Illinois Department of Transportation

STATE OF ILLINOIS
062-050019
TERRENCE L. MC CLEARY
LICENSED ENGINEER

Abbreviated Structure Geotechnical Report

Original Report Date: 6/4/14 Proposed SN: 006-0188 Route: IL 89, FAP 698
Revised Date: 5/2/15 Existing SN: 006-0106 Section: (101 BR-2)BR
Geotechnical Engineer: Terry McCleary of McCleary Engineering County: Bureau
Structural Engineer: Mike Okrent, Bloom Companies Contract: 66A21

Indicate the proposed structure type, substructure types, and foundation locations (attach plan and elevation drawing): **A three span structure, 70 ft. in total length from back to back of abutments is proposed. The superstructure will be a concrete slab supported by integral abutments and two solid stem piers. The factored loadings are estimated to be near 560 kips at the abutments and near 825 kips at the two piers. The pier foundation width was estimated to be near 36 ft. Please refer to the draft TSL drawing for a more accurate picture of what is to be constructed. See the attached piling discussion. Boring data from the 1983 bridge construction is not available.**

Discuss the existing boring data, existing plans foundation information, new subsurface exploration and need for any additional exploration to be provided with SGR Technical Memo (attach all data and subsurface profile plot): **Two borings exist for this structure from 2009. In general, both the borings show similar soil stratification. Boring #1 was chosen to represent both borings and is therefore described here. This boring showed stiff clay soils down to an approximate depth of 15 ft. where loose Silt was encountered to a depth of 17 ft. Between 17 ft. and 42 ft. a medium dense to dense loamy fine Sand to coarse Gravel (with N-values as high as 64 at the bottom of this layer) were reported in the log. Between 42 ft. and 50 ft. depth a very stiff Silty Clay Loam (TILL) was encountered. Between 50 ft. depth and the end of the boring at 61.5 ft. the soils encountered were a hard Sandy Clay Loam (Till). See the attached boring logs and soils profile for more detailed descriptions of the subsurface conditions. Each of the existing closed abutments rest on spread footing foundations with no piling. Pier borings would have to be taken through the deck to be close enough to be useful. It has been the District's policy to not core through PPC deck beams. The two abutment borings are only 90 ft. apart and show similar soils; therefore at this time I see no need for additional investigation. No borings were available from the investigation for the existing structure.**

Provide the location and maximum height of any new soil fill or magnitude of footing bearing pressure. Estimate the amount and time of the expected settlement. Indicate if further testing, analysis, and/or ground improvement/treatment is necessary: **At the time of this report it is my understanding there is no additional embankment behind the new integral abutment. It also appears there will be a slight raise in grade due to the proposed wearing surface on approach pavement. No ground improvement beyond normal construction practice is expected at this site therefore no further testing or analysis is proposed at this time.**

Identify any new cuts or fill slope angles and heights. Estimate the factor of safety against slope failure. Indicate if further testing, analysis or ground improvement/treatment is necessary. **Minimal grade change is expected. The end slope on the stream side of the abutment will remain a 1:2(V:H) slope with a slope height near 8 ft. to the bottom of the proposed abutment. The short term FOS is estimated to be 2.05. We estimate the long term FOS to be 1.55. These factors of safety were estimated using the commercially available software SLIDE 6.0. Boring #1 for the South Abutment was used for the analysis. No further analysis, testing or ground improvement is expected for this project.**

Indicate at each substructure, the 100-year and 200-year total scour depths in the Hydraulics Report, the non-granular scour depth reduction, the proposed ground surface, and the recommended foundation design scour elevations. **No scour was accounted for at the abutments per IDOT policy. The design scour elevations and bottom of abutment elevations are 687.28 ft and 687.40 for the south abutment and north abutment respectively. The 100-year and 200-year total scour for the piers is estimated to be 25.04 ft and 25.25 ft, respectively. Because of the soils encountered in the borings near the streambed elevation no reduction in the scour depth is recommended, per Department policy. The design scour elevation at the piers is estimated to be 653.96 ft. The propose ground elevation at the piers is near 679.0 ft. See the attached scour table.**

Determining the seismic soil site class, the seismic performance zone, the 0.2 and 1.0 second design spectral accelerations and indicate if the soils are liquefiable. **This site is in a seismic performance zone, SPZ=1 and has a seismic soil site class of "D", an SDs = 0.159 and an SD1=0.095. Because of the SPZ a liquefaction analysis was not performed.**

cc: Bureau of Bridges and Structures

Confirm feasibility of the proposed foundation or wall type and provide design parameters. Attach a pile design table indicating feasible pile types, various nominal required bearings, factored resistances available and corresponding estimated lengths at locations where piles will be used. Provide factored bearing resistance and unit sliding resistance at various elevations and confirm no ground improvement/treatment is necessary where spread footings are proposed. Estimated top of rock elevations as well as preliminary skin friction and end bearing values shall be indicated when drilled shafts are proposed. **See attached discussion of pile length analysis and estimated pile design table.**
Calculate the estimated water surface elevation and determine the need for cofferdam(s) and seal coat: **There will be two piers that will require in stream work. Because the EWSE of 682.58 ft. Elev. is greater than 6 ft. above the bottom of the concrete of the pier foundation, a type II cofferdam, by Department policy is recommended. From the data shown in the borings logs there should not be an issue with driving the sheet piling to design depth at this location. The soil near the bottom of the proposed pier elevations may be granular and may require a sealcoat to reduce the amount of water flowing up through this material.**
Assess the need for sheeting/soil retention versus using a temporary construction slope and provide recommendation for the most feasible option. **At this time the author anticipates the structure to be constructed under staged construction conditions therefore Temporary Sheet Piling will be needed at a stage line. From the data shown in the boring logs the author does not anticipate problems with driving the sheets to design depth. As mentioned above the author also believes sheet piling will be the preferred option for the cofferdam.**

Pile Discussion for 006-0188:

In 2009 two abutment borings were taken to design the foundations of the proposed structure. The factored loads for the foundation units are relatively low at approximately 560 kip for the abutments and 825 kip for the piers.

Metal Shell 14 inch pilings and HP piling are acceptable for this structure however each pile type has its issues. The H-piling analyzed will likely drive substantially longer than the metal shell piling, at some of the higher nominal bearings the pile will extend beyond the end of the borings. Should H-piling be chosen it may be prudent to advance a boring to 100 ft. or deeper to determine the characteristics of the soils below the tip of the proposed piling.

The metal shell piling should be driven to their maximum Nominal Bearing in efforts to gain enough embedment below the design scour depth to resist lateral loading. It is understood that much of the factored resistance available could go unused but the depth of pile embedment below the scour will likely control the situation versus the vertical resistance. Per the All Bridge Designers Memorandum, ABD 12.3, the MS 12 piling is allowed, however the MS12 piling are not recommended at the piers as the author feels the pile would also be overstressed before the desired factored resistance and sufficient embedment below the design scour depth was achieved.

At the request of the Bureau of Bridges and Structures a lateral load analysis on the piers was performed while the review of the original SGR was completed. The lateral load analysis was performed on the south pier using the commercial software, AllPile7, and the soil information from boring B-1. Three piling were analyzed, a 50 ft. long MS14 with 0.312 inch thick walls, a 70 ft. long HP12x63 and a 70 ft. long HP14x89. The analysis was performed using a range of lateral loads from 0.3 kips/pile to 2.87 kips/pile. Using the design scour depths, a fixed head condition and a 24 inch square concrete section surrounding the pile to the bottom of the concrete pier the analysis shows the MS14 piling moved 2.0 inches at a load of 2.87 kip/pile. The graphical results are attached to this report. The MS14 piling under a 125 kip/pile vertical load and a 2.87 kip/pile lateral load with a fixed head condition has theoretical deflection fixity of approximately 42 ft. To confirm this depth multiple pile lengths between 45 and 70 ft. were modeled with no appreciable change in head deflection. The lateral load analysis is preliminary and should be verified in the final design.

Boring, B-1 shows a dense layer of sand and gravel with the potential for cobbles at a depth of 40 ft. below the ground surface at the boring. The boring log shows this layer to be only 2 ft. thick. It is possible that the MS 14 with 0.312 inch thick walls could be driven through this, but it is also possible that damage to the pile could occur. A pile shoe may be required for the metal shell piling to get through this material. For this reason and because there is no boring data at the pier locations, the author recommends using a test pile at each of the pier substructures with a pile shoe for the south pier. It may be prudent to utilize a test pile at each of the four substructure elements.

Assumptions used for the pile length analysis include: Bottom of abutment elevation are 687.28 ft. and 687.40 ft., south and north respectively; no geotechnical losses accounted for; and a 2.0 ft. pile embedment into the abutment is presumed. The pile cutoff elevation, for the piers, the author assumed to be 689.23 with a scour elevation of 653.96 ft.

Table 1: PILE LENGTH TABLES USING SOIL DATA for South Abutment and Pier

South Abutment, Using Boring B-1				South Pier, Using Boring B-1		
Nominal Required Bearing (KIPS)	**Factored Resistance Available (KIPS)**	**Estimated Pile Length (Ft.)**		**Nominal Required Bearing (KIPS)**	**Factored Resistance Available (KIPS)**	**Estimated Pile Length (Ft.)**
MS 12 with 0.179" wall				MS 12 with 0.179" wall		
77	43	12		This pile is not recommended		
153	85	16				
223	123	26				
254	140	30				
MS 12 with 0.25" wall				MS 12 with 0.25" wall		
77	43	12				
154	85	16		This pile is not recommended		
224	123	26				
272	150	31				
353	194	35				
MS 14 with 0.25" wall				MS 14 with 0.25" wall		
98	54	12				
197	108	16		This pile is not recommended		
252	139	21				
298	164	29				
413	227	35				
MS 14 with 0.312" wall				MS 14 with 0.312" wall		
197	108	16		419	118	40
252	139	21		453	136	44
298	164	29		466	143	45
361	199	34		493	158	47
513	283	55		513	170	48
HP 12x53				HP 12x53		
116	64	37		160	64	45
187	103	47		252	114	54
276	152	57		264	121	58
418	230	*		418	206	*
HP 12x63				HP 12x63		
94	52	31		162	65	45
141	78	41		205	89	49
207	114	49		255	116	54
278	153	57		267	122	58
493	271	*		493	247	*
HP 14x73				HP 14x73		
112	61	31		198	80	45
175	96	41		253	110	49
254	140	49		313	143	54
341	188	57		325	150	58
578	318	*		578	289	*
HP 14x89				HP 14x89		
114	63	31		201	82	45
177	97	41		256	112	49
258	142	49		317	145	54
346	190	57		329	152	58
705	388	*		705	359	*

***Maximum nominal bearing can be achieved; however, it occurs at a depth greater than the available boring data.**

Table 2: PILE LENGTH TABLES USING SOIL DATA for North Abutment and Pier

North Abutment, Using Boring B-2				North Pier, Using Boring B-2		
Nominal Required Bearing (KIPS)	**Factored Resistance Available (KIPS)**	**Estimated Pile Length (Ft.)**		**Nominal Required Bearing (KIPS)**	**Factored Resistance Available (KIPS)**	**Estimated Pile Length (Ft.)**
MS 12 with 0.179" wall				MS 12 with 0.179" wall		
220	121	24				
250	137	29		This pile is not recommended		
214	118	34				
254	140	38				
MS 12 with 0.25" wall				MS 12 with 0.25" wall		
220	121	24				
250	137	29				
214	118	34		309	76	44
269	148	39		340	93	47
353	194	44		353	100	48
MS 14 with 0.25" wall				MS 14 with 0.25" wall		
278	153	24				
312	172	29				
257	141	34		307	59	39
322	177	39		339	77	41
382	210	44		368	93	44
413	227	47		413	118	48
MS 14 with 0.312" wall				MS 14 with 0.312" wall		
231	127	19		307	59	39
289	159	26		339	77	41
226	124	31		368	93	44
291	160	37		404	113	47
413	227	47		464	145	52
513	283	53		513	172	54
HP 12x53				HP 12x53		
88	48	24		281	123	55
131	72	34		286	126	57
231	127	44		348	160	60
375	206	61		349	161	63
418	230	*		418	198	*
HP 12x63				HP 12x63		
90	49	24		269	116	52
134	73	34		289	127	57
233	128	44		352	162	60
379	208	61		353	162	63
493	271	*		493	239	*
HP 14x73				HP 14x73		
106	59	24		329	144	52
158	87	34		351	156	57
287	158	44		434	202	60
468	257	61		432	201	63
578	318	*		578	281	*
HP 14x89				HP 14x89		
109	60	24		333	146	52
161	89	34		356	158	57
291	160	44		442	205	60
475	261	61		438	204	63
705	388	*		705	350	*

***Maximum nominal bearing can be achieved; however, it occurs at a depth greater than the available boring data.**

BLOOM COMPANIES, LLC | Project BM3-1308C

Project Description: IL-89 Over Brush Creek | Prepared by: BCM | Checked by BDT

Calculation: | Date: 4/8/2014 | Date: 4/9/2014

Foundation Reactions

Reactions onto Foundations

	Abutment		
	Service	Strength I	Strength IV
DC_Super	158.05	197.56	237.07
DC_Sub	69.72	87.15	104.58
DW	32.88	49.32	73.98
LL (Lane)	29.21	51.11	0.00
LL (Truck)	99.66	174.41	0.00
Total	389.52	559.55	415.63

Note: Does not include impact per AASHTO 3.6.2.1

	Pier		
	Service	Strength I	Strength IV
DC_Super	235.31	294.14	352.97
DC_Sub	156.12	195.15	234.18
DW	45.57	68.36	102.53
LL (Lane)	36.66	64.16	0.00
LL (Truck)	115.88	202.79	0.00
Total	589.54	824.59	689.68

Governing Reactions (kip)		
	Service	Strength
Abutment	389.52	559.55
Pier	589.54	824.59

BLOOM COMPANIES, LLC | Project BM3-1308C

Project Description: IL-89 Over Brush Creek | Prepared by: JRS | Checked by BCM

Calculation: | Date: 10/10/2014 | Date: 10/10/2014

Foundation Reactions

Lateral Pile Forces

	Loads Transverse to Pier (kips)				
	Load	Service I	Strength I	Strength III	Strength V
WA (stream)	0.00	0.00	0.00	0.00	0.00
WS (wind on structure)	0.13	0.04	0.00	0.18	0.05
WL (wind on live)	0.09	0.09	0.00	0.00	0.09
BR (braking)	1.62	1.62	2.84	0.00	2.19
TU (uniform temp.)	0.03	0.04	0.04	0.04	0.04
Total		1.79	2.87	0.22	2.37

	Loads Longitudinal to Pier (kips)				
	Load	Service I	Strength I	Strength III	Strength V
WA (stream)	1.12	1.12	1.12	1.12	1.12
WS (wind on structure)	0.58	0.17	0.00	0.81	0.23
WL (wind on live)	0.21	0.21	0.00	0.00	0.21
BR (braking)	0.00	0.00	0.00	0.00	0.00
TU (uniform temp.)	0.00	0.00	0.00	0.00	0.00
Total		1.50	1.12	1.93	1.56

Maximum Combined Shear on Piles (kips)				
	Service I	Strength I	Strength III	Strength V
Pier	2.33	3.08	1.94	2.83

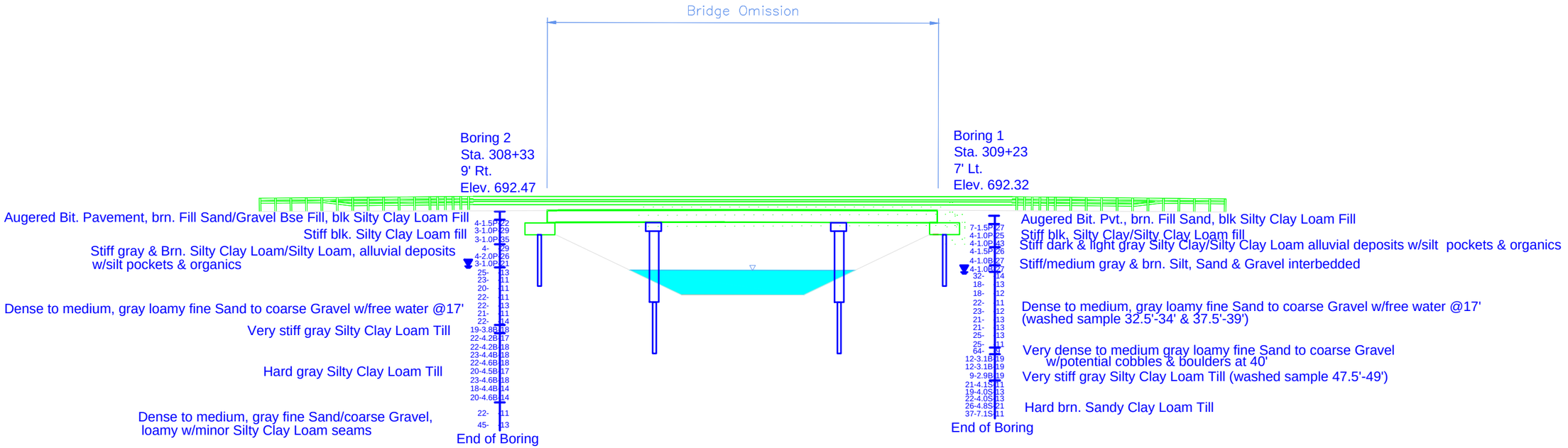
*Note that these loads are based on 8 piles/pier.

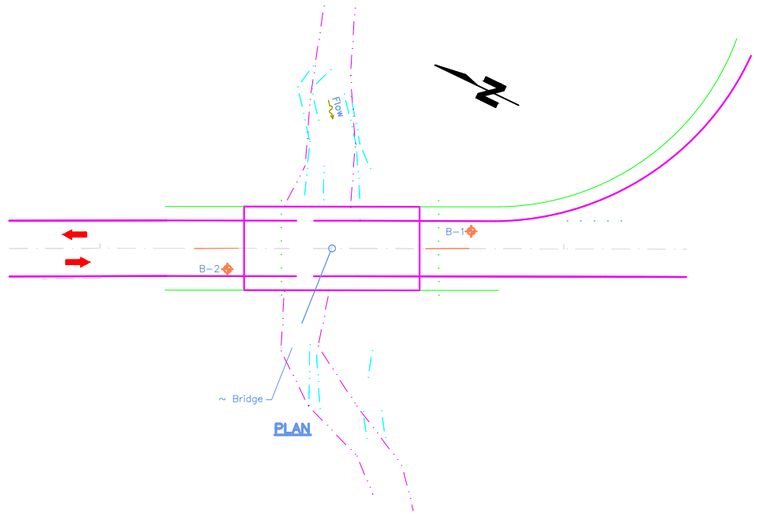
If the piles change to Npiles, (New Loading) = (Old Loading) x (8 Old Piles) / (Npiles)

SN 006-0188
Revised as per ABD memo 14.2 of 11-7-2014

SCOUR ELEVATION TABLE

Event/Limit State	Design Scour Elevations (ft.)				Item 113
	N. Abut.	Pier 1	Pier 2	S. Abut.	
Q100	687.40	653.96	653.96	687.28	5
Q200	687.40	653.75	653.75	687.28	
Design	687.40	653.96	653.96	687.28	
Check	687.40	653.75	653.75	687.28	





McCleary Engineering	Designed by:	Date:	Soil Profile - ILL. 89 Bridge over Brush Creek			Route	Section	County
	Drawn by: MLL	Date: 4/01/14				ILL 89		Bureau
	Checked by: TLM	Date: 5/24/14	Scale =	Sheet 1 of 1	Sta. _____ to Sta._____	Bridge number: 006-0106 Exist.		

Illinois Department of Transportation
Division of Highways
IDOT

SOIL BORING LOG

Date 6/17/09

ROUTE FAP 698 (IL 89) **DESCRIPTION** IL 89 over Brush Creek, 1.2 Miles South of Arlington **LOGGED BY** Larry Myers

SECTION 101-B **LOCATION** South 1/2, **SEC.** 16, **TWP.** 17N, **RNG.** 11E, 4th **PM**, **Latitude** , **Longitude**

COUNTY Bureau **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME Automatic

STRUCT. NO. 006-0106 (Exist.)
Station 308+78

BORING NO. 1 (S.E. Quad.)
Station 309+23
Offset 7.0 ft Lt.
Ground Surface Elev. 692.32 ft

Surface Water Elev. 680.67 ft
Stream Bed Elev. 678.77 ft

Groundwater Elev.:
First Encounter 675.3 ft ▼
Upon Completion 678.3 ft ▽
After ____ **Hrs.** ____ ft

Material Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Augered Bit. Pavement, Brown Fill Sand, Black Silty Clay Loam Fill				
	689.82			
Stiff Black Silty Clay/Silty Clay Loam Fill		3		
		3 4	1.5 P	27
	-5			
		wh		
		2 2	1.0 P	25
		wh		
		2 2	1.0 P	43
	682.82			
Stiff Dark & Light Gray Silty Clay/Silty Clay Loam Alluvial deposits with Silt pockets & Organics	-10			
		wh		
		2 2	1.5 P	26
		wh		
	▽	2 2	1.0 B	27
	677.32	-15		
Stiff/Medium Gray & Brown Silt, Sand & Gravel interbedded		wh		
		3 5		17
	675.32 ▼			
Dense to Medium Gray Loamy Fine Sand to Coarse Gravel with free water @ 17' (washed sample 32.5'-34' & 37.5'-39')		10		
		16 16		14
	-20			
Dense to Medium Gray Loamy Fine Sand to Coarse Gravel with free water @ 17' (washed sample 32.5'-34' & 37.5'-39') *(continued)*		9		
		11 7		13
		11		
		9 9		12
	-25			
		9		
		11 11		11
		9		
		11 12		12
	-30			
		9		
		9 12		13
		9		
		10 11		13
	-35			
		11		
		12 13		13
		9		
		12 13		11
	652.32 -40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
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Groundwater Elev.:
First Encounter 675.3 ft ▼
Upon Completion 678.3 ft ▽
After ____ **Hrs.** ____ ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very Dense to Medium Gray Loamy Fine Sand to Coarse Gravel with potential Cobbles and Boulders @ 40'		9		
		26		9
		38		
	650.32			
Very Stiff Gray Silty Clay Loam Till (washed sample 47.5'-49')		3		
		5	3.1	19
		7	B	
	-45			
		3		
		5	3.1	19
		7	B	
		4		
		4	2.9	19
		5	B	
	642.32			
	-50	5		
Hard Brown Sandy Clay Loam Till		9	4.1	11
		12	S	
		6		
		8	4.0	13
		11	S	
	-55			
		4		
		9	4.0	13
		13	S	
		8		
		12	4.8	21
		14	S	
	-60			

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard Brown Sandy Clay Loam Till *(continued)*		9		
		16	7.1	11
	630.82	21	S	
End of Boring				
	-65			
	-70			
	-75			
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
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SOIL BORING LOG

Date 6/22/09

ROUTE FAP 698 (IL 89) **DESCRIPTION** IL 89 over Brush Creek, 1.2 Miles South of Arlington **LOGGED BY** Larry Myers

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COUNTY Bureau **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** CME Automatic

STRUCT. NO. 006-0106 (Exist.)
Station 308+78

BORING NO. 2 (N.W. Quad.)
Station 308+33
Offset 9.0 ft Rt.
Ground Surface Elev. 692.47 ft

Surface Water Elev. 680.67 ft
Stream Bed Elev. 679.47 ft

Groundwater Elev.:
First Encounter 675.5 ft ▼
Upon Completion 676.5 ft ▽
After ____ **Hrs.** ____ ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Augered Bit. Pavement, Brown Sand/Gravel Base Fill, Black Silty Clay Loam Fill			
689.97			
Stiff Black Silty Clay Loam Fill	2		
	2 2	1.5 P	22
-5			
	2		
	1 2	1.0 P	29
	1		
	1 2	1.0 P	35
682.47 -10			
Stiff Gray & Brown Silty Clay Loam / Silty Loam, Alluvial deposits with Organics & Silt pockets	wh		
	2 2		29
	2		
	2 2	2.0 P	26
-15			
	wh		
▽	1 2	1.0 P	21
675.47 ▼			
Dense to Medium Gray Loamy Fine Sand / Coarse Gravel with free water @ 17'	9		
	12 13		13
-20			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Dense to Medium Gray Loamy Fine Sand / Coarse Gravel with free water @ 17' *(continued)*	9		
	11 12		11
	10		
	10 10		11
-25			
	9		
	11 11		11
	10		
	11 11		13
-30			
	10		
	11 10		11
	10		
	11 11		14
657.97			
-35 Very Stiff Gray Silty Clay Loam Till	6		
	9 10	3.8 B	18
655.47			
Hard Gray Silty Clay Loam Till	8		
	10 12	4.2 B	17
-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

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Stream Bed Elev. 679.47 ft

Groundwater Elev.:
First Encounter 675.5 ft ▼
Upon Completion 676.5 ft ▽
After ____ **Hrs.** ____ ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	9		
	11	4.2	18
	11	B	
	9		
	11	4.4	18
	12	B	
-45			
	8		
	10	4.6	18
	12	B	
	8		
	10	4.5	17
	10	B	
-50			
	8		
	11	4.6	18
	12	B	
	6		
	8	4.4	14
	10	B	
-55			
	8		
	8	4.6	14
	12	B	

Hard Gray Silty Clay Loam Till *(continued)*

634.47

Medium to Dense Gray Fine Sand / Coarse Gravel, Loamy with minor Silty Clay Loam seams

-60

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	11		
	11		11
	11		
-65			
	14		
	19		13
	26		

Medium to Dense Gray Fine Sand / Coarse Gravel, Loamy with minor Silty Clay Loam seams *(continued)*

625.97

End of Boring

-70

-75

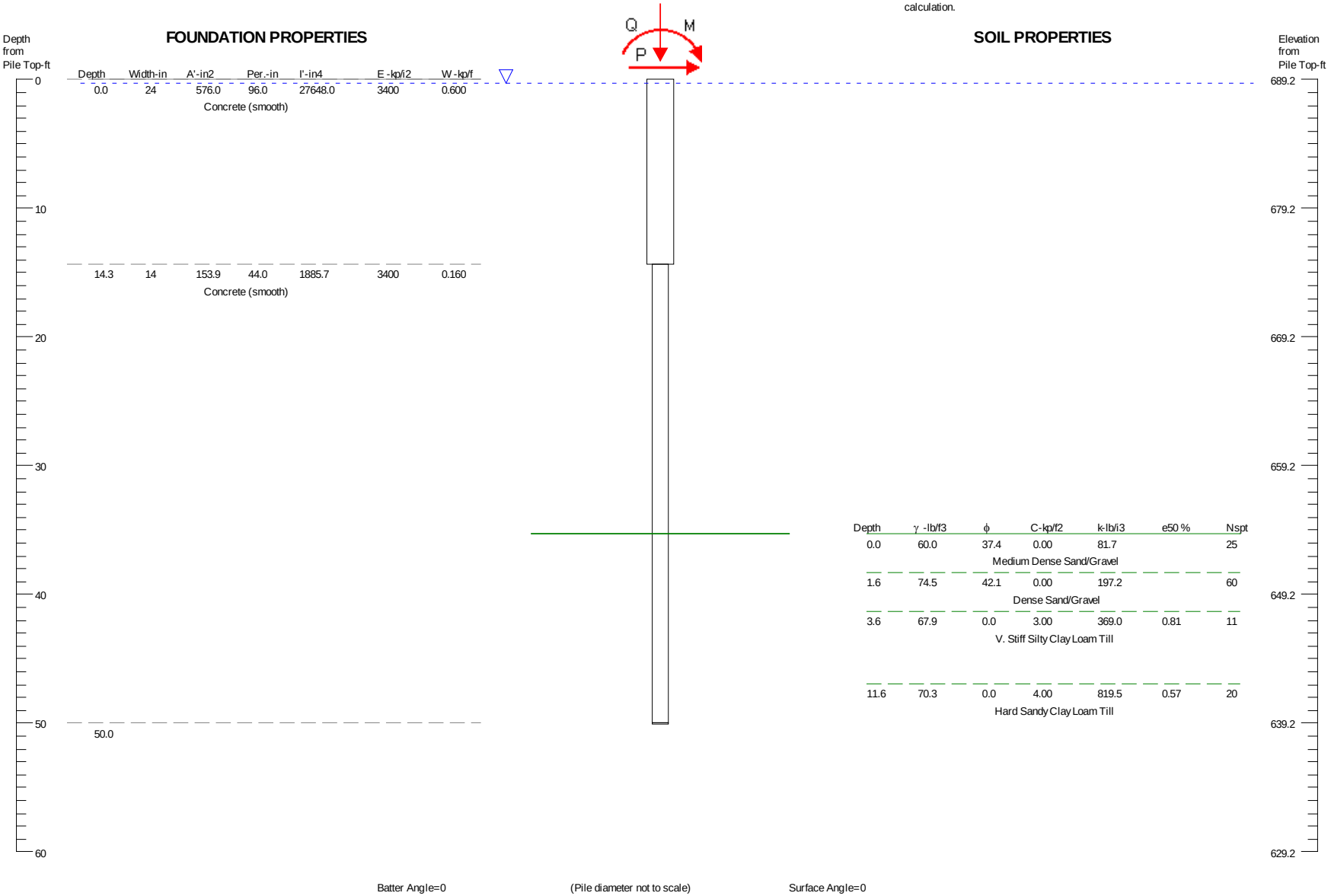
-80

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

SN 006-0188
2.87 kip/pile loading transverse to Pier
MS14 w/0.312”thick walls
Fixed Head Connection

FOUNDATION PROFILE & SOIL CONDITIONS

Displacement pile: Closed End pipe. Soil is displaced during driving. Higher friction expected. Total area is used in bearing calculation.



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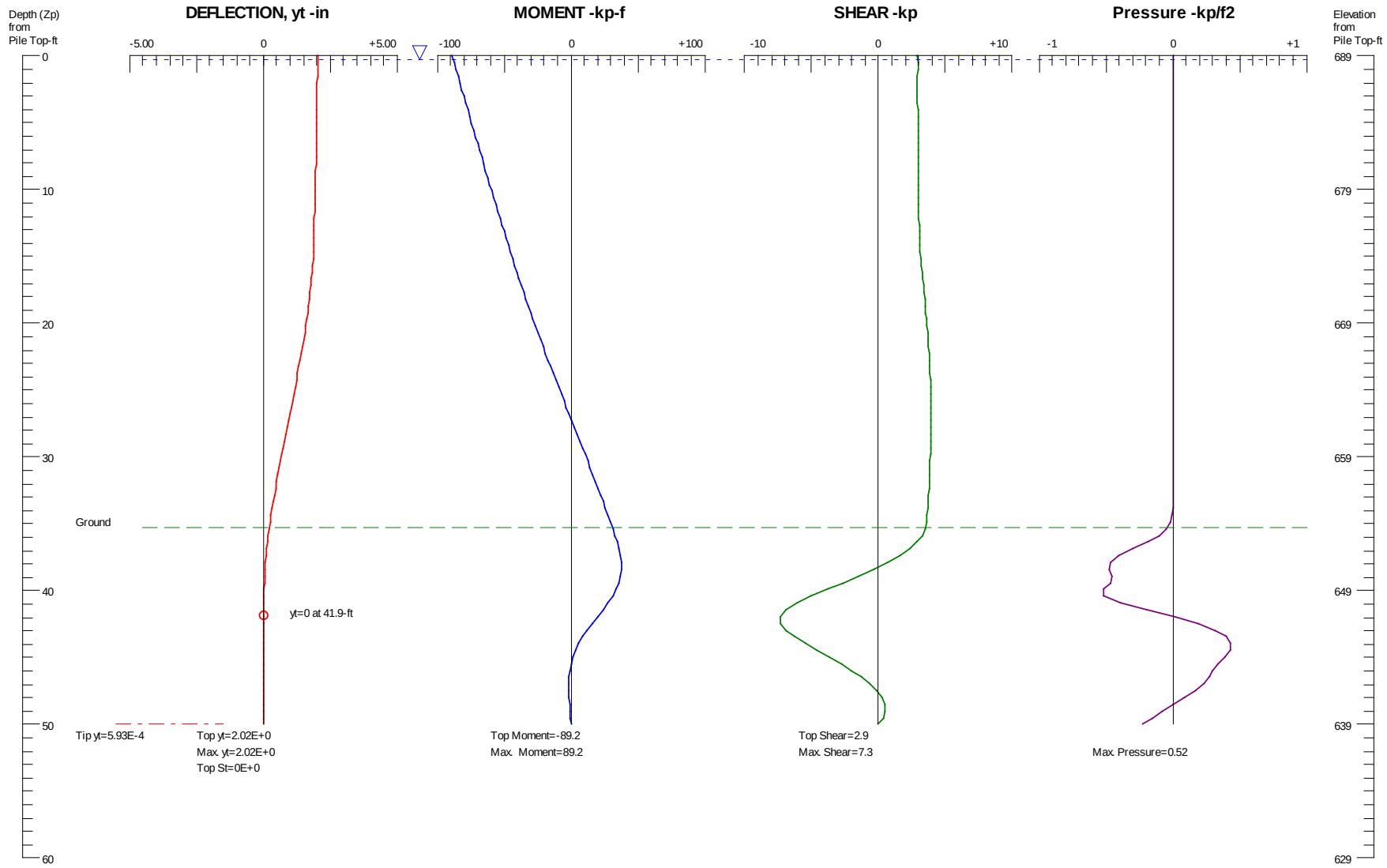
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, MS14 with 0.312" walls

Figure 1

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=5, Kbc=2



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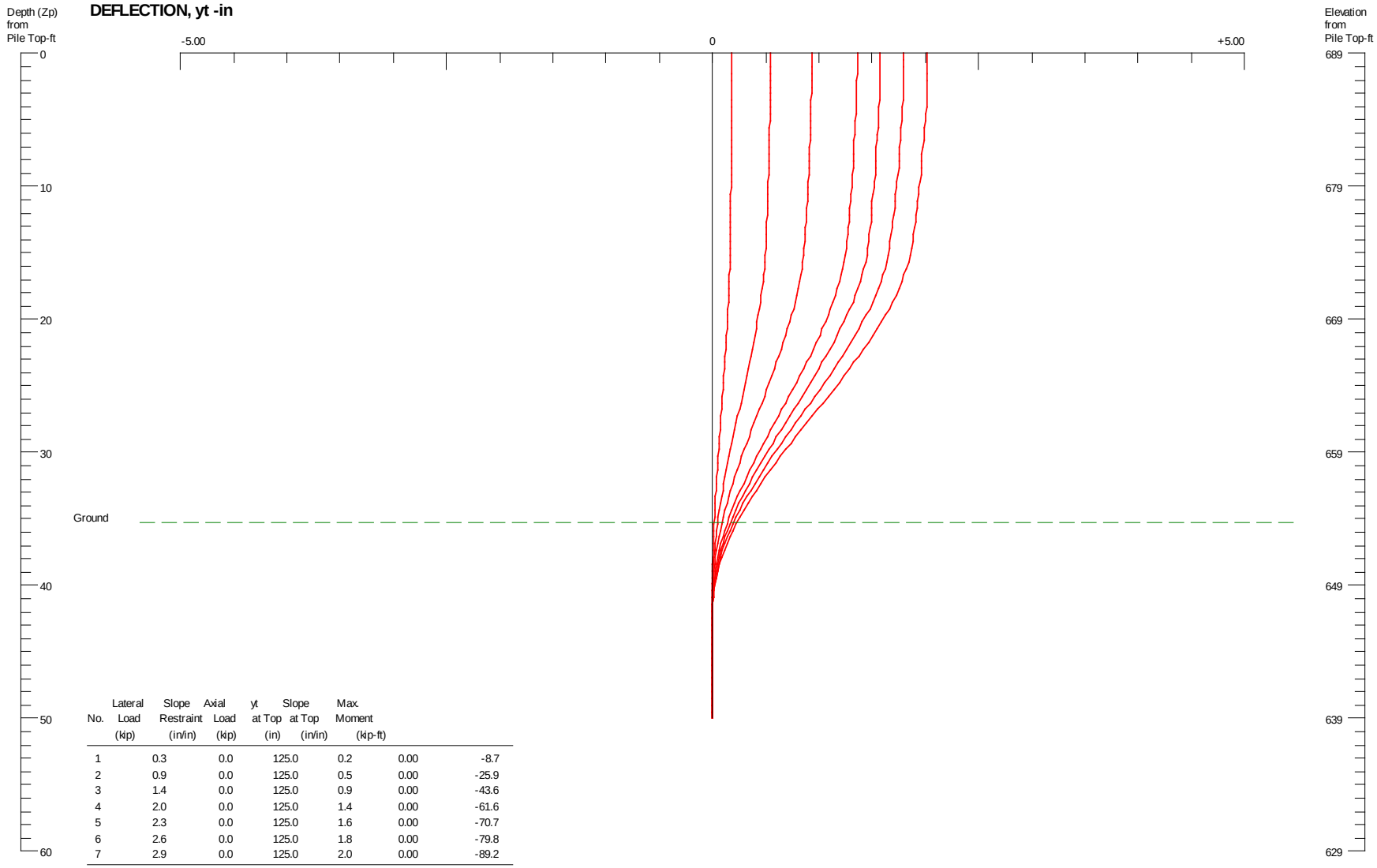
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, MS14 with 0.312" walls

Figure 2

PILE DEFLECTION vs LOADING

Single Pile, Khead=5, Kbc=2



No.	Lateral Load (kip)	Slope Restraint (in/in)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	0.3		0.0	125.0	0.2	0.00	-8.7
2	0.9		0.0	125.0	0.5	0.00	-25.9
3	1.4		0.0	125.0	0.9	0.00	-43.6
4	2.0		0.0	125.0	1.4	0.00	-61.6
5	2.3		0.0	125.0	1.6	0.00	-70.7
6	2.6		0.0	125.0	1.8	0.00	-79.8
7	2.9		0.0	125.0	2.0	0.00	-89.2

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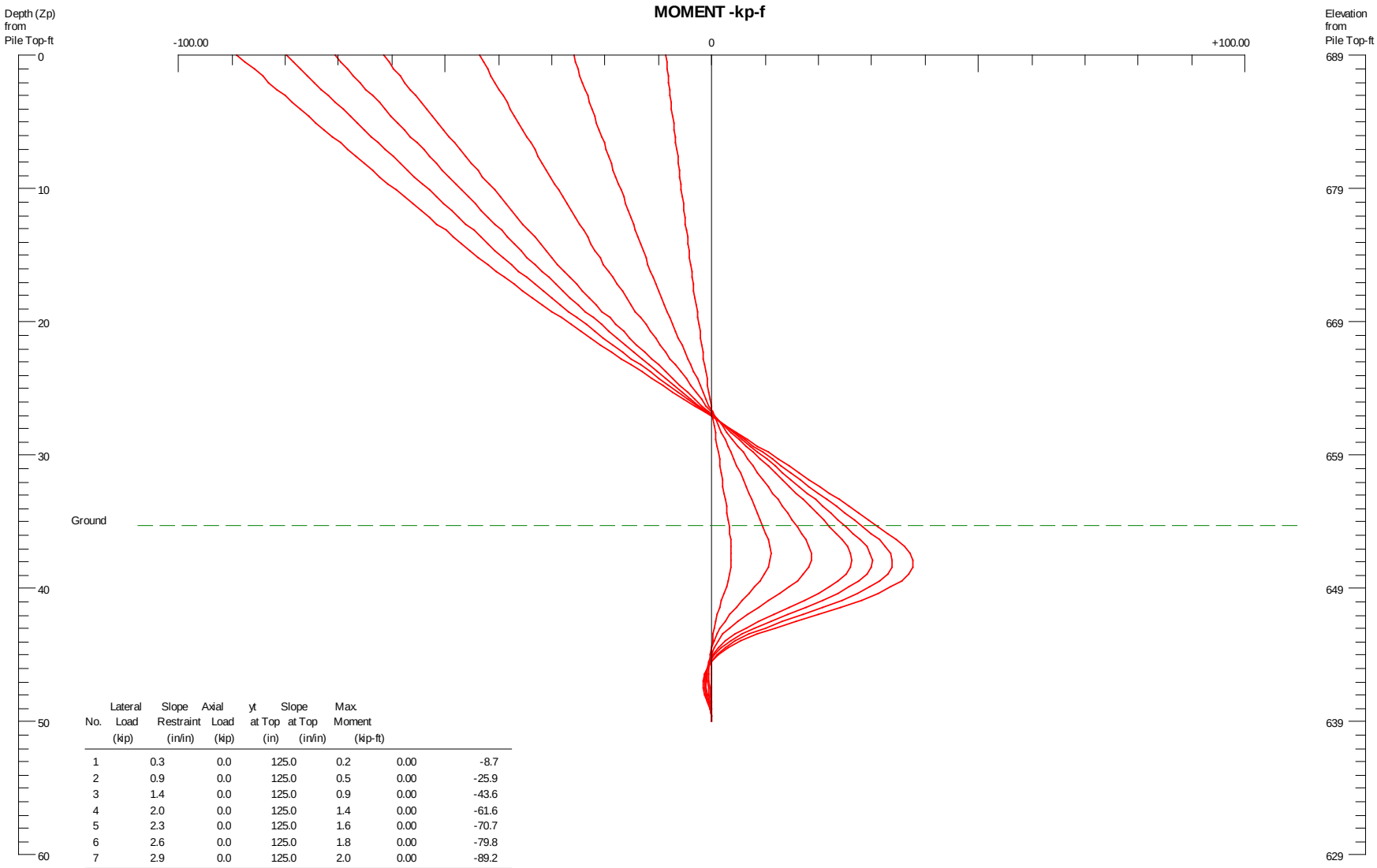
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, MS14 with 0.312" walls

Figure 2

PILE MOMENT vs LOADING

Single Pile, Khead=5, Kbc=2



No.	Lateral Load (kip)	Slope Restraint (in/in)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	0.3	0.0	125.0	0.2	0.00	-8.7	
2	0.9	0.0	125.0	0.5	0.00	-25.9	
3	1.4	0.0	125.0	0.9	0.00	-43.6	
4	2.0	0.0	125.0	1.4	0.00	-61.6	
5	2.3	0.0	125.0	1.6	0.00	-70.7	
6	2.6	0.0	125.0	1.8	0.00	-79.8	
7	2.9	0.0	125.0	2.0	0.00	-89.2	

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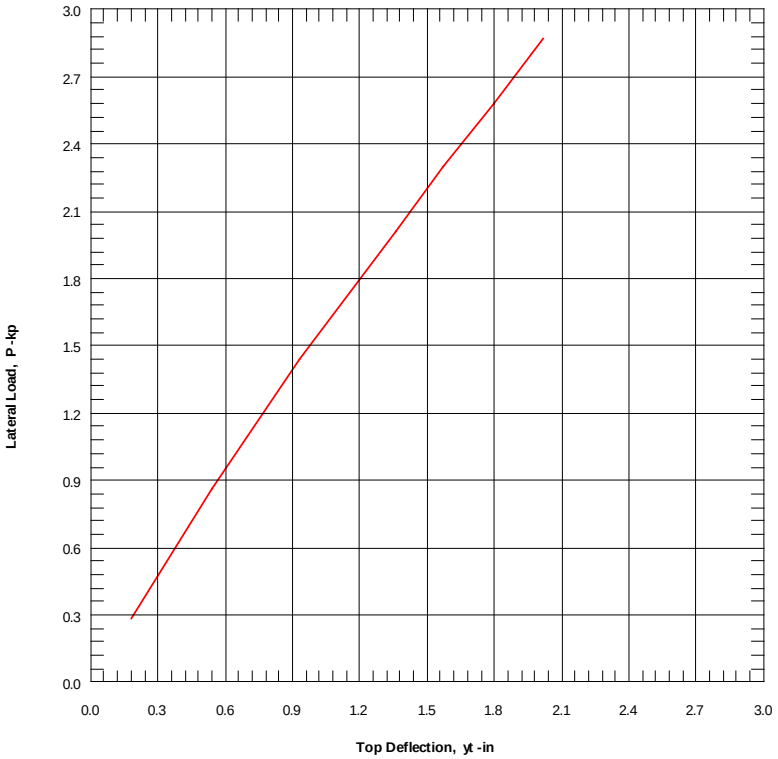
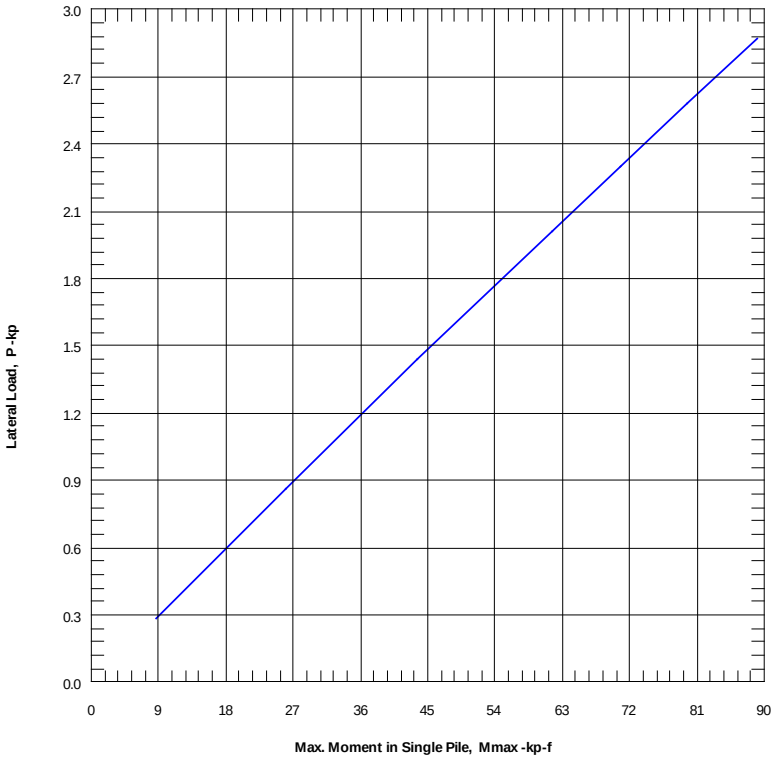
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, MS14 with 0.312" walls

Figure 2

LATERAL LOAD vs DEFLECTION & MAX. MOMENT





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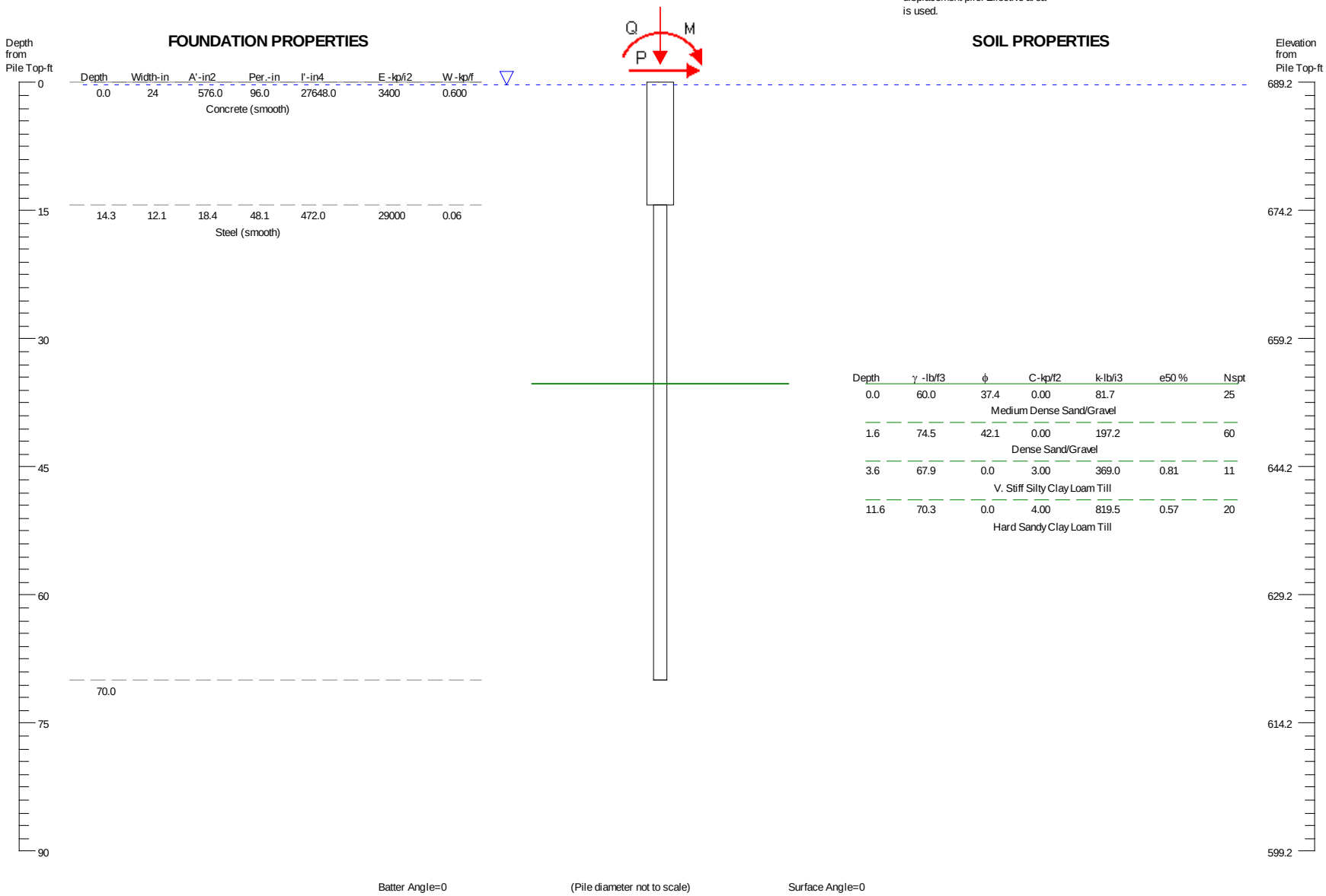
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, MS14 with 0.312" walls

Figure 2

SN 006-0188
6 kip/pile loading longitudinal
to centerline of Pier
HP 12x63, Fixed Head Connection

FOUNDATION PROFILE & SOIL CONDITIONS

Non-displacement pile: H pile or open-ended pipe. Little soil is displaced. Friction is less than displacement pile. Effective area is used.



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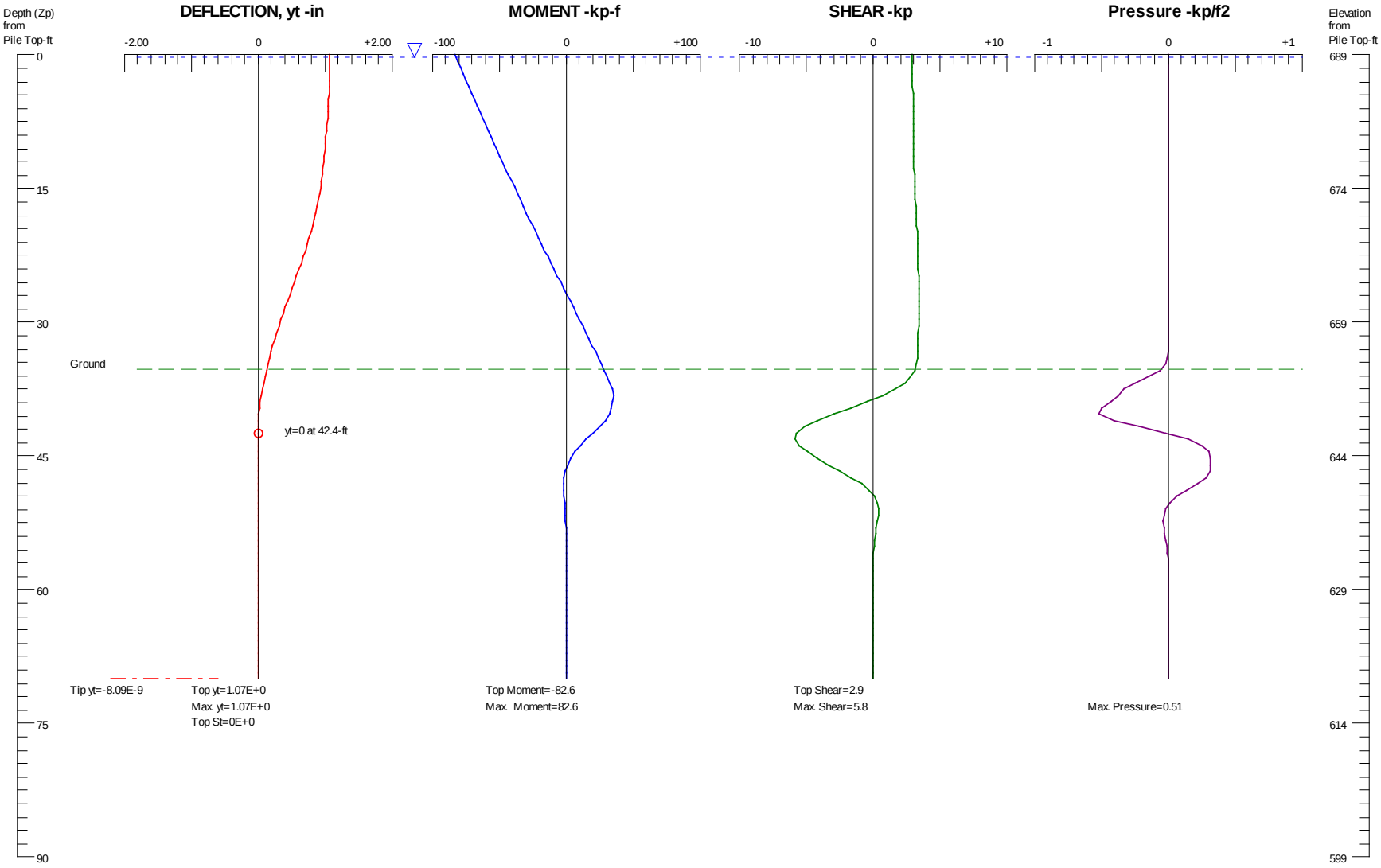
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP12x63

Figure 1

PILE DEFLECTION & FORCE vs DEPTH
Single Pile, Khead=5, Kbc=2



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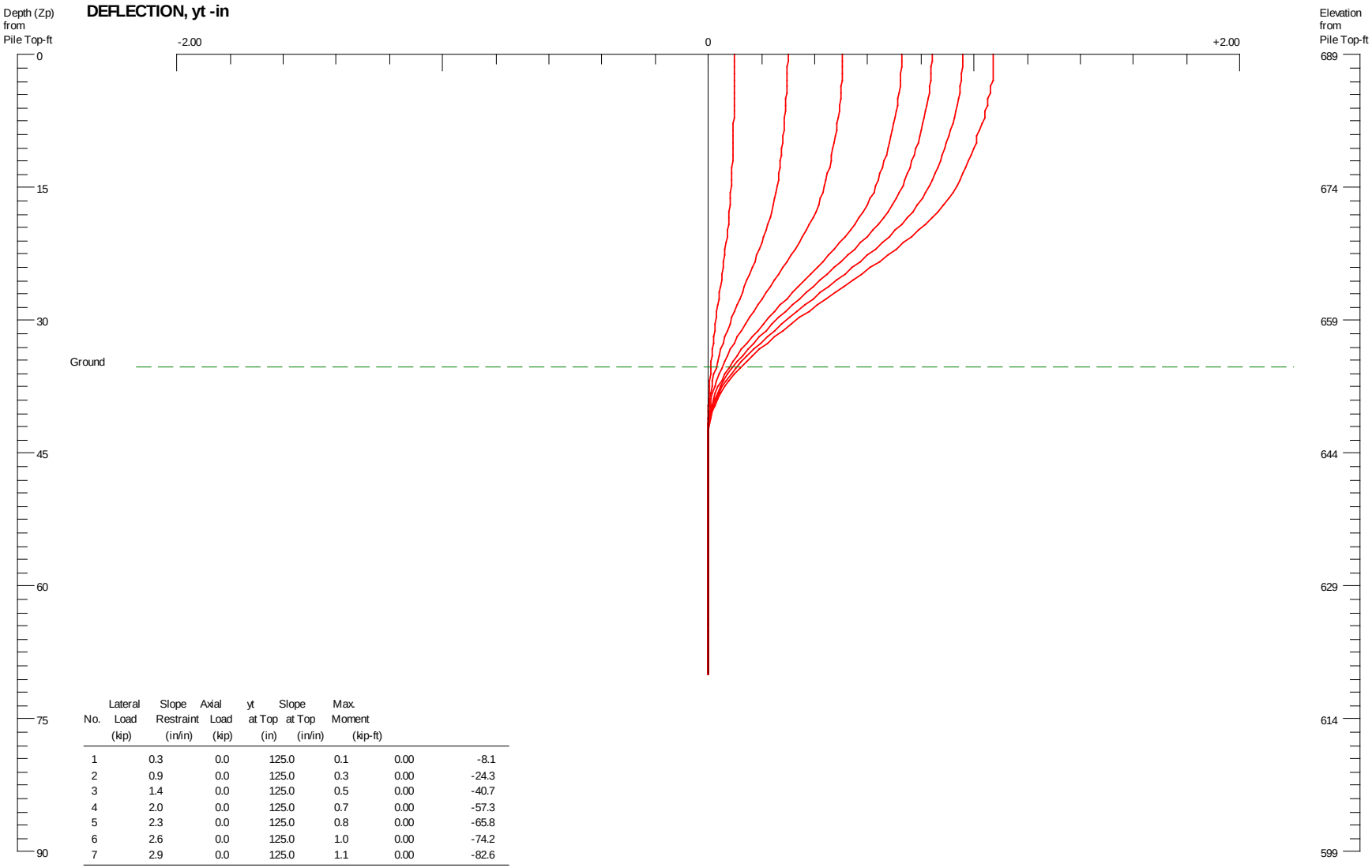
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP12x63

Figure 2

PILE DEFLECTION vs LOADING
Single Pile, Khead=5, Kbc=2



No.	Lateral Load (kip)	Slope Restraint (in/in)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	0.3		0.0	125.0	0.1	0.00	-8.1
2	0.9		0.0	125.0	0.3	0.00	-24.3
3	1.4		0.0	125.0	0.5	0.00	-40.7
4	2.0		0.0	125.0	0.7	0.00	-57.3
5	2.3		0.0	125.0	0.8	0.00	-65.8
6	2.6		0.0	125.0	1.0	0.00	-74.2
7	2.9		0.0	125.0	1.1	0.00	-82.6

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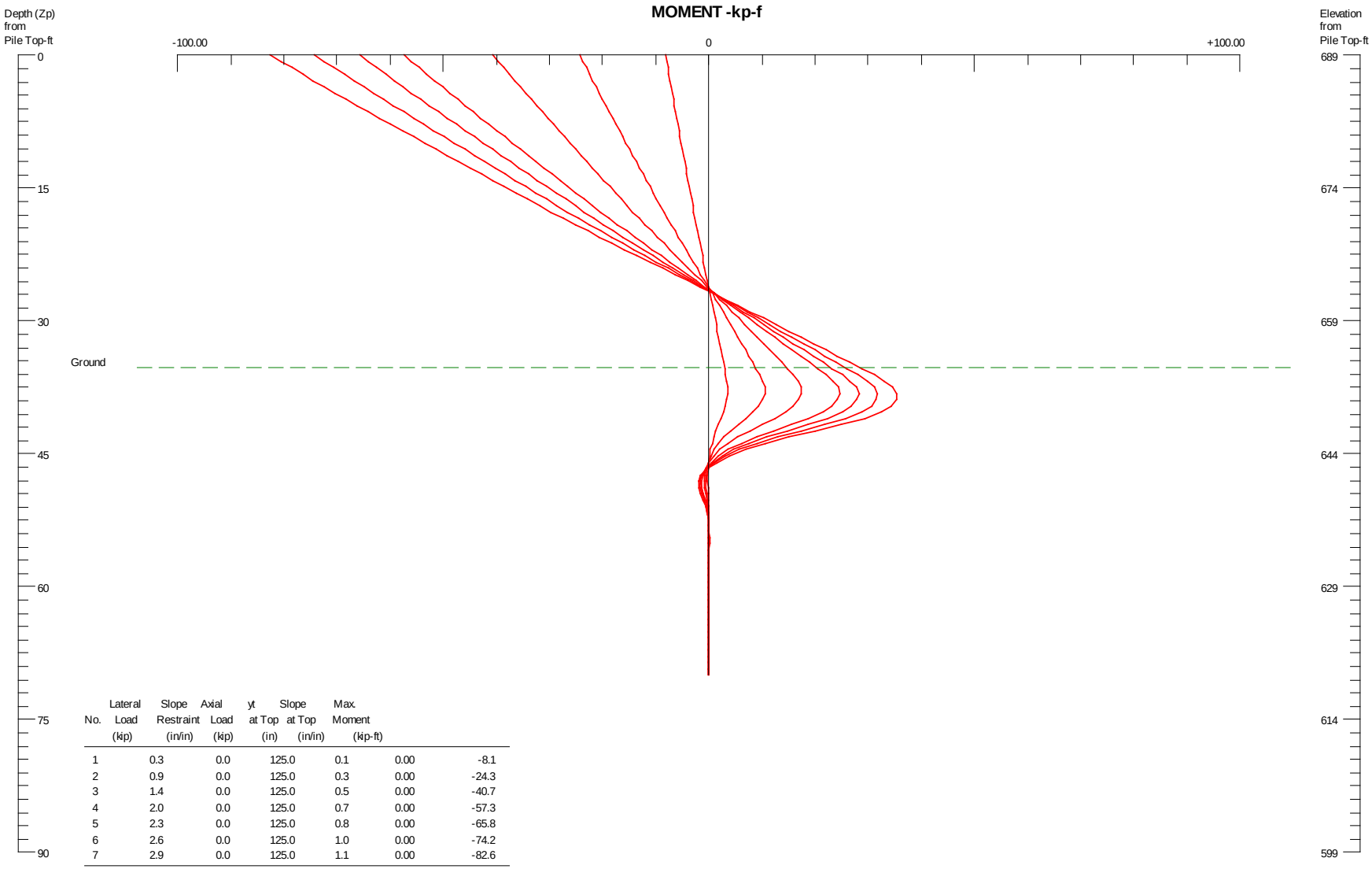
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP12x63

Figure 2

PILE MOMENT vs LOADING
Single Pile, Khead=5, Kbc=2



No.	Lateral Load (kip)	Slope Restraint (in/in)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	0.3	0.0	125.0	0.1	0.00	-8.1	
2	0.9	0.0	125.0	0.3	0.00	-24.3	
3	1.4	0.0	125.0	0.5	0.00	-40.7	
4	2.0	0.0	125.0	0.7	0.00	-57.3	
5	2.3	0.0	125.0	0.8	0.00	-65.8	
6	2.6	0.0	125.0	1.0	0.00	-74.2	
7	2.9	0.0	125.0	1.1	0.00	-82.6	

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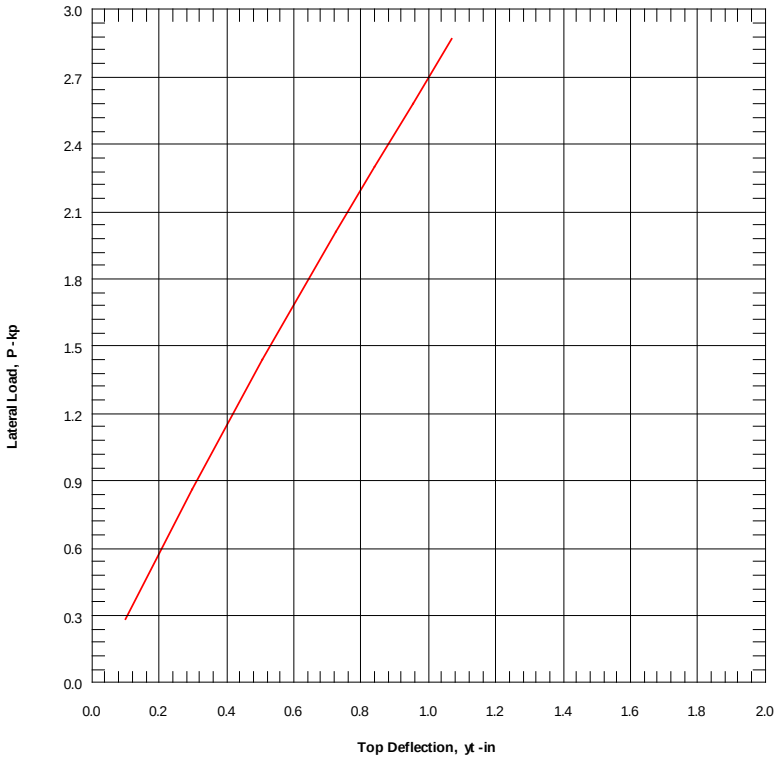
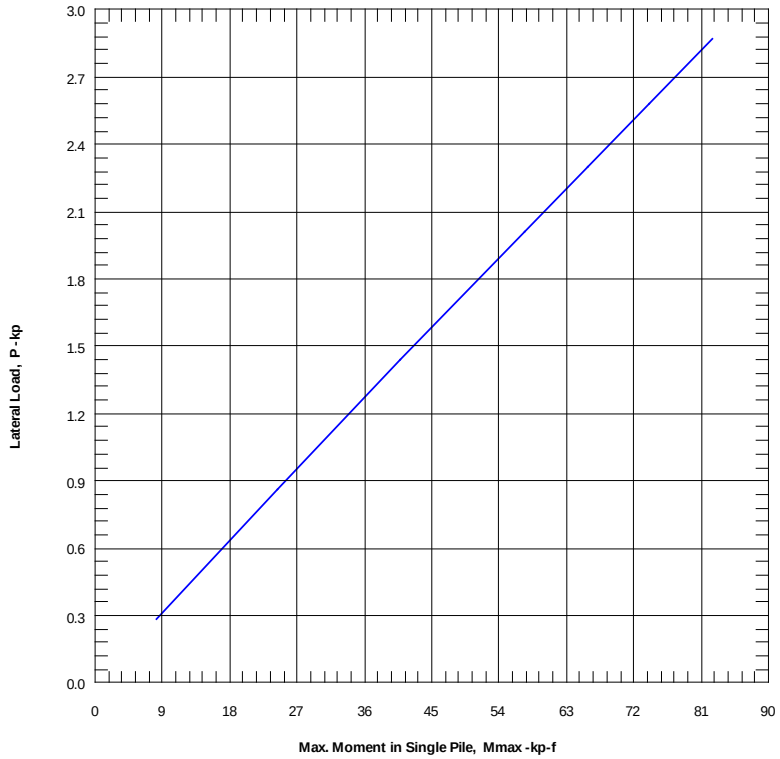
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP12x63

Figure 2

LATERAL LOAD vs DEFLECTION & MAX. MOMENT





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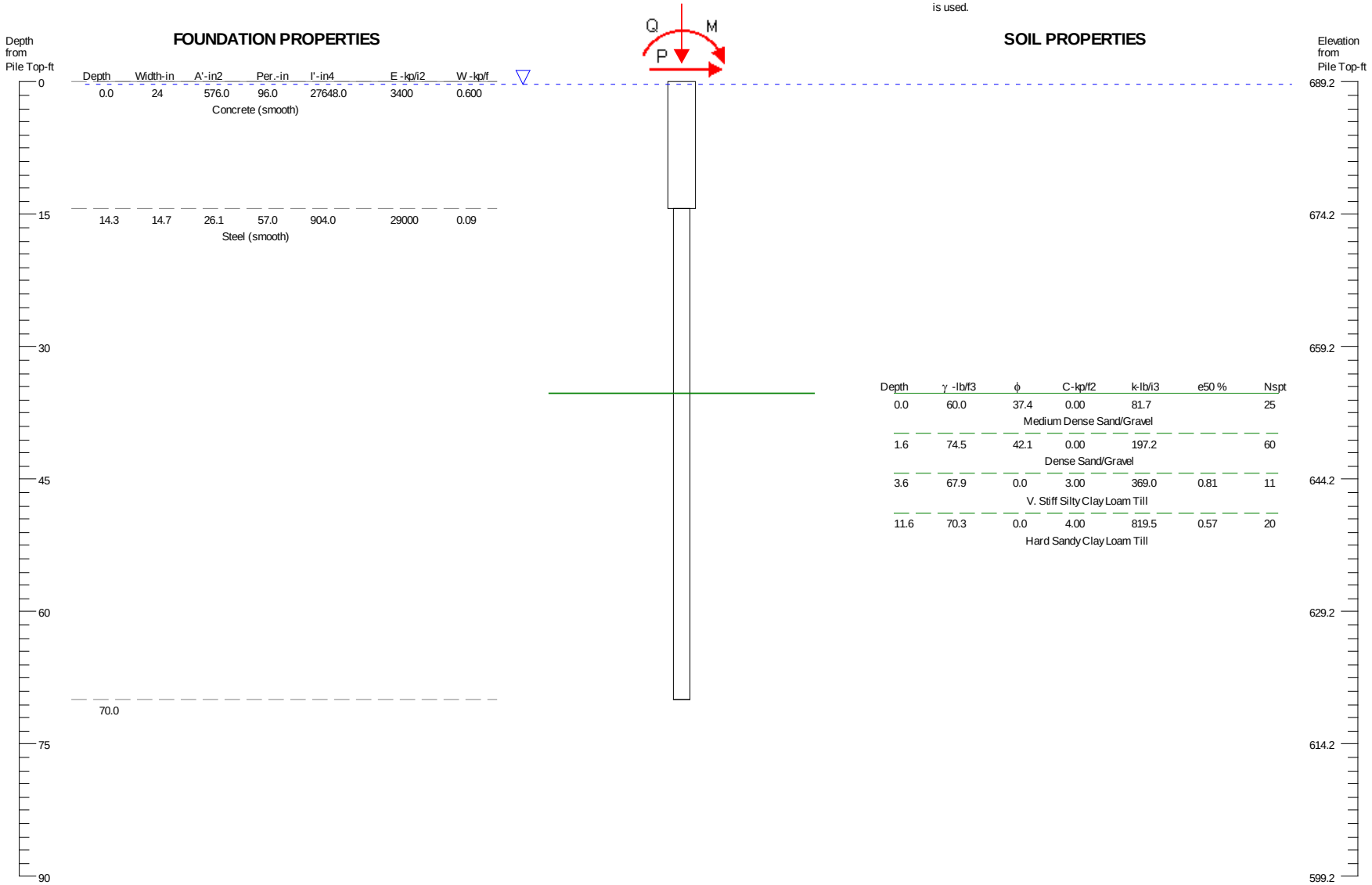
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP12x63

Figure 2

SN 006-0188
6 kip/pile loading longitudinal
to centerline of Pier
HP 14x89, Fixed Head Connection

Non-displacement pile: H pile or open-ended pipe. Little soil is displaced. Friction is less than displacement pile. Effective area is used.

FOUNDATION PROFILE & SOIL CONDITIONS



Batter Angle=0 (Pile diameter not to scale) Surface Angle=0

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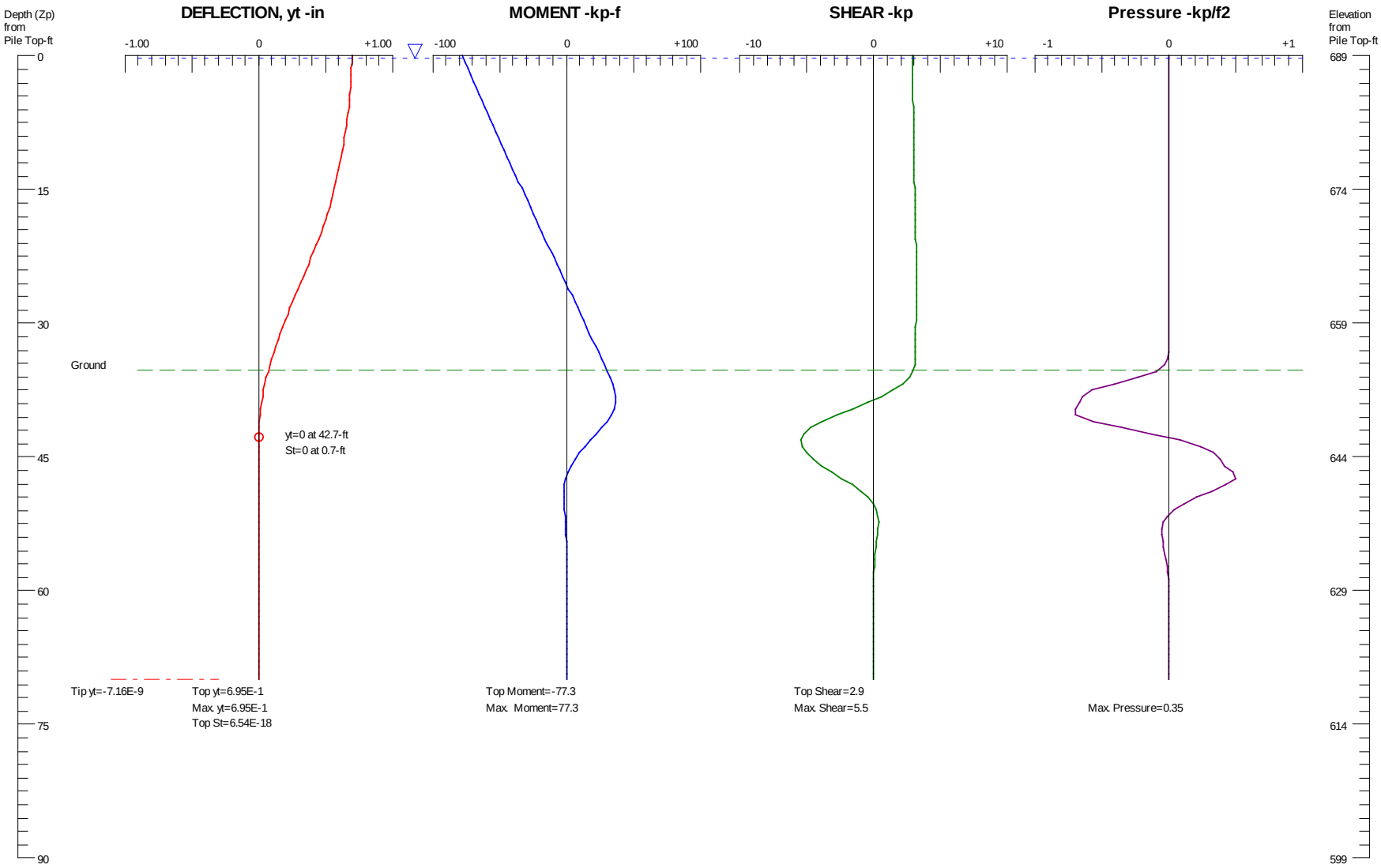
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP14x89

Figure 1

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=5, Kbc=2



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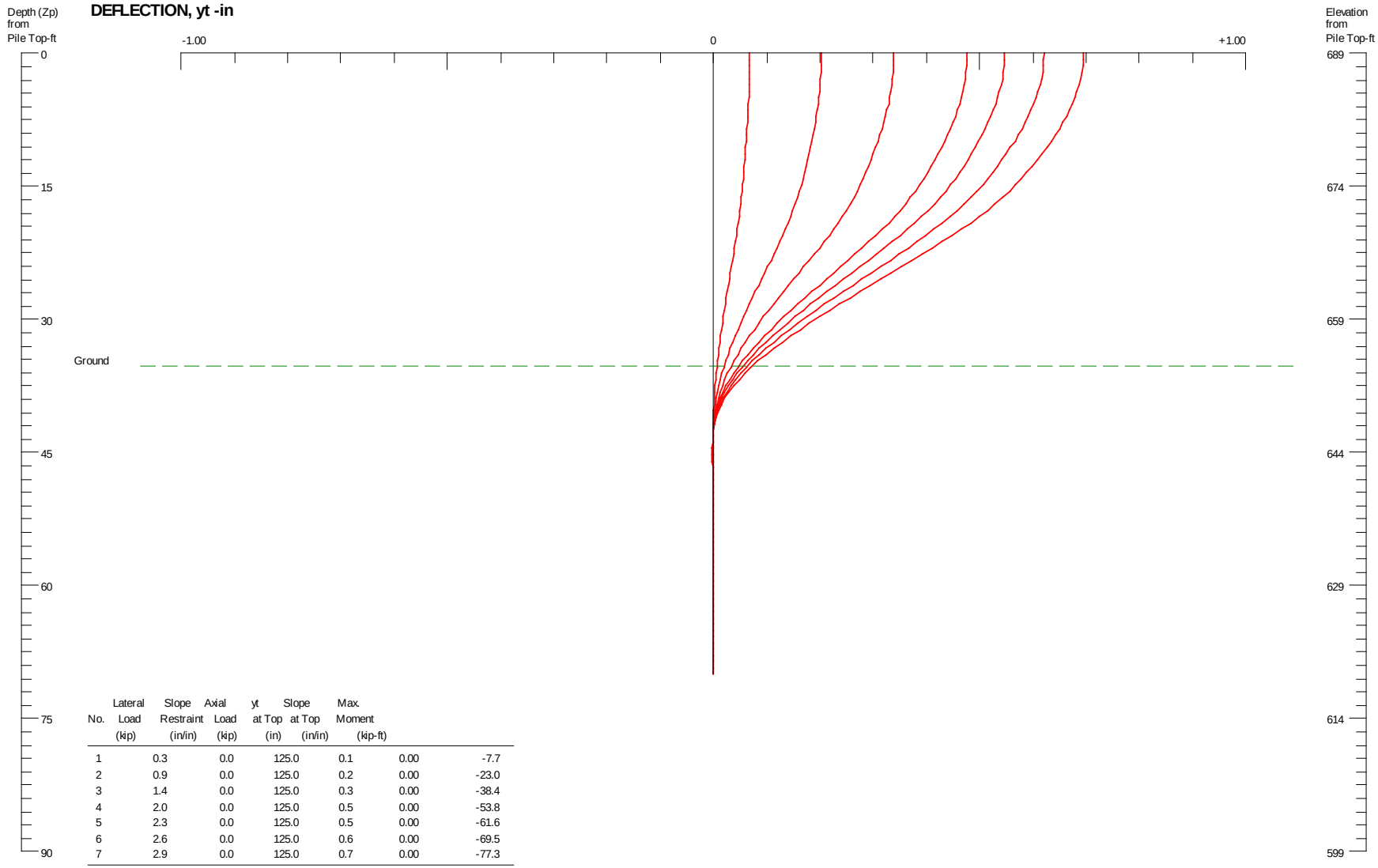
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP14x89

Figure 2

PILE DEFLECTION vs LOADING
Single Pile, Khead=5, Kbc=2



No.	Lateral Load (kip)	Slope Restraint (in/in)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	0.3		0.0	125.0	0.1	0.00	-7.7
2	0.9		0.0	125.0	0.2	0.00	-23.0
3	1.4		0.0	125.0	0.3	0.00	-38.4
4	2.0		0.0	125.0	0.5	0.00	-53.8
5	2.3		0.0	125.0	0.5	0.00	-61.6
6	2.6		0.0	125.0	0.6	0.00	-69.5
7	2.9		0.0	125.0	0.7	0.00	-77.3

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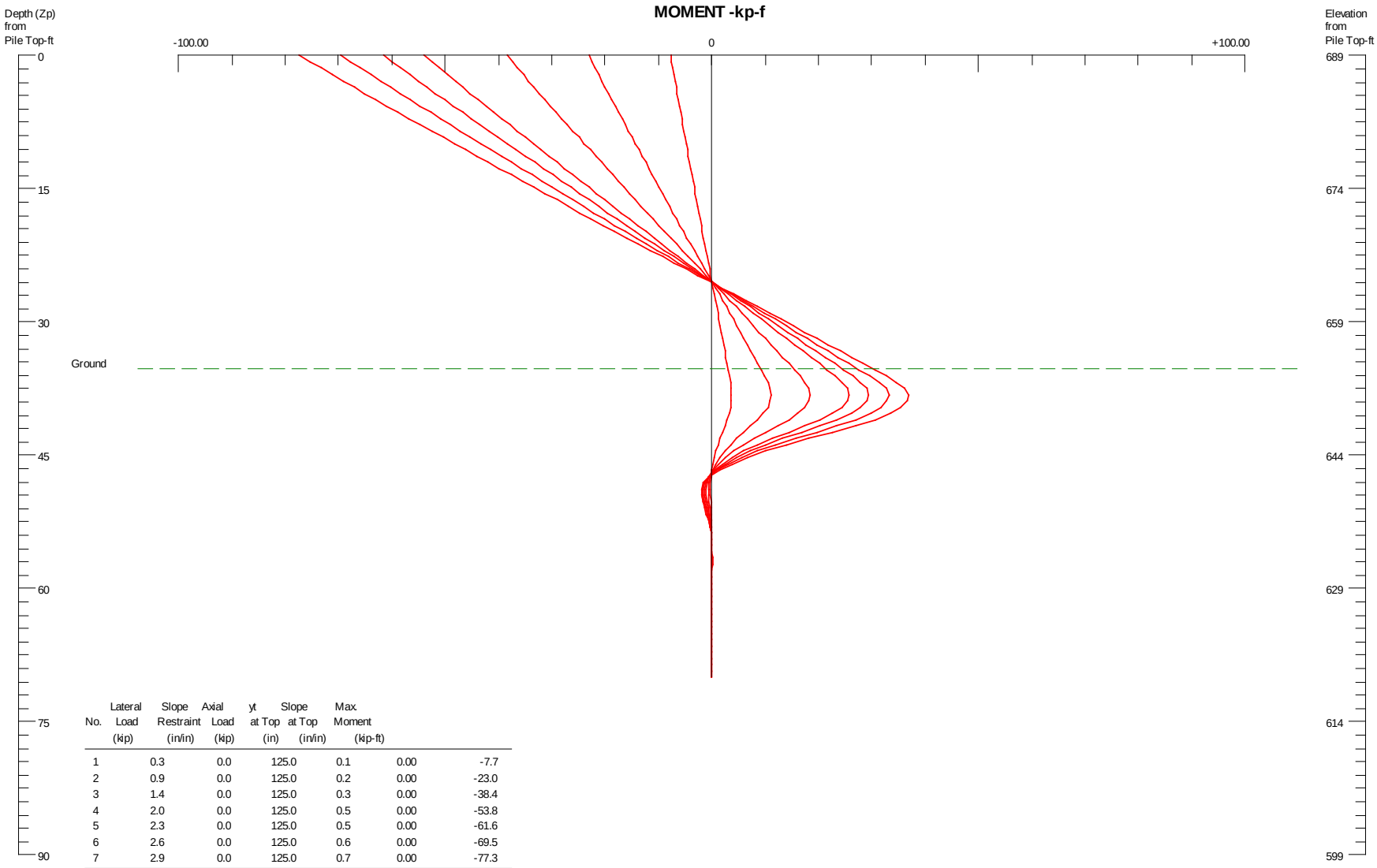
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP14x89

Figure 2

PILE MOMENT vs LOADING
Single Pile, Khead=5, Kbc=2



No.	Lateral Load (kip)	Slope Restraint (in/in)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	0.3	0.0	125.0	0.1	0.00	-7.7	
2	0.9	0.0	125.0	0.2	0.00	-23.0	
3	1.4	0.0	125.0	0.3	0.00	-38.4	
4	2.0	0.0	125.0	0.5	0.00	-53.8	
5	2.3	0.0	125.0	0.5	0.00	-61.6	
6	2.6	0.0	125.0	0.6	0.00	-69.5	
7	2.9	0.0	125.0	0.7	0.00	-77.3	

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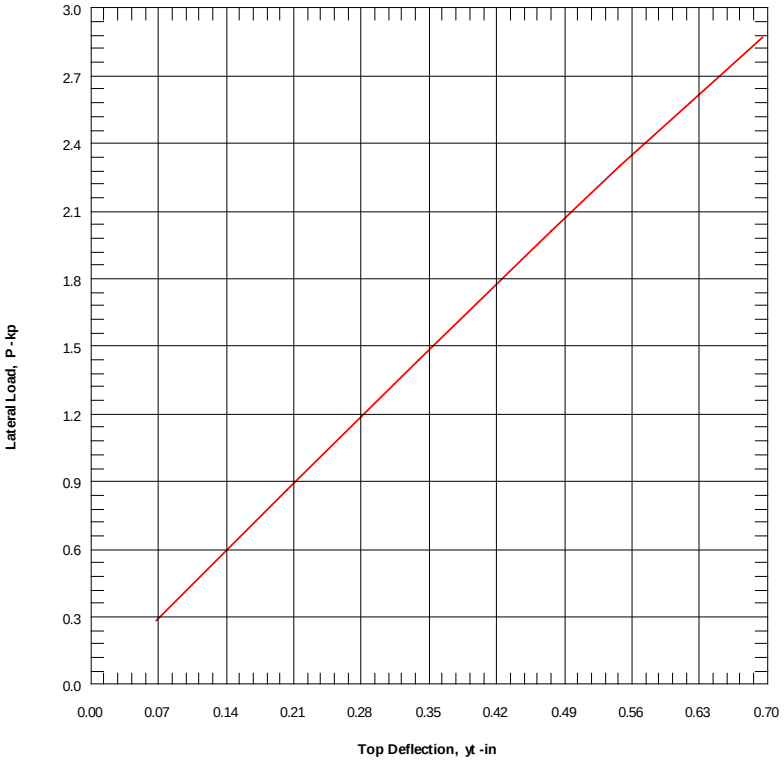
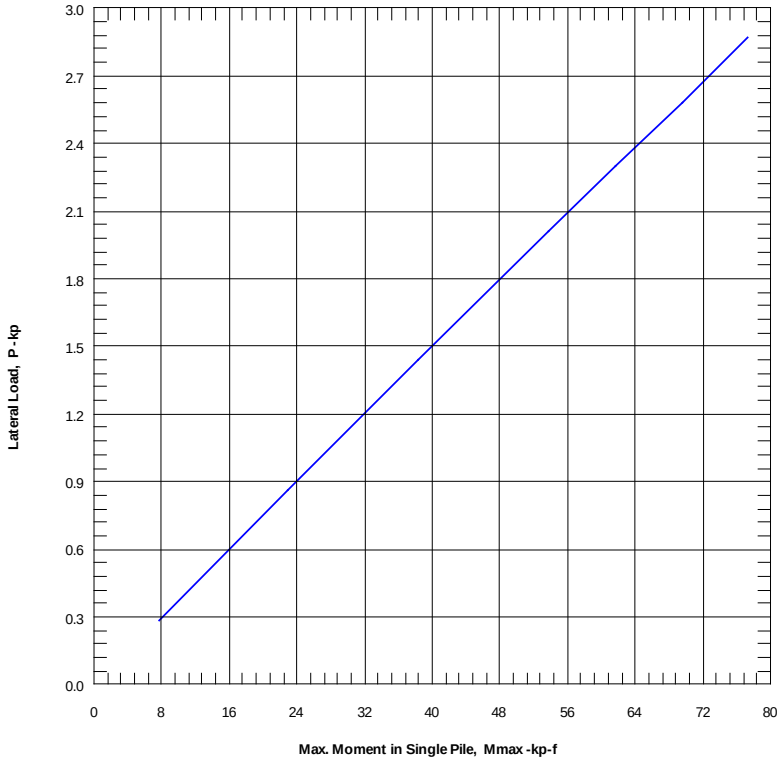
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP14x89

Figure 2

LATERAL LOAD vs DEFLECTION & MAX. MOMENT





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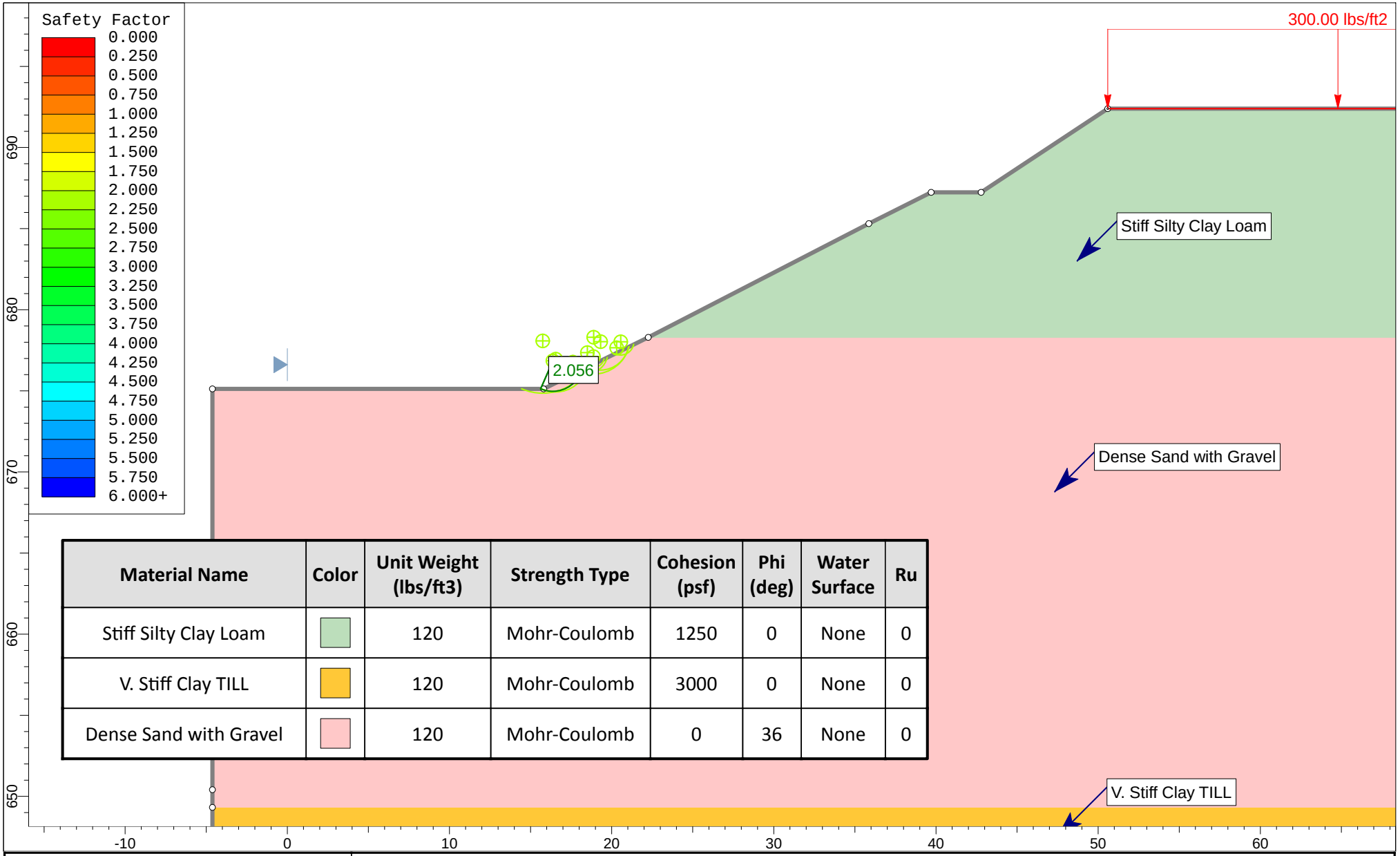
IL 89 over Brush Creek, Bureau County, District #3
SN006-0188 Proposed, SOUTH PIER, HP14x89

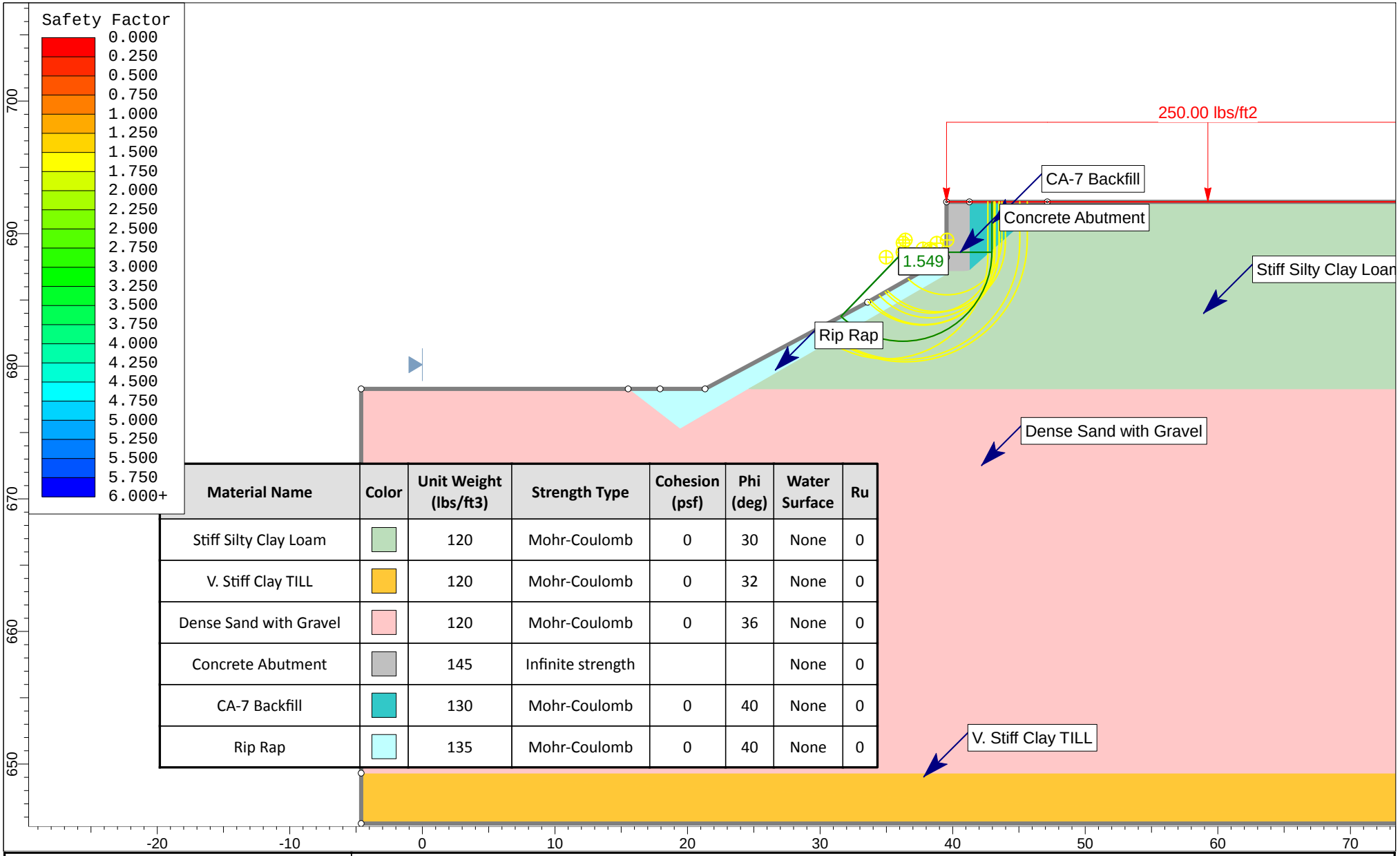
Figure 2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Stiff Silty Clay Loam		120	Mohr-Coulomb	1250	0	None	0
V. Stiff Clay TILL		120	Mohr-Coulomb	3000	0	None	0
Dense Sand with Gravel		120	Mohr-Coulomb	0	36	None	0

SLIDEINTERPRET 6.025

Project	IL 89 over Brush Creek, SN006-0188		
Analysis Description	Bishop Undrained Conditions (Short Term)		
Drawn By	TLM	Company	McCleary Engineering
Date	4/16/2014, 11:16:54 AM	File Name	South Abutment Short Term.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Stiff Silty Clay Loam		120	Mohr-Coulomb	0	30	None	0
V. Stiff Clay TILL		120	Mohr-Coulomb	0	32	None	0
Dense Sand with Gravel		120	Mohr-Coulomb	0	36	None	0
Concrete Abutment		145	Infinite strength			None	0
CA-7 Backfill		130	Mohr-Coulomb	0	40	None	0
Rip Rap		135	Mohr-Coulomb	0	40	None	0

rocscience

SLIDEINTERPRET 6.025

Project	IL 89 over Brush Creek, SN006-0188		
Analysis Description	Bishop Drained Conditions (Long Term)		
Drawn By	TLM	Company	McCleary Engineering
Date	4/16/2014, 11:16:54 AM	File Name	South Abutment Long Term.slim

SEISMIC SITE CLASS DETERMINATION

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified on 12/10/10

PROJECT TITLE=====IL 89 over Brush Creek, South of Arlington, IL, Existing SN 006-0106, Proposed SN 006-0188

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	687.28	ft.
Pile or Shaft Dia.	14	inches
Boring Number	South Abutment	
Top of Boring Elev.	692.32	ft.
Approximate Fixity Elev.	680.28	ft.

Individual Site Class Definition:

N (bar): 19 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 23 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 3.57 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	687.8	4.50	7	1.50	
	685.3	2.50	4	1.00	
	682.8	2.50	4	1.00	
	680.3	2.50	4	1.50	
3.0	677.3	3.00	4	1.00	b
5.0	675.3	2.00	8		B
7.5	672.8	2.50	36		
10.0	670.3	2.50	18		
12.5	667.8	2.50	18		
15.0	665.3	2.50	22		
17.5	662.8	2.50	23		
20.0	660.3	2.50	21		
22.5	657.8	2.50	21		
25.0	655.3	2.50	25		
27.5	652.8	2.50	25		
30.0	650.3	2.50	64		b
32.5	647.8	2.50	12	3.10	
35.5	644.8	3.00	12	3.10	
38.0	642.3	2.50	9	2.90	
40.0	640.3	2.00	21	4.10	
42.5	637.8	2.50	19	4.00	
45.0	635.3	2.50	22	4.00	
47.5	632.8	2.50	26	4.80	
50.0	630.3	2.50	37	7.10	
100.0	580.3	50.00	28	5.30	b

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	687.4	ft.
Pile or Shaft Dia.	14	inches
Boring Number	North Abutment	
Top of Boring Elev.	692.47	ft.
Approximate Fixity Elev.	680.4	ft.

Individual Site Class Definition:

N (bar): 20 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 28 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 3.28 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	688.0	4.50	4	1.50	
	685.5	2.50	3	1.00	
	682.5	3.00	3	1.00	
0.4	680.0	2.50	4		
2.9	677.5	2.50	4	2.00	
4.9	675.5	2.00	3	1.00	b
7.4	673.0	2.50	25		
9.9	670.5	2.50	23		
12.4	668.0	2.50	20		
14.9	665.5	2.50	22		
17.4	663.0	2.50	22		
19.9	660.5	2.50	21		
22.4	658.0	2.50	22		b
24.9	655.5	2.50	19	3.80	
27.4	653.0	2.50	22	4.20	
29.9	650.5	2.50	22	4.20	
32.4	648.0	2.50	23	4.40	
34.9	645.5	2.50	22	4.60	
37.4	643.0	2.50	20	4.50	
39.9	640.5	2.50	23	4.60	
42.4	638.0	2.50	18	4.40	
45.9	634.5	3.50	20	4.60	b
48.4	632.0	2.50	22		
50.9	629.5	2.50	22		
54.4	626.0	3.50	45		
100.0	580.4	45.60	29		b

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)	676.5	ft.
Pile or Shaft Dia.	14	inches
Boring Number	South Pier	
Top of Boring Elev.	692.32	ft.
Approximate Fixity Elev.	669.5	ft.

Individual Site Class Definition:

N (bar): 22 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 27 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 4 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	687.8	4.50	7	1.50	
	685.3	2.50	4	1.00	
	682.8	2.50	4	1.00	
	680.3	2.50	4	1.50	
	677.3	3.00	4	1.00	b
	675.3	2.00	8		B
	672.8	2.50	36		
	670.3	2.50	18		
1.7	667.8	2.50	18		
4.2	665.3	2.50	22		
6.7	662.8	2.50	23		
9.2	660.3	2.50	21		
11.7	657.8	2.50	21		
14.2	655.3	2.50	25		
16.7	652.8	2.50	25		
19.2	650.3	2.50	64		b
21.7	647.8	2.50	12	3.10	
24.7	644.8	3.00	12	3.10	
27.2	642.3	2.50	9	2.90	
29.2	640.3	2.00	21	4.10	
31.7	637.8	2.50	19	4.00	
34.2	635.3	2.50	22	4.00	
36.7	632.8	2.50	26	4.80	
39.2	630.3	2.50	37	7.10	
100.0	569.5	60.80	28	5.30	b

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)	676.5	ft.
Pile or Shaft Dia.	14	inches
Boring Number	North Pier	
Top of Boring Elev.	692.47	ft.
Approximate Fixity Elev.	669.5	ft.

Individual Site Class Definition:

N (bar): 26 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 28 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 4.37 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	688.0	4.50	4	1.50	
	685.5	2.50	3	1.00	
	682.5	3.00	3	1.00	
	680.0	2.50	4		
	677.5	2.50	4	2.00	
	675.5	2.00	3	1.00	b
	673.0	2.50	25		
	670.5	2.50	23		
1.5	668.0	2.50	20		
4.0	665.5	2.50	22		
6.5	663.0	2.50	22		
9.0	660.5	2.50	21		
11.5	658.0	2.50	22		b
14.0	655.5	2.50	19	3.80	
16.5	653.0	2.50	22	4.20	
19.0	650.5	2.50	22	4.20	
21.5	648.0	2.50	23	4.40	
24.0	645.5	2.50	22	4.60	
26.5	643.0	2.50	20	4.50	
29.0	640.5	2.50	23	4.60	
31.5	638.0	2.50	18	4.40	
35.0	634.5	3.50	20	4.60	b
37.5	632.0	2.50	22		
40.0	629.5	2.50	22		
43.5	626.0	3.50	45		
100.0	569.5	56.50	29		b

Global Site Class Definition: Substructures 1 through 4

N (bar): 22 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 27 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 3.79 (ksf) Soil Site Class C