Supporting Documents

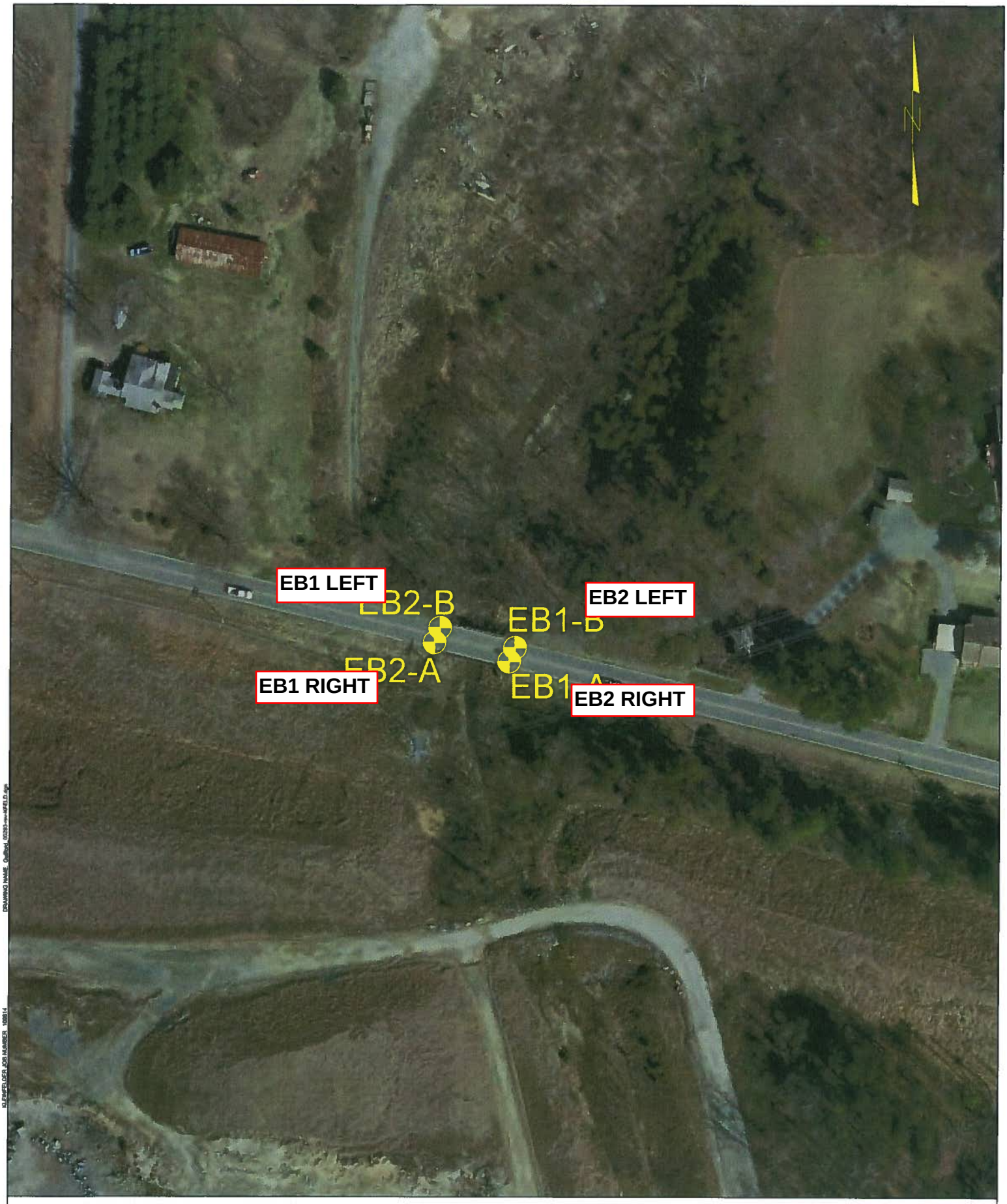
B-5754 (17BP.7.R.118)

BRIDGE NO. 400293 OVER LITTLE ALLAMANCE CREEK ON SR 3314 (WILEY LEWIS RD)

End Bent Geometry and Loads (Box Beams)

Bridge Width	BB Unit Length	Factored Pile Reaction (kips)	Factored Pile Reaction (tons)
27'-0''	75'-0"	214	107
	80'-0"	221	111
	85'-0"	229	114
	90'-0"	238	119
	95'-0"	252	126
	100'-0"	259	130
30'-0''	75'-0"	228	114
	80'-0"	236	118
	85'-0"	244	122
	90'-0"	254	127
	95'-0"	269	135
	100'-0"	277	139
33'-0''	75'-0"	187	94
	80'-0"	194	97
	85'-0"	200	100
	90'-0"	208	104
	95'-0"	220	110
	100'-0"	226	113
36'-0''	75'-0"	197	99
	80'-0"	204	102
	85'-0"	211	105
	90'-0"	219	110
	95'-0"	233	116
	100'-0"	239	120
39'-0''	75'-0"	207	103
	80'-0"	214	107
	85'-0"	221	111
	90'-0"	231	115
	95'-0"	245	122
	100'-0"	252	126

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



GRAPHIC SCALE

100 0 50 100

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PROJECT NO. 42608.1.ST7	SITE PLAN		SHEET NO.
DRAWN: 03/03/2010	REPLACE BRIDGE NO.293 OVER LITTLE ALAMANCE CREEK ON SR 3314		3
DRAWN BY: DJH			
CHECKED BY: PW	TIP NO. M-0423	STUCTURE NO. 010134	
SCALE: 1" = 100'	GUILFORD COUNTY NORTH CAROLINA		

DRAWING NAME: Guilford_42608-site-KEFELD.dgn

KLEINFELDER JOB NUMBER: 42608.14

OFFICE LOCATION: GREENSBORO

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

EB1 - RIGHT

PROJECT NO. 42068.1.ST7	**ID.** M-0423	**COUNTY** Guilford	**GEOLOGIST** T. Wells
SITE DESCRIPTION Bridge 293 on SR 3314 over Little Alamance Creek			**GROUND WTR (ft)**
BORING NO. ~~EB2-A~~	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A — **0 HR.** Dry
COLLAR ELEV. 99.3 ft	**TOTAL DEPTH** 24.0 ft	**NORTHING** 824,449	**EASTING** 1,779,088 — **24 HR.** FIAD
DRILL MACHINE CME-55	**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER R. Toothman	**START DATE** 03/01/10	**COMP. DATE** 03/01/10	**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)
100										~~99.3~~ 708 GROUND SURFACE	0.0
95	95.8	3.5	1	2	3	5		W		**ROADWAY EMBANKMENT** Medium Stiff, Orange Brown, Coarse to Fine Sandy, Silty CLAY	
90	90.8	8.5	3	2	4	6		W		~~90.8~~ 699.5 Medium Stiff, Light Brown, Coarse to Fine Sandy SILT	8.5
85	85.8	13.5	4	5	3	8		M		~~86.8~~ 695.5 **ALLUVIAL** Loose to Medium Dense, Gray, Silty, Fine to Coarse SAND	12.5
80	80.8	18.5	3	6	4	10		Sat.		~~77.3~~ 686	22.0
75	75.8 / 75.3	23.5 / 24.0	60/0.2 / 60/0.0			60/0.2 / 60/0.0				~~75.3~~ 684 **WEATHERED ROCK** Gray, Metamorphosed Granitic Rock	24.0
70										Boring Terminated with Standard Penetration Test Refusal at Elevation 75.3 ft on Crystalline Rock: Metamorphosed Granitic Rock	
65										Note: Assume Benchmark Elevation = 100.0 ft.	
60											
55											
50											
45											
40											
35											
30											
25											
20											

NCDOT BORE SINGLE 109814.GPJ NC_DOT.GDT 3/10/10

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

EB1 - LEFT

PROJECT NO. 42068.1.ST7	**ID.** M-0423	**COUNTY** Guilford	**GEOLOGIST** T. Wells
SITE DESCRIPTION Bridge 293 on SR 3314 over Little Alamance Creek			**GROUND WTR (ft)**
BORING NO. ~~EB2B~~	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A — 0 HR. Dry
COLLAR ELEV. 99.3 ft	**TOTAL DEPTH** 26.5 ft	**NORTHING** 824,459	**EASTING** 1,779,092 — 24 HR. FIAD
DRILL MACHINE CME-55	**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER R. Toothman	**START DATE** 03/01/10	**COMP. DATE** 03/01/10	**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)
100										99.3 708 GROUND SURFACE	0.0
95	95.8	3.5	2	3	3	6		W		**ROADWAY EMBANKMENT** Medium Stiff to Stiff, Orange and Brown, Clayey, Coarse to Fine Sandy SILT	
90	90.8	8.5	2	4	4	8		M			
85	85.8	13.5	6	4	3	7		M		85.3 694	14.0
80	80.8	18.5	2	2	5	7		W		**ALLUVIAL** Loose, Brown and Gray, Silty, Coarse to Fine SAND	
75	75.8	23.5	60/0.3			60/0.3				77.8 686.5	21.5
	72.8	26.5	60/0.0			60/0.0				**WEATHERED ROCK** Gray and Brown, Metamorphosed Granitic Rock	
										72.8 681.5	26.5
70										Boring Terminated with Standard Penetration Test Refusal at Elevation 72.8 ft on Crystalline Rock: Metamorphosed Granitic Rock	
65										Note: Assume Benchmark Elevation = 100.0 ft.	
60											
55											
50											
45											
40											
35											
30											
25											
20											

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

EB2-LEFT

PROJECT NO. 42068.1.ST7	ID. M-0423	COUNTY Guilford	GEOLOGIST T. Wells
SITE DESCRIPTION Bridge 293 on SR 3314 over Little Alamance Creek			GROUND WTR (ft)
BORING NO. ~~EB1-B~~	STATION N/A	OFFSET N/A	ALIGNMENT N/A — 0 HR. Dry
COLLAR ELEV. 99.3 ft	TOTAL DEPTH 23.0 ft	NORTHING 824,443	EASTING 1,779,151 — 24 HR. FIAD
DRILL MACHINE CME-55	DRILL METHOD H.S. Augers		HAMMER TYPE Automatic
DRILLER R. Toothman	START DATE 03/01/10	COMP. DATE 03/01/10	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)
100										~~99.3~~ 709 GROUND SURFACE	0.0
95	95.8	3.5	2	2	3	5		M		**ROADWAY EMBANKMENT** Medium Stiff, Gray and Brown, Coarse to Fine Sandy SILT with Trace Gravel	
90	90.8	8.5	2	2	3	5		W			
85	85.8	13.5	1	3	4	7		W		~~87.3~~ 697 **ALLUVIAL** Medium Stiff, Brown and Gray, Coarse to Fine Sandy SILT	12.0
80	80.8	18.5	2	15	13	28		M		~~80.3~~ 690 **RESIDUAL** Medium Dense, Gray, Silty, Coarse to Fine SAND	19.0
75	76.3	23.0	60/0.0			60/0.0				~~78.3~~ 685 ~~78.3~~ 686 **WEATHERED ROCK** Metamorphosed Granitic Rock	21.0 / 23.0
70										Boring Terminated with Standard Penetration Test Refusal at Elevation 76.3 ft on Crystalline Rock: Metamorphosed Granitic Rock	
65										Note: Assume Benchmark Elevation = 100.0 ft.	
60											
55											
50											
45											
40											
35											
30											
25											
20											

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

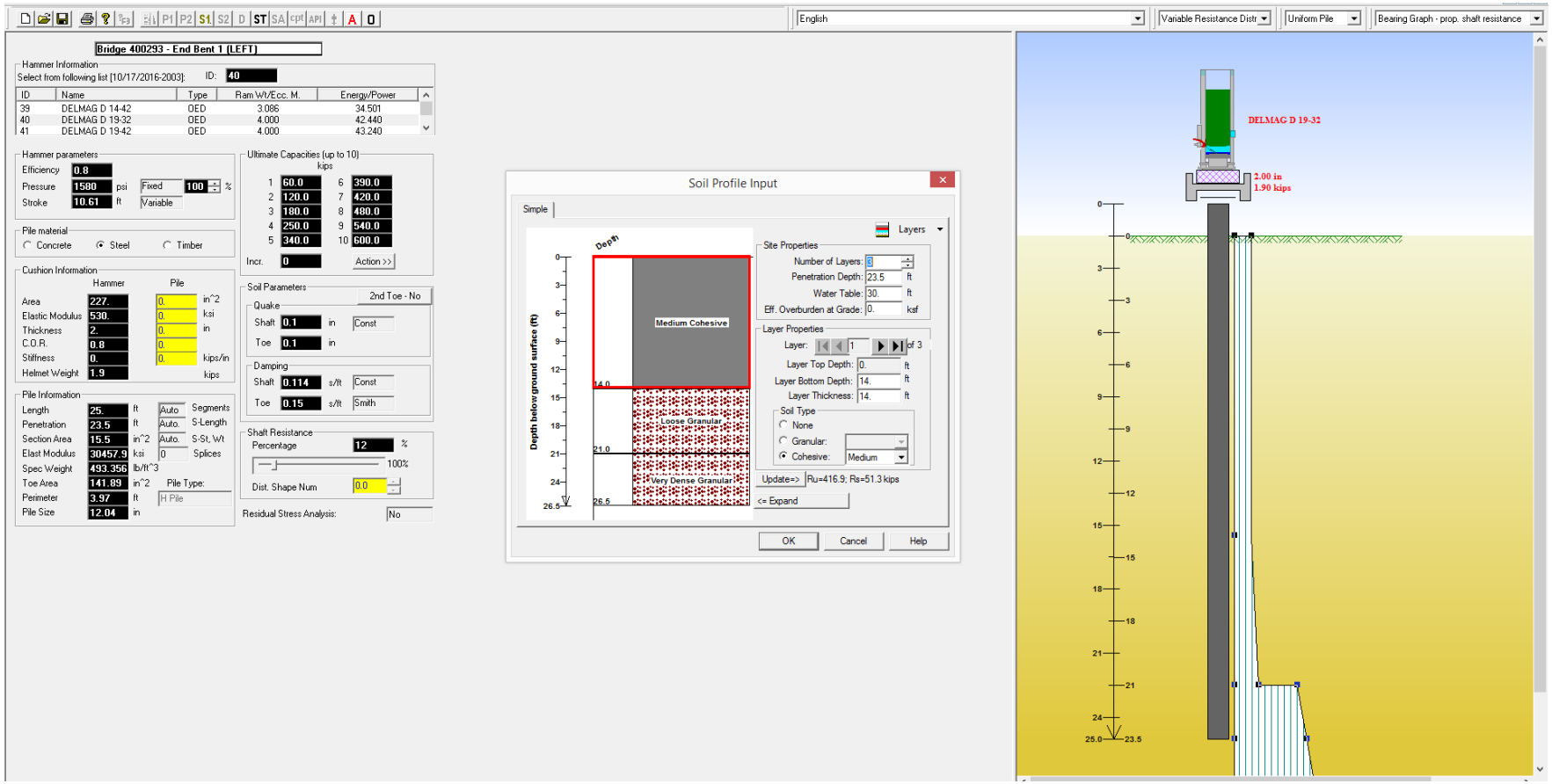
EB2 - Right

PROJECT NO. 42068.1.ST7	**ID.** M-0423	**COUNTY** Guilford	**GEOLOGIST** T. Wells
SITE DESCRIPTION Bridge 293 on SR 3314 over Little Alamance Creek			**GROUND WTR (ft)**
BORING NO. ~~EB1-A~~	**STATION** N/A	**OFFSET** N/A	**ALIGNMENT** N/A — **0 HR.** Dry
COLLAR ELEV. 99.4 ft	**TOTAL DEPTH** 24.5 ft	**NORTHING** 824,432	**EASTING** 1,779,146 — **24 HR.** FIAD
DRILL MACHINE CME-55	**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER R. Toothman	**START DATE** 03/01/10	**COMP. DATE** 03/01/10	**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)
100										99.4 709 GROUND SURFACE	0.0
95	95.9	3.5	3	2	3	5		W		**ROADWAY EMBANKMENT** Medium Stiff, Orange Brown, Coarse to Fine Sandy, Silty CLAY	
90	90.9	8.5	2	4	3	7		W		91.9 701.5 Medium Stiff, Orange Brown, Coarse to Fine Sandy SILT	7.5
85	85.9	13.5	2	2	3	5		Sat.		87.4 697 **ALLUVIAL** Loose to Medium Dense, Gray and Brown, Silty, Coarse to Fine SAND	12.0
80	80.9	18.5	7	5	8	13		Sat.		78.4 688 **WEATHERED ROCK** Gray, Metamorphosed Granitic Rock	21.0
75	75.9 / 74.9	23.5 / 24.5	60/0.3 / 60/0.0			60/0.3 / 60/0.0				74.9 684.5 Boring Terminated with Standard Penetration Test Refusal at Elevation 74.9 ft on Crystalline Rock: Metamorphosed Granitic Rock	24.5
70										Note: Assume Benchmark Elevation = 100.0 ft.	
65											
60											
55											
50											
45											
40											
35											
30											
25											
20											

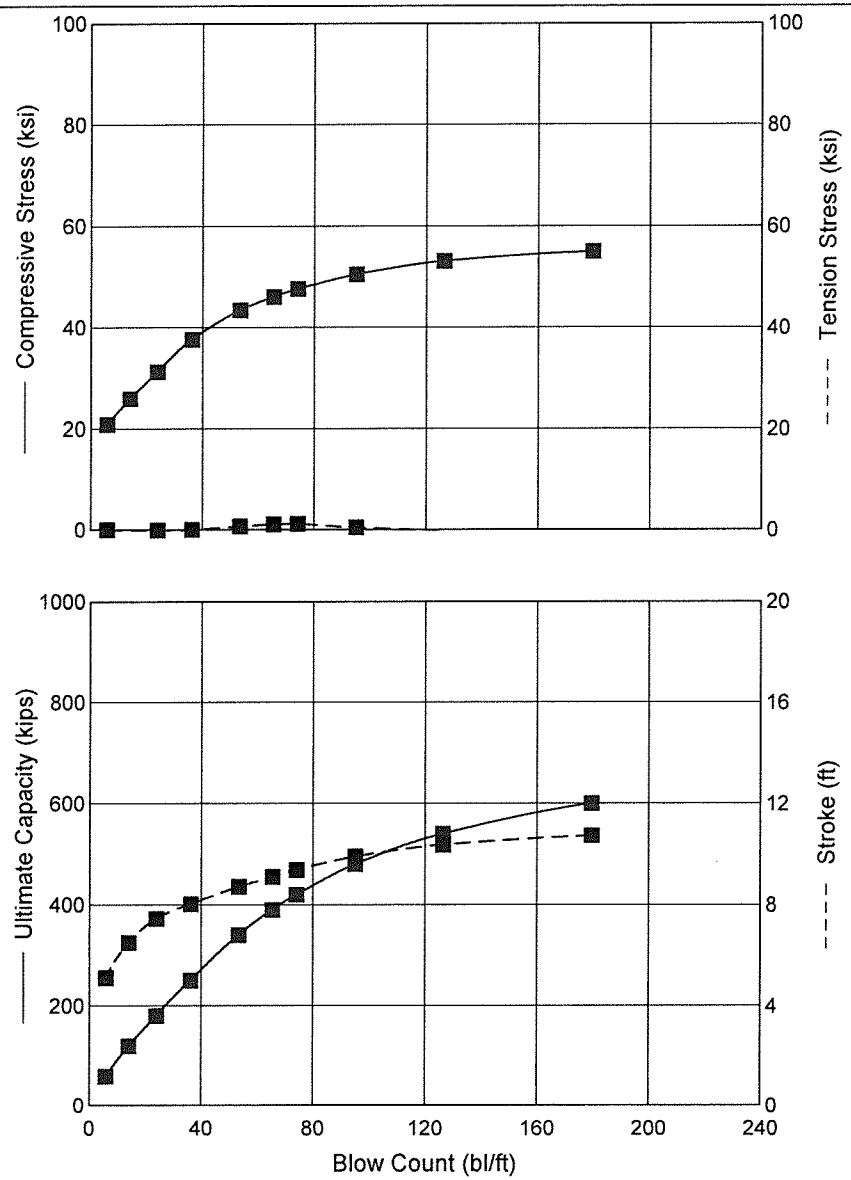
NCDOT BORE SINGLE 109814.GPJ NC_DOT.GDT 3/10/10

H-PILES END BENT 1


English
Variable Resistance Distr
Uniform Pile
Bearing Graph - prop. shaft resistance
Bridge 400293 - End Bent 1 (LEFT)
Hammer Information
Select from following list [10/17/2016-2003]: ID: 40
ID Name Type Ram Wt/Ecc. M. Energy/Power
39 DELMAG D 14-42 OED 3.086 34.501
40 DELMAG D 19-32 OED 4.000 42.440
41 DELMAG D 19-42 OED 4.000 43.240
Hammer parameters
Efficiency 0.8
Pressure 1580 psi Fixed 100 %
Stroke 10.61 ft Variable
Pile material
Concrete Steel Timber
Cushion Information
Hammer Pile
Area 227. 0. in^2
Elastic Modulus 530. 0. ksi
Thickness 2. 0. in
C.O.R. 0.8 0.
Stiffness 0. 0. kips/in
Helmet Weight 1.9 kips
Pile Information
Length 25. ft Auto. Segments
Penetration 23.5 ft Auto. S-Length
Section Area 15.5 in^2 Auto. S-St, Wt
Elast Modulus 30457.9 ksi 0 Splices
Spec Weight 493.356 lb/ft^3
Toe Area 141.89 in^2 Pile Type:
Perimeter 3.97 ft H Pile
Pile Size 12.04 in
Ultimate Capacities (up to 10)
kips
1 60.0 6 390.0
2 120.0 7 420.0
3 180.0 8 480.0
4 250.0 9 540.0
5 340.0 10 600.0
Incr. 0 Action >>
Soil Parameters
2nd Toe - No
Quake
Shaft 0.1 in Const
Toe 0.1 in
Damping
Shaft 0.114 s/ft Const
Toe 0.15 s/ft Smith
Shaft Resistance
Percentage 12 %
100%
Dist. Shape Num 0.0
Residual Stress Analysis: No
Soil Profile Input
Simple
Depth
Depth below ground surface (ft)
Medium Cohesive
Loose Granular
Very Dense Granular
14.0
21.0
26.5
Layers
Site Properties
Number of Layers: 3
Penetration Depth: 23.5 ft
Water Table: 30. ft
Eff. Overburden at Grade: 0. ksf
Layer Properties
Layer: 1 of 3
Layer Top Depth: 0. ft
Layer Bottom Depth: 14. ft
Layer Thickness: 14. ft
Soil Type
None
Granular:
Cohesive: Medium
Update=> Ru=416.9; Rs=51.3 kips
<= Expand
OK Cancel Help
DELMAG D 19-32
2.00 in
1.90 kips
25.0
23.5

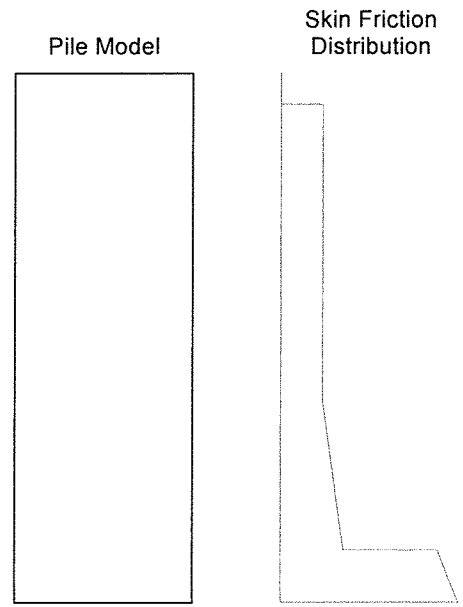
Terracon
Bridge 400293 - End Bent 1 (LEFT)

19-Feb-2018
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	0.100	in
Skin Damping	0.114	s/ft
Toe Damping	0.150	s/ft
Pile Length	25.00	ft
Pile Penetration	23.50	ft
Pile Top Area	15.50	in2



Res. Shaft = 12 %
(Proportional)

Terracon
Bridge 400293 - End Bent 1 (LEFT)

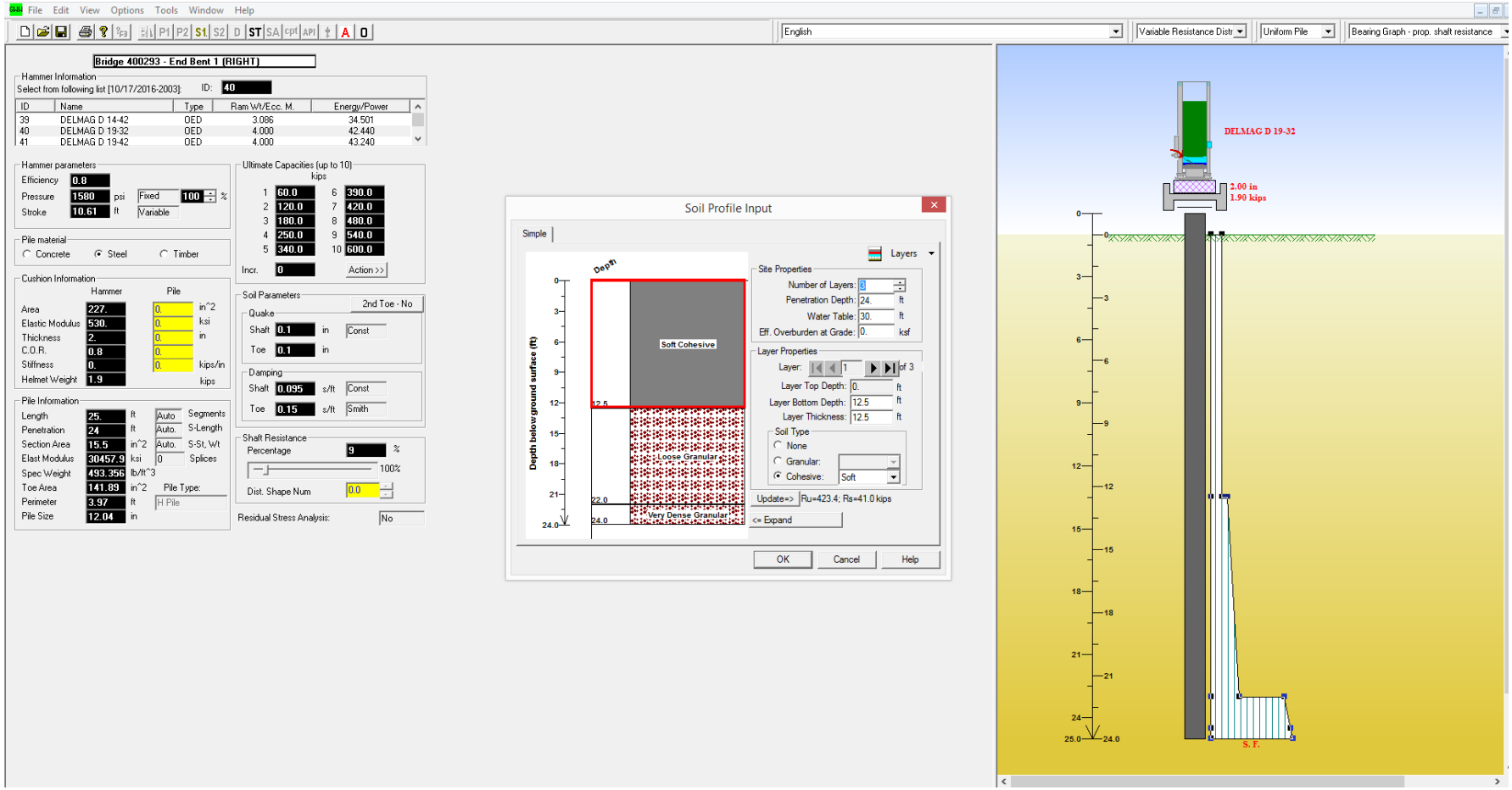
19-Feb-2018
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
60.0	20.87	0.07	6.0	5.10	21.54
120.0	25.95	0.00	14.1	6.50	18.66
180.0	31.29	0.02	24.0	7.45	17.67
250.0	37.62	0.08	36.3	8.03	17.28
340.0	43.44 <45ksi	0.72	30 < 53.5 < 180	8.71	18.00
390.0	46.08	1.09	65.5	9.11	18.53
420.0	47.62	1.21	74.1	9.38	18.88
480.0	50.50	0.49	95.1	9.91	19.68
540.0	53.10	0.00	126.4	10.37	20.34
600.0	55.01	0.00	179.5	10.73	20.82

$R_R = 100 \text{ tons} = 200 \text{ kips} \quad \phi = 0.6$

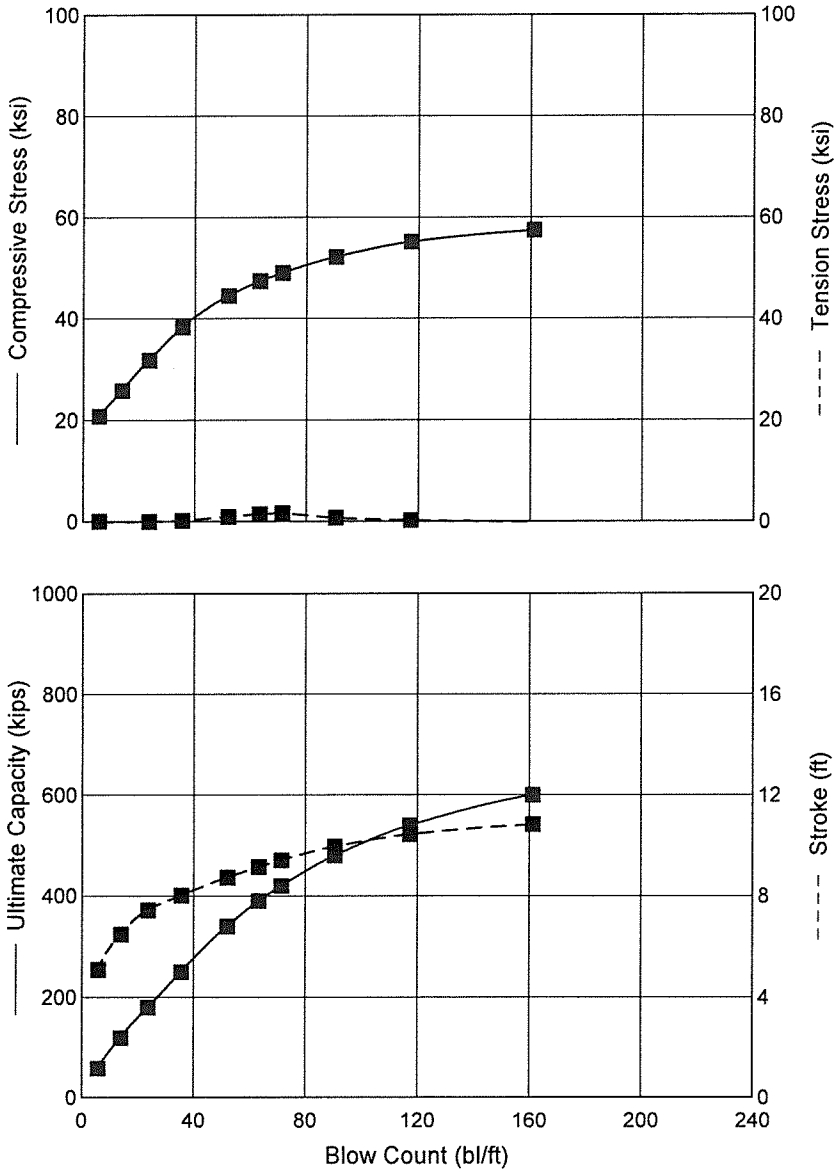
$R_n = R_R / \phi = \frac{200 \text{ kips}}{0.6} = 333 \text{ kips}$

USE 340 kips


File Edit View Options Tools Window Help
English
Variable Resistance Distr
Uniform Pile
Bearing Graph - prop. shaft resistance
Bridge 400293 - End Bent 1 (RIGHT)
Hammer Information
Select from following list [10/17/2016-2003]: ID: 40
ID Name Type Ram Wt/Ecc. M. Energy/Power
39 DELMAG D 14-42 OED 3.086 34.501
40 DELMAG D 19-32 OED 4.000 42.440
41 DELMAG D 19-42 OED 4.000 43.240
Hammer parameters
Efficiency 0.8
Pressure 1580 psi Fixed 100 %
Stroke 10.61 ft Variable
Pile material
Concrete Steel Timber
Cushion Information
Hammer Pile
Area 227. 0. in^2
Elastic Modulus 530. 0. ksi
Thickness 2. 0. in
C.O.R. 0.8 0.
Stiffness 0. 0. kips/in
Helmet Weight 1.9 kips
Pile Information
Length 25. ft Auto Segments
Penetration 24 ft Auto. S-Length
Section Area 15.5 in^2 Auto. S-St, Wt
Elast Modulus 30457.9 ksi 0 Splices
Spec Weight 493.356 lb/ft^3
Toe Area 141.89 in^2 Pile Type:
Perimeter 3.97 ft H Pile
Pile Size 12.04 in
Ultimate Capacities (up to 10)
kips
1 60.0 6 390.0
2 120.0 7 420.0
3 180.0 8 480.0
4 250.0 9 540.0
5 340.0 10 600.0
Incr. 0 Action >>
Soil Parameters
2nd Toe - No
Quake
Shaft 0.1 in Const
Toe 0.1 in
Damping
Shaft 0.095 s/ft Const
Toe 0.15 s/ft Smith
Shaft Resistance
Percentage 9 %
100%
Dist. Shape Num 0.0
Residual Stress Analysis: No
Soil Profile Input
Simple
Layers
Depth
Soft Cohesive
Loose Granular
Very Dense Granular
Depth below ground surface (ft)
Site Properties
Number of Layers: 3
Penetration Depth: 24. ft
Water Table: 30. ft
Eff. Overburden at Grade: 0. ksf
Layer Properties
Layer: 1 of 3
Layer Top Depth: 0. ft
Layer Bottom Depth: 12.5 ft
Layer Thickness: 12.5 ft
Soil Type
None
Granular:
Cohesive: Soft
Update=> Ru=423.4; Rs=41.0 kips
<= Expand
OK Cancel Help
DELMAG D 19-32
2.00 in
1.90 kips
S. F.

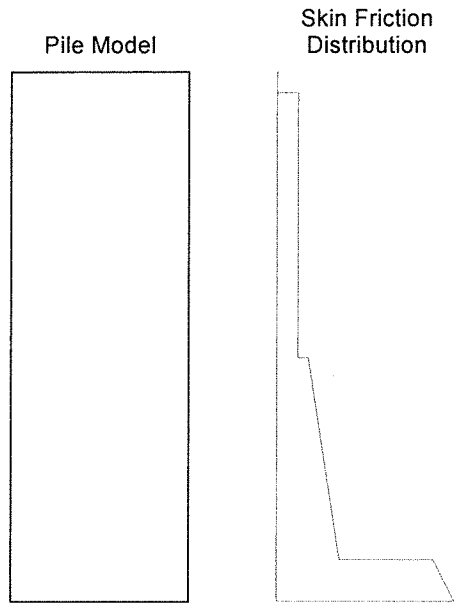
Terracon
Bridge 400293 - End Bent 1 (RIGHT)

19-Feb-2018
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	0.100	in
Skin Damping	0.091	s/ft
Toe Damping	0.150	s/ft
Pile Length	25.00	ft
Pile Penetration	24.00	ft
Pile Top Area	15.50	in2



Res. Shaft = 10 %
(Proportional)

Terracon
Bridge 400293 - End Bent 1 (RIGHT)

19-Feb-2018
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
60.0	20.84	0.07	5.9	5.09	21.60
120.0	25.83	0.00	14.0	6.49	18.71
180.0	31.85	0.05	23.7	7.44	17.70
250.0	38.40	0.21	35.6	8.02	17.39
340.0	44.62	<45ksi 1.02	30 < 52.1 < 180	8.73	18.20
390.0	47.50	1.49	63.3	9.15	18.79
420.0	49.12	1.67	71.4	9.42	19.12
480.0	52.22	0.79	90.5	9.96	19.95
540.0	55.24	0.31	117.3	10.44	20.71
600.0	57.51	0.00	161.2	10.83	21.23

$R_R = 100$ tons $= 200$ kips $\quad \phi = 0.6$

$R_n = R_R/\phi = \frac{200 \text{ kips}}{0.6} = 333$ kips

USE 340 kips

MICRO PILES END BENTS 1 & 2

70175067 EB1 Micropiles.xlsx
AASHTO Geotechnical

Bridge Width	33.0'		
Span Length	85.0'		
Load/Pile	200	kips	NCDOT End Bent Geometry and Loads
#Piles	7		"
Total Factored Load per Cap	1400	kips	

$$R_s = \sum_{i=0}^{n} \pi d_{bi} L_{bi}$$ eqn. 10.9.3.5.2-1

$$R_R = \varphi R_S$$ eqn. 10.9.3.5.1-1

Table C10.9.3.5.2-1	α_b	Values
Table C10.5.5.2.5-1	ϕ	Values

Geotechnical Capacity **End Bent 1**

	D*	Soil L_b	Soil α_b ksf	PWR L_b	PWR α_b ksf	Rock L_b	Rock α_b ksf	Rs, kips	ϕ	R_R, kips	Factored Load, kips	#Piles	Ltot	BOC	TOP OR WR	TOP OF ROCK	Max Tip
EB1 LEFT	7.0''	14.6'	0.0	5.0'	5.0	6.0'	25.0	321	0.7	224	1400	6.2	25.6'	701.1'	686.5'	681.5'	675.5'
EB1 RIGHT	7.0''	21.0'	0.0	2.0'	5.0	6.0'	25.0	293	0.7	205	1400	6.8	29.0'	701.1'	686.0'	684.0'	678.0'

* D is the diameter of the rock socket

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Bridge Width	33.0'		
Span Length	85.0'		
Load/Pile	200	kips	NCDOT End Bent Geometry and Loads
#Piles	7		"
Total Factored Load per Cap	1400	kips	

$$R_s = \sum_{i=0}^{n} \pi d_{bi} L_{bi}$$ eqn. 10.9.3.5.2-1

$$R_R = \varphi R_S$$ eqn. 10.9.3.5.1-1

Table C10.9.3.5.2-1	α_b	Values
Table C10.5.5.2.5-1	ϕ	Values

Geotechnical Capacity **End Bent 2**

	D*	Soil L_b	Soil α_b ksf	PWR L_b	PWR α_b ksf	Rock L_b	Rock α_b ksf	Rs, kips	ϕ	R_R, kips	Factored Load, kips	#Piles	Ltot	BOC	TOP OR WR	TOP OF ROCK	Max Tip
EB2 LEFT	7.0''	13.6'	0.0	2.0'	5.0	6.0'	25.0	293	0.7	205	1400	6.8	21.6'	701.6'	688.0'	686.0'	680.0'
EB2 RIGHT	7.0''	21.0'	0.0	2.0'	5.0	6.0'	25.0	293	0.7	205	1400	6.8	29.0'	701.6'	688.0'	684.5'	678.5'

* D is the diameter of the rock socket

Table C10.9.3.5.2-1—Summary of Typical α_b Values (Grout-to-Ground Bond) for Preliminary Micropile Design (modified after Sabatini, et al., 2005)

Soil/Rock Description	Typical Range of Grout-to-Ground Bond Nominal Resistance for Micropile Types[1] (ksf)				
	Type A	Type B	Type C	Type D	Type E
Silt & Clay (some sand) (soft medium plastic)	0.7–1.4	0.7–2.0	0.7–2.5	0.7–3.0	0.7–2.0
Silt & Clay (some sand) (stiff, dense to very dense)	0.7–2.5	1.4–4.0	2.0–4.0	2.0–4.0	1.4–4.0
Sand (some silt) (fine, loose-medium dense)	1.4–3.0	1.4–4.0	2.0–4.0	2.0–5.0	1.4–5.0
Sand (some silt, gravel) (fine-coarse, medium-very dense)	2.0–4.5	2.5–7.5	3.0–7.5	3.0–8.0	2.5–7.5
Gravel (some sand) (medium-very dense)	2.0–5.5	2.5–7.5	3.0–7.5	3.0–8.0	2.5–7.5
Glacial Till (silt, sand, gravel) (medium-very dense, cemented)	2.0–4.0	2.0–6.5	2.5–6.5	2.5–7.0	2.0–6.5
Soft Shales (fresh-moderate fracturing, little to no weathering)	4.3–11.5 5	N/A	N/A	N/A	N/A
Slates and Hard Shales (fresh-moderate fracturing, little to no weathering)	10.8–28.8	N/A	N/A	N/A	N/A
Limestone (fresh-moderate fracturing, little to no weathering)	21.6–43.2	N/A	N/A	N/A	N/A
Sandstone (fresh-moderate fracturing, little to no weathering)	10.8–36.0	N/A	N/A	N/A	N/A
Granite and Basalt (fresh-moderate fracturing, little to no weathering)	25 28.8–87.7	N/A	N/A	N/A	N/A

[1] Refer to Article 10.9.1 for description of micropile types.

10.9.3.5.3—Estimation of Micropile Tip Resistance in Rock

The methods used for design of micropiles bearing on rock shall consider the presence, orientation, and condition of discontinuities, weathering profiles, and other similar profiles as they apply at a particular site. The designer shall judge the competency of a rock mass in accordance with the provisions of Article 10.4.6.4.

For micropiles founded on competent rock, tip resistance may be estimated in accordance with the provisions of Article 10.8.3.5.4c.

C10.9.3.5.3

Micropiles are generally designed based on bond into rock rather than tip resistance. Tip resistance is generally considered only for micropiles bearing on competent rock.

For micropiles founded on competent rock, the rock is usually so sound that the structural capacity will govern the design.

Weak rock includes some shales and mudstones or poor-quality weathered rocks. The term "weak" has no generally accepted, quantitative definition; therefore, judgment and experience are required to make this determination.

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