Printz Engineering Services, LLC

January 27, 2023

Mr. Jonny Macfarlane
Mays Construction Specialties
2399 Riverside Parkway
Grand Junction, Colorado 81505
970-245-0834 ph

RE: 183 River Ridge Court, Grand Junction, CO – Micropile Verification Test

Dear Mr. Macfarlane,

Attached, please find the results of micropile verification test performed on 01/26/23.

The pile installation for the micropile verification test conducted on 1/26/23 was accomplished using simultaneous drilling and grouting operations to an overall installation depth of 50' through a T30/11 hollow reinforcing bar using a 4" diameter sacrificial steel drill bit. The verification test micropile has a 30'-0" bond length, a 20' PVC sleeved length and 3'-0" above ground free length.

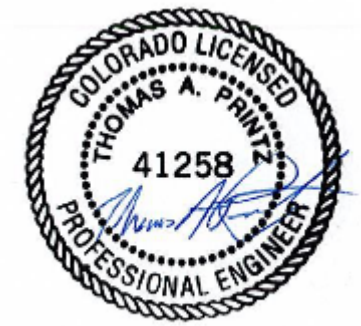
> Verification Test Pile – Tension Test – The pile was installed to a 30' total bonded length using the drilling method described above. At 200% of the design load, the micropile experienced permanent and elastic movement of 0.023" and 0.180"; respectively. At the end of the test, the micropile debonded -9.01' and has an apparent bond length of 39.01'. Since the micropile head movement at 200% design load (0.203") is less than (0.025 in/kip * 30 kip = 0.75") load versus micropile head settlement and the creep criteria was satisfied, the test passes the micropile verification test per NHI-05-039 "Micropile Design and Construction Manual".

The micropile did not debond the entire sleeved length; therefore, debonding is showing as a negative number; however, the PVC sleeve did debond 10.99'. Based on the verification test results, we have calculated the minimum micropile length, considering the depth of the weathered Dakota Formation. The weather Dakota formation is expansive when wetted; therefore, PVC sleeve and bond length below the weathered formation are required. We recommend a minimum micropile overall length of 40'-0", with the upper 30' PVC sleeved and 3" nominal schedule 40 PVC from 1'-0" below grade to extend into structural concrete for corrosion protection continuation through the 12" void form.

Please do not hesitate to contact me with any questions or concerns that you may have.

Kind Regards,

Thomas A. Printz, P.E.
President
Printz Engineering Services, LLC



1-27-2023

PRINTZ ENGINEERING SERVICES, LLC
1248 W. EL TORO WAY
PUEBLO WEST, CO 81007
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Attachments:
Verification Test (6 pages)
15 kip micropile design with grade beam connection (3 pages)
15 kip micropile design with pad footing connection (3 pages)

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Kelley Residence																			
183 River Ridge Court, GJ CO							Test Performed by Mays Construction Specialties: Josh & Trever						Observed by	N/A					
Pile:		Sacrificial Test Pile installed					**Test Date:**						**No. of Elements:**				1		
Starting Free Length:		23.00	ft	276	in		**Design Load:**			15.000	kip		**Modulus of Elasticity:**				29000	kip/in2	
Starting Bond Length:		30.00	ft	360	in								**Bar Diameter:**			T30/11	1.180	in	
Below Ground Free Length:		20	ft	240	in		**Max Test Load (200% DL):**			30.000	kip		**Bar Area:**				0.940	in2	
Above Ground Free Length:		3.00	ft	36	in								**Casing OD:**				0.00	in	
Total Length:		53.00	ft	636	in								**Casing TW:**				0.00	in	
													Casing ID:				0.00	in	
Theoretical Elongation (calculate at max test load):				0.304	inches		***Casing is not considered for a Tension Test						**Jack-Gauge Factor:**				0.0118382	kip/psi	
													Load Cell Serial Number:				-		
													Load Cell Zero reading (avg.):				-		
													Load Cell Scale Factor:				-		
													Load Cell Offset:				-		
													Casing Area:				0	in^2	

Test started at approximately 12:15 AM

% Design Load (%)	Holding Time (min)	Spec. Load (kips)	Calc. Jack Press. (psi)	Time of Reading (24h)	Observed Jack Press. (psi)	Dial Gauge G1 (in)	Dial Gauge G2 (in)	Correct. Avg. (in)	Elastic Movement (theoretical)	Comments				
5%	2.5	0.8	194	12:21	195	0.000	0.000	0.000	0.008					
15%	2.5	2.3	314	12:25	315	0.009	0.004	0.007	0.023					
30%	2.5	4.5	494	12:29	495	0.021	0.019	0.020	0.046					
45%	2.5	6.8	674	12:32	675	0.043	0.036	0.040	0.068					
5%	1	0.8	194	12:35	195	0.008	0.011	0.010	0.008					
								0.000						
15%	1	2.3	314	12:36	315	0.015	0.016	0.016	0.023					
45%	1	6.8	674	12:38	675	0.040	0.035	0.038	0.068					
60%	2.5	9.0	854	12:42	855	0.056	0.050	0.053	0.091					
75%	2.5	11.3	1034	12:46	1034	0.075	0.065	0.070	0.114					
90%	2.5	13.5	1214	12:49	1215	0.093	0.080	0.087	0.137					
100%	2.5	15.0	1334	12:52	1335	0.099	0.090	0.095	0.152					
5%	1	0.8	194	12:54	195	0.015	0.021	0.018	0.008					
15%	1	2.3	314	12:57	315	0.022	0.026	0.024	0.023					
100%	1	15.0	1334	1:01	1335	0.105	0.094	0.100	0.152					
115%	2.5	17.3	1514	1:04	1515	0.118	0.105	0.112	0.175					
130%	1	19.5	1694	1:08	1695	0.136	0.120	0.128	0.197					
130%	1	19.5	1694	1:09	1695	0.136	0.120	0.128	0.197					
130%	1	19.5	1694	1:10	1695	0.136	0.121	0.129	0.197					
130%	1	19.5	1694	1:11	1695	0.136	0.121	0.129	0.197					
130%	1	19.5	1694	1:12	1695	0.136	0.121	0.129	0.197					
130%	1	19.5	1694	1:13	1695	0.136	0.121	0.129	0.197					
130%	4	19.5	1694	1:19	1695	0.136	0.122	0.129	0.197	0.001	if less than 0.040" in 10 minutes			
130%	10	19.5	1694					0.000	0.197		end creep test			
130%	10	19.5	1694					0.000	0.197					
130%	20	19.5	1694	-				0.000	0.197					
130%	10	19.5	1694	-				0.000	0.197					
145%	2.5	21.8	1874	1:25	1875	0.153	0.136	0.145	0.220	PES must have these readings, as well				
5%	1	0.8	194	1:28	195	0.016	0.023	0.020	0.008					
										Bring back up to 30kips & increase by 10 kip intervals until failure				
15%	1	2.3	314	1:30	314	0.025	0.030	0.028	0.023	40k	3400		0.305	0.276
145%	1	21.8	1874	1:33	1875	0.151	0.135	0.143	0.220	50k	4200		0.408	0.372
160%	1	24.0	2054	1:35	2055	0.165	0.149	0.157	0.243	60k	5000		0.524	0.48
175%	2.5	26.3	2234	1:41	2235	0.184	0.164	0.174	0.266	70k	5800	failure at 5600psi	0.99	0.899
200%	10	30.0	2534	1:53	2535	0.214	0.192	0.203	0.304	Load at Failure =		68279.2		
150%	5	22.5	1934	1:59	1935	0.185	0.168	0.177	0.228					
100%	5	15.0	1334	2:07	1335	0.145	0.132	0.139	0.152	t.u = P.fail/(pi*dh*L.b)		15.09301693	USE 7.5 PSI WORKING BOND STRESS	
50%	5	7.5	734	2:13	735	0.083	0.083	0.083	0.076				IN MICROPILE DESIGN	
5%	5	0.8	194	2:19	195	0.020	0.026	0.023	0.008					

Kelley Residence

Pile:	Sacrificial Test Pile installed			
Starting Free Length:	23.00	ft	276	in
Starting Bond Length:	30.00	ft	360	in
Below Ground Free Length:	20.00	ft	240	in
Above Ground Free Length:	3.00	ft	36	in
Total Length:	53.00	ft	636	in

Theoretical Elongation (calculate at max test load): 0.304 inches

At 200% design load

Apparent Free Length:	**167.9**	inches	**13.99**	ft
Debonding:	**-108.1**	inches	**-9.01**	ft
Apparent Bond Length:	**468.1**	inches	**39.01**	ft

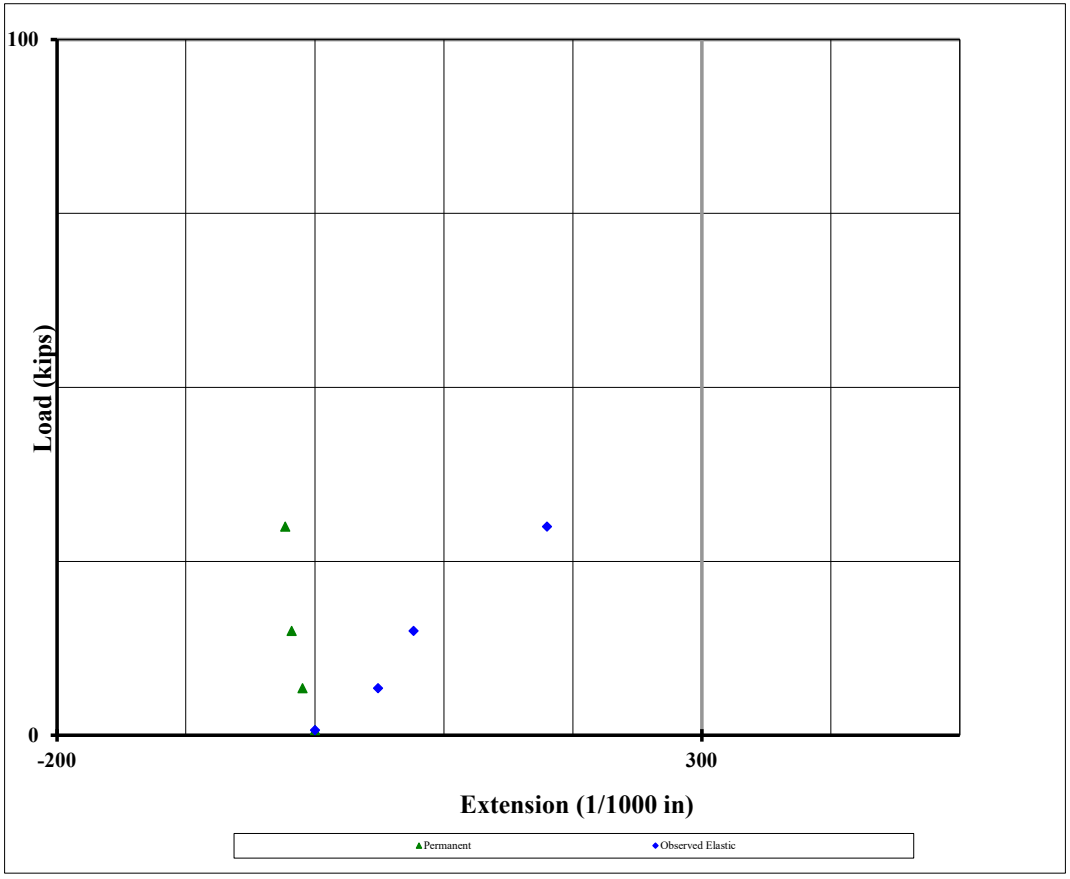
Test Date:	01/00/00	
Design Load (100%):	15	kip
Max Test Load (200% DL):	30	kip

No. of Elements:	1	
Modulus of Elasticity:	29000	kip/in2
Element Area:	0.94	in2
Casing OD:		in
Casing TW:		in
Casing ID:		in
Jack-Gauge Factor:	0.011838196	kip/psi
Load Cell Serial Number:	-	
Load Cell Zero reading (avg.):	-	
Load Cell Scale Factor:	-	
Load Cell Offset:	-	
Casing Area:	0	in^2

% Design Load (%)	Holding Time (min)	Spec. Load (kips)	Time of Reading (24h)	Calc. Jack Press. (psi)	Observed Jack Press. (psi)	Observed Jack Load (kips)	Dial Gauge G1 (in)	Dial Gauge G2 (in)	Dial Gauge Corrected (in)	Total Movement (in)	Perm. Movement (in)	Elastic Movement (in)	Elastic Movement (theory)
5%	2.5	0.8		194	195	0.8	0.000	0.000	0.000	0.000			0.008
15%	2.5	2.3		314	315	2.3	0.009	0.004	0.007	0.007			0.023
30%	2.5	4.5		494	495	4.5	0.021	0.019	0.020	0.020			0.046
45%	2.5	6.8		674	675	6.8	0.043	0.036	0.040	0.040	0.010	0.049	0.068
5%	1	0.8		194	195	0.8	0.008	0.011	0.010	0.010			0.008
													0.000
15%	1	2.3		314	315	2.3	0.015	0.016	0.016	0.016			0.023
45%	1	6.8		674	675	6.8	0.040	0.035	0.038	0.038			0.068
60%	2.5	9.0		854	855	9.0	0.056	0.050	0.053	0.053			0.091
75%	2.5	11.3		1034	1034	11.2	0.075	0.065	0.070	0.070			0.114
90%	2.5	13.5		1214	1215	13.5	0.093	0.080	0.087	0.087			0.137
100%	2.5	15.0		1334	1335	15.0	0.099	0.090	0.095	0.095	0.018	0.077	0.152
5%	1	0.8		194	195	0.8	0.015	0.021	0.018	0.018			0.008
													0.000
15%	1	2.3		314	315	2.3	0.022	0.026	0.024	0.024			0.023
100%	1	15.0		1334	1335	15.0	0.105	0.094	0.100	0.100			0.152
115%	2.5	17.3		1514	1515	17.2	0.118	0.105	0.112	0.112			0.175
130%	1	19.5		1694	1695	19.5	0.136	0.120	0.128	0.128			0.197
130%	1	19.5		1694	1695	19.5	0.136	0.120	0.128	0.128			0.197
130%	1	19.5		1694	1695	19.5	0.136	0.121	0.129	0.129			0.197
130%	1	19.5		1694	1695	19.5	0.136	0.121	0.129	0.129			0.197
130%	1	19.5		1694	1695	19.5	0.136	0.121	0.129	0.129			0.197
130%	1	19.5		1694	1695	19.5	0.136	0.121	0.129	0.129			0.197
130%	4	19.5		1694	1695	19.5	0.136	0.122	0.129	0.129	0.001	creep	0.197
130%	10	19.5		1694	0	-1.7	0.000	0.000	0.000	0.000			0.197
130%	10	19.5		1694	0	-1.7	0.000	0.000	0.000	0.000			0.197
130%	20	19.5		1694	0	-1.7	0.000	0.000	0.000	0.000			0.197
130%	10	19.5		1694	0	-1.7	0.000	0.000	0.000	0.000			0.197
145%	2.5	21.8		1874	1875	21.7	0.153	0.136	0.145	0.145	0.020	0.125	0.220
5%	1	0.8		194	195	0.8	0.016	0.023	0.020	0.020			0.008
													0.000
15%	1	2.3		314	314	2.2	0.025	0.030	0.028	0.028			0.023
145%	1	21.8		1874	1875	21.7	0.151	0.135	0.143	0.143			0.220
160%	1	24.0		2054	2055	24.0	0.165	0.149	0.157	0.157			0.243
175%	2.5	26.3		2234	2235	26.2	0.184	0.164	0.174	0.174			0.266
200%	10	30.0	-	2534	2535	30.0	0.214	0.192	0.203	0.203	0.023	0.180	0.304
150%	5	22.5		1934	1935	22.5	0.185	0.168	0.177	0.177			0.228
100%	5	15.0		1334	1335	15.0	0.145	0.132	0.139	0.139			0.152
50%	5	7.5		734	735	7.5	0.083	0.083	0.083	0.083			0.076
5%	5	0.8		194	195	0.8	0.020	0.026	0.023	0.023			0.008

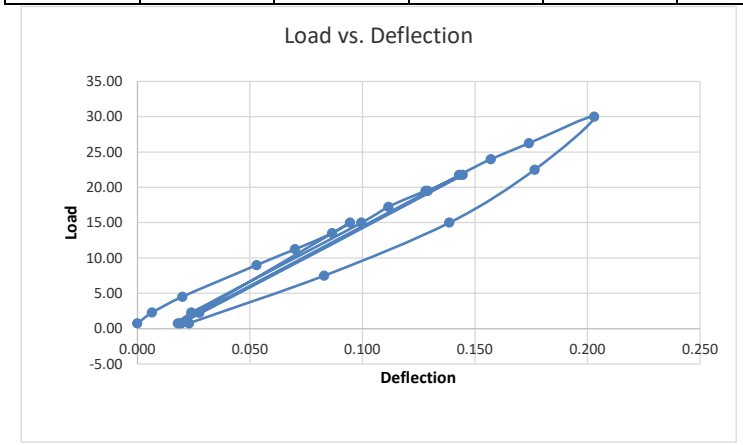
Pile: Sacrificial Test Pile installed

Target % Des. Load (%)	Target % Des. Load (KIPS)	Calculated Load (kips)	Total Movement (0.001 in)	Perm. Movement (0.001 in)	Elastic Movement (0.001 in)
5%	0.75	0.75994	0	0	0
45%	7	7	39.5	-9.5	49.0
100%	15	15	94.5	-18.0	76.5
200%	30	30	203.0	-23.0	180.0

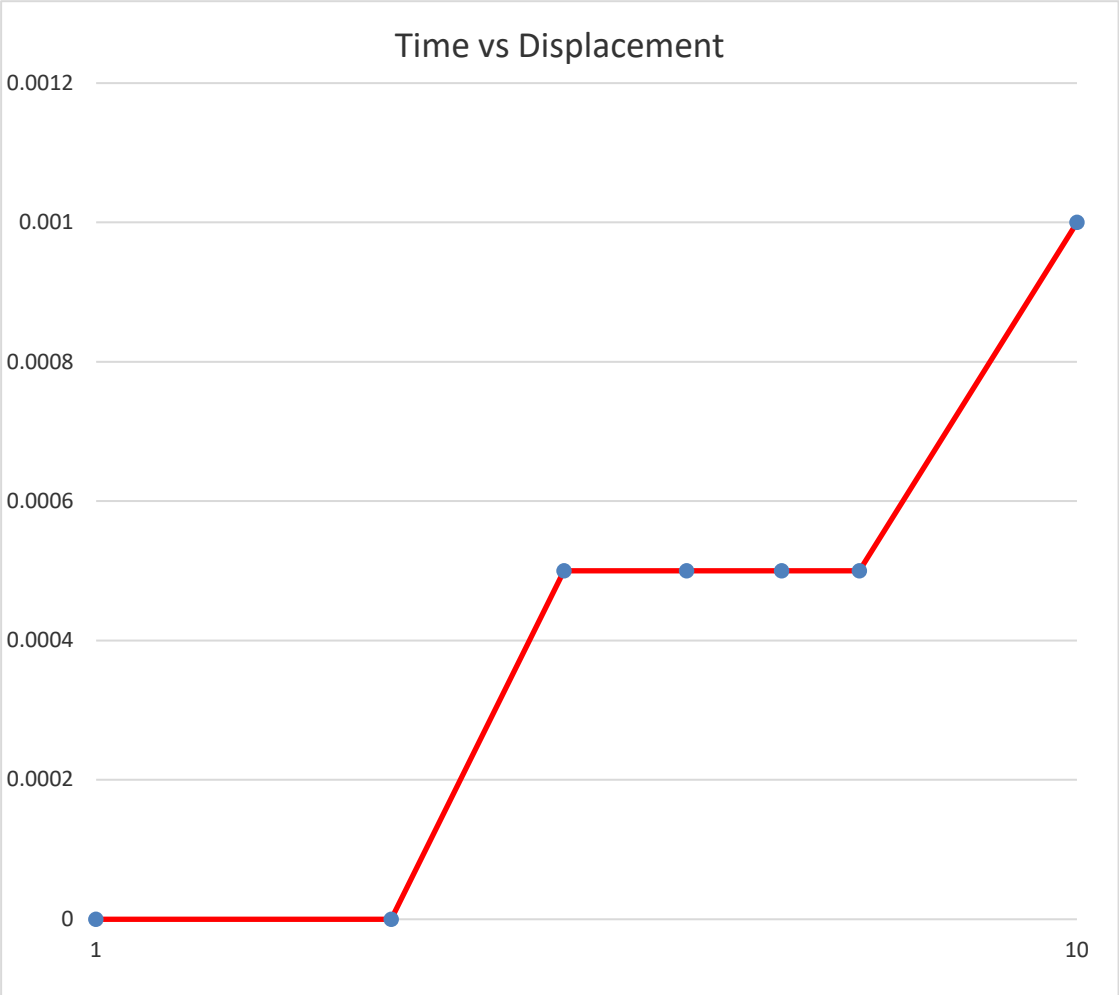


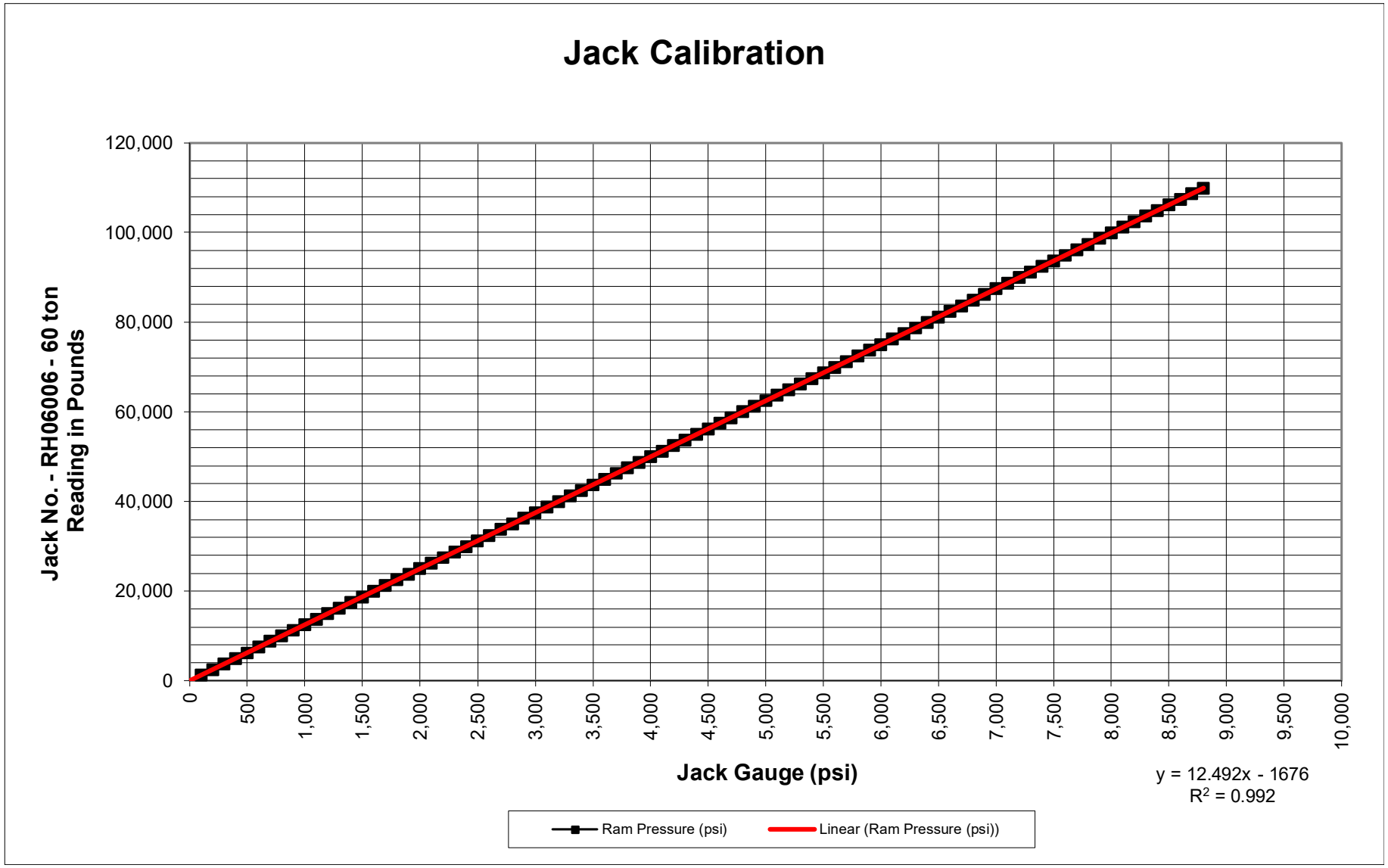
Pile: Sacrificial Test Pile installed

Target % Des. Load (%)	Spec. Load (kips)	Observed Load Jack (psi)	Observed Load Jack (kips)	Total Movement (in)	Total Movement (1/1000in)
5.0%	1	195.00	0.76	0.000	0
15.0%	2	315.00	2.26	0.007	7
30.0%	5	495.00	4.51	0.020	20
60.0%	9	855.00	9.00	0.053	53
75.0%	11	1034.00	11.24	0.070	70
90.0%	14	1215.00	13.50	0.087	87
100.0%	15	1335.00	15.00	0.095	95
5.0%	1	195.00	0.76	0.018	18
15.0%	2	315.00	2.26	0.024	24
100.0%	15	1335.00	15.00	0.100	100
115.0%	17	1515.00	17.25	0.112	112
130.0%	20	1695.00	19.50	0.128	128
130.0%	20	1695.00	19.50	0.129	129
145.0%	22	1875.00	21.75	0.145	145
5.0%	1	195.00	0.76	0.020	20
15.0%	2	314.00	2.25	0.028	28
145.0%	22	1875.00	21.75	0.143	143
160.0%	24	2055.00	24.00	0.157	157
175.0%	26	2235.00	26.24	0.174	174
200.0%	30	2535.00	29.99	0.203	203
150.0%	23	1935.00	22.50	0.177	177
100.0%	15	1335.00	15.00	0.139	139
50.0%	8	735.00	7.51	0.083	83
5.0%	1	195.00	0.76	0.023	23



Test Load (kips)	Time (min)	Dial Gauge (in)	Creep (in)
19.5	1	0.128	0
19.5	2	0.128	0
19.5	3	0.1285	0.0005
19.5	4	0.1285	0.0005
19.5	5	0.1285	0.0005
19.5	6	0.1285	0.0005
19.5	10	0.129	0.001




Jack Calibration
Jack No. - RH06006 - 60 ton
Reading in Pounds
120,000
100,000
80,000
60,000
40,000
20,000
0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
6,500
7,000
7,500
8,000
8,500
9,000
9,500
10,000
Jack Gauge (psi)
y = 12.492x - 1676
R2 = 0.992
Ram Pressure (psi)
Linear (Ram Pressure (psi))

Micropile Design

kips := 1000lbf
ksi := 1000psi

Based on Federal Highway Administration Publication: "Micropile Design and Construction"

(Publication No. FHWA-NHI-05-039) December 2005 and IBC 2018

Micropile Properties

$P := 15kip$ Micropile Capacity

$P_t := 15kip$ Micropile Tension Load

Select:
1) IBC Method
2) FHWA Method

$D := 4in$ 4" bit Micropile Diameter

$D_b := 1.18in$ Nominal Bar Diameter

$f_c := 4000psi$ Grout 28-day Compressive Strength

1) Titan 30/16
2) Titan 30/11
3) Titan 40/20
4) Titan 40/16
5) Titan 52/26

Select Reinforcing Bar

$F_y = 42.7 \cdot kips$ Yield Strength of Reinforcing Bar

$\phi_c = 0.33 \quad \phi_y = 0.4 \quad \phi_t = 0.6$ Reduction Factors

Geotechnical Design

	Bond Stress	Layer Thickness	
Soil-Grout ULTIMATE Bond Stress	0	35	
(and thickness of corresponding soil layer)	0	0	
	0	0	
Bond stress FoS $FS_b := 2$	0	0	
	40	0	Bearing Soils

Soil-Grout Bond (first 4 layers)

$$G := \sum_{x=0}^{3} \left[\left(\frac{Bs_x}{FS_b} \cdot D \cdot \pi \right) \cdot Hs_x \cdot psi \cdot ft \right] \qquad G = 0 \cdot kips$$

Additional Length Required in Last Geostrata

$$L_b := \frac{(P - G) \cdot FS_b}{Bs_4 \cdot D \cdot \pi \cdot psi} \qquad L_b = 4.974 \cdot ft$$

Total Pile Length Required

$$L_{total} := \sum_{x=0}^{3} \left(Hs_x \cdot ft \right) + L_b \qquad L_{total} = 40 \cdot ft$$

Use 40 ft embedment

Structural Design

Area of Grout

$$A_g := \left(0.25 \cdot \pi \cdot D^2\right) - \left(0.25 \cdot \pi \cdot D_b^{\,2}\right) \qquad A_g = 11.473 \cdot in^2$$

Compression Capacity

$$P_c := \phi_c \cdot f_c \cdot A_g + \phi_y \cdot F_y \qquad P_c = 32.224 \cdot kips$$

Tensile Capacity $P_{t.a} := \phi_t \cdot F_y$ $P_{t.a} = 25.62 \cdot kips$

$check_{P.c} := if(P_c \geq P, "OK", "NO GOOD")$ $check_{P.c} = "OK"$

$check_{P.t} := if(P_{t.a} \geq P_t, "OK", "NO GOOD")$ $check_{P.t} = "OK"$

USE - T30/16 X 40'-0" (OR EQUIVALENT STRENGTH MICROPILE REINFORCING ELEMENT) EMBEDDED LENGTH IN A 4" EFFECTIVE DIAMETER DRILL HOLE DIAMETER.

Connection Design

Check Cone Shear

$f_{cc} := 4000psi$ f'c of Concrete

Number of plates $n := 1$

$b := 4in$ $b_2 := 10in$ Plate Dimensions

$h_c := 4in$ Concrete Cover

Equivalent Diameter $d_1 := \sqrt{\frac{4 \cdot b \cdot b_2}{\pi}}$ $d_1 = 7.136 \cdot in$

Bottom of Cone Diameter $d_2 := d_1 + 2 \cdot h_c$ $d_2 = 15.136 \cdot in$

Area of Cone $A_{cp} := \frac{\pi}{4} \cdot \left({d_2}^2 - {d_1}^2 \right)$ $A_{cp} = 139.945 \cdot in^2$

Cone Strength $P_{cone} := 4 \cdot \sqrt{\frac{f_{cc}}{psi}} \cdot A_{cp} \cdot psi$ $P_{cone} = 35.404 \cdot kips$

Cone Design Strength $P_{cd} := n \cdot 0.67 \cdot P_{cone}$ $P_{cd} = 23.72 \cdot kips$

Development Length in Concrete

Deformed Bar to Grout Bond $t_w := 250psi$

Length of Deformed Bar in Concrete $L_d := 0in$

Development Strength $P_{dev} := L_d \cdot t_w \cdot D_b \cdot \pi$ $P_{dev} = 0 \cdot kips$

Total Connection Strength $P_{total} := P_{cd} + P_{dev}$ $P_{total} = 23.7 \cdot kips$

Plate Thickness

$OD_r := 4in$ Outside diameter of rigid body on plate

Plate Area $A_p := b \cdot b_2$ $A_p = 40 \cdot in^2$

Yield Stress $f_y := 36ksi$

Bearing Compression $wbp := \frac{P - P_{dev}}{A_p}$ $wbp = 375 \cdot psi$

Maximum Moment $M_{max} := wbp \cdot \left(\frac{b_2 - OD_r}{2} \right)^2 \cdot \frac{0.5}{n} in$ $M_{max} = 1687.5 \cdot in \cdot lbf$

Required Section Modulus $S_x := \frac{M_{max}}{0.55 \cdot f_y}$ $S_x = 0.085 \cdot in^3$

Required Plate Thickness $t := \sqrt{\frac{6 \cdot S_x}{0.5 \cdot b}}$ $t = 0.506 \cdot in$

USE -1/2"X4"X10" WITH A MINIMUM OF 4" CONCRETE CLEARANCE TO THE TOP AND BOTTOM OF PLATE TO THE OPEN EDGE OF CONCRETE.

Summary

Design Load	$P = 15 \cdot kips$	Concrete Cover	$h_c = 4 \cdot in$
Pile Length	$L_{total} = 40 \cdot ft$	Development Length of Bar	$L_b = 59.683 \cdot in$
Structural Capacity	$P_c = 32.224 \cdot kips$	Required Plate Thickness	$t = 0.506 \cdot in$
Bar Yield	$F_y = 42.7 \cdot kips$	Total Connection Strength	$P_{total} = 23.72 \cdot kips$
Bar Diameter	$D_b = 1.18 \cdot in$		
Plate Width	$b = 4 \cdot in$		check = "OK"

CONCLUSION - USE T30/16 HOLLOW BAR REINFORCING WITH A 4" DIA. DRILL BIT TO AN OVERALL BELOW GRADE DEPTH OF 40'-0" AND SLEEVE THE UPPER 30' WITH PVC BOND BREAKER. USE 3" NOMINAL SCH. 40 PVC A MINIMUM OF 1'-0" BELOW GRADE TO EXTEND THROUGH THE VOID AND INTO THE GRADE BEAM TO CONTINUE COROSSION PROTECTION THROUGH THE VOID. USE 1/2"X4"X10" A36 STEEL PLATE FOR THE STRUCTURAL CONNECTION, LOCATED A MINIMUM OF 4" UP FROM THE BOTTOM OF THE GRADE BEAM CONCRETE.

Micropile Design

kips := 1000lbf
ksi := 1000psi

Based on Federal Highway Administration Publication: "Micropile Design and Construction"

(Publication No. FHWA-NHI-05-039) December 2005 and IBC 2018

Micropile Properties

$P := 15kip$ Micropile Capacity

$P_t := 15kip$ Micropile Tension Load

Select:
1) IBC Method
2) FHWA Method

$D := 4in$ 4" bit Micropile Diameter

$D_b := 1.18in$ Nominal Bar Diameter

$f_c := 4000psi$ Grout 28-day Compressive Strength

1) Titan 30/16
2) Titan 30/11
3) Titan 40/20
4) Titan 40/16
5) Titan 52/26

Select Reinforcing Bar

$F_y = 42.7 \cdot kips$ Yield Strength of Reinforcing Bar

$\phi_c = 0.33$ $\phi_y = 0.4$ $\phi_t = 0.6$ Reduction Factors

Geotechnical Design

	Bond Stress	Layer Thickness
Soil-Grout ULTIMATE Bond Stress	0	35
(and thickness of corresponding soil layer)	0	0
	0	0
	0	0
	40	0

Bearing Soils

Bond stress FoS $FS_b := 2$

Soil-Grout Bond (first 4 layers)

$$G := \sum_{x=0}^{3} \left[\left(\frac{Bs_x}{FS_b} \cdot D \cdot \pi \right) \cdot Hs_x \cdot psi \cdot ft \right] \qquad G = 0 \cdot kips$$

Additional Length Required in Last Geostrata

$$L_b := \frac{(P - G) \cdot FS_b}{Bs_4 \cdot D \cdot \pi \cdot psi} \qquad L_b = 4.974 \cdot ft$$

Total Pile Length Required

$$L_{total} := \sum_{x=0}^{3} \left(Hs_x \cdot ft \right) + L_b \qquad L_{total} = 40 \cdot ft$$

Use 40 ft embedment

Structural Design

Area of Grout

$$A_g := \left(0.25 \cdot \pi \cdot D^2\right) - \left(0.25 \cdot \pi \cdot D_b^{\,2}\right) \qquad A_g = 11.473 \cdot in^2$$

Compression Capacity

$$P_c := \phi_c \cdot f_c \cdot A_g + \phi_y \cdot F_y \qquad P_c = 32.224 \cdot kips$$

Tensile Capacity $P_{t.a} := \phi_t \cdot F_y$ $P_{t.a} = 25.62 \cdot kips$

$check_{P.c} := if(P_c \geq P, "OK", "NO GOOD")$ $check_{P.c} = "OK"$

$check_{P.t} := if(P_{t.a} \geq P_t, "OK", "NO GOOD")$ $check_{P.t} = "OK"$

USE - T30/16 X 40'-0" (OR EQUIVALENT STRENGTH MICROPILE REINFORCING ELEMENT) EMBEDDED LENGTH IN A 4" EFFECTIVE DIAMETER DRILL HOLE DIAMETER.

Connection Design

Check Cone Shear

$f_{cc} := 4000psi$ f'c of Concrete

Number of plates $n := 1$

$b := 6in$ $b_2 := 6in$ Plate Dimensions

$h_c := 4in$ Concrete Cover

Equivalent Diameter $d_1 := \sqrt{\frac{4 \cdot b \cdot b_2}{\pi}}$ $d_1 = 6.77 \cdot in$

Bottom of Cone Diameter $d_2 := d_1 + 2 \cdot h_c$ $d_2 = 14.77 \cdot in$

Area of Cone $A_{cp} := \frac{\pi}{4} \cdot \left(d_2^2 - d_1^2 \right)$ $A_{cp} = 135.343 \cdot in^2$

Cone Strength $P_{cone} := 4 \cdot \sqrt{\frac{f_{cc}}{psi}} \cdot A_{cp} \cdot psi$ $P_{cone} = 34.239 \cdot kips$

Cone Design Strength $P_{cd} := n \cdot 0.67 \cdot P_{cone}$ $P_{cd} = 22.94 \cdot kips$

Development Length in Concrete

Deformed Bar to Grout Bond $t_w := 250psi$

Length of Deformed Bar in Concrete $L_d := 0in$

Development Strength $P_{dev} := L_d \cdot t_w \cdot D_b \cdot \pi$ $P_{dev} = 0 \cdot kips$

Total Connection Strength $P_{total} := P_{cd} + P_{dev}$ $P_{total} = 22.9 \cdot kips$

Plate Thickness

$OD_r := 4in$ Outside diameter of rigid body on plate

Plate Area $A_p := b \cdot b_2$ $A_p = 36 \cdot in^2$

Yield Stress $f_y := 36ksi$

Bearing Compression $wbp := \frac{P - P_{dev}}{A_p}$ $wbp = 416.7 \cdot psi$

Maximum Moment $M_{max} := wbp \cdot \left(\frac{b_2 - OD_r}{2} \right)^2 \cdot \frac{0.5}{n} in$ $M_{max} = 208.3 \cdot in \cdot lbf$

Required Section Modulus $S_x := \frac{M_{max}}{0.55 \cdot f_y}$ $S_x = 0.011 \cdot in^3$

Required Plate Thickness $t := \sqrt{\frac{6 \cdot S_x}{0.5 \cdot b}}$ $t = 0.145 \cdot in$

USE -1/2"X6"X6"WITH A MINIMUM OF 4" CONCRETE CLEARANCE TO THE TOP AND BOTTOM OF PLATE TO THE OPEN EDGE OF CONCRETE.

Summary

Design Load	$P = 15 \cdot kips$	Concrete Cover	$h_c = 4 \cdot in$
Pile Length	$L_{total} = 40 \cdot ft$	Development Length of Bar	$L_b = 59.683 \cdot in$
Structural Capacity	$P_c = 32.224 \cdot kips$	Required Plate Thickness	$t = 0.145 \cdot in$
Bar Yield	$F_y = 42.7 \cdot kips$	Total Connection Strength	$P_{total} = 22.94 \cdot kips$
Bar Diameter	$D_b = 1.18 \cdot in$		
Plate Width	$b = 6 \cdot in$		check = "OK"

CONCLUSION - USE T30/16 HOLLOW BAR REINFORCING WITH A 4" DIA. DRILL BIT TO AN OVERALL BELOW GRADE DEPTH OF 40'-0" AND SLEEVE THE UPPER 30' WITH PVC BOND BREAKER. USE 3" NOMINAL SCH. 40 PVC A MINIMUM OF 1'-0" BELOW GRADE TO EXTEND THROUGH THE VOID AND INTO THE PAD FOOTING TO CONTINUE COROSSION PROTECTION THROUGH THE VOID. USE 1/2"X6"X6" A36 STEEL PLATE FOR THE STRUCTURAL CONNECTION, LOCATED A MINIMUM OF 4" UP FROM THE BOTTOM OF THE PAD FOOTING CONCRETE.