304	13.73
6	-8.7	812.4	-0.41	37.96	12.57	0.278	12.95

(Eq) Strokes Analyzed and Last Return (ft):
10.61 9.27 9.24

Max. Combustion Pressure 1580.0 psi

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	4.2	4.64	4.60	-0.49	2	4	16.91	2	2	22.9	55.0
100.0	9.9	5.84	5.89	-0.12	5	36	21.56	2	2	19.7	48.7
150.0	16.6	6.88	6.82	-0.17	4	49	24.79	2	2	18.6	45.1
200.0	25.0	7.52	7.51	-0.18	4	40	26.65	2	2	17.7	43.1
250.0	33.8	7.99	7.99	-0.16	3	36	27.96	2	2	17.4	41.8
300.0	42.8	8.31	8.34	-0.21	3	32	30.01	6	3	17.2	41.0
340.0	50.7	8.55	8.59	-0.39	3	29	32.44	6	3	17.2	40.4
350.0	52.7	8.61	8.65	-0.43	3	28	33.01	6	3	17.2	40.3
400.0	63.2	8.92	8.93	-0.75	3	26	35.56	6	3	17.5	39.7
450.0	74.9	9.27	9.24	-0.65	4	48	37.96	6	3	17.9	39.0



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Hu Type
Proposed Roadway Embankment Fill		120	Mohr-Coulomb	50	30		Water Surface	Automatically Calculated
Existing Roadway Embankment		105	Mohr-Coulomb	400	0		Water Surface	Automatically Calculated
Residual - V. Stiff A-4		120	Mohr-Coulomb	0	32		Water Surface	Automatically Calculated
Weathered Rock		130	Mohr-Coulomb	4000	0		Water Surface	Automatically Calculated
Concrete		145	Infinite strength			No	Water Surface	Automatically Calculated
Class II		160	Infinite strength			No	Water Surface	Automatically Calculated

SLIDEINTERPRET 9.023

Project	Bridge No. 269 on SR 1599 over Peak Creek		
Group	Group 1	*Scenario*	Master Scenario
Drawn By	KND	*Company*	ECS Southeast, LLP
Date	5/12/2023, 8:23:38 AM	*File Name*	End Slope Stability - EB2.slmd