Appendix F
Northern Impoundment BMP Wall-Type Analysis

100021356

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Appendix F-1
Northern Impoundment BMP Wall-Type Analysis

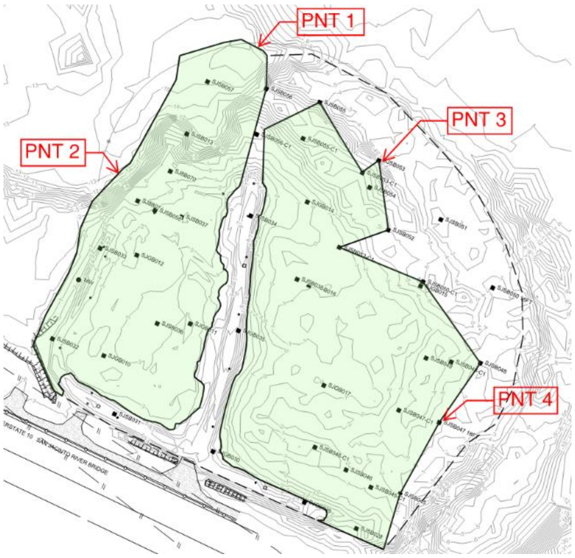
Northern Impoundment BMP Wall Type Analysis

Wall Type Preliminary Calculations

For the preliminary 30% remedial design (30% RD), four locations, shown in Figure F.1, around the Northern Impoundment were selected to prepare a preliminary BMP wall analysis. After reviewing the BMP layout and varying conditions (topography, depth of waste material, river elevation, etc.), these locations were selected to represent four varying wall height conditions for the design. Wall height is the critical parameter in determining depth of the piles, and size of the piles, used to construct the BMP. These four locations provide a preliminary overview of the range of wall sizes and pile types, embedment depths, and constructability issues that will need to be further evaluated as the design progresses. For this analysis, the locations selected have four different mudline elevations on the exterior face of the BMP. Additionally, these locations each have different bottom of excavation depths on the inside face of the wall. As the design progresses, additional combinations and analysis points around each cell would have to be evaluated to complete the BMP design.

Wall analyses were performed by Ardaman and Associates using DeepEx pile analysis software with input elevations provided by GHD. Each analysis point represents a theoretical wall section at that location with the respective mudline and excavation bottom elevations. Analysis of each point was performed using the same section (PAZ66) for the initial results for comparison purposes. Stability calculations and the resulting pile embedment depth are not based on the size and section properties of the wall. Balanced forces, hence stability, are based on an assumption of a rigid pile element. Once the pile length for stability is known, the internal structural forces, shear and moment, are determined. This allows for the required steel section size to be selected. Due to the nature of this stability calculation, it was only necessary for DeepEx to be run using one pile section in order to give preliminary results. Based on these results, the required steel section modulus for strength was calculated from the resulting internal moments from the stability analysis.

Figure F.1: Preliminary BMP Analysis Locations



1.1.1 Design Criteria

For the 30% RD, the proposed BMP would be designed as a rigid cantilever pile wall, in accordance with Engineer Manuals (EM) 1110-2-2504. Both the undrained and drained conditions are being evaluated to determine the pile section that meets the criteria below.

1.1.1.1 Design Water Level

The BMP will be designed to consider two water elevations for differing conditions. One will be defined as the usual condition and one as the unusual condition. These terms are then used to select Safety Factors (SFs) from EM1110-2-2504.

The usual condition represents a more frequent expected water elevation that will be associated with the following:

Exterior Water Elevations

- Usual Water Elevation = +5 feet NAVD88
- Unusual Water Elevation = +9 feet NAVD88

Interior Water Elevation

- Lowest Dewatered Elevation = -8 feet NAVD88

1.1.1.2 Safety Factors

SFs are defined by EM1110-2-2504 for floodwalls and retaining walls as shown in Figure F.2 below. Pile walls for the Northern Impoundment RD serve as both floodwalls and retaining walls. The SFs highlighted below have been selected for the Northern Impoundment RD.

Water elevation loading essentially drives the basis of the wall design. Therefore, SFs for floodwalls were chosen over the SFs for retaining walls. A minimum SF of 1.5 for Q-case loading (the usual case) and 1.25 for S-case loading (the unusual case) is selected for the Northern Impoundment RD.

Figure F.2: Safety Factors from EM1110-2-2504

Minimum Safety Factors for Determining the Depth of Penetration Applied to the Passive Pressures

Loading Case	Fine-Grain Soils	Free-Draining Soils
Floodwalls		
Usual	1.50 Q-Case 1.10 S-Case	1.50 S-Case
Unusual	1.25 Q-Case 1.10 S-Case	1.25 S-Case
Extreme	1.10 Q-Case 1.10 S-Case	1.10 S-Case
Retaining Walls		
Usual	2.00 Q-Case 1.50 S-Case	1.50 S-Case
Unusual	1.75 Q-Case 1.25 S-Case	1.25 S-Case
Extreme	1.50 Q-Case 1.10 S-Case	1.10 S-Case

1.1.1.3 Rotational Stability

It is a standard design assumption that rotational stability is proportional to the embedment of a rigid cantilever wall. The total embedment of the pile is the maximum of the depths required for undrained and drained loading conditions.

The BMP will be designed with the SFs outlined in red in Figure F.2 above.

1.1.1.4 Steel Section Strength

The BMP will be designed and analyzed as a rigid cantilever wall for the loads described in Section 5.4.1.3.

The allowable stress in the pile for the usual design water elevation will be 0.5 F_y for bending and 0.33 F_y for shear. These values equate to SFs of 2.0 and 3.0 for bending and shear, respectively.

The allowable stress for the unusual design water elevation will be 0.66 F_y and 0.44 F_y for bending and shear, respectively. These values equate to SFs of 1.5 and 2.3 for bending and shear, respectively.

1.1.1.5 Deflection

Total system displacements comprised of structural steel deformation, rotation and translation of the entire BMP and soil system will be evaluated. Since the BMP will be designed as a cantilever wall, maximum deflections occur at the top of the wall.

Neither EM 1110-22-504 nor ASCE 7 provide guidance on limiting system deflection. Structural steel can deform significantly before structural failure occurs; hence, structural steel deformation cannot be used as a limiting parameter for the design.

A professional practice rule of 0.01 times the wall height, measured from top of wall to bottom of excavation, is typically applied to limit the total deflections. This limit is appropriate for retaining walls considering the activation of active and passive soil pressures. This limit is used to evaluate deflection over the unbalanced depth of the excavation.

The following is an example of the maximum case:

WALL HEIGHT = +9FT + (-28FT) = 37 FT

ALLOWABLE DEFLECTION = 0.01 X 37 FT = 0.37 FT = 4.4 INCHES.

An allowable deflection of 4.4 inches would be extremely difficult to meet for hydrostatic load of a cantilevered sheetpile wall at this maximum height. The height varies along the length of BMP walls; therefore, this represents the highest deflection allowed for the tallest wall location. In many cases the walls may be shorter. Where walls are shorter, the allowable deflection would be smaller.

Spreadsheets to Verify Pile Size Calculations

Spreadsheet calculations were used to confirm the pile cross section analysis and to select the minimum pile size to meet the moment demand. This analysis was completed to select the required pile size based on internal shear and moment demand. DeepEx analysis were completed using only one pile size as described above. Once the required pile depth was selected for stability, the correlated shear and moment demands for each pile length were produced from the DeepEx results. Spreadsheet results provided herein show the selection of the proper pile section size for those moments. Results from each point shown above are provided herein.

DeepEx Reports for Wall Stability and Deflection Calculations

A total of eight reports for DeepEx runs are included in this Appendix. Four from the Q-case, or quick loading, for the undrained case, and four from the S-case, or slow loading, for the drained case, are included.

Appendix F-2
Cross Section and Minimum Pile Size Verification Calculations

PNT 1

Project: San Jacinto Waste Pits
Project No.: 18-2876
DeepEx Summary Page - Northern Impoundment (Cell #1 @ Sta. 0+75)

Date: 5/13/2020
Pile Type Selected in DeepEx: PAZ66/AZ38-700N

Top of Wall =	9.0	ft., NAVD88
Governing Tip Elev. =	-102.58	ft., NAVD88
Length of Sheetting =	111.58	ft.
Use =	115.0	ft.

Ground Surface (Outside) =	-17.0	ft., NAVD88
Ground Surface (Inside) =	-28.0	ft., NAVD88
Design Tip Elev. =	-106.0	ft., NAVD88
Design Length of Sheeting =	115.0	ft.

Sheet Pile Fy	50	ksi
Bending Stress	25	ksi
Shear Stress	16.5	ksi

Condition	Stage	Description	Water (Driving)	Water (Passive)	FS_{Active}	$FS_{Passive}$	Tip Elev.	Max Moment	Max Shear	Deflection	X = fb / Fy	fb	Req'd Smin	Recommended Section
			(ft., NAVD88)	(ft., NAVD88)			(ft., NAVD88)	(kip-ft)	(kip)	(in)			(in^3 /ft of wall)	
Q-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-41.95	293.5	67.1	1.09	0.50	25.0	140.9	PAZ42 / AZ38-700N
Q-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-43.93	--	--	--				
Q-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-45.51	--	--	--				
Q-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-44.33	386.3	76.4	1.59	0.50	25.0	185.4	PAZ48 / AZ38-700N
Q-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-46.70	--	--	--				
Q-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-48.67	--	--	--				
Q-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-45.90	496.0	88.5	2.27	0.67	33.3	179.0	PAZ60 / AZ38-700N
Q-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-48.27	--	--	--	0.50	25.0	238.1	PAZ60 / AZ38-700N
Q-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-50.65	--	--	--				
Q-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-48.27	598.3	96.4	2.98	0.67	33.3	215.9	PAZ54 / AZ38-700N
Q-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-51.04	--	--	--	0.50	25.0	287.2	PAZ66 / AZ38-700N
Q-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-54.20	--	--	--				
S-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-68.40	544.4	68.0	5.34	0.50	25.0	261.3	PAZ60 / AZ38-700N
S-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-75.50	--	--	--				
S-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-82.59	--	--	--				
S-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-75.50	809.5	89.3	9.54	0.50	25.0	388.6	PAZ78 / AZ38-700N
S-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-83.88	--	--	--				HZ880M C
S-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-91.62	--	--	--				
S-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-78.08	989.1	101.2	12.70	0.67	33.3	357.0	PAZ72 / AZ38-700N
S-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-86.46	--	--	--	0.50	25.0	474.8	HZ1080M A
S-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-94.20	--	--	--				
S-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-84.53	1,321.2	139.5	19.61	0.67	33.3	476.8	HZ1080M A
S-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-92.91	--	--	--	0.50	25.0	634.2	HZ1080M D
S-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-102.58	--	--	--				
						Governing Value:	-102.58	1,321.17	139.52	19.61	0.67	33.3	634.2	HZ1080M D

Cantilever Length (H) = 37.0 ft.
Deflection to Cantilever Ratio (d / H) = 0.044

Type	Section	Width	C/S Area	S	MI
		in	in2 /ft	in^3 / ft	in^4 /ft
Typical	AZ38-700N	27.56	10.87	70.6	694.5
Combi-wall	PAZ42 / AZ38-700N	99.48	18.25	137.1	2879
	PAZ48 / AZ38-700N	105.48	20.89	185.6	4455
	PAZ54 / AZ38-700N	111.48	21.54	218.2	5891
	PAZ60 / AZ38-700N	117.48	24.46	285.6	8567
	PAZ66 / AZ38-700N	123.48	25.1	327.1	10793
	PAZ72 / AZ38-700N	129.48	25.68	370.1	13324
	PAZ78 / AZ38-700N	135.48	26.22	414.5	16165
	PAZ84 / AZ38-700N	141.48	26.7	460	19319
H-H Combi C1	HZ880M A	18.7	31.28	356.2	5939
	HZ880M C	187.7	35.81	409.2	6836.8
	HZ1080M A	18.5	39.49	545.5	11736.7
	HZ1080M D	18.5	49.17	674.3	15075.7
	HZ1180M A	18.7	51.79	730.1	15938.9
	HZ1180M D	18.7	59.12	846.9	18656.7

PNT 2

Project: San Jacinto Waste Pits
Project No.: 18-2876
DeepEx Summary Page - Northern Impoundment (Cell #1 @ Sta. 3+50)

Date: 5/13/2020
Pile Type Selected in DeepEx: PAZ66/AZ38-700N

Top of Wall =	9.0	ft., NAVD88
Governing Tip Elev. =	-82.18	ft., NAVD88
Length of Sheeting =	91.18	ft.
Use =	115.0	ft.

Ground Surface (Outside) =	-17.0	ft., NAVD88
Ground Surface (Inside) =	-17.0	ft., NAVD88
Design Tip Elev. =	-106.0	ft., NAVD88
Design Length of Sheeting =	115.0	ft.

Sheet Pile Fy	50	ksi
Bending Stress	25	ksi
Shear Stress	16.5	ksi

Condition	Stage	Description	Water (Driving)	Water (Passive)	FS_{Active}	$FS_{Passive}$	Tip Elev.	Max Moment	Max Shear	Deflection	X = fb / Fy	fb	Req'd Smin	Recommended Section
			(ft., NAVD88)	(ft., NAVD88)			(ft., NAVD88)	(kip-ft)	(kip)	(in)			(in^3 /ft of wall)	
Q-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-38.80	220.9	59.9	0.75	0.50	25.0	106.0	
Q-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-40.77	--	--	--				
Q-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-42.35	--	--	--				
Q-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-41.16	300.7	70.6	1.10	0.50	25.0	144.3	
Q-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-43.14	--	--	--				
Q-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-45.12	--	--	--				
Q-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-42.74	405.4	83.5	1.67	0.67	33.3	146.3	
Q-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-45.12	--	--	--	0.50	25.0	194.6	
Q-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-47.09	--	--	--				
Q-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-44.72	493.6	90.9	2.19	0.67	33.3	178.1	
Q-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-47.48	--	--	--	0.50	25.0	236.9	
Q-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-50.25	--	--	--				
S-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-48.34	219.6	36.2	1.20	0.50	25.0	105.4	
S-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-53.98	--	--	--				
S-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-60.09	--	--	--				
S-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-54.45	334.4	48.4	2.26	0.50	25.0	160.5	PAZ48 / AZ38-700N
S-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-61.97	--	--	--				
S-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-69.49	--	--	--				
S-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-58.21	463.6	61.8	3.58	0.67	33.3	167.3	PAZ48 / AZ38-700N
S-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-65.73	--	--	--	0.50	25.0	222.5	PAZ60 / AZ38-700N
S-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-73.25	--	--	--				
S-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-63.85	626.9	75.9	5.68	0.67	33.3	226.2	PAZ60 / AZ38-700N
S-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-72.28	--	--	--	0.50	25.0	300.9	PAZ66 / AZ38-700N
S-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-82.18	--	--	--				
						Governing Value:	-82.18	626.88	90.92	5.68	0.67	33.3	300.9	

Cantilever Length (H) = 26.0 ft.
Deflection to Cantilever Ratio (δ / H) = 0.018

Type	Section	Width	C/S Area	S	MI
		in	in2 /ft	in^3 / ft	in^4 /ft
Typical	AZ38-700N	27.56	10.87	70.6	694.5
Combi-wall	PAZ42 / AZ38-700N	99.48	18.25	137.1	2879
	PAZ48 / AZ38-700N	105.48	20.89	185.6	4455
	PAZ54 / AZ38-700N	111.48	21.54	218.2	5891
	PAZ60 / AZ38-700N	117.48	24.46	285.6	8567
	PAZ66 / AZ38-700N	123.48	25.1	327.1	10793
	PAZ72 / AZ38-700N	129.48	25.68	370.1	13324
	PAZ78 / AZ38-700N	135.48	26.22	414.5	16165
	PAZ84 / AZ38-700N	141.48	26.7	460	19319
H-H Combi C1	HZ880M A	18.7	31.28	356.2	5939
	HZ880M C	187.7	35.81	409.2	6836.8
	HZ1080M A	18.5	39.49	545.5	11736.7
	HZ1080M D	18.5	49.17	674.3	15075.7
	HZ1180M A	18.7	51.79	730.1	15938.9
	HZ1180M D	18.7	59.12	846.9	18656.7

PNT 3

Project: San Jacinto Waste Pits
Project No.: 18-2876
DeepEx Summary Page - Northern Impoundment (Cell #2 @ Sta. 0+75)

Date: 5/13/2020
Pile Type Selected in DeepEx: PAZ66/AZ38-700N

Top of Wall =	9.0	ft., NAVD88	Ground Surface (Outside) =	-10.0	ft., NAVD88	Sheet Pile Fy	50 ksi
Governing Tip Elev. =	-89.5	ft., NAVD88	Ground Surface (Inside) =	-15.0	ft., NAVD88	Bending Stress	25 ksi
Length of Sheeting =	98.5	ft.	Design Tip Elev. =	-91.0	ft., NAVD88	Shear Stress	16.5 ksi
Use =	100.0	ft.	Design Length of Sheeting =	100.0	ft.		

Condition	Stage	Description	Water (Driving) (ft., NAVD88)	Water (Passive) (ft., NAVD88)	FS_{Active}	$FS_{Passive}$	Tip Elev. (ft., NAVD88)	Max Moment (kip-ft)	Max Shear (kip)	Deflection (in)	X = fb / Fy	fb	Req'd Smin (in^3 /ft of wall)	Recommended Section
Q-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-22.60	58.3	19.9	0.08	0.50	25.0	28.0	
Q-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-23.78	--	--	--				
Q-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-24.58	--	--	--				
Q-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-24.58	72.7	17.5	0.12	0.50	25.0	34.9	
Q-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-26.55	--	--	--				
Q-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-28.52	--	--	--				
Q-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-28.13	125.4	25.3	0.26	0.67	33.3	45.3	
Q-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-30.10	--	--	--	0.50	25.0	60.2	
Q-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-31.69	--	--	--				
Q-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-30.50	144.4	40.1	0.36	0.67	33.3	52.1	
Q-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-32.48	--	--	--	0.50	25.0	69.3	
Q-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-34.06	--	--	--				
S-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-52.88	254.4	37.9	1.61	0.50	25.0	122.1	
S-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-60.30	--	--	--				
S-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-68.22	--	--	--				
S-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-59.81	392.7	50.1	3.14	0.50	25.0	188.5	
S-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-69.21	--	--	--				
S-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-77.62	--	--	--				
S-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-63.76	532.5	65.2	4.86	0.67	33.3	192.2	PAZ54 / AZ38-700N
S-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-72.68	--	--	--	0.50	25.0	255.6	PAZ60 / AZ38-700N
S-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-81.09	--	--	--				
S-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-69.70	730.8	84.3	7.94	0.67	33.3	263.8	PAZ60 / AZ38-700N
S-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-79.60	--	--	--	0.50	25.0	350.8	PAZ66 / AZ38-700N
S-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-89.50	--	--	--				
						Governing Value:	-89.5	730.84	84.31	7.94	0.67	33.3	350.8	

Cantilever Length (H) = 24.0 ft.
Deflection to Cantilever Ratio (d / H) = 0.028

Type	Section	Width (in)	C/S Area (in2 /ft)	S (in^3 / ft)	MI (in^4 /ft)
Typical	AZ38-700N	27.56	10.87	70.6	694.5
Combi-wall	PAZ42 / AZ38-700N	99.48	18.25	137.1	2879
	PAZ48 / AZ38-700N	105.48	20.89	185.6	4455
	PAZ54 / AZ38-700N	111.48	21.54	218.2	5891
	PAZ60 / AZ38-700N	117.48	24.46	285.6	8567
	PAZ66 / AZ38-700N	123.48	25.1	327.1	10793
	PAZ72 / AZ38-700N	129.48	25.68	370.1	13324
	PAZ78 / AZ38-700N	135.48	26.22	414.5	16165
	PAZ84 / AZ38-700N	141.48	26.7	460	19319
H-H Combi C1	HZ880M A	18.7	31.28	356.2	5939
	HZ880M C	187.7	35.81	409.2	6836.8
	HZ1080M A	18.5	39.49	545.5	11736.7
	HZ1080M D	18.5	49.17	674.3	15075.7
	HZ1180M A	18.7	51.79	730.1	15938.9
	HZ1180M D	18.7	59.12	846.9	18656.7

PNT 4

Project: San Jacinto Waste Pits
Project No.: 18-2876
DeepEx Summary Page - Northern Impoundment (Cell #3 @ Sta. 5+75)

Date: 5/13/2020
Pile Type Selected in DeepEx: PAZ66/AZ38-700N

Top of Wall = 9.0 ft., NAVD88
Governing Tip Elev. = -103 ft., NAVD88
Length of Sheeting = 112 ft.
Use = 115.0 ft.

Ground Surface (Outside) = -2.0 ft., NAVD88
Ground Surface (Inside) = -22.0 ft., NAVD88
Design Tip Elev. = -106.0 ft., NAVD88
Design Length of Sheeting = 115.0 ft.

Sheet Pile Fy 50 ksi
Bending Stress 25 ksi
Shear Stress 16.5 ksi

Condition	Stage	Description	Water (Driving)	Water (Passive)	FS Active	FS Passive	Tip Elev.	Max Moment	Max Shear	Deflection	X = fb / Fy	fb	Req'd Smin	Recommended Section
			(ft., NAVD88)	(ft., NAVD88)			(ft., NAVD88)	(kip-ft)	(kip)	(in)			(in^3 /ft of wall)	
Q-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-39.58	156.0	28.5	0.52	0.50	25.0	74.9	
Q-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-44.33	--	--	--				
Q-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-48.67	--	--	--				
Q-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-44.33	228.3	42.8	0.96	0.50	25.0	109.6	
Q-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-49.06	--	--	--				
Q-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-52.62	--	--	--				
Q-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-46.70	306.6	61.9	1.52	0.67	33.3	110.7	
Q-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-51.04	--	--	--	0.50	25.0	147.2	
Q-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-54.99	--	--	--				
Q-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-49.85	398.7	84.6	2.32	0.67	33.3	143.9	
Q-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-54.20	--	--	--	0.50	25.0	191.4	
Q-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-58.94	--	--	--				
S-Case	1	Open excavation - degraded	5	-4	1.0	1.00	-68.00	669.5	81.9	6.66	0.50	25.0	321.4	
S-Case	1A	Open excavation - degraded	5	-4	1.0	1.25	-75.70	--	--	--				
S-Case	1B	Open excavation - degraded	5	-4	1.0	1.50	-83.00	--	--	--				
S-Case	2	Open excavation - degraded	5	-8	1.0	1.00	-74.30	924.2	105.7	10.64	0.50	25.0	443.6	HZ1080M A
S-Case	2A	Open excavation - degraded	5	-8	1.0	1.25	-83.00	--	--	--				
S-Case	2B	Open excavation - degraded	5	-8	1.0	1.50	-91.80	--	--	--				
S-Case	3	Open excavation - degraded	9	-4	1.0	1.00	-76.40	1,100.0	115.9	13.60	0.67	33.3	397.0	HZ880M C
S-Case	3A	Open excavation - degraded	9	-4	1.0	1.25	-85.50	--	--	--	0.50	25.0	528.0	HZ1080M A
S-Case	3B	Open excavation - degraded	9	-4	1.0	1.50	-94.60	--	--	--				
S-Case	4	Open excavation - degraded	9	-8	1.0	1.00	-82.00	1,413.1	135.8	19.71	0.67	33.3	510.0	HZ1080M A
S-Case	4A	Open excavation - degraded	9	-8	1.0	1.25	-91.80	--	--	--	0.50	25.0	678.3	HZ1180M A
S-Case	4B	Open excavation - degraded	9	-8	1.0	1.50	-103.00	--	--	--				
						Governing Value:	-103	1,413.12	135.82	19.71	0.67	33.3	678.3	

Cantilever Length (H) = 31.0 ft.
Deflection to Cantilever Ratio (δ / H) = 0.053

Type	Section	Width	C/S Area	S	MI
		in	in2 /ft	in^3 / ft	in^4 /ft
Typical	AZ38-700N	27.56	10.87	70.6	694.5
Combi-wall	PAZ42 / AZ38-700N	99.48	18.25	137.1	2879
	PAZ48 / AZ38-700N	105.48	20.89	185.6	4455
	PAZ54 / AZ38-700N	111.48	21.54	218.2	5891
	PAZ60 / AZ38-700N	117.48	24.46	285.6	8567
	PAZ66 / AZ38-700N	123.48	25.1	327.1	10793
	PAZ72 / AZ38-700N	129.48	25.68	370.1	13324
	PAZ78 / AZ38-700N	135.48	26.22	414.5	16165
	PAZ84 / AZ38-700N	141.48	26.7	460	19319
H-H Combi C1	HZ880M A	18.7	31.28	356.2	5939
	HZ880M C	187.7	35.81	409.2	6836.8
	HZ1080M A	18.5	39.49	545.5	11736.7
	HZ1080M D	18.5	49.17	674.3	15075.7
	HZ1180M A	18.7	51.79	730.1	15938.9
	HZ1180M D	18.7	59.12	846.9	18656.7

Appendix F-3
DeepEx Run Reports

DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 5/5/2020 9:03:24 AM

File: C:\Users\George.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

ANALYSIS AND CHECKING SUMMARY

The following tables summarize critical resuls for all design sections. These results may include wall moments, shears, displacements, stress checks, wall embedment safety factors, basal & slope stability safety factors, etc.

Summary vs Design Section

Base model	Wall Moment	Wall Shear	Wall Displace	Max Support	Critical Support	Embedment	Comments
	(k-ft/ft)	(k/ft)	(in)	Reaction (k/ft)	Check	Wall FS	
Base model	641.46	96.35	0	No supports	No supports	1.51	Calculation successful

Extended Summary

Table: Extended summary for all design sections.

Design Section	Calculation Result	Wall Displacement	Settlement
Name		(in)	(in)
Base model	Calculation successful	4.01	0.26

Table: Extended summary for wall moments and shears for all design sections.

Design Section	Wall Moment	Wall Moment	Wall Shear	Wall Shear
Name	(k-ft/ft)	(k-ft)	(k/ft)	(k)
Base model	641.46	6600.57	96.35	991.46

Table: Extended summary for wall stress checks for all design sections.

Design Section	STR Combined	STR Moment	STR Shear	Wall Concrete Service
Name	Wall Ratio	Wall Ratio	Wall Ratio	Stress Ratio FIC
Base model	0.786	0.786	0.27	N/A

Table notes:

STR Combined: Combined stress check, along eccentricity line considering axial load and moment (demand/capacity).
STR Moment : Moment stress check, assuming constant axial load on wall (demand/capacity).
STR Shear : Shear stress check (shear force demand/wall shear capacity).

Table: Extended summary for support results for all design sections

Design Section	Max Support	Max Support	Critical	STR Support	Support Geotech
Name	Reaction (k/ft)	Reaction (k)	Support Check	Ratio	Capacity Ratio (pull
Base model	No supports	No supports	No supports	No supports	No supports

Table notes:

STR Support ratio: Critical structural stress check for support (force demand/structural capacity).
Support geotech capacity ratio: Critical geotechnical capacity stress check (demand/geotechnical capacity).
Critical support check: Critical demand/design capacity ratio (structural or geotechnical).

Table: Summary for basal stability and wall embedment safety factors from conventional analyses.

Design Section	FS	Toe FS	Toe FS	Toe FS
Name	Basal	Passive	Rotation	Length
Base model	4.364	1.992	1.51	1.603

Table notes:

FSbasal : Critical basal stability safety factor (relevant only when soft clays are present beneath the excavation).
TOE FS Passive : Safety factor for wall embedment based on FS= Available horizontal thrust resistance/Driving hor. thrust.
TOE FS Rotation: Safety factor for wall embedment based on FS= Available resisting moment/Driving moment.
TOE FS Length : Safety factor for wall embedment based on FS= Available wall embedment/Required embedment for FS=1.0

Table: Summary for wall embedment safety factors from elastoplastic analyses.

Design Section	FS Mobilized	FS
Name	Passive	True/Active
Base model	N/A	N/A

Table notes:

FS Mobilized Passive : Safety factor= Available horizontal passive resistance/Mobilized passive thrust.
FS True/Active : Soil thrust on retained wall side/Minimum theoretically horizontal active force thrust.

Table: Summary for hydraulic safety factors, water flow, and slope stability

Design Section	Hydraulic	Qflow	FSslope
Name	Heave FS	(ft3/hr)	
Base model	N/A	N/A	N/A

Max. Moment vs Stage

	Base Model
M stg0 (k-ft/ft)	DS: 0
M stg1 (k-ft/ft)	-300.07
M stg2 (k-ft/ft)	-306.64
M stg3 (k-ft/ft)	-386.27
M stg4 (k-ft/ft)	-397.99
M stg5 (k-ft/ft)	-409.64
M stg6 (k-ft/ft)	-495.96
M stg7 (k-ft/ft)	-510.33
M stg8 (k-ft/ft)	-524.6
M stg9 (k-ft/ft)	-598.31
M stg10 (k-ft/ft)	-620.08
M stg11 (k-ft/ft)	-641.46

Max. Shear vs Stage

	Base Model
V stg0 (k/ft)	DS: 0
V stg1 (k/ft)	-62.54
V stg2 (k/ft)	-57.34
V stg3 (k/ft)	-76.43
V stg4 (k/ft)	-70.79
V stg5 (k/ft)	-64.59
V stg6 (k/ft)	-88.49
V stg7 (k/ft)	-79.3
V stg8 (k/ft)	-72.33
V stg9 (k/ft)	-96.35
V stg10 (k/ft)	-85.69
V stg11 (k/ft)	-79.02

Max. Support F vs Stage

	Base Model
Rmax Stage 0 (k/ft)	DS: 0
Rmax Stage 1 (k/ft)	N/A
Rmax Stage 2 (k/ft)	N/A
Rmax Stage 3 (k/ft)	N/A
Rmax Stage 4 (k/ft)	N/A
Rmax Stage 5 (k/ft)	N/A
Rmax Stage 6 (k/ft)	N/A
Rmax Stage 7 (k/ft)	N/A
Rmax Stage 8 (k/ft)	N/A
Rmax Stage 9 (k/ft)	N/A
Rmax Stage 10 (k/ft)	N/A
Rmax Stage 11 (k/ft)	N/A

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)

A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

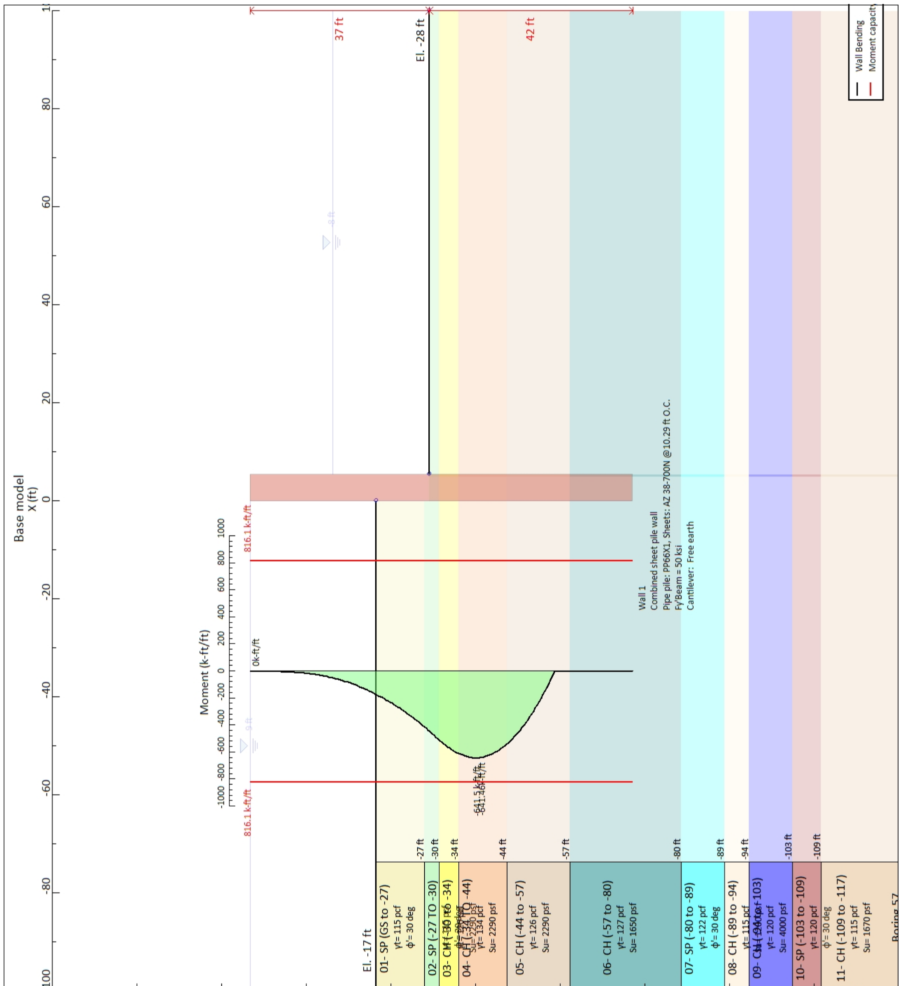
Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength
Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

ANALYSIS AND CHECKING SUMMARY



Company: Ardaman - Associates, Inc. Engineer: George Segré	Quick summary	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP		1/7/2020

Summary of Wall Moments and Toe Requirements

Top Wall	Wall	L-Wall	H-Exc.	Max+M/Cap	Max-M/Cap	FS Toe	FS Toe	FS Toe	FS 1 Toe EL.	Slope
(ft)	Section	(ft)	(ft)	(k-ft/ft)	(k-ft/ft)	Passive	Rotation	Embedment	(ft)	Stab. FS
9	Wall 1	79	11	0/816.12	641.46/816.12	1.992	1.51	1.603	-54.2	N/A

Summary of Basal Stability and Predicted Wall Movements According to Clough 1989 Method Wall: W

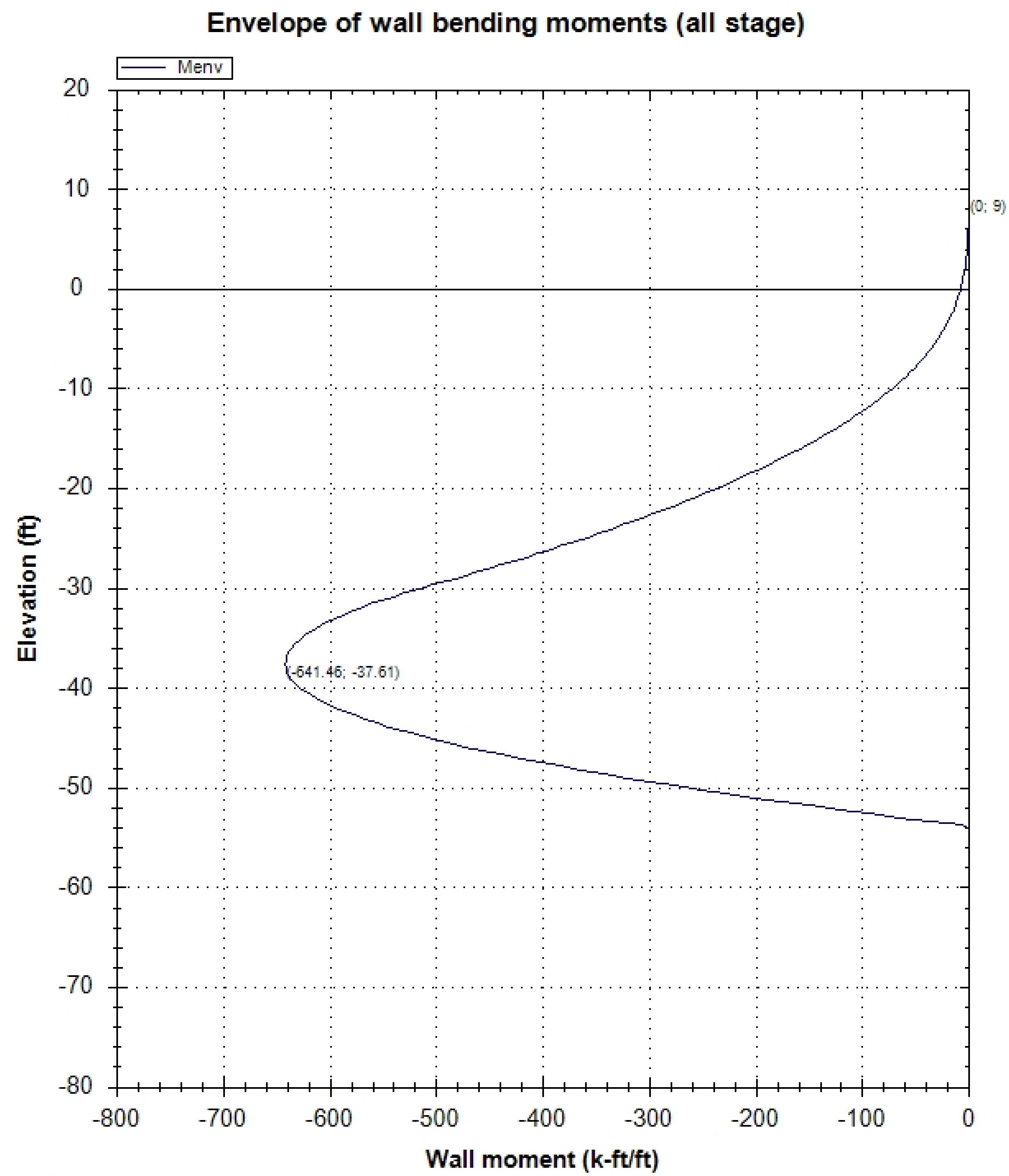
1. FSmin	2. DxMax (in)	2. Stiffness	2. FSbasal	3. Dx/H (%)	3. Stiffness	3. FSbasal
@ stage 9	@ stage 9	@ DxMax	@ DxMax	@ stage 9	@ Dx/H max	@ Dx/H max
4.364	0.062	2379.2	4.364	0.047	2379.153	4.364

General assumptions for last stage: Q-Case 4 FS=1.50

Concrete Code:	ACI 318-11/1.6
Steel Code:	AISC 360-16 ALL.
1st Wall Limit Equilibrium	Assume: Blum's method
Drain State Clays	Undrained-Total stress (clays)
Water γ= 62.4 pcf (no net)	Hydrostatic
Drive	Ka
Resist	Kp/1.5

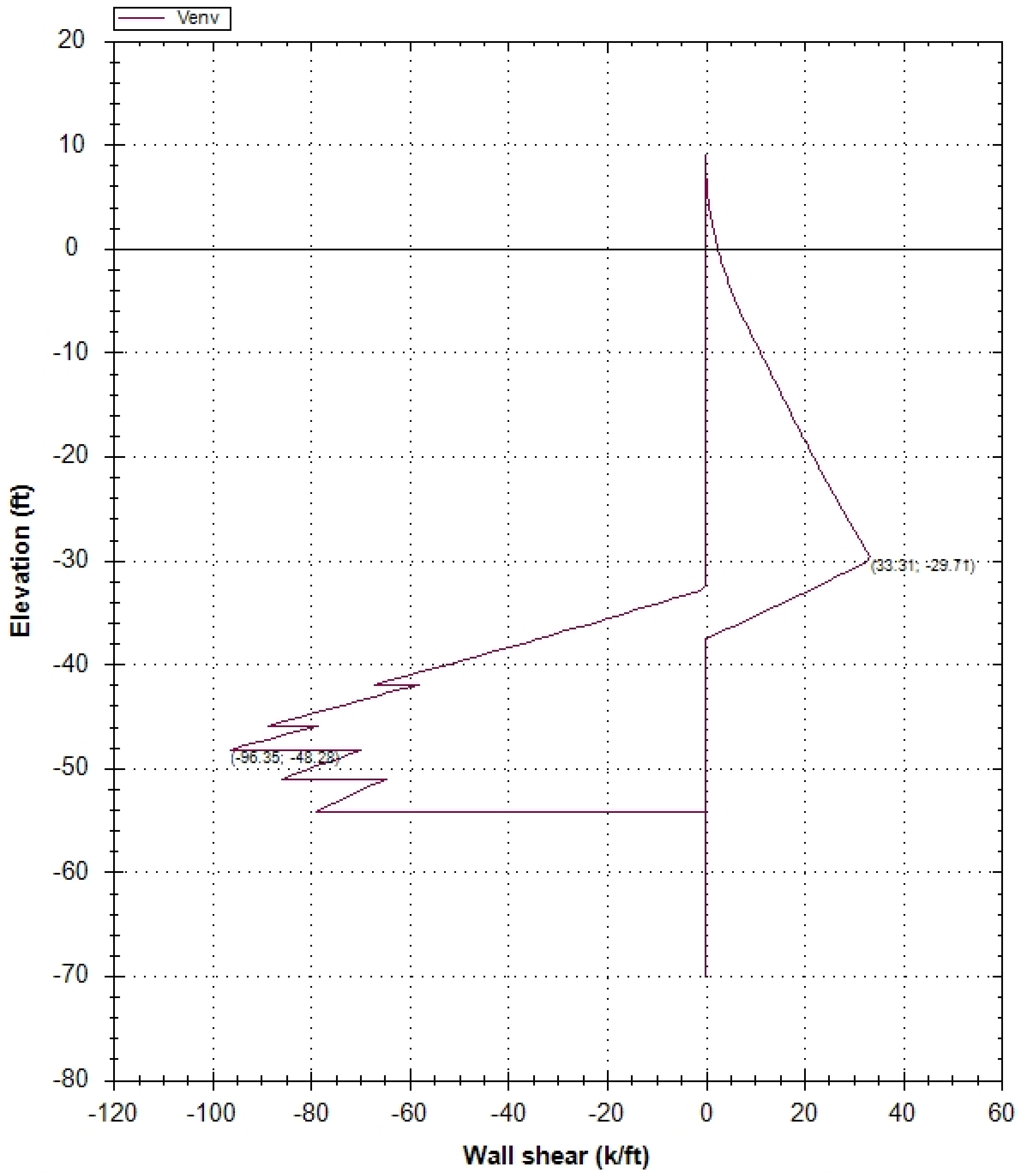
Envelope of results

A sequence of result diagrams for each excavation stage is reported

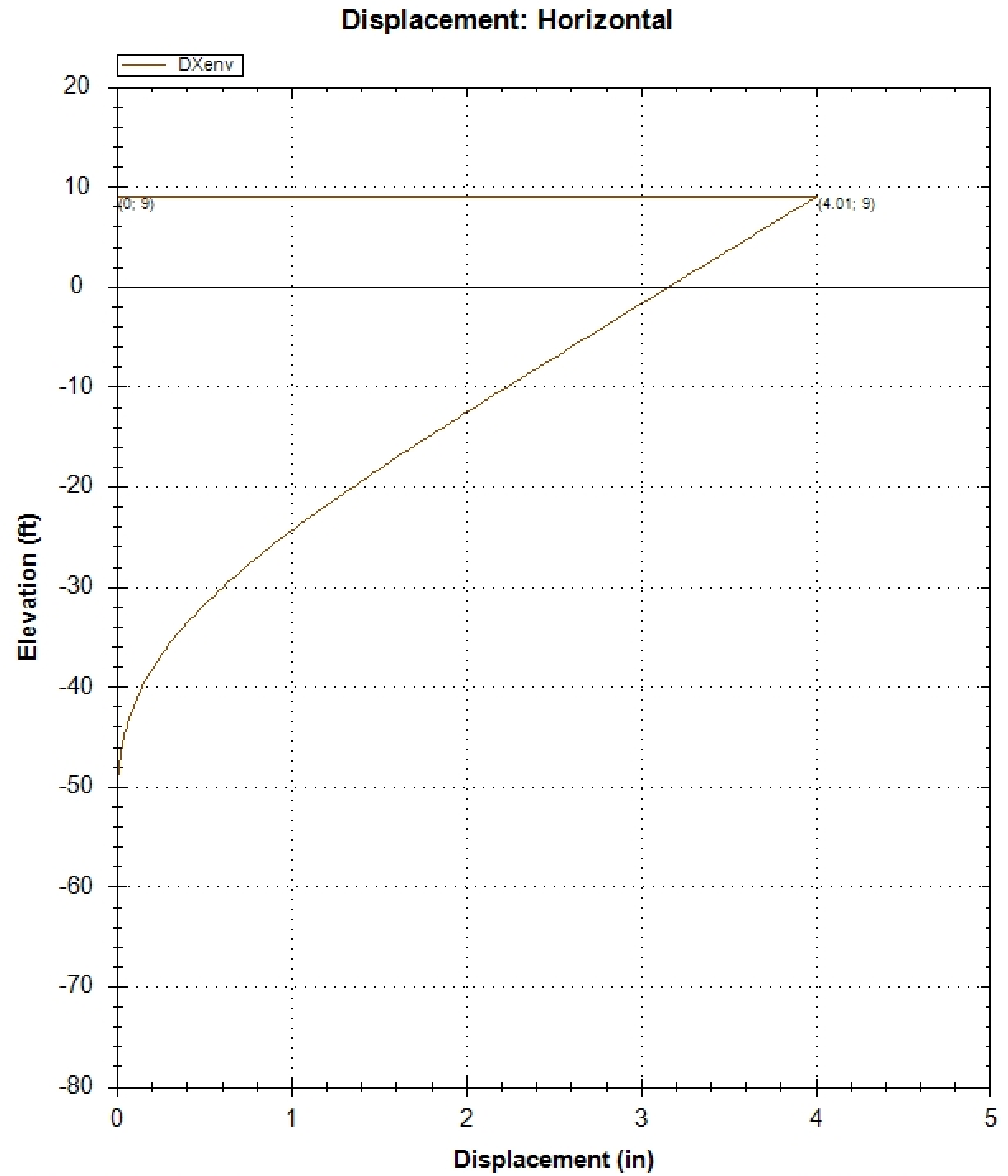


Company: Ardaman - Associates, Inc. Engineer: George Segré	DS: 0 (left wall) Envelope of results	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP		5/5/2020

Envelope of wall shear (all stage)



Company: Ardaman - Associates, Inc. Engineer: George Segré	DS: 0 (left wall) Envelope of results	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP		5/5/2020



Company: Ardaman - Associates, Inc. Engineer: George Segré	DS: 0 (left wall) Envelope of results	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP		5/5/2020

Extended vs Stage

	Calculation Result	Wall Displaceme	Settlement	Wall Moment	Wall Moment
		(in)	(in)	(k-ft/ft)	(k-ft)
Q-Case 1 - FS=1.0	Calculated	1.09	0.22	293.47	3019.84
Q-Case 1 - FS=1.25	Calculated	1.22	0.22	300.07	3087.7
Q-Case 1 - FS=1.50	Calculated	1.34	0.22	306.64	3155.33
Q-Case 2 FS=1.0	Calculated	1.59	0.22	386.27	3974.77
Q-Case 2 FS=1.25	Calculated	1.81	0.22	397.99	4095.28
Q-Case 2 FS=1.50	Calculated	2.04	0.22	409.64	4215.21
Q-Case 3 FS=1.0	Calculated	2.27	0.25	495.96	5103.44
Q-Case 3 FS=1.25	Calculated	2.59	0.25	510.33	5251.3
Q-Case 3 FS=1.50	Calculated	2.93	0.25	524.6	5398.15
Q-Case 4 FS=1.0	Calculated	2.98	0.26	598.31	6156.57
Q-Case 4 FS=1.25	Calculated	3.48	0.26	620.08	6380.59
Q-Case 4 FS=1.50	Calculated	4.01	0.26	641.46	6600.57

	Wall Shear	Wall Shear	STR Combined	STR Moment	STR Shear
	(k/ft)	(k)	Wall Ratio	Wall Ratio	Wall Ratio
Q-Case 1 - FS=1.0	67.06	690.02	0.36	0.36	0.188
Q-Case 1 - FS=1.25	62.54	643.53	0.368	0.368	0.188
Q-Case 1 - FS=1.50	57.34	590.06	0.376	0.376	0.175
Q-Case 2 FS=1.0	76.43	786.43	0.473	0.473	0.214
Q-Case 2 FS=1.25	70.79	728.45	0.488	0.488	0.214
Q-Case 2 FS=1.50	64.59	664.68	0.502	0.502	0.199
Q-Case 3 FS=1.0	88.49	910.55	0.608	0.608	0.248
Q-Case 3 FS=1.25	79.3	816	0.625	0.625	0.248
Q-Case 3 FS=1.50	72.33	744.23	0.643	0.643	0.222
Q-Case 4 FS=1.0	96.35	991.46	0.733	0.733	0.27
Q-Case 4 FS=1.25	85.69	881.78	0.76	0.76	0.27
Q-Case 4 FS=1.50	79.02	813.07	0.786	0.786	0.24

Table notes:

STR Combined: Combined stress check, along eccentricity line considering axial load and moment (demand/capacity).
STR Moment : Moment stress check, assuming constant axial load on wall (demand/capacity).
STR Shear : Shear stress check (shear force demand/wall shear capacity).

	Max Support	Max Support	Critical	STR Support	Support Geotech
	Reaction (k/ft)	Reaction (k)	Support Check	Ratio	Capacity Ratio (pull out
Q-Case 1 - FS=1.0	No supports	No supports	No supports	No supports	No supports
Q-Case 1 - FS=1.25	No supports	No supports	No supports	No supports	No supports
Q-Case 1 - FS=1.50	No supports	No supports	No supports	No supports	No supports
Q-Case 2 FS=1.0	No supports	No supports	No supports	No supports	No supports
Q-Case 2 FS=1.25	No supports	No supports	No supports	No supports	No supports
Q-Case 2 FS=1.50	No supports	No supports	No supports	No supports	No supports
Q-Case 3 FS=1.0	No supports	No supports	No supports	No supports	No supports
Q-Case 3 FS=1.25	No supports	No supports	No supports	No supports	No supports
Q-Case 3 FS=1.50	No supports	No supports	No supports	No supports	No supports
Q-Case 4 FS=1.0	No supports	No supports	No supports	No supports	No supports
Q-Case 4 FS=1.25	No supports	No supports	No supports	No supports	No supports
Q-Case 4 FS=1.50	No supports	No supports	No supports	No supports	No supports

Table notes:

STR Support ratio: Critical structural stress check for support (force demand/structural capacity).
Support geotech capacity ratio: Critical geotechnical capacity stress check (demand/geotechnical capacity).
Critical support check: Critical demand/design capacity ratio (structural or geotechnical).

	FS	Toe FS	Toe FS	Toe FS	Zcut	FS Mobilized	FS
	Basal	Passive	Rotation	Length	(nonlinear)	Passive	True/Active
Q-Case 1 - FS=1.0	4.871	3.547	2.89	3.011	N/A	N/A	N/A
Q-Case 1 - FS=1.2	4.871	2.879	2.392	2.637	N/A	N/A	N/A
Q-Case 1 - FS=1.5	4.871	2.433	2.06	2.399	N/A	N/A	N/A
Q-Case 2 FS=1.0	4.777	3.389	2.69	2.572	N/A	N/A	N/A
Q-Case 2 FS=1.25	4.777	2.741	2.208	2.246	N/A	N/A	N/A
Q-Case 2 FS=1.50	4.777	2.309	1.886	2.032	N/A	N/A	N/A
Q-Case 3 FS=1.0	4.45	3.059	2.313	2.346	N/A	N/A	N/A
Q-Case 3 FS=1.25	4.45	2.483	1.915	2.072	N/A	N/A	N/A
Q-Case 3 FS=1.50	4.45	2.099	1.649	1.854	N/A	N/A	N/A
Q-Case 4 FS=1.0	4.364	2.924	2.153	2.072	N/A	N/A	N/A
Q-Case 4 FS=1.25	4.364	2.364	1.767	1.823	N/A	N/A	N/A
Q-Case 4 FS=1.50	4.364	1.992	1.51	1.603	N/A	N/A	N/A

	Hydraulic	Qflow	FSslope
	Heave FS	(ft3/hr)	
Q-Case 1 - FS=1.0	N/A	N/A	N/C
Q-Case 1 - FS=1.25	N/A	N/A	N/C
Q-Case 1 - FS=1.50	N/A	N/A	N/C
Q-Case 2 FS=1.0	N/A	N/A	N/C
Q-Case 2 FS=1.25	N/A	N/A	N/C
Q-Case 2 FS=1.50	N/A	N/A	N/C
Q-Case 3 FS=1.0	N/A	N/A	N/C
Q-Case 3 FS=1.25	N/A	N/A	N/C
Q-Case 3 FS=1.50	N/A	N/A	N/C
Q-Case 4 FS=1.0	N/A	N/A	N/C
Q-Case 4 FS=1.25	N/A	N/A	N/C
Q-Case 4 FS=1.50	N/A	N/A	N/C

Support Force/S vs Stage

	No Supports
0:Q-Case 1 - FS=1.0	No support
1:Q-Case 1 - FS=1.25	
2:Q-Case 1 - FS=1.50	
3:Q-Case 2 FS=1.0	
4:Q-Case 2 FS=1.25	
5:Q-Case 2 FS=1.50	
6:Q-Case 3 FS=1.0	
7:Q-Case 3 FS=1.25	
8:Q-Case 3 FS=1.50	
9:Q-Case 4 FS=1.0	
10:Q-Case 4 FS=1.25	
11:Q-Case 4 FS=1.50	

Support Force vs Stage

Support Force vs Stage

	No Supports
0:Q-Case 1 - FS=1.0	No support
1:Q-Case 1 - FS=1.25	
2:Q-Case 1 - FS=1.50	
3:Q-Case 2 FS=1.0	
4:Q-Case 2 FS=1.25	
5:Q-Case 2 FS=1.50	
6:Q-Case 3 FS=1.0	
7:Q-Case 3 FS=1.25	
8:Q-Case 3 FS=1.50	
9:Q-Case 4 FS=1.0	
10:Q-Case 4 FS=1.25	
11:Q-Case 4 FS=1.50	

Embedment FS vs Stage

	Min Toe FS	FS1 Passive	FS2 Rotation	FS3 Length (from FS1, FS2)	FS4 Mobilized Passive	FS5 Actual Drive Thrust / Theory
Stage 0	2.89	3.547	2.89	3.011	N/A	N/A
0:Q-Case 1 -	2.392	2.879	2.392	2.637	N/A	N/A
1:Q-Case 1 -	2.06	2.433	2.06	2.399	N/A	N/A
2:Q-Case 1 -	2.572	3.389	2.69	2.572	N/A	N/A
3:Q-Case 2	2.208	2.741	2.208	2.246	N/A	N/A
4:Q-Case 2	1.886	2.309	1.886	2.032	N/A	N/A
5:Q-Case 2	2.313	3.059	2.313	2.346	N/A	N/A
6:Q-Case 3	1.915	2.483	1.915	2.072	N/A	N/A
7:Q-Case 3	1.649	2.099	1.649	1.854	N/A	N/A
8:Q-Case 3	2.072	2.924	2.153	2.072	N/A	N/A
9:Q-Case 4	1.767	2.364	1.767	1.823	N/A	N/A
10:Q-Case 4	1.51	1.992	1.51	1.603	N/A	N/A

Table notes:

FSbasal : Critical basal stability safety factor (relevant only when soft clays are present beneath the excavation).
Wall embedment safety factors from conventional analysis (limit-equilibrium):
FS1 Passive : Safety factor for wall embedment based on FS= Available horizontal thrust resistance/Driving hor. thrust.
FS2 Rotation: Safety factor for wall embedment based on FS= Available resisting moment/Driving moment.
FS3 Length : Safety factor for wall embedment based on FS= Available wall embedment/Required embedment for FS=1.0
Wall embedment safety factors from non-linear analysis:
FS4 Mobilized Passive : Safety factor= Available horizontal passive resistance/Mobilized passive thrust.
FS5 True/Active : Soil thrust on retained wall side/Minimum theoretically horizontal active force thrust.

Tables for stress checks follow: Support force/Design capacity

Support Check vs Stage

	No Supports
0:Q-Case 1 - FS=1.0	No support
1:Q-Case 1 - FS=1.25	
2:Q-Case 1 - FS=1.50	
3:Q-Case 2 FS=1.0	
4:Q-Case 2 FS=1.25	
5:Q-Case 2 FS=1.50	
6:Q-Case 3 FS=1.0	
7:Q-Case 3 FS=1.25	
8:Q-Case 3 FS=1.50	
9:Q-Case 4 FS=1.0	
10:Q-Case 4 FS=1.25	
11:Q-Case 4 FS=1.50	

Forces (Res. F, M/Drive F, M)

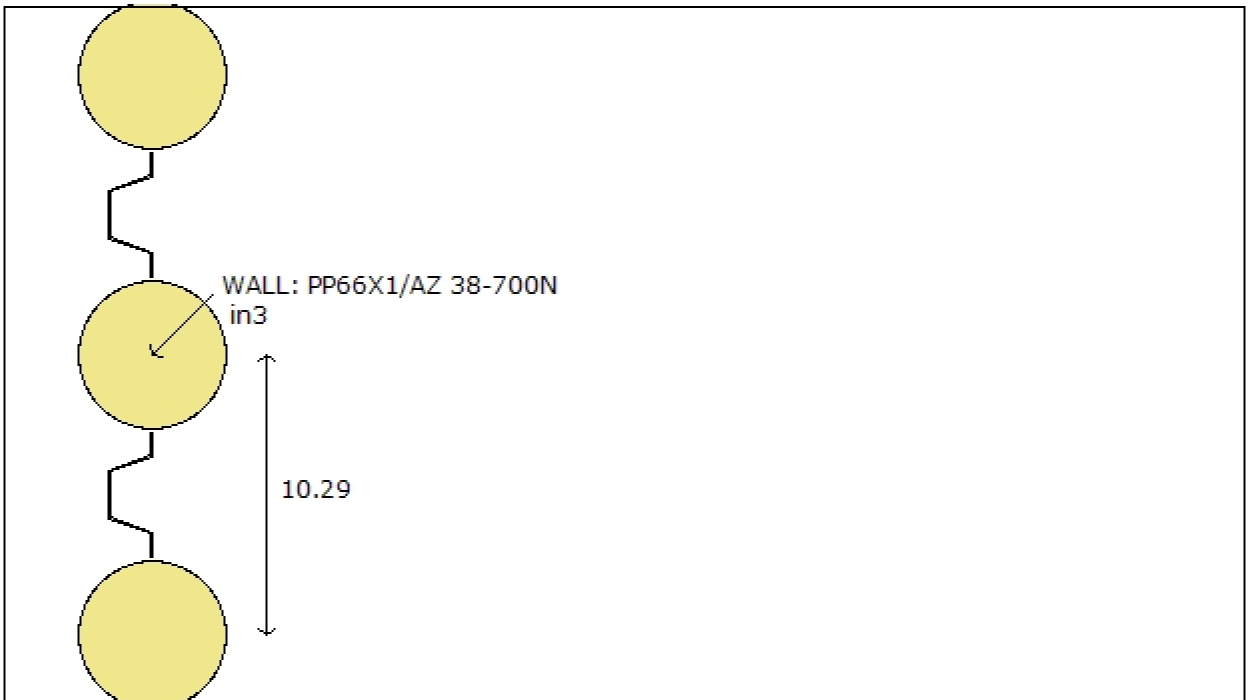
	FS1 Passive	FS2 Rotation	FS3 Length	FS4 Mobilized Passive	FS5 Actual Drive	Fh EQ Soil	Fh EQ Water
	(FxResist/FxDrive)	(Mresist/Mdrive)	(Embedment/ToeFS=1)	(FxPassive/FxPas_Mobili	/ Theory Active		
Stage 0	3696.691/1042.299	66728.23/7258.6	42/13.95	N/A	N/A	N/A	N/A
Stage 1	3000.448/1042.299	53633.29/7258.6	42/15.93	N/A	N/A	N/A	N/A
Stage 2	2536.287/1042.299	44903.33/7258.6	42/17.51	N/A	N/A	N/A	N/A
Stage 3	3532.819/1042.299	64462.91/7258.6	42/16.33	N/A	N/A	N/A	N/A
Stage 4	2857.07/1042.299	51780.82/7258.6	42/18.7	N/A	N/A	N/A	N/A
Stage 5	2406.57/1042.299	43326.09/7258.6	42/20.67	N/A	N/A	N/A	N/A
Stage 6	3696.691/1208.376	66728.23/8463.6	42/17.9	N/A	N/A	N/A	N/A
Stage 7	3000.448/1208.376	53633.29/8463.6	42/20.27	N/A	N/A	N/A	N/A
Stage 8	2536.287/1208.376	44903.33/8463.6	42/22.65	N/A	N/A	N/A	N/A
Stage 9	3532.819/1208.376	64462.91/8463.6	42/20.27	N/A	N/A	N/A	N/A
Stage 10	2857.07/1208.376	51780.82/8463.6	42/23.04	N/A	N/A	N/A	N/A
Stage 11	2406.57/1208.376	43326.09/8463.6	42/26.2	N/A	N/A	N/A	N/A

Reinforcement Requirements

	Parameter Description
Note:	Wall does not use steel reinforcement. Section does not apply.

WALL DATA

Wall section 0: Wall 1



Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP		5/5/2020

Wall type: Combined sheet pile wall
Top wall El: 9 ft   Bottom wall El: -70 ft
Hor. wall spacing: 10.29 ft   Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft   Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi   Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.
Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

GENERAL WALL DATA
Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk

F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
01- SP (GS to	115	115	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	EXP	
02- SP (-27 T	115	115	30	0	N/A	N/A	N/A	60	3	0.33	3	N/A	N/A	True	Linear	
03- CH (-30 t	126	126	0	0	2290	0	0	150	3	1	1	1	1	True	Linear	
04- CH (-34 T	134	134	0	0	2290	0	0	521.92	3	1	1	1	1	True	Linear	
05- CH (-44 to	126	126	0	0	2290	21.1	30	417.54	3	0.47	2.12	0.33	3	True	Linear	
06- CH (-57 to	127	127	0	0	1650	0	0	626.3	3	1	1	1	1	True	Linear	
07- SP (-80 to	122	122	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
08- CH (-89 to	115	115	0	0	1200	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
09- CH (-94 to	120	120	0	0	4000	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
10- SP (-103 t	120	120	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
11- CH (-109 t	115	115	0	0	1670	0	0	300	3	0.33	3	0.33	0.33	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
01- SP (GS to	0.4	-	-	0.5	0.5	1	0	7.2	4.8	20	-
02- SP (-27 T	0.4	-	-	0.5	0.5	-	-	5.1	3.4	20	-
03- CH (-30 t	0.3	0	0	1	0.5	-	-	13	8.7	20	-
04- CH (-34 T	0.3	0	0	1	0.5	-	-	21.8	14.5	30	-
05- CH (-44 to	0.45	0.1	0	0.45	0.5	-	-	18.1	12.1	30	-
06- CH (-57 to	0.35	0	0	1	0.5	-	-	29	19.3	70	-
07- SP (-80 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
08- CH (-89 to	0.3	0	0	1	0.8	-	-	0	0	0	-
09- CH (-94 to	0.25	0	0	1	0.8	-	-	0	0	0	-
10- SP (-103 t	0.35	-	-	0.5	0.8	-	-	0	0	0	-
11- CH (-109 t	0.35	0	0	1	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction
SIMC= Simplified Clay mode

SOIL BORINGS

Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Boring 57, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
-17	01- SP (GS to -	1	0.5
-27	02- SP (-27 TO	1	0.5
-30	03- CH (-30 to	1	1
-34	04- CH (-34 TO	1	1
-44	05- CH (-44 to	1	0.45
-57	06- CH (-57 to	1	1
-80	07- SP (-80 to -	1	0.5
-89	08- CH (-89 to	1	1
-94	09- CH (-94 to	1	1
-103	10- SP (-103 to	1	0.5
-109	11- CH (-109 t	1	1

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 8	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 9	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 10	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 11	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

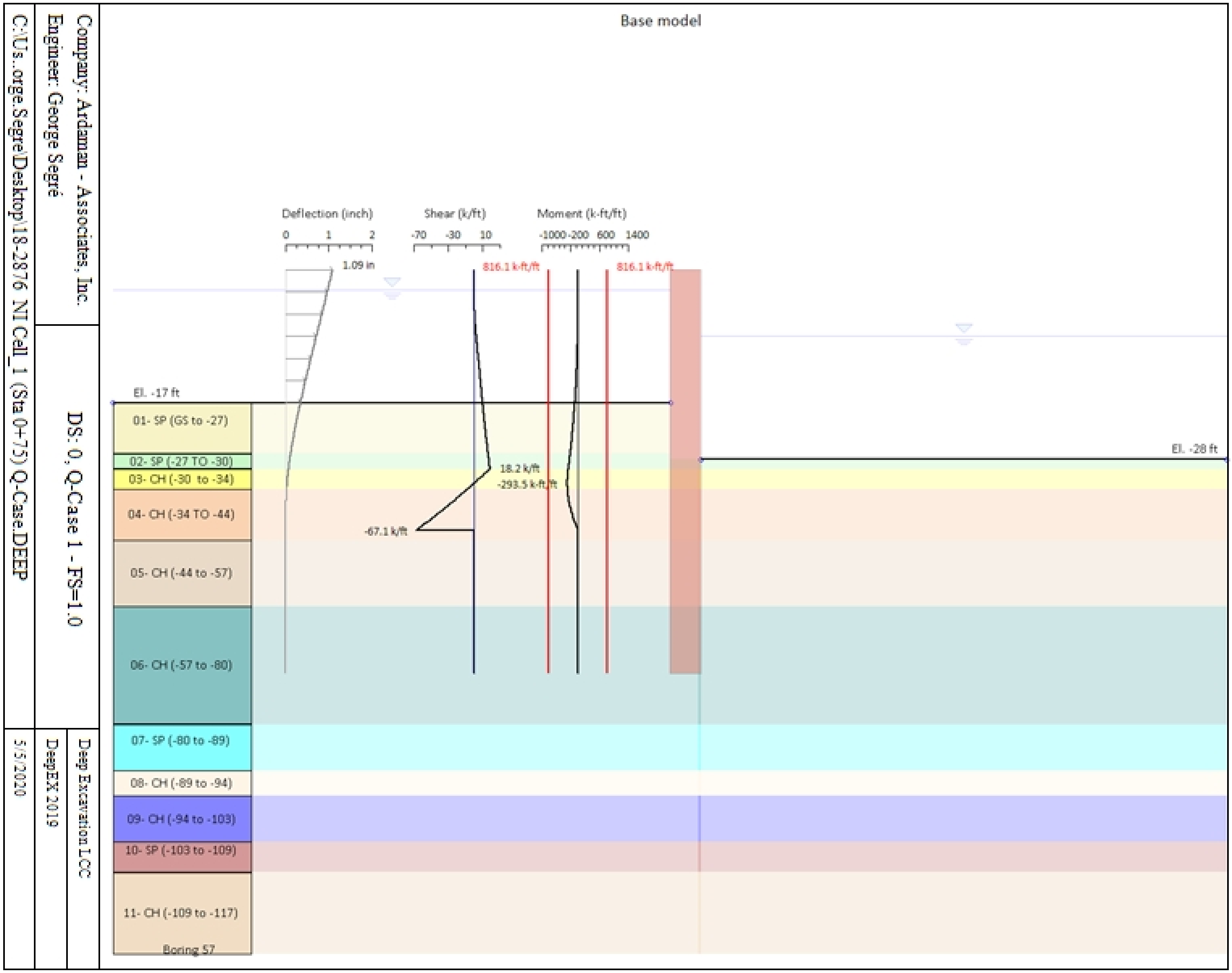
Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	2.89	2.89	3.547
Stage 1	Simple span	N/A	1.6	2.392	2.392	2.879
Stage 2	Simple span	N/A	1.6	2.06	2.06	2.433
Stage 3	Simple span	N/A	1.6	2.572	2.69	3.389
Stage 4	Simple span	N/A	1.6	2.208	2.208	2.741
Stage 5	Simple span	N/A	1.6	1.886	1.886	2.309
Stage 6	Simple span	N/A	1.6	2.313	2.313	3.059
Stage 7	Simple span	N/A	1.6	1.915	1.915	2.483
Stage 8	Simple span	N/A	1.6	1.649	1.649	2.099
Stage 9	Simple span	N/A	1.6	2.072	2.153	2.924
Stage 10	Simple span	N/A	1.6	1.767	1.767	2.364
Stage 11	Simple span	N/A	1.6	1.51	1.51	1.992

Name=excavation stage name
Analysis method
springs = Elastoplastic spring analysis used
DR = Drained condition for CLAY model
U = Undrained condition for CLAY model for all the soils
Up = Undrained condition just for selected soil
Limit equilibrium analysis settings
Drive press:
Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,
FHWA= Federal Highway Administration apparent pressure diagrams.
Ko = At-rest lateral earth pressures.
Peck = Peck 1969 Apparent earth pressure diagrams.
2 Step rect = Two step rectangular apparent earth pressure diagram.
User def. = User defined apparent earth pressure diagram.
Ka+d (and so on) indicates that wall friction is applied

ka mult = multiplication factor for Ka when Ka-Trap is selected
Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H
Resit press = Kp (passive earth pressures)
Res Mult = Safety factor applied directly on resisting pressures (
COntle Method = cantilever analysis method for limit equilibrium analysis.
Support Model: Method for calculating support reactions in limit-equlibrium analysis.
Beam= support reactions beam analysis (uses Blum's method).
Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).
Axial Incl = Axial loads included for structural design
Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

EXCAVATION STAGES SKETCHES

A sequence of figures for each excavation stage is reported


Company: Ardaman - Associates, Inc.
Engineer: George Segré
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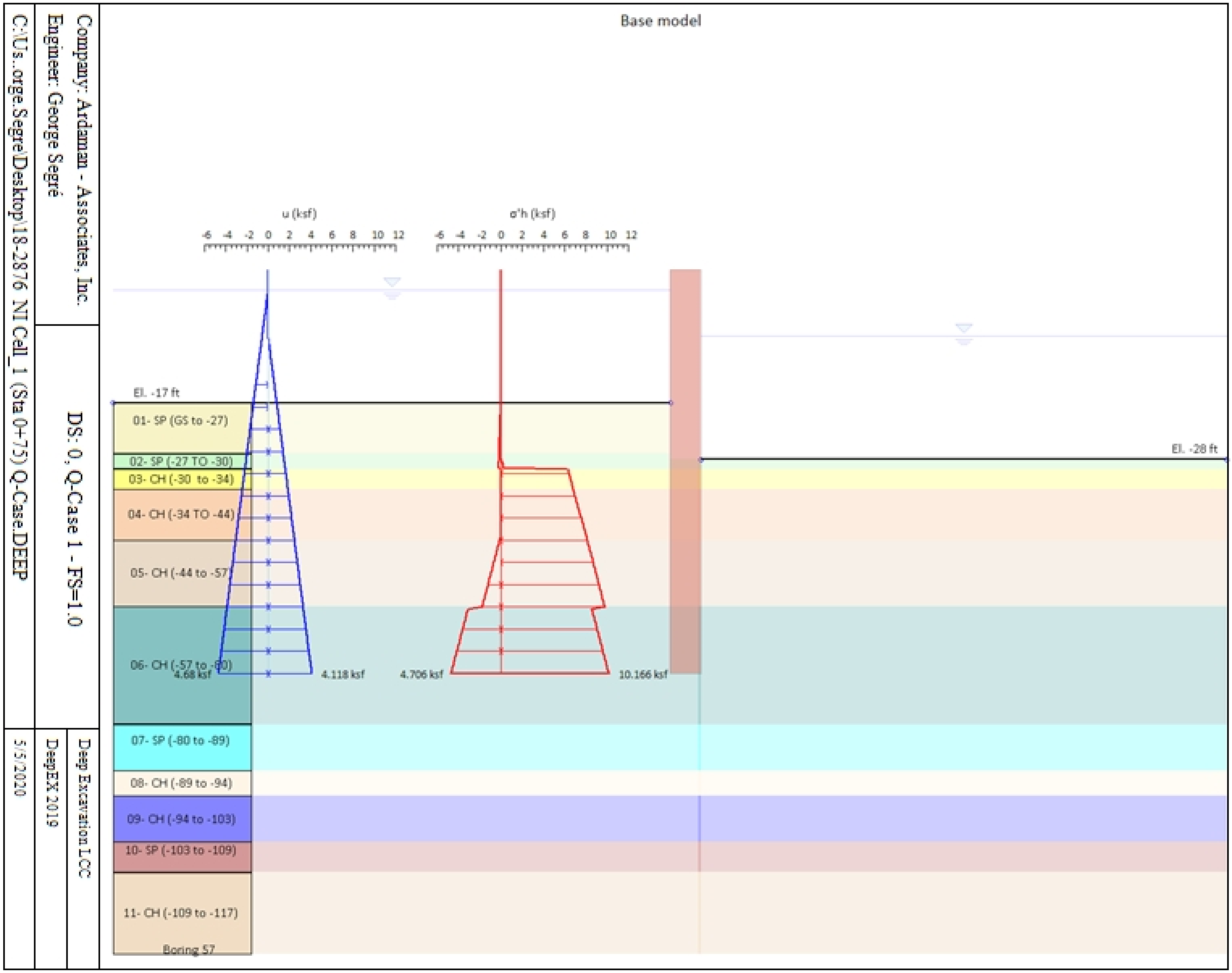
DS: 0, Q-Case 1 - FS=1.0
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
Deflection (inch)
0
1
2
Shear (k/ft)
-70
-30
10
Moment (k-ft/ft)
-1000
-200
600
1400
1.09 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -17 ft
El. -28 ft
18.2 k/ft
-293.5 k-ft/ft
-67.1 k/ft
01- SP (GS to -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57


Company: Ardaman - Associates, Inc.
Engineer: George Segré
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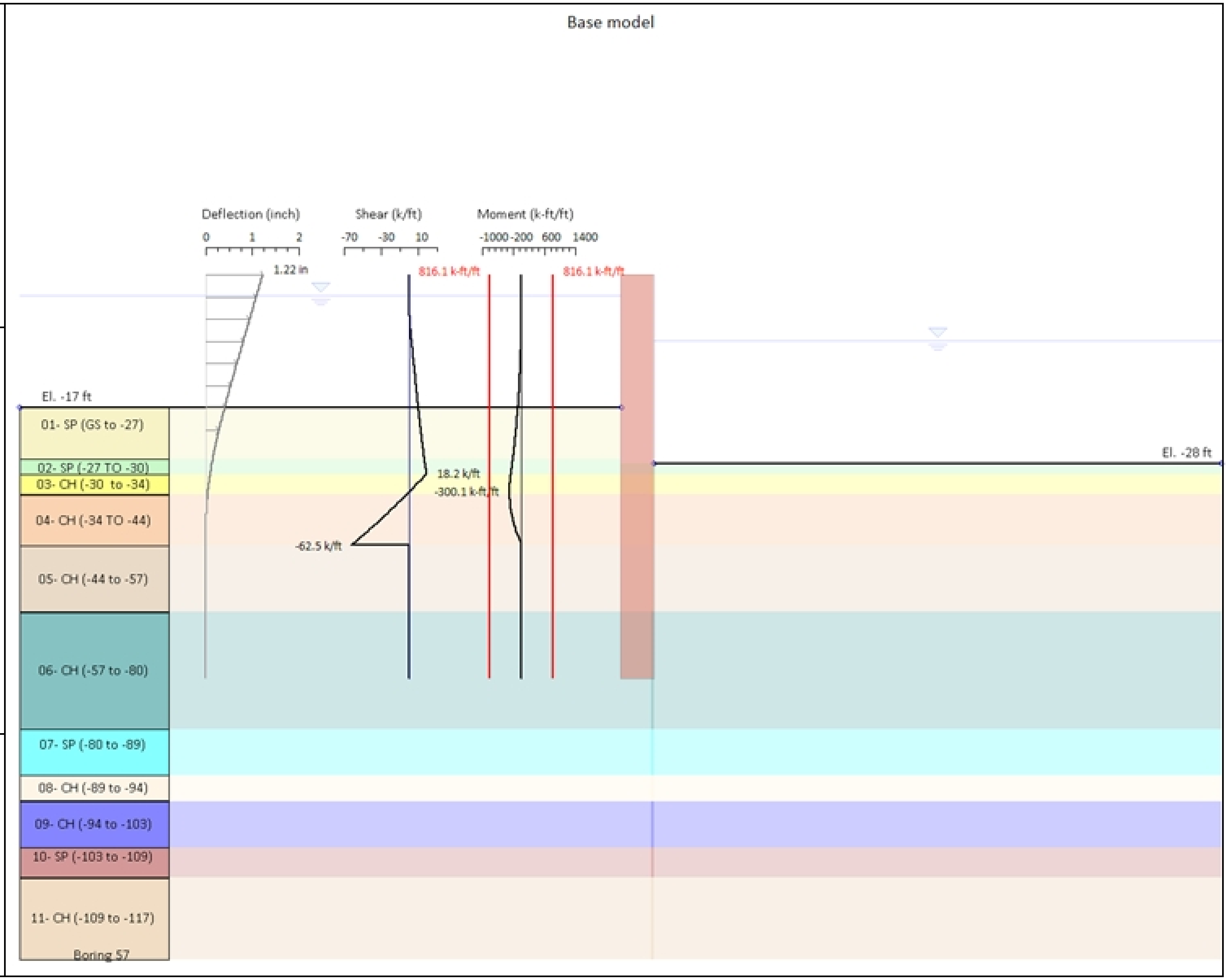
DS: 0, Q-Case 1 - FS=1.0
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
u (ksf)
σ'h (ksf)
El. -17 ft
El. -28 ft
01- SP (GS to -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57
4.68 ksf
4.118 ksf
4.706 ksf
10.166 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 1 - FS=1.25

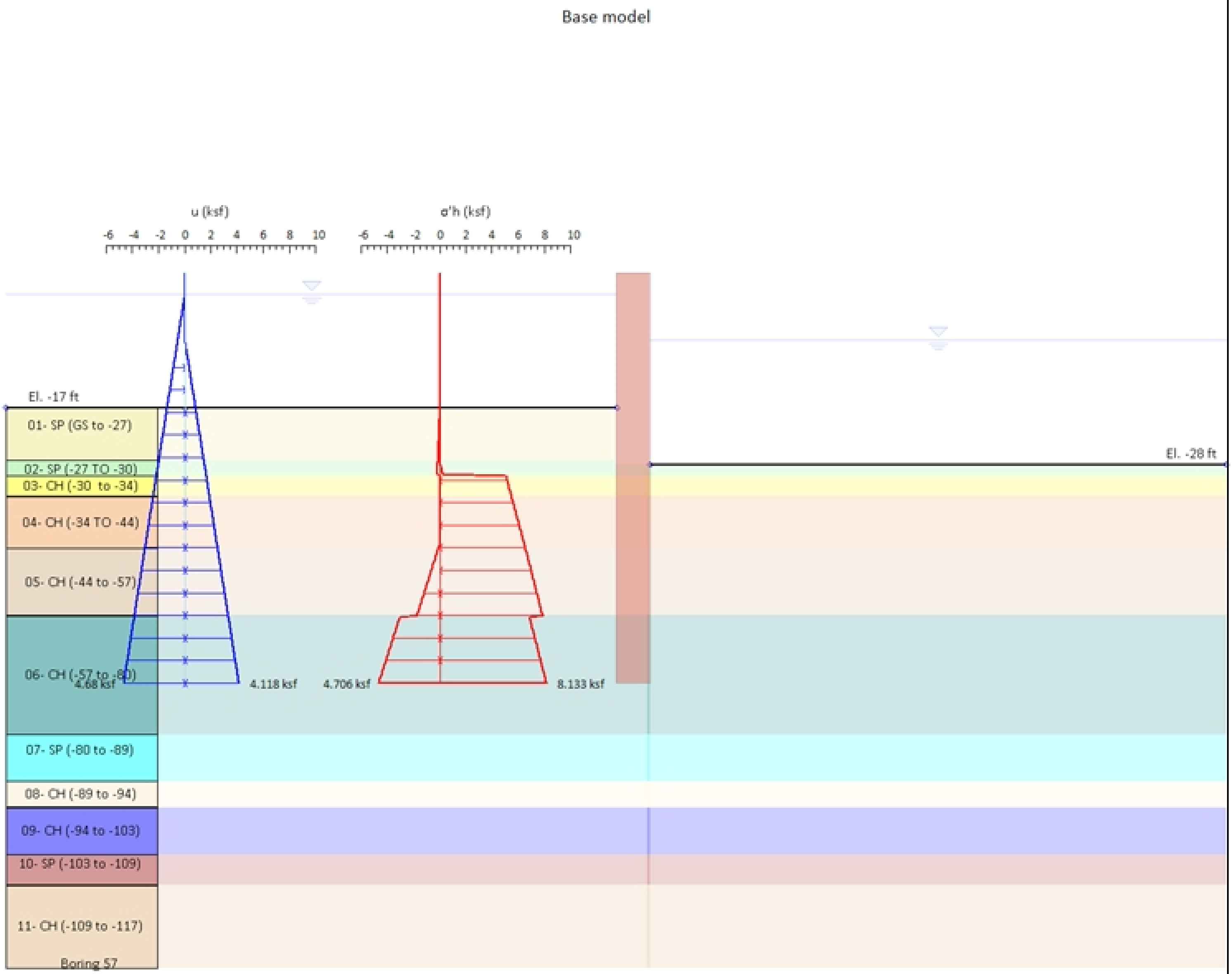
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 1 - FS=1.25

Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré

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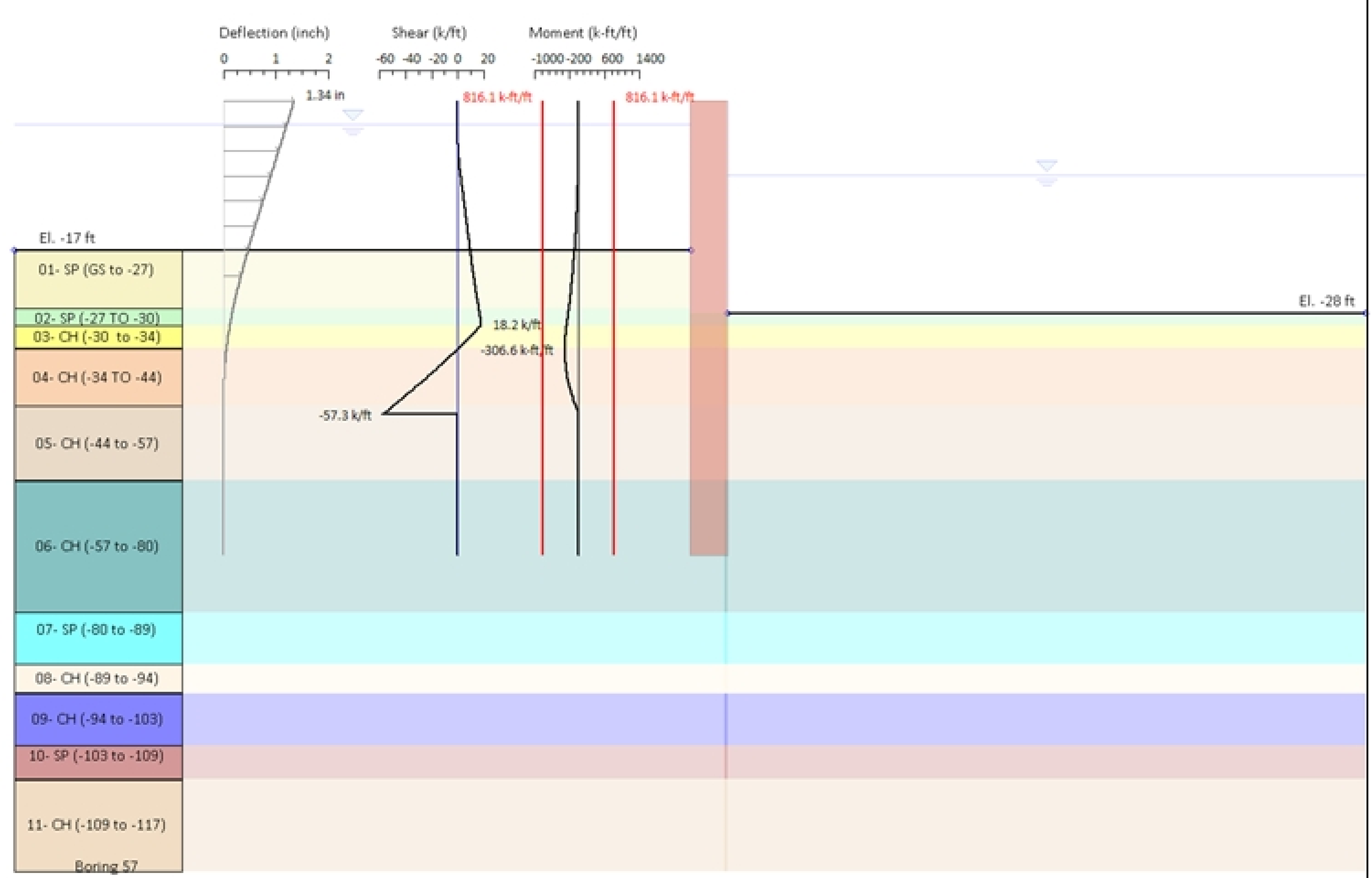
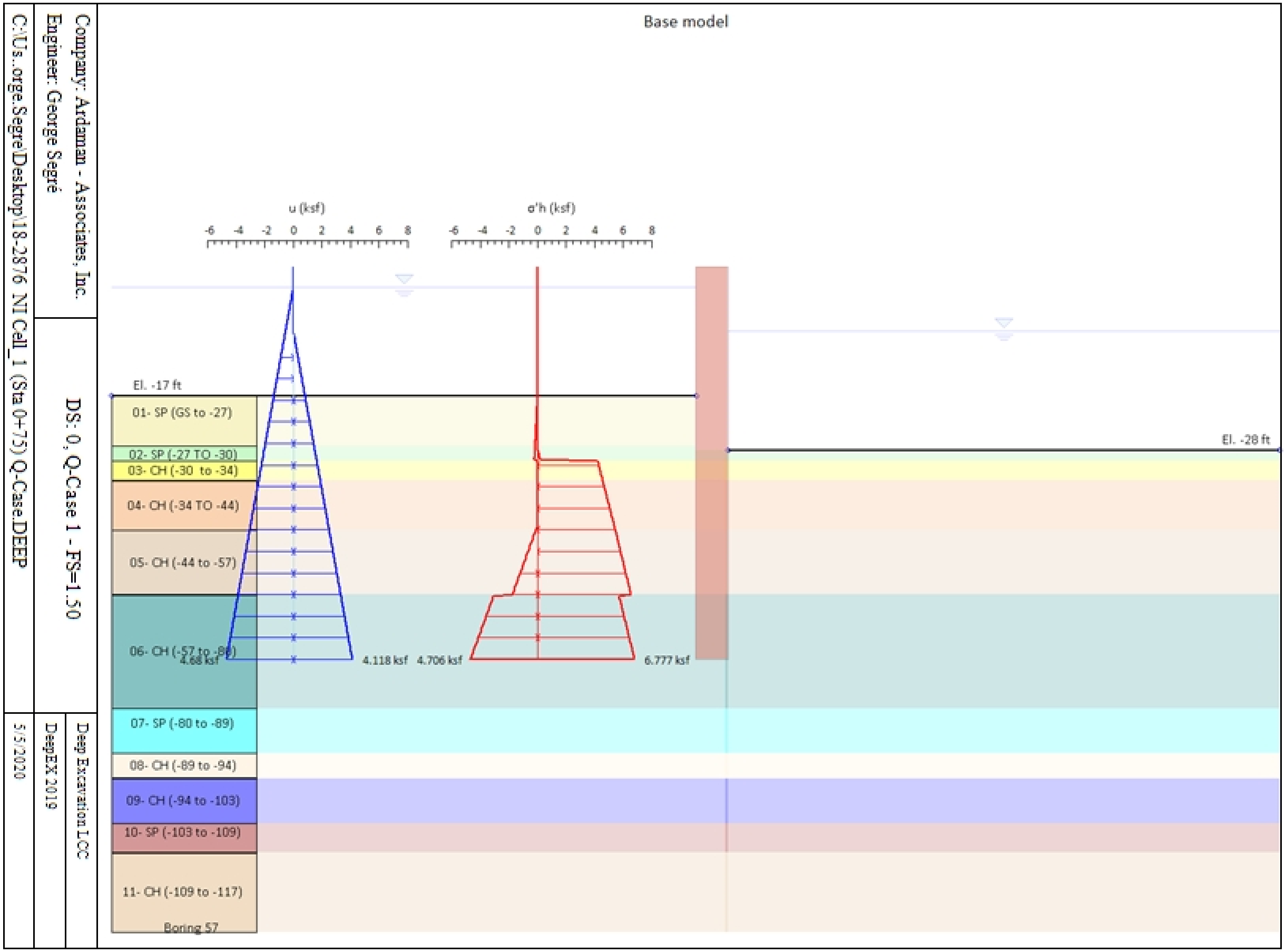
DS: 0, Q-Case 1 - FS=1.50

Deep Excavation LCC
DeepEX 2019
5/5/2020

Base model

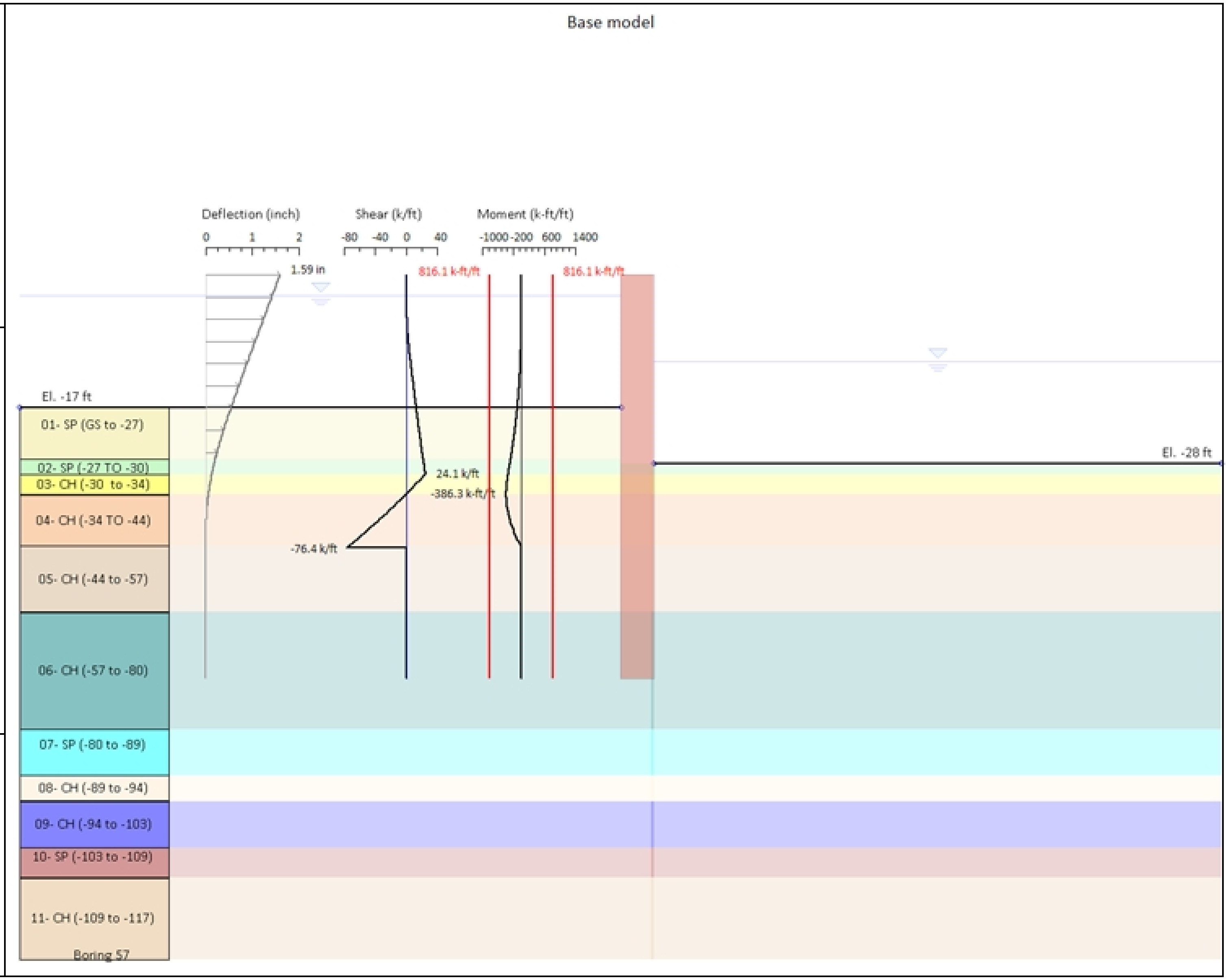



Base model
u (ksf)
σ'h (ksf)
-6 -4 -2 0 2 4 6 8
El. -17 ft
El. -28 ft
01- SP (GS to -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57
4.68 ksf
4.118 ksf
4.706 ksf
6.777 ksf
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP
DS: 0, Q-Case 1 - FS=1.50
Deep Excavation LCC
DeepEX 2019
5/5/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 2 FS=1.0

Deep Excavation LCC
DeepEX 2019
5/5/2020

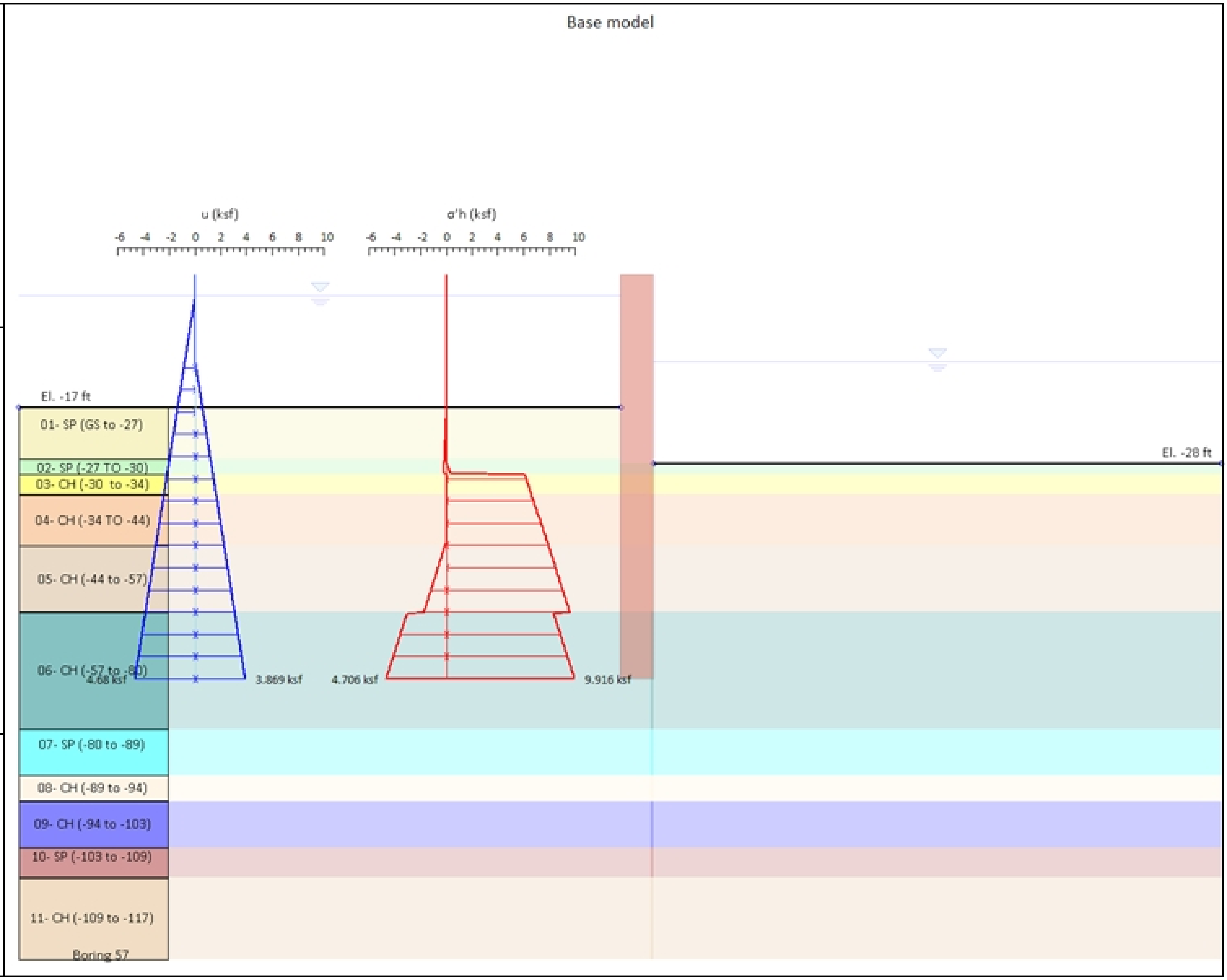


Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 2 FS=1.0

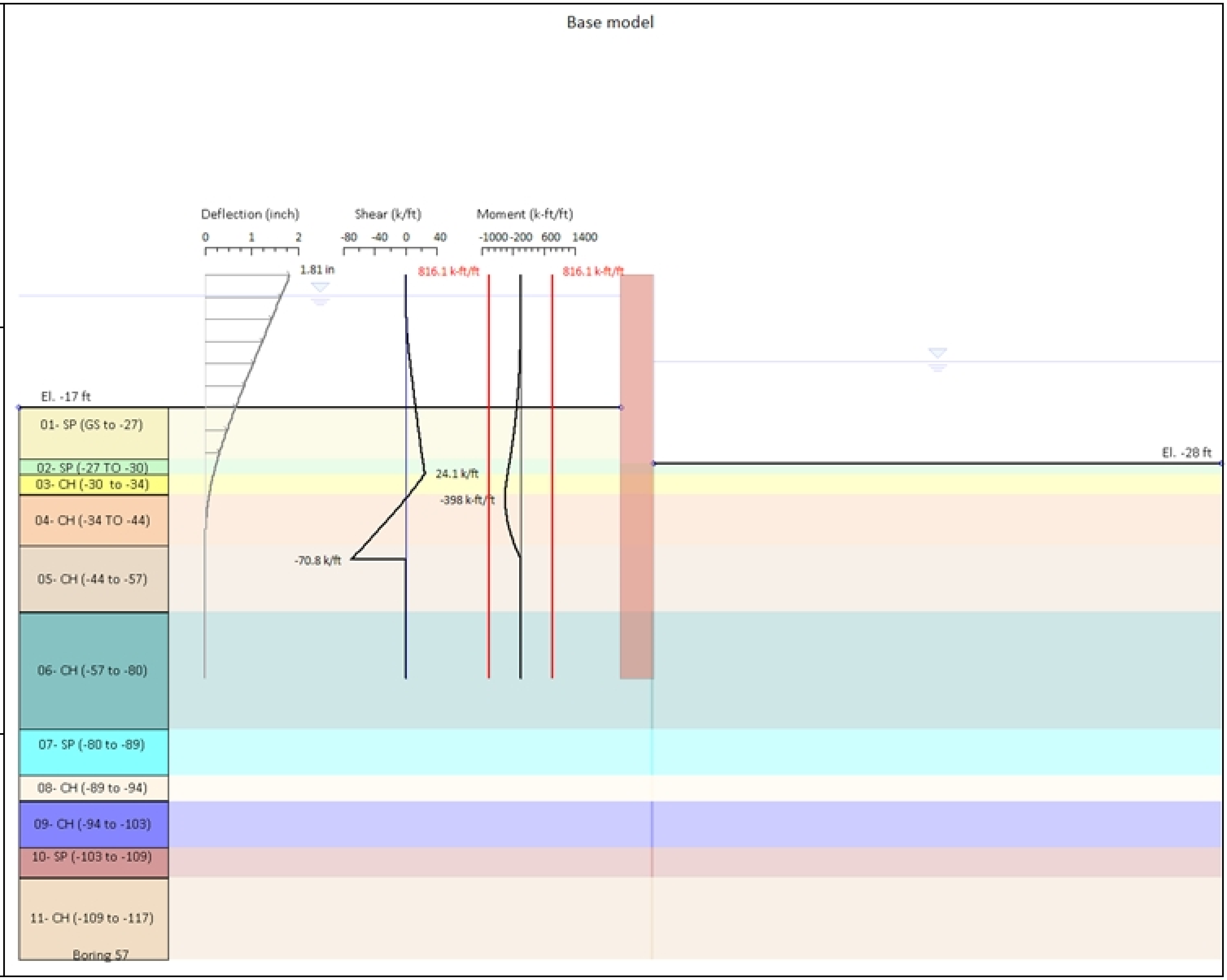
Deep Excavation LCC
DeepEX 2019
5/5/2020

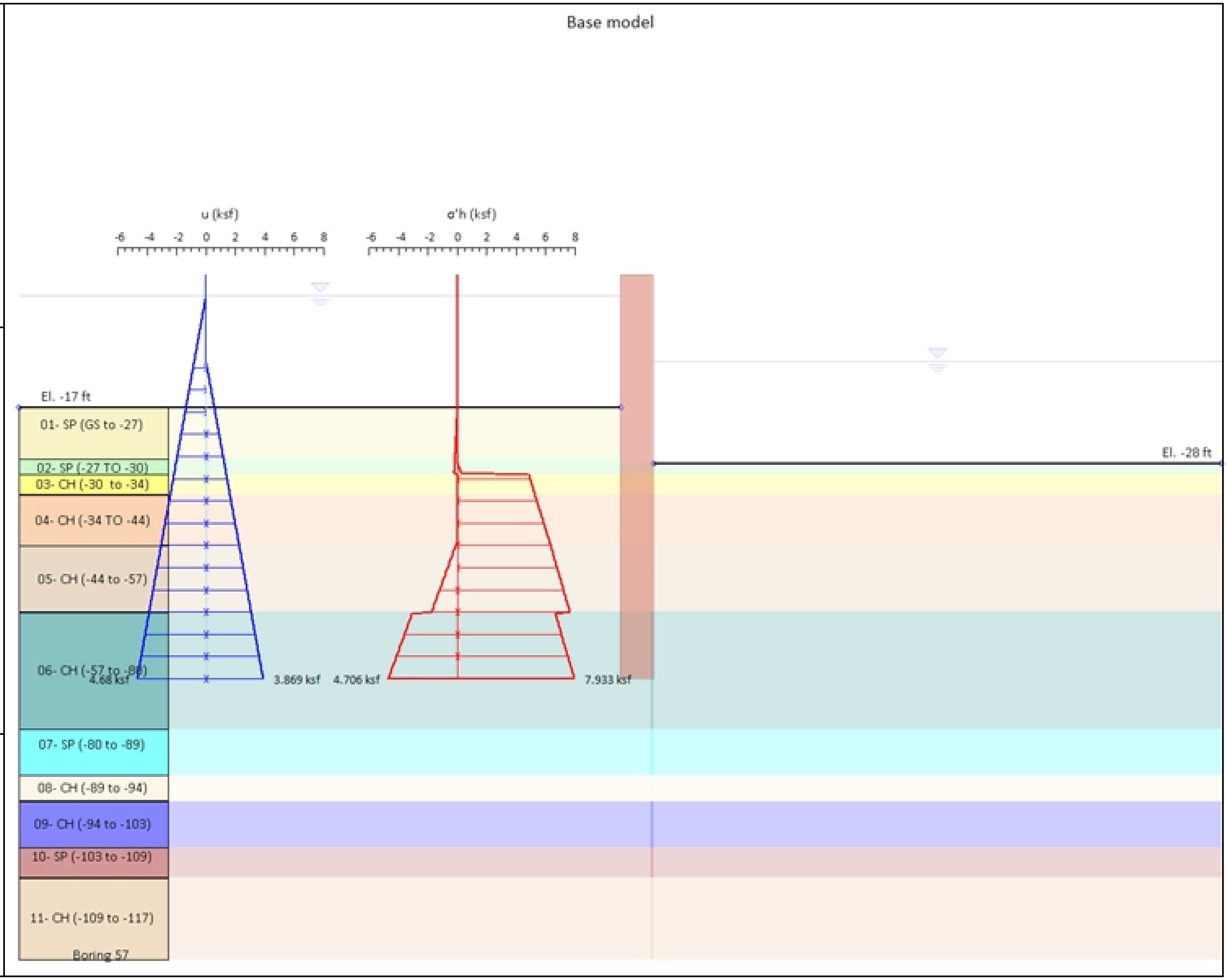


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 2 FS=1.25

Deep Excavation LCC
DeepEX 2019
5/5/2020





Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

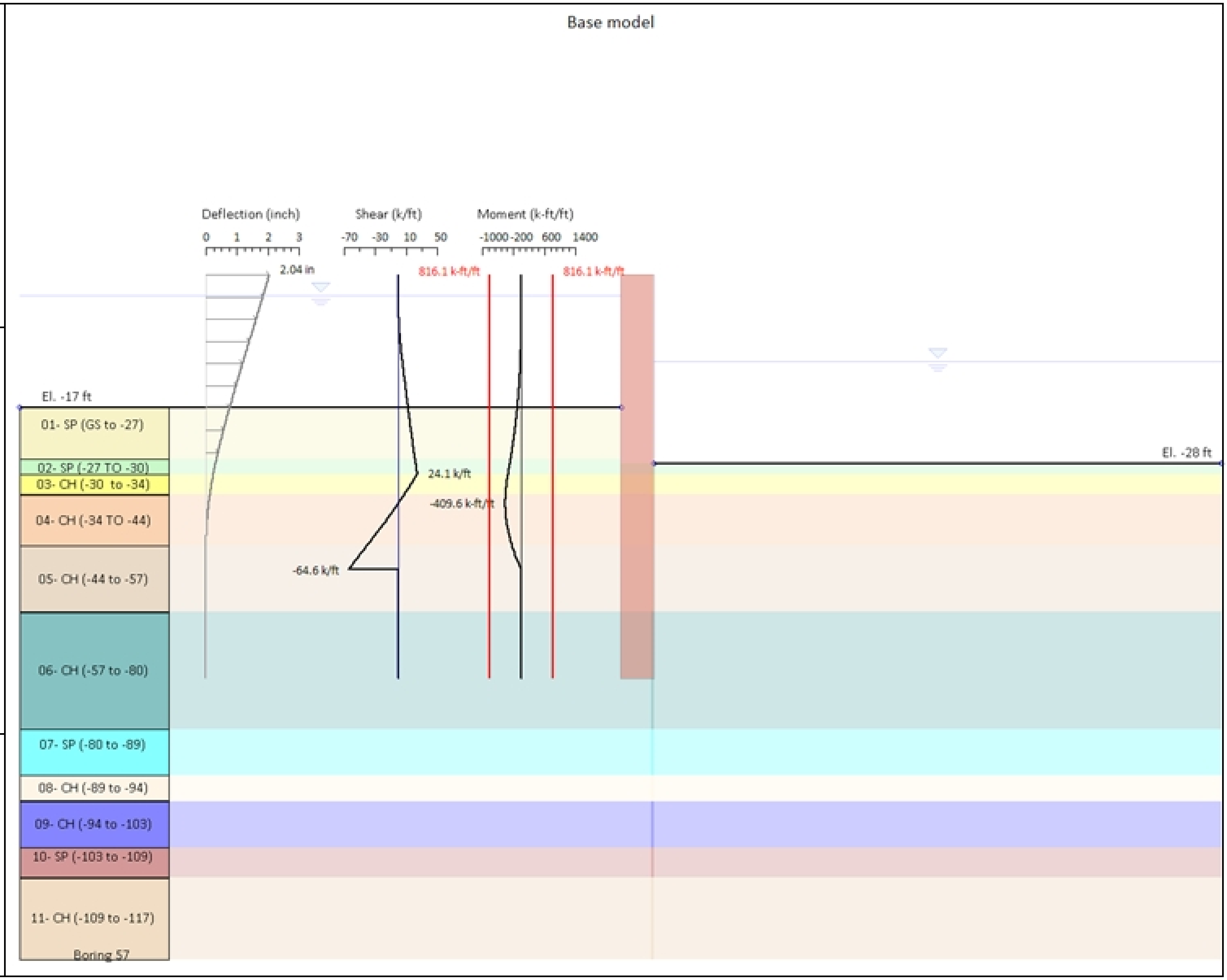
DS: 0, Q-Case 2 FS=1.25

Deep Excavation LCC
DeepEX 2019
5/5/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 2 FS=1.50

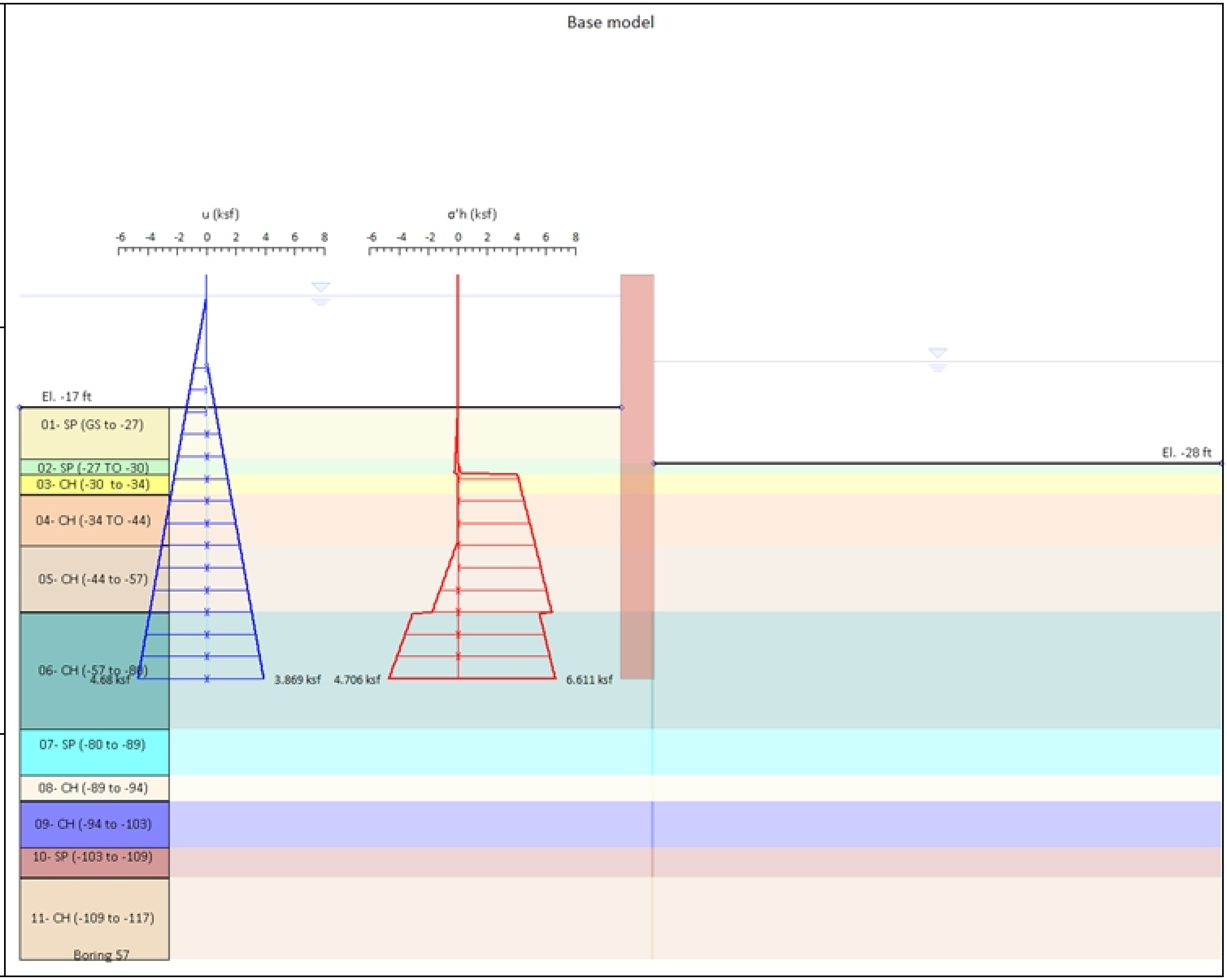
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 2 FS=1.50

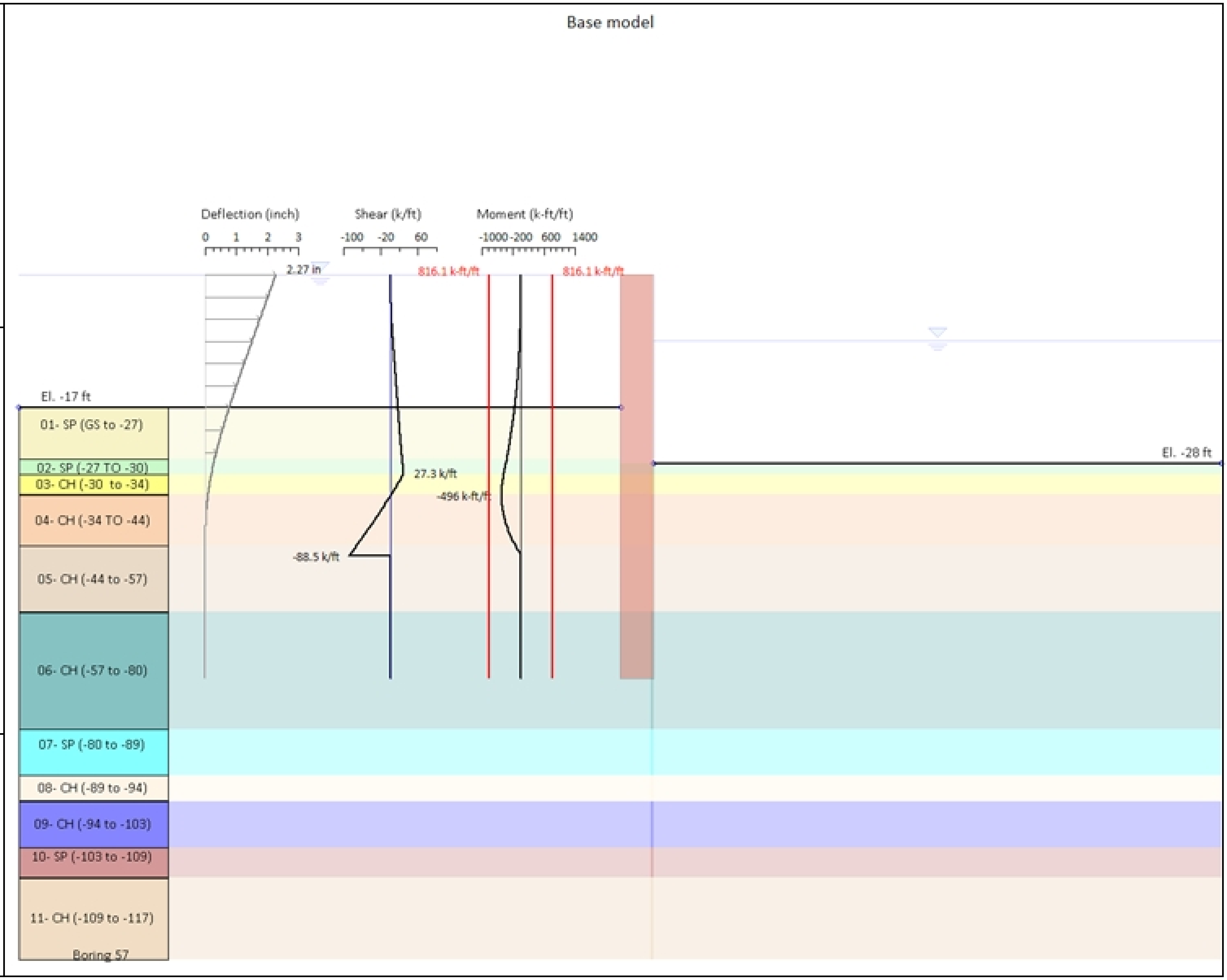
Deep Excavation LCC
DeepEX 2019
5/5/2020

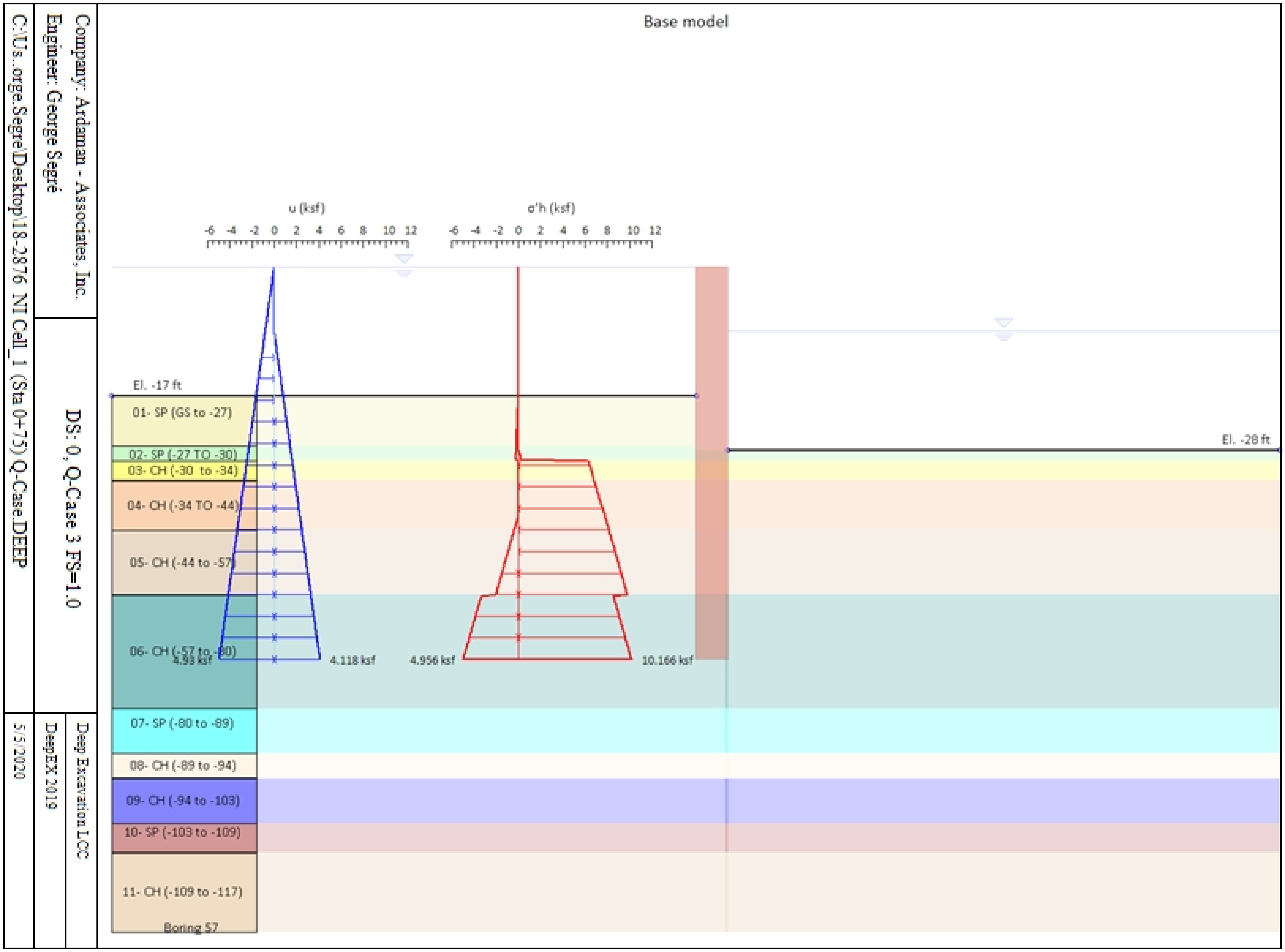


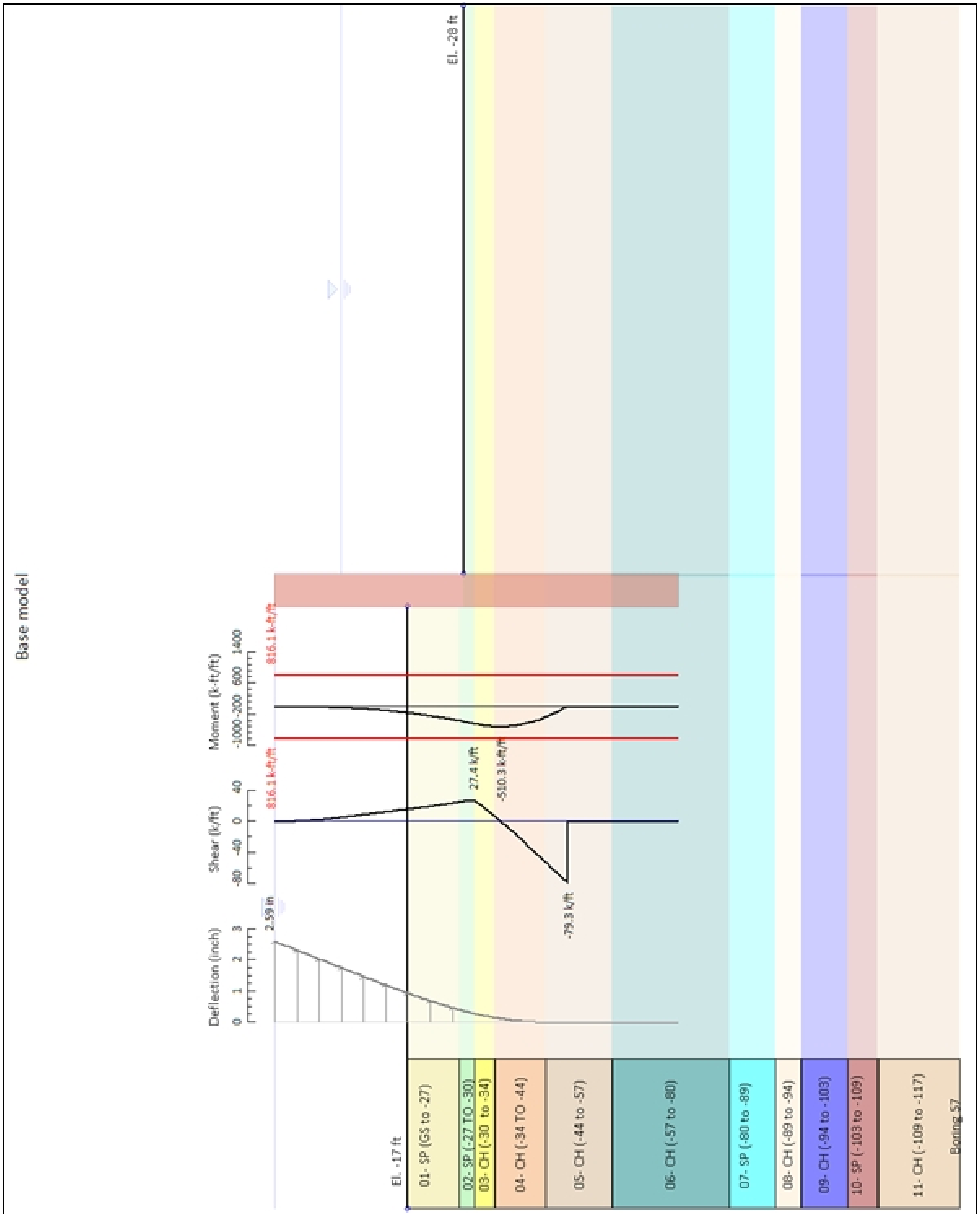
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 3 FS=1.0

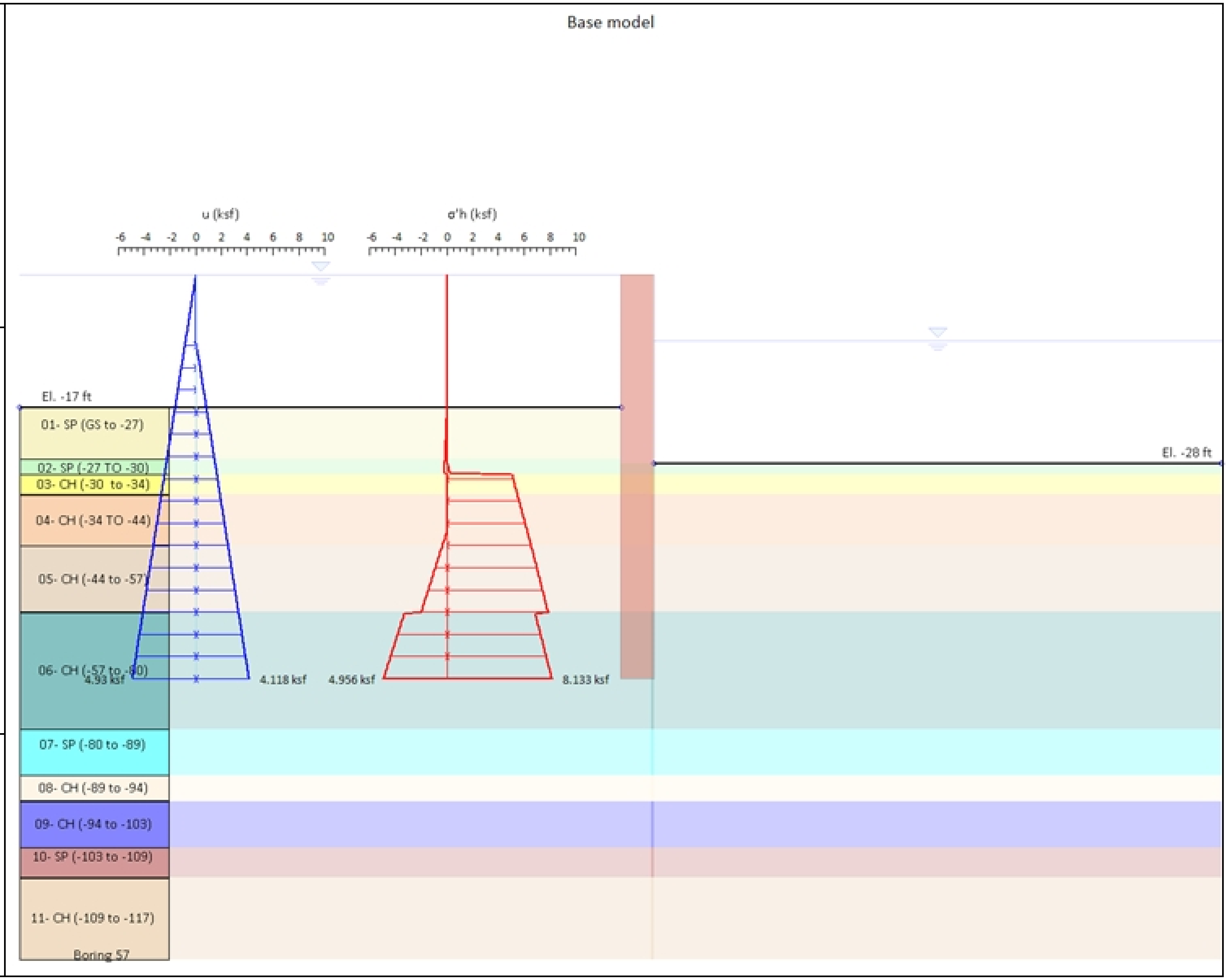
Deep Excavation LCC
DeepEX 2019
5/5/2020




Base model
u (ksf)
-6 -4 -2 0 2 4 6 8 10 12
σ'h (ksf)
-6 -4 -2 0 2 4 6 8 10 12
El. -17 ft
El. -28 ft
01- SP (GS to -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
4.93 ksf
4.118 ksf
4.956 ksf
10.166 ksf
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP
DS: 0, Q-Case 3 FS=1.0
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc. Engineer: George Segré	DS: 0, Q-Case 3 FS=1.25	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP		5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, Q-Case 3 FS=1.25

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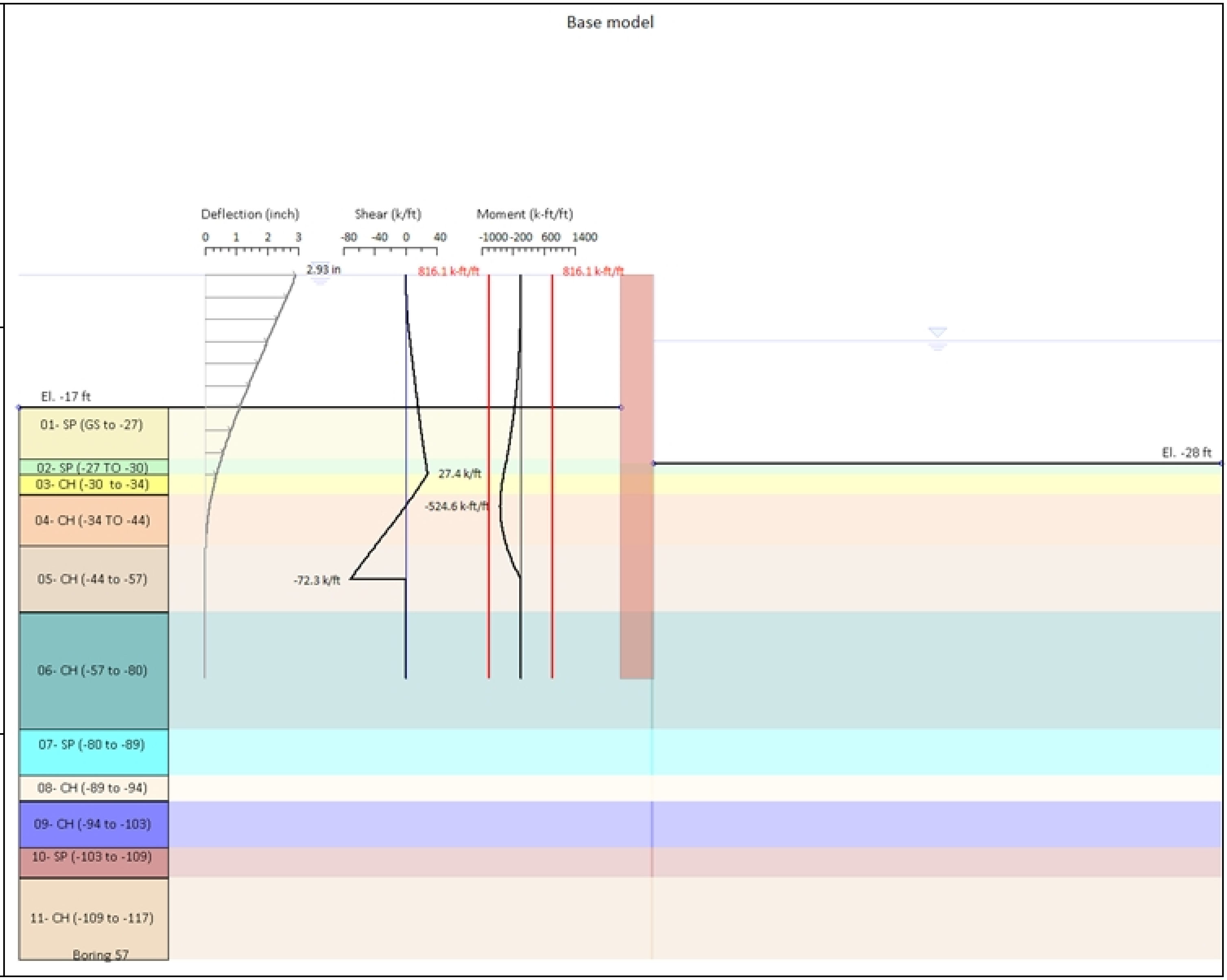
Deep Excavation LCC

DeepEX 2019

5/5/2020

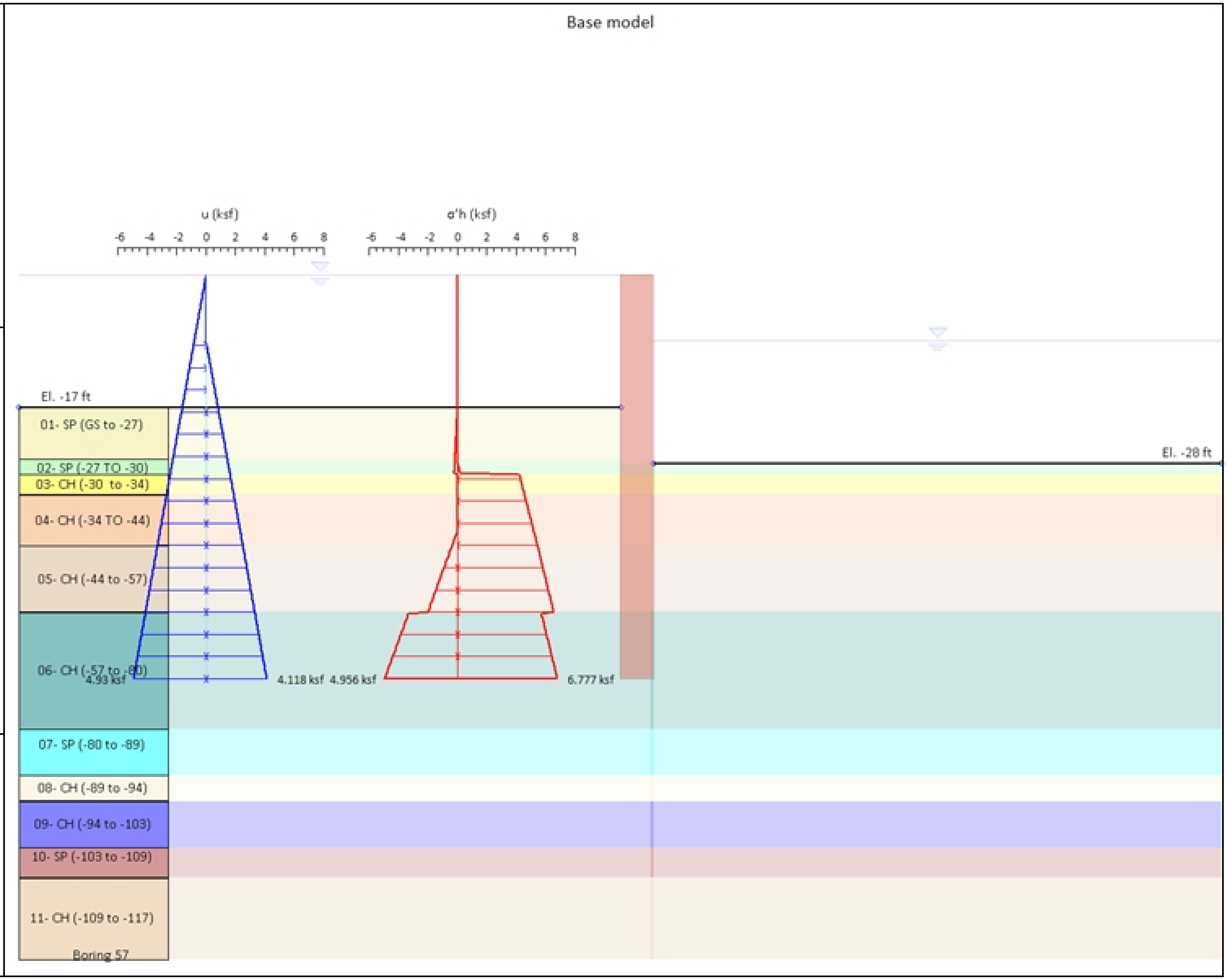
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP
DS: 0, Q-Case 3 FS=1.50
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 3 FS=1.50

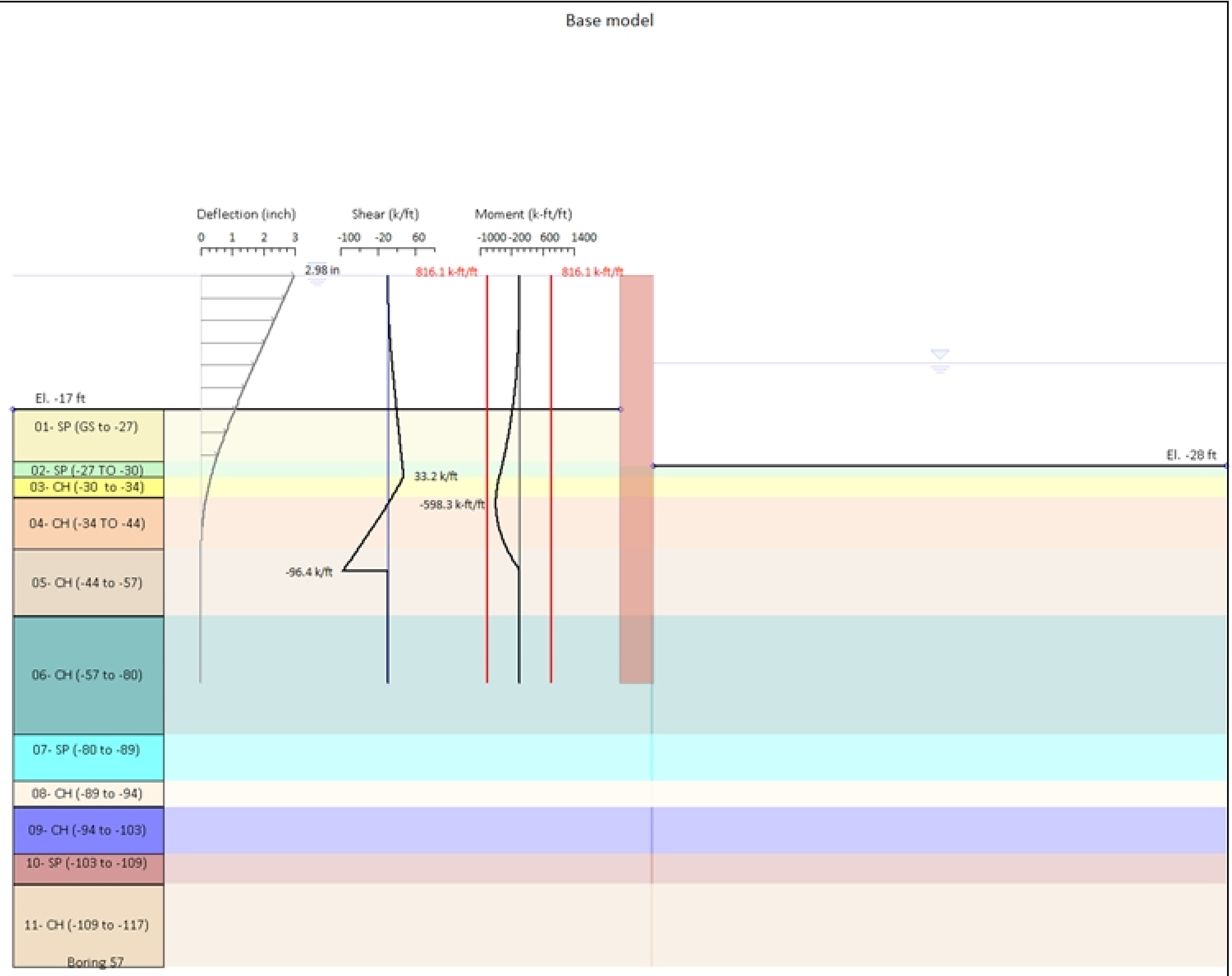
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 4 FS=1.0

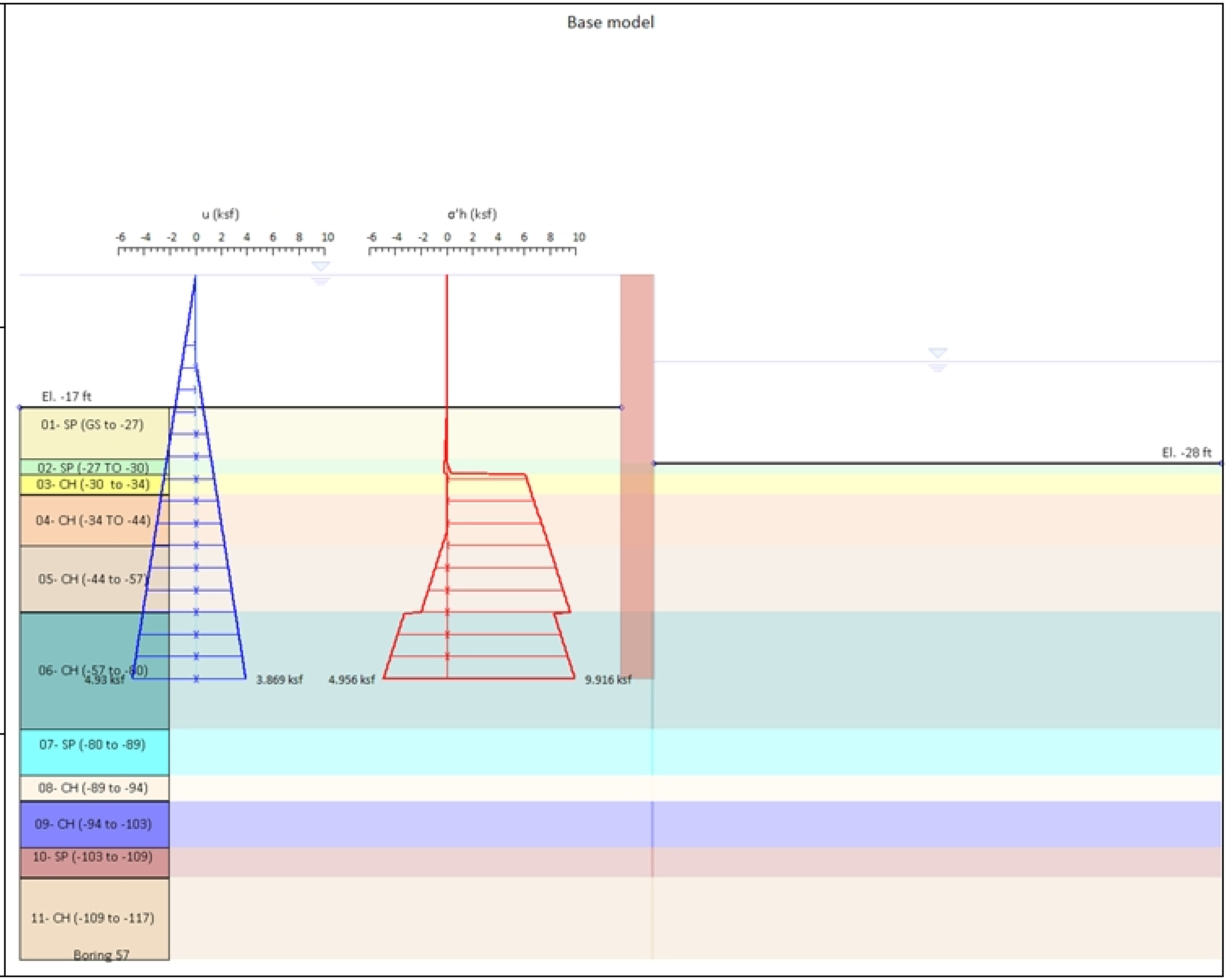
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 4 FS=1.0

Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré

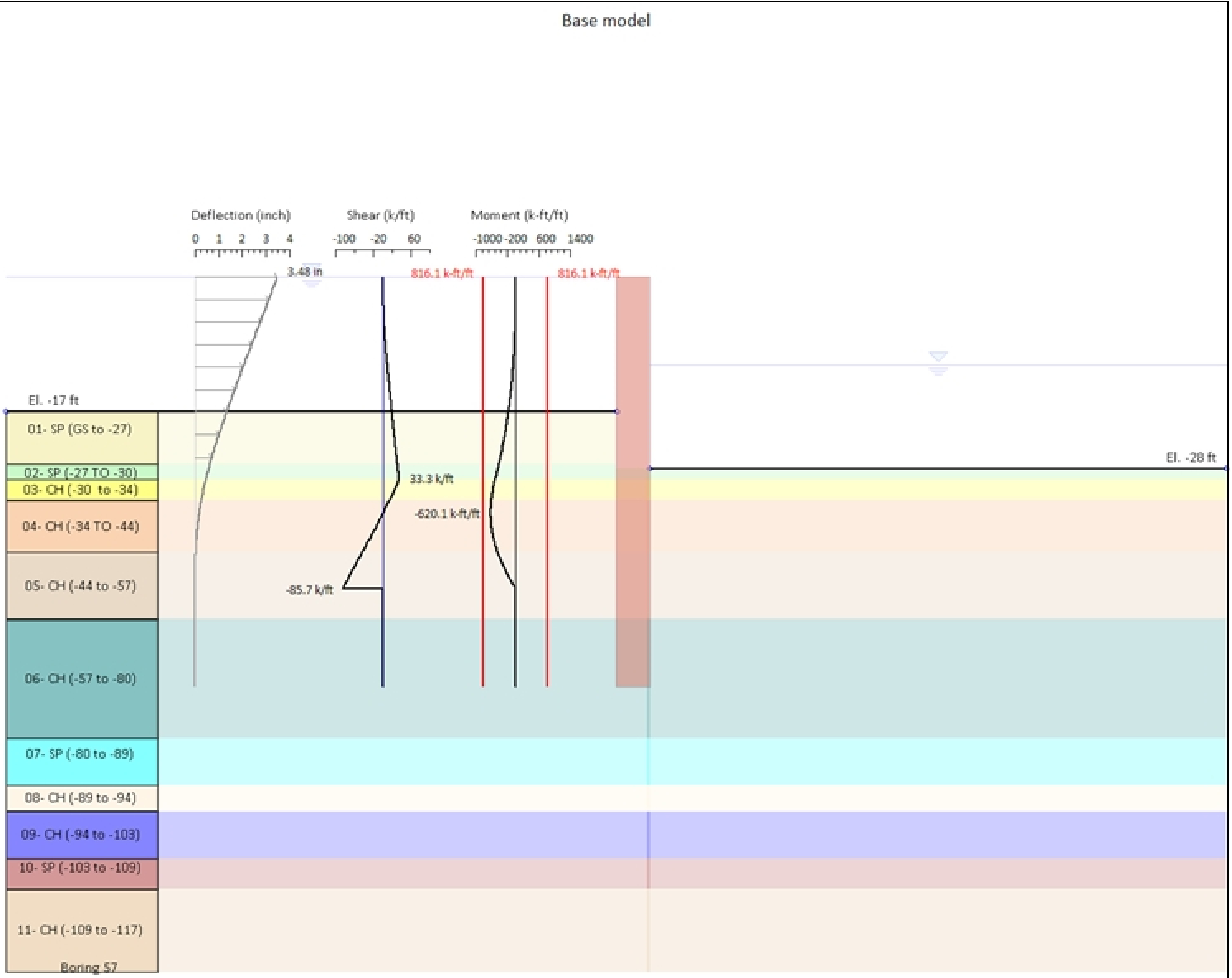
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

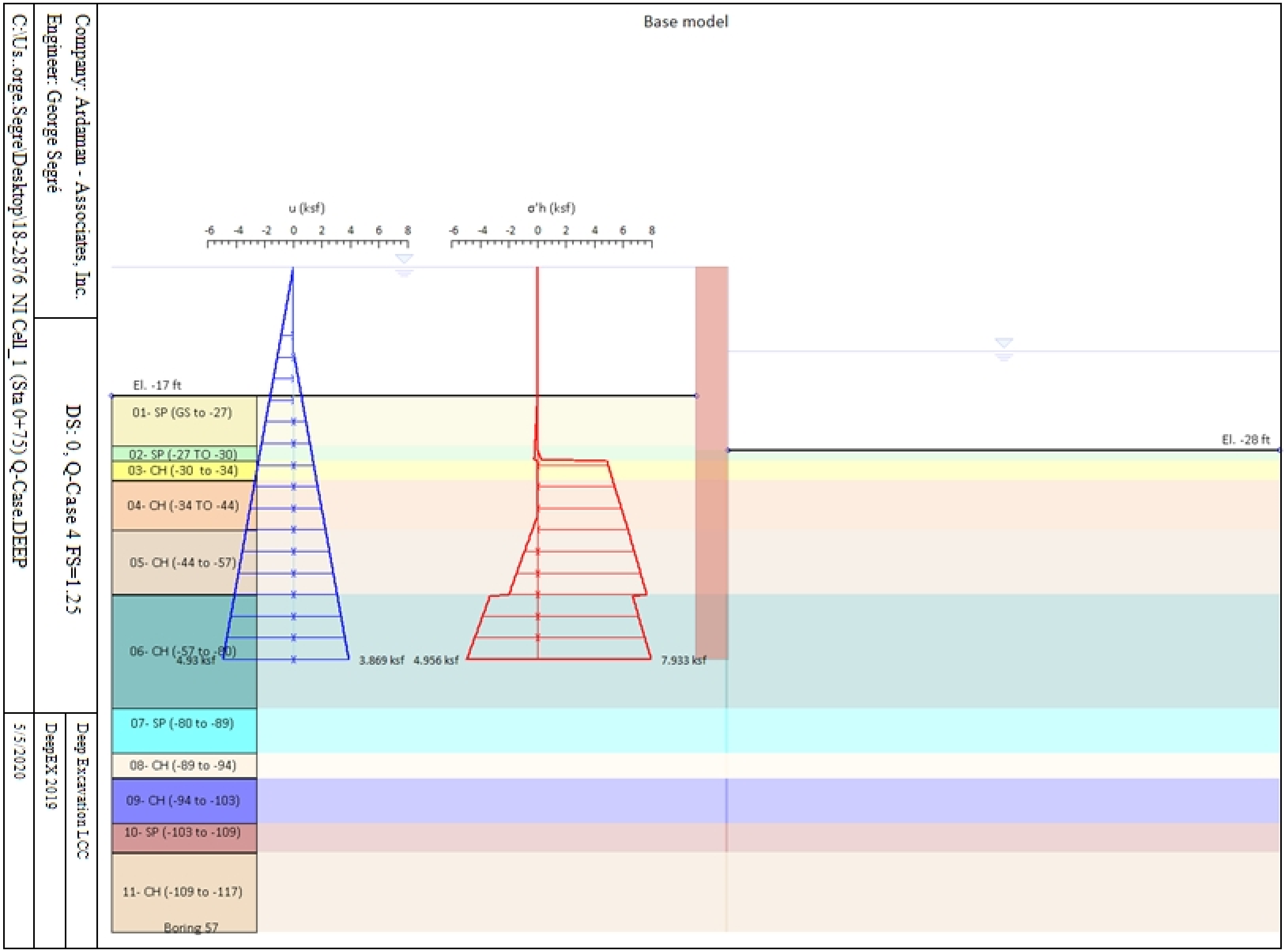
DS: 0, Q-Case 4 FS=1.25

Deep Excavation LCC

DeepEX 2019

5/5/2020

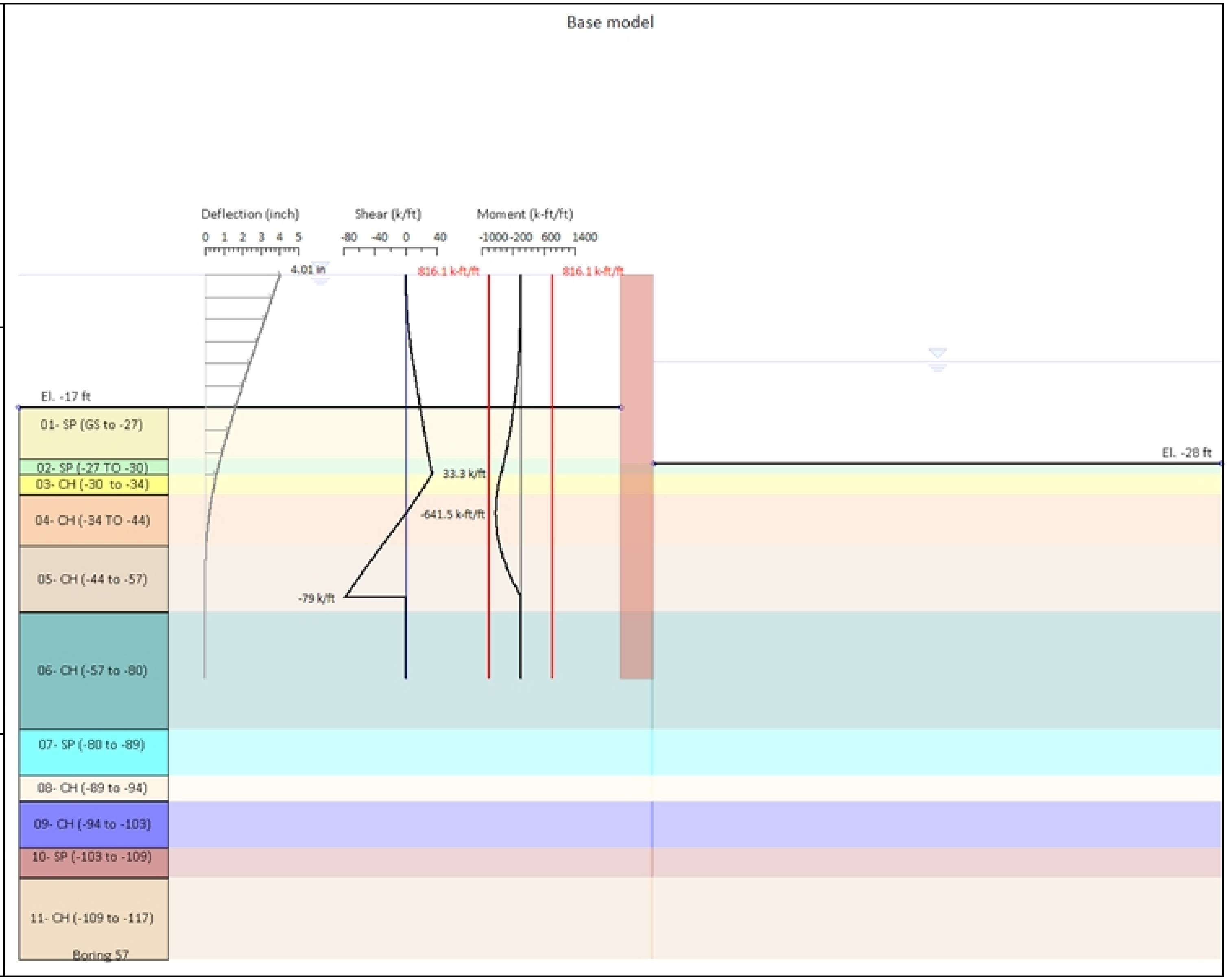



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP
DS: 0, Q-Case 4 FS=1.25
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
u (ksf)
σ'h (ksf)
-6 -4 -2 0 2 4 6 8
El. -17 ft
El. -28 ft
01- SP (GS to -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57
4.93 ksf
3.869 ksf
4.956 ksf
7.933 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

DS: 0, Q-Case 4 FS=1.50

Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré

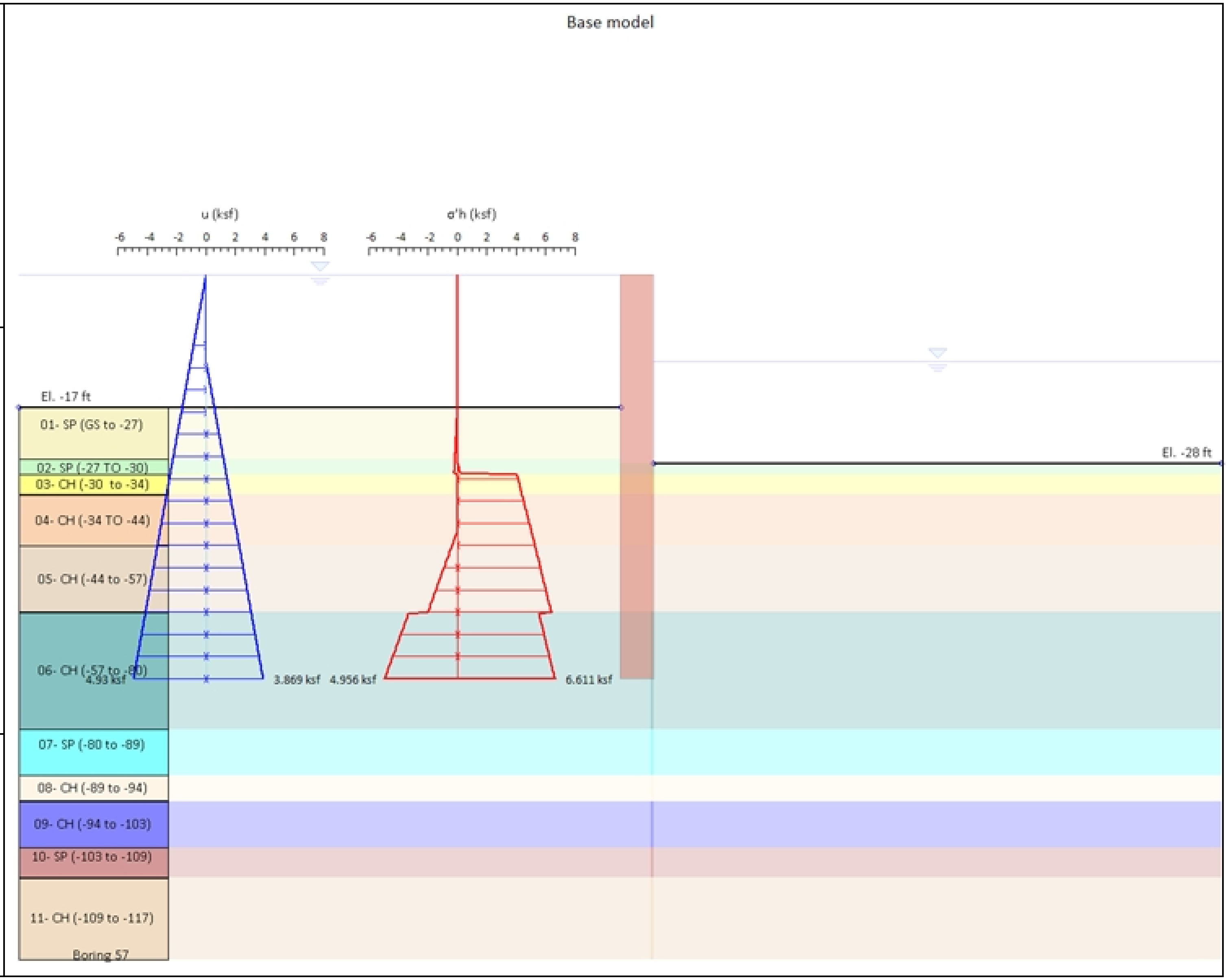
DS: 0, Q-Case 4 FS=1.50

C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) Q-Case.DEEP

Deep Excavation LCC

DeepEX 2019

5/5/2020



DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 5/5/2020 9:04:39 AM

File: C:\Users\George.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

ANALYSIS AND CHECKING SUMMARY

The following tables summarize critical resuls for all design sections. These results may include wall moments, shears, displacements, stress checks, wall embedment safety factors, basal & slope stability safety factors, etc.

Summary vs Design Section

Base model	Wall Moment	Wall Shear	Wall Displace	Max Support	Critical Support	Embedment	Comments
	(k-ft/ft)	(k/ft)	(in)	Reaction (k/ft)	Check	Wall FS	
Base model	1831.44	139.52	0	No supports	No supports	1.128	Calculation successful,

Extended Summary

Table: Extended summary for all design sections.

Design Section	Calculation Result	Wall Displacement	Settlement
Name		(in)	(in)
Base model	Calculation successful, however items may be unsafe	39.61	2.79

Table: Extended summary for wall moments and shears for all design sections.

Design Section	Wall Moment	Wall Moment	Wall Shear	Wall Shear
Name	(k-ft/ft)	(k-ft)	(k/ft)	(k)
Base model	1831.44	18845.54	139.52	1435.69

Table: Extended summary for wall stress checks for all design sections.

Design Section	STR Combined	STR Moment	STR Shear	Wall Concrete Service
Name	Wall Ratio	Wall Ratio	Wall Ratio	Stress Ratio FIC
Base model	2.244	2.244	0.391	N/A

Table notes:

STR Combined: Combined stress check, along eccentricity line considering axial load and moment (demand/capacity).
STR Moment : Moment stress check, assuming constant axial load on wall (demand/capacity).
STR Shear : Shear stress check (shear force demand/wall shear capacity).

Table: Extended summary for support results for all design sections

Design Section	Max Support	Max Support	Critical	STR Support	Support Geotech
Name	Reaction (k/ft)	Reaction (k)	Support Check	Ratio	Capacity Ratio (pull
Base model	No supports	No supports	No supports	No supports	No supports

Table notes:

STR Support ratio: Critical structural stress check for support (force demand/structural capacity).
Support geotech capacity ratio: Critical geotechnical capacity stress check (demand/geotechnical capacity).
Critical support check: Critical demand/design capacity ratio (structural or geotechnical).

Table: Summary for basal stability and wall embedment safety factors from conventional analyses.

Design Section	FS	Toe FS	Toe FS	Toe FS
Name	Basal	Passive	Rotation	Length
Base model	1.081	1.383	1.128	1.234

Table notes:

FSbasal : Critical basal stability safety factor (relevant only when soft clays are present beneath the excavation).
TOE FS Passive : Safety factor for wall embedment based on FS= Available horizontal thrust resistance/Driving hor. thrust.
TOE FS Rotation: Safety factor for wall embedment based on FS= Available resisting moment/Driving moment.
TOE FS Length : Safety factor for wall embedment based on FS= Available wall embedment/Required embedment for FS=1.0

Table: Summary for wall embedment safety factors from elastoplastic analyses.

Design Section	FS Mobilized	FS
Name	Passive	True/Active
Base model	N/A	N/A

Table notes:

FS Mobilized Passive : Safety factor= Available horizontal passive resistance/Mobilized passive thrust.
FS True/Active : Soil thrust on retained wall side/Minimum theoretically horizontal active force thrust.

Table: Summary for hydraulic safety factors, water flow, and slope stability

Design Section	Hydraulic	Qflow	FSslope
Name	Heave FS	(ft3/hr)	
Base model	N/A	N/A	N/A

Max. Moment vs Stage

	Base Model
M stg0 (k-ft/ft)	DS: 0
M stg1 (k-ft/ft)	-619.69
M stg2 (k-ft/ft)	-704.33
M stg3 (k-ft/ft)	-809.5
M stg4 (k-ft/ft)	-944.4
M stg5 (k-ft/ft)	-1098.72
M stg6 (k-ft/ft)	-989.14
M stg7 (k-ft/ft)	-1142.07
M stg8 (k-ft/ft)	-1315.48
M stg9 (k-ft/ft)	-1321.17
M stg10 (k-ft/ft)	-1558.57
M stg11 (k-ft/ft)	-1831.44

Max. Shear vs Stage

	Base Model
V stg0 (k/ft)	DS: 0
V stg1 (k/ft)	-68.68
V stg2 (k/ft)	-75.58
V stg3 (k/ft)	-89.3
V stg4 (k/ft)	-100.86
V stg5 (k/ft)	-107.59
V stg6 (k/ft)	-101.22
V stg7 (k/ft)	-118.17
V stg8 (k/ft)	-115.7
V stg9 (k/ft)	-139.52
V stg10 (k/ft)	-138.84
V stg11 (k/ft)	-131.94

Max. Support F vs Stage

	Base Model
Rmax Stage 0 (k/ft)	DS: 0
Rmax Stage 1 (k/ft)	N/A
Rmax Stage 2 (k/ft)	N/A
Rmax Stage 3 (k/ft)	N/A
Rmax Stage 4 (k/ft)	N/A
Rmax Stage 5 (k/ft)	N/A
Rmax Stage 6 (k/ft)	N/A
Rmax Stage 7 (k/ft)	N/A
Rmax Stage 8 (k/ft)	N/A
Rmax Stage 9 (k/ft)	N/A
Rmax Stage 10 (k/ft)	N/A
Rmax Stage 11 (k/ft)	N/A

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)

A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength
Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
01- SP (GS TO	115	115	33	0	N/A	N/A	N/A	300	3	0.3	3.39	N/A	N/A	True	EXP	
02- SP (-27 T	115	115	33	0	N/A	N/A	N/A	60	3	0.3	3.39	N/A	N/A	True	Linear	
03- CH (-30 t	126	126	26	0	N/A	N/A	N/A	150	3	0.39	2.56	N/A	N/A	True	Linear	
04- CH (-34 T	134	134	26	0	N/A	N/A	N/A	521.92	3	0.39	2.56	N/A	N/A	True	Linear	
05- CH (-44 to	126	126	26	0	N/A	N/A	N/A	417.54	3	0.39	2.56	N/A	N/A	True	Linear	
06- CH (-57 to	127	127	26	0	N/A	N/A	N/A	626.3	3	0.39	2.56	N/A	N/A	True	Linear	
07- SP (-80 to	122	122	33	0	N/A	N/A	N/A	300	3	0.3	3.39	N/A	N/A	True	Linear	
08- CH (-89 to	115	115	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	
09- CH (-94 to	120	120	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	
10- SP (-103 t	120	120	33	0	N/A	N/A	N/A	300	3	0.3	3.39	N/A	N/A	True	Linear	
11- CH (-109 t	115	115	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
01- SP (GS TO	0.4	-	-	0.455	0.5	1	0	7.2	4.8	20	-
02- SP (-27 T	0.4	-	-	0.455	0.5	-	-	5.1	3.4	20	-
03- CH (-30 t	0.3	-	-	0.562	0.5	-	-	13	8.7	20	-
04- CH (-34 T	0.3	-	-	0.562	0.5	-	-	21.8	14.5	30	-
05- CH (-44 to	0.45	-	-	0.562	0.5	-	-	18.1	12.1	30	-
06- CH (-57 to	0.35	-	-	0.562	0.5	-	-	29	19.3	70	-
07- SP (-80 to	0.35	-	-	0.455	0.8	-	-	0	0	0	-
08- CH (-89 to	0.3	-	-	0.562	0.8	-	-	0	0	0	-
09- CH (-94 to	0.25	-	-	0.562	0.8	-	-	0	0	0	-
10- SP (-103 t	0.35	-	-	0.455	0.8	-	-	0	0	0	-
11- CH (-109 t	0.35	-	-	0.562	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction
SIMC= Simplified Clay mode

SOIL BORINGS

Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Boring 57, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
-17	01- SP (GS TO	1	0.46
-27	02- SP (-27 TO	1	0.46
-30	03- CH (-30 to	1	0.56
-34	04- CH (-34 TO	1	0.56
-44	05- CH (-44 to	1	0.56
-57	06- CH (-57 to	1	0.56
-80	07- SP (-80 to -	1	0.46
-89	08- CH (-89 to	1	0.56
-94	09- CH (-94 to	1	0.56
-103	10- SP (-103 to	1	0.46
-109	11- CH (-109 t	1	1

WALL DATA

Wall section 0: Wall 1

Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP		5/5/2020

Wall uses wall section 0: Wall 1
Wall type: Combined sheet pile wall
Top wall El: 9 ft   Bottom wall El: -120 ft
Hor. wall spacing: 10.29 ft   Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft   Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi   Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.

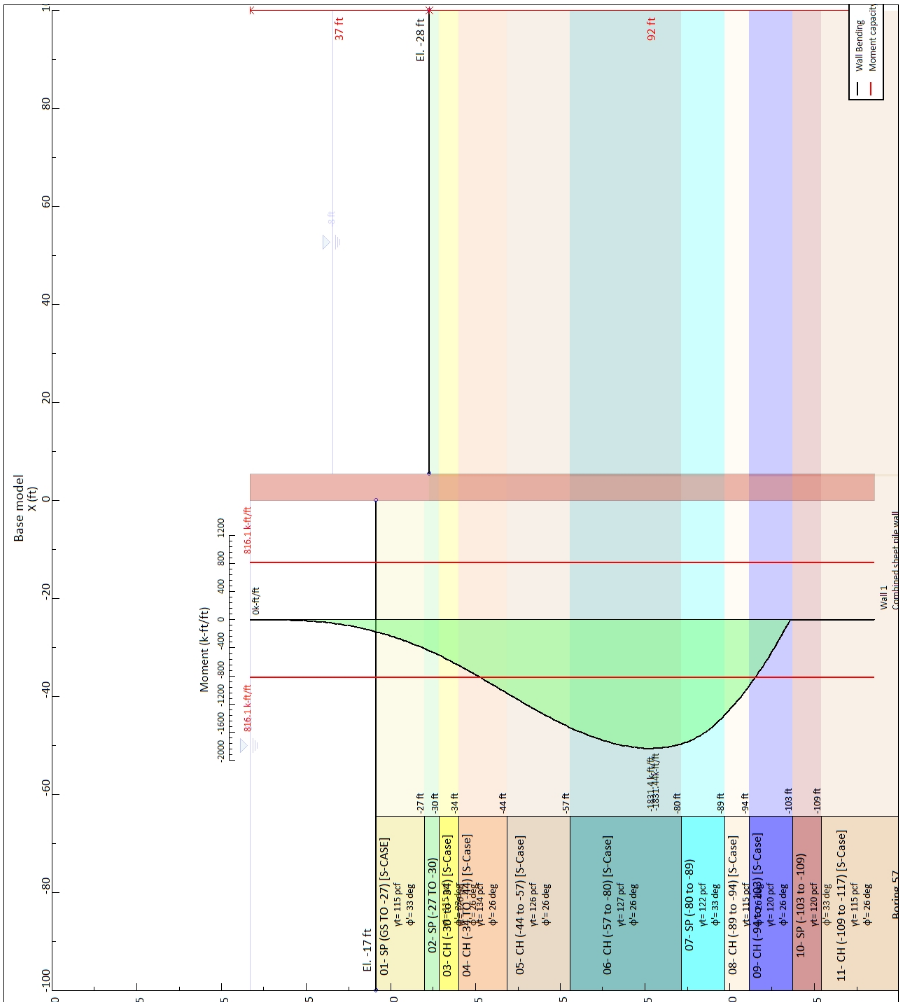
Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

GENERAL WALL DATA
Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk
F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

ANALYSIS AND CHECKING SUMMARY



Company: Ardaman - Associates, Inc.	Quick summary	Deep Excavation LCC
Engineer: George Segré		DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP		8/9/2020

Summary of Wall Moments and Toe Requirements

Top Wall	Wall	L-Wall	H-Exc.	Max+M/Cap	Max-M/Cap	FS Toe	FS Toe	FS Toe	FS 1 Toe EL.	Slope
(ft)	Section	(ft)	(ft)	(k-ft/ft)	(k-ft/ft)	Passive	Rotation	Embedment	(ft)	Stab. FS
9	Wall 1	129	11	0/816.12	1831.44/816.12	1.383	1.128	1.234	-102.58	N/A

Summary of Basal Stability and Predicted Wall Movements According to Clough 1989 Method Wall: W

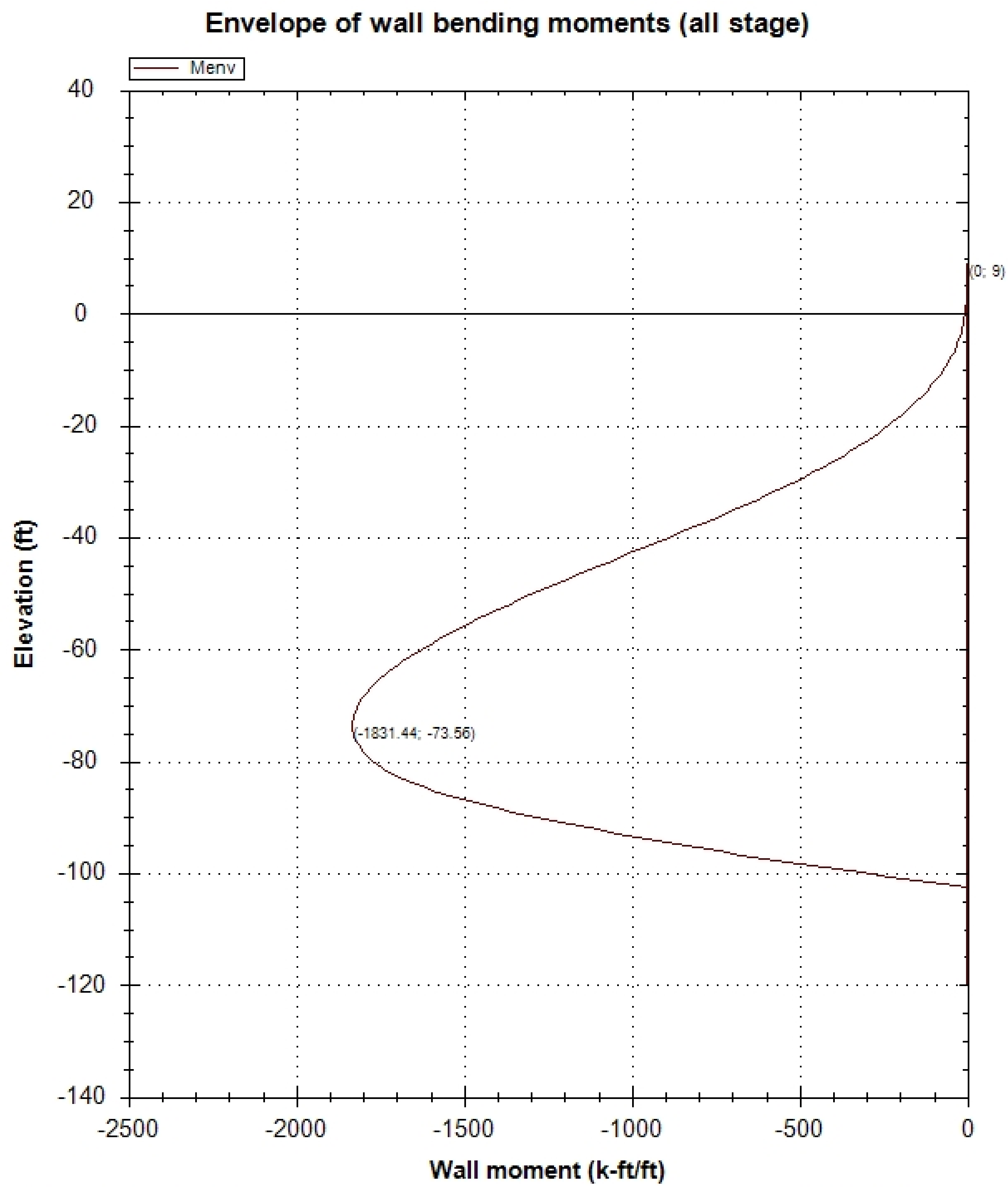
1. FSmin	2. DxMax (in)	2. Stiffness	2. FSbasal	3. Dx/H (%)	3. Stiffness	3. FSbasal
@ stage 9	@ stage 9	@ DxMax	@ DxMax	@ stage 9	@ Dx/H max	@ Dx/H max
1.081	0.664	2379.2	1.081	0.503	2379.153	1.081

General assumptions for last stage: S-Case 4 FS = 1.50

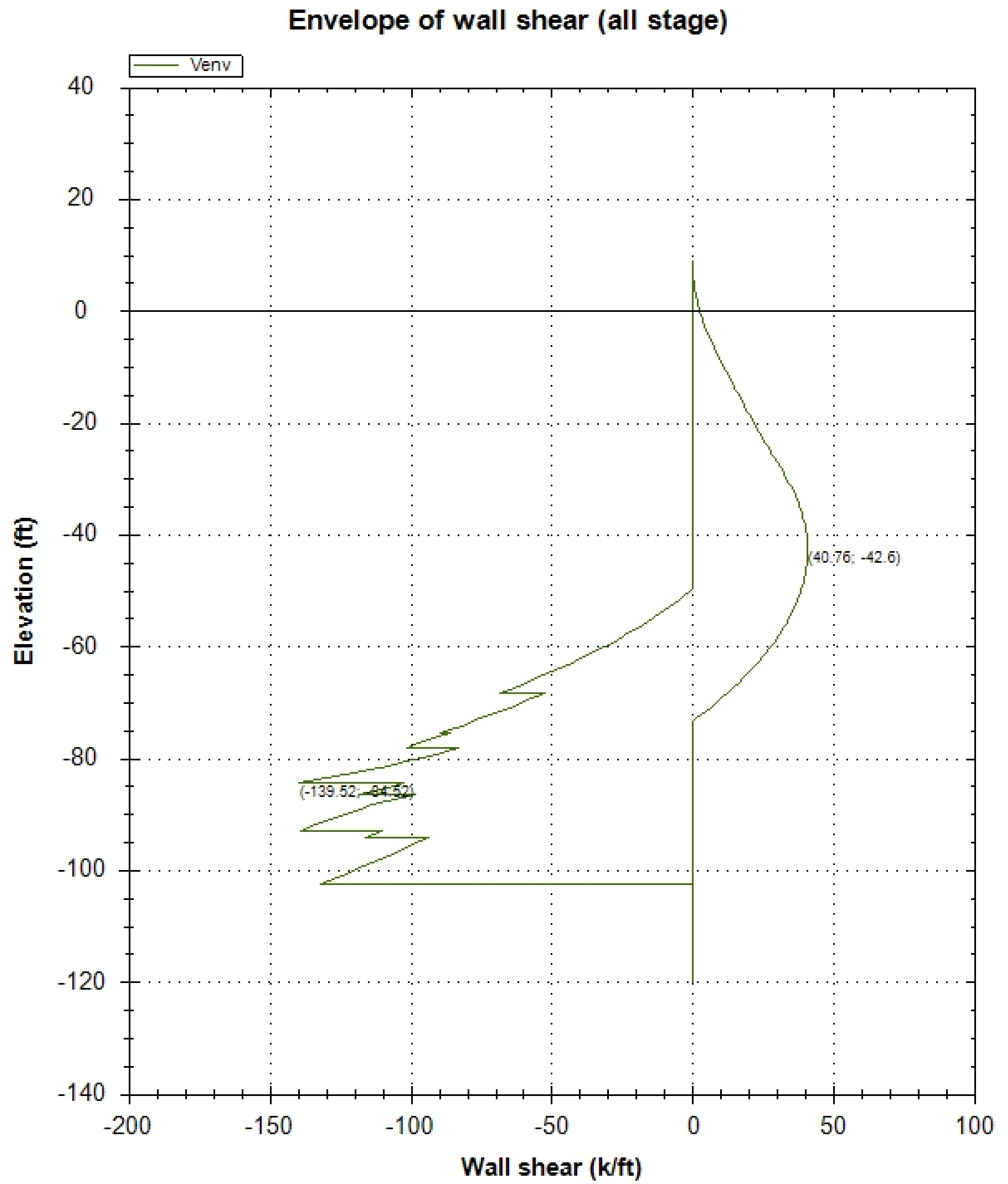
Concrete Code:	ACI 318-11/1.6
Steel Code:	AISC 360-16 ALL.
1st Wall Limit Equilibrium	Assume: Blum's method
Drain State Clays	Undrained-Total stress (clays)
Water γ= 62.4 pcf (no net)	Hydrostatic
Drive	Ka
Resist	Kp/1.5

Envelope of results

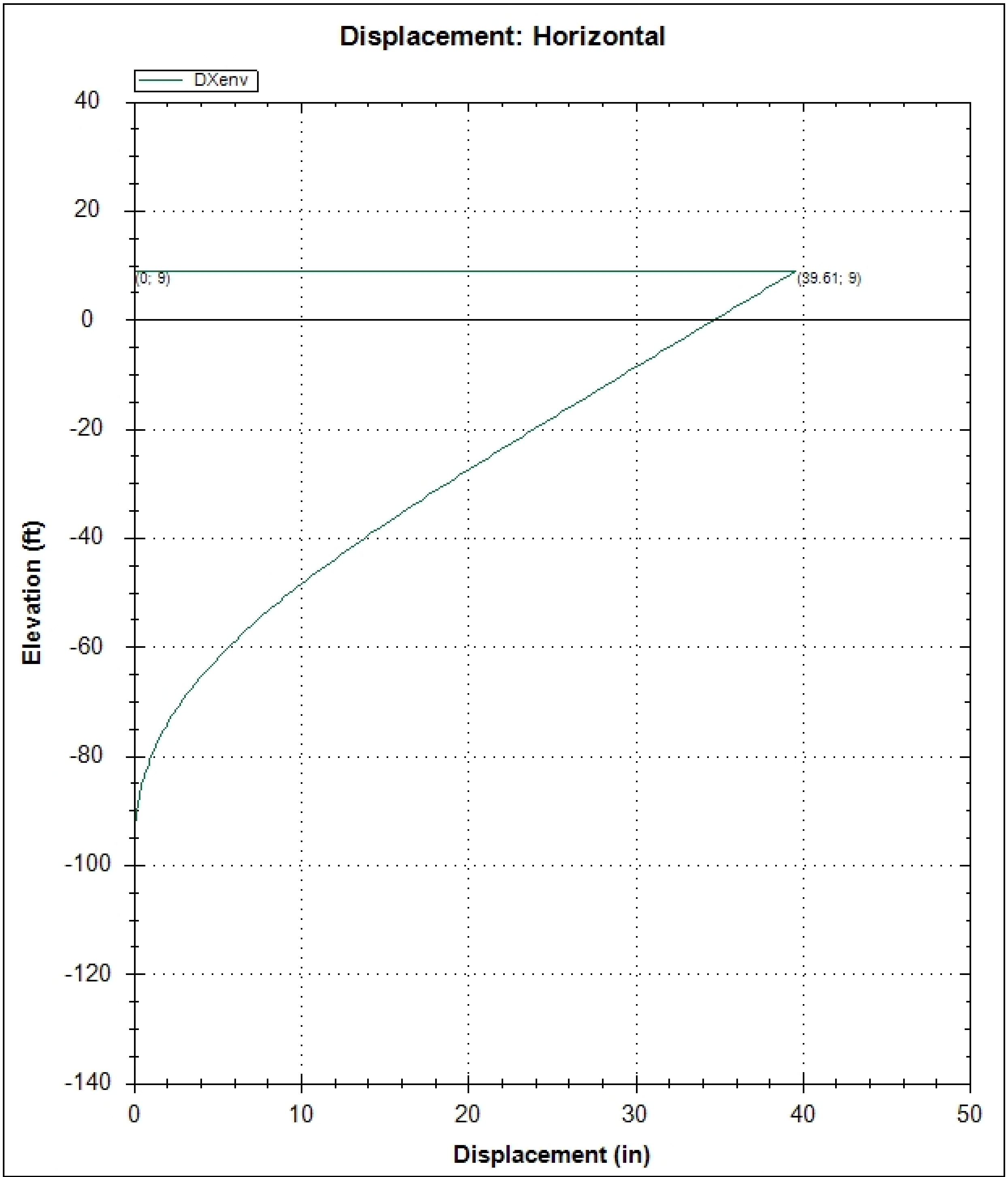
A sequence of result diagrams for each excavation stage is reported



Company: Ardaman - Associates, Inc. Engineer: George Segré	DS: 0 (left wall) Envelope of results	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP		5/5/2020



Company: Ardaman - Associates, Inc. Engineer: George Segré	DS: 0 (left wall) Envelope of results	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP		5/5/2020



Company: Ardaman - Associates, Inc. Engineer: George Segré	DS: 0 (left wall) Envelope of results	Deep Excavation LCC DeepEX 2019
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP		5/5/2020

Extended vs Stage

	Calculation Result	Wall Displaceme	Settlement	Wall Moment	Wall Moment
		(in)	(in)	(k-ft/ft)	(k-ft)
S-Case 1 - FS=1.0	Calculated	5.34	2.1	544.4	5601.85
S-Case 1 - FS=1.25	Calculated	7.32	2.1	619.69	6376.66
S-Case 1 - FS=1.50	Calculated	9.93	2.1	704.33	7247.52
S-Case 2 - FS=1.0	Calculated	9.54	2.39	809.5	8329.79
S-Case 2 FS=1.25	Calculated	13.71	2.39	944.4	9717.9
S-Case 2 FS=1.5	Calculated	19.08	2.39	1098.72	11305.83
S-Case 3 FS=1.0	Calculated	12.7	2.45	989.14	10178.29
S-Case 3 FS=1.25	Calculated	17.96	2.45	1142.07	11751.86
S-Case 3 FS=1.50	Calculated	24.51	2.45	1315.48	13536.27
S-Case 4 FS=1.0	Calculated	19.61	2.79	1321.17	13594.8
S-Case 4 FS=1.25	Calculated	28.33	2.79	1558.57	16037.68
S-Case 4 FS = 1.50	Calculated	39.61	2.79	1831.44	18845.54

	Wall Shear	Wall Shear	STR Combined	STR Moment	STR Shear
	(k/ft)	(k)	Wall Ratio	Wall Ratio	Wall Ratio
S-Case 1 - FS=1.0	67.97	699.39	0.667	0.667	0.191
S-Case 1 - FS=1.25	68.68	706.76	0.759	0.759	0.193
S-Case 1 - FS=1.50	75.58	777.71	0.863	0.863	0.212
S-Case 2 - FS=1.0	89.3	918.87	0.992	0.992	0.25
S-Case 2 FS=1.25	100.86	1037.88	1.157	1.157	0.283
S-Case 2 FS=1.5	107.59	1107.11	1.346	1.346	0.302
S-Case 3 FS=1.0	101.22	1041.59	1.212	1.212	0.302
S-Case 3 FS=1.25	118.17	1215.99	1.399	1.399	0.331
S-Case 3 FS=1.50	115.7	1190.56	1.612	1.612	0.331
S-Case 4 FS=1.0	139.52	1435.69	1.619	1.619	0.391
S-Case 4 FS=1.25	138.84	1428.68	1.91	1.91	0.391
S-Case 4 FS = 1.50	131.94	1357.69	2.244	2.244	0.389

Table notes:

STR Combined: Combined stress check, along eccentricity line considering axial load and moment (demand/capacity).
STR Moment : Moment stress check, assuming constant axial load on wall (demand/capacity).
STR Shear : Shear stress check (shear force demand/wall shear capacity).

	Max Support	Max Support	Critical	STR Support	Support Geotech
	Reaction (k/ft)	Reaction (k)	Support Check	Ratio	Capacity Ratio (pull out
S-Case 1 - FS=1.0	No supports	No supports	No supports	No supports	No supports
S-Case 1 - FS=1.25	No supports	No supports	No supports	No supports	No supports
S-Case 1 - FS=1.50	No supports	No supports	No supports	No supports	No supports
S-Case 2 - FS=1.0	No supports	No supports	No supports	No supports	No supports
S-Case 2 FS=1.25	No supports	No supports	No supports	No supports	No supports
S-Case 2 FS=1.5	No supports	No supports	No supports	No supports	No supports
S-Case 3 FS=1.0	No supports	No supports	No supports	No supports	No supports
S-Case 3 FS=1.25	No supports	No supports	No supports	No supports	No supports
S-Case 3 FS=1.50	No supports	No supports	No supports	No supports	No supports
S-Case 4 FS=1.0	No supports	No supports	No supports	No supports	No supports
S-Case 4 FS=1.25	No supports	No supports	No supports	No supports	No supports
S-Case 4 FS = 1.50	No supports	No supports	No supports	No supports	No supports

Table notes:

STR Support ratio: Critical structural stress check for support (force demand/structural capacity).
Support geotech capacity ratio: Critical geotechnical capacity stress check (demand/geotechnical capacity).
Critical support check: Critical demand/design capacity ratio (structural or geotechnical).

	FS Basal	Toe FS Passive	Toe FS Rotation	Toe FS Length	Zcut (nonlinear)	FS Mobilized Passive	FS True/Active
S-Case 1 - FS=1.0	1.278	1.907	1.598	2.277	N/A	N/A	N/A
S-Case 1 - FS=1.2	1.278	1.664	1.411	1.937	N/A	N/A	N/A
S-Case 1 - FS=1.5	1.278	1.502	1.287	1.685	N/A	N/A	N/A
S-Case 2 - FS=1.0	1.184	1.86	1.532	1.937	N/A	N/A	N/A
S-Case 2 FS=1.25	1.184	1.617	1.345	1.646	N/A	N/A	N/A
S-Case 2 FS=1.5	1.184	1.455	1.22	1.446	N/A	N/A	N/A
S-Case 3 FS=1.0	1.168	1.812	1.477	1.837	N/A	N/A	N/A
S-Case 3 FS=1.25	1.168	1.581	1.304	1.574	N/A	N/A	N/A
S-Case 3 FS=1.50	1.168	1.427	1.189	1.39	N/A	N/A	N/A
S-Case 4 FS=1.0	1.081	1.767	1.416	1.627	N/A	N/A	N/A
S-Case 4 FS=1.25	1.081	1.537	1.243	1.417	N/A	N/A	N/A
S-Case 4 FS = 1.5	1.081	1.383	1.128	1.234	N/A	N/A	N/A

	Hydraulic Heave FS	Qflow (ft3/hr)	FSslope
S-Case 1 - FS=1.0	N/A	N/A	N/C
S-Case 1 - FS=1.25	N/A	N/A	N/C
S-Case 1 - FS=1.50	N/A	N/A	N/C
S-Case 2 - FS=1.0	N/A	N/A	N/C
S-Case 2 FS=1.25	N/A	N/A	N/C
S-Case 2 FS=1.5	N/A	N/A	N/C
S-Case 3 FS=1.0	N/A	N/A	N/C
S-Case 3 FS=1.25	N/A	N/A	N/C
S-Case 3 FS=1.50	N/A	N/A	N/C
S-Case 4 FS=1.0	N/A	N/A	N/C
S-Case 4 FS=1.25	N/A	N/A	N/C
S-Case 4 FS = 1.50	N/A	N/A	N/C

Support Force/S vs Stage

	No Supports
0:S-Case 1 - FS=1.0	No support
1:S-Case 1 - FS=1.25	
2:S-Case 1 - FS=1.50	
3:S-Case 2 - FS=1.0	
4:S-Case 2 FS=1.25	
5:S-Case 2 FS=1.5	
6:S-Case 3 FS=1.0	
7:S-Case 3 FS=1.25	
8:S-Case 3 FS=1.50	
9:S-Case 4 FS=1.0	
10:S-Case 4 FS=1.25	
11:S-Case 4 FS = 1.50	

Support Force vs Stage

Support Force vs Stage

	No Supports
0:S-Case 1 - FS=1.0	No support
1:S-Case 1 - FS=1.25	
2:S-Case 1 - FS=1.50	
3:S-Case 2 - FS=1.0	
4:S-Case 2 FS=1.25	
5:S-Case 2 FS=1.5	
6:S-Case 3 FS=1.0	
7:S-Case 3 FS=1.25	
8:S-Case 3 FS=1.50	
9:S-Case 4 FS=1.0	
10:S-Case 4 FS=1.25	
11:S-Case 4 FS = 1.50	

Embedment FS vs Stage

	Min Toe FS	FS1 Passive	FS2 Rotation	FS3 Length (from FS1, FS2)	FS4 Mobilized Passive	FS5 Actual Drive Thrust / Theory
Stage 0	1.598	1.907	1.598	2.277	N/A	N/A
0:S-Case 1 -	1.411	1.664	1.411	1.937	N/A	N/A
1:S-Case 1 -	1.287	1.502	1.287	1.685	N/A	N/A
2:S-Case 1 -	1.532	1.86	1.532	1.937	N/A	N/A
3:S-Case 2 -	1.345	1.617	1.345	1.646	N/A	N/A
4:S-Case 2 F	1.22	1.455	1.22	1.446	N/A	N/A
5:S-Case 2 F	1.477	1.812	1.477	1.837	N/A	N/A
6:S-Case 3 F	1.304	1.581	1.304	1.574	N/A	N/A
7:S-Case 3 F	1.189	1.427	1.189	1.39	N/A	N/A
8:S-Case 3 F	1.416	1.767	1.416	1.627	N/A	N/A
9:S-Case 4 F	1.243	1.537	1.243	1.417	N/A	N/A
10:S-Case 4	1.128	1.383	1.128	1.234	N/A	N/A

Table notes:

FSbasal : Critical basal stability safety factor (relevant only when soft clays are present beneath the excavation).
Wall embedment safety factors from conventional analysis (limit-equilibrium):
FS1 Passive : Safety factor for wall embedment based on FS= Available horizontal thrust resistance/Driving hor. thrust.
FS2 Rotation: Safety factor for wall embedment based on FS= Available resisting moment/Driving moment.
FS3 Length : Safety factor for wall embedment based on FS= Available wall embedment/Required embedment for FS=1.0
Wall embedment safety factors from non-linear analysis:
FS4 Mobilized Passive : Safety factor= Available horizontal passive resistance/Mobilized passive thrust.
FS5 True/Active : Soil thrust on retained wall side/Minimum theoretically horizontal active force thrust.

Tables for stress checks follow: Support force/Design capacity

Support Check vs Stage

	No Supports
0:S-Case 1 - FS=1.0	No support
1:S-Case 1 - FS=1.25	
2:S-Case 1 - FS=1.50	
3:S-Case 2 - FS=1.0	
4:S-Case 2 FS=1.25	
5:S-Case 2 FS=1.5	
6:S-Case 3 FS=1.0	
7:S-Case 3 FS=1.25	
8:S-Case 3 FS=1.50	
9:S-Case 4 FS=1.0	
10:S-Case 4 FS=1.25	
11:S-Case 4 FS = 1.50	

Forces (Res. F, M/Drive F, M)

	FS1 Passive	FS2 Rotation	FS3 Length	FS4 Mobilized Passive	FS5 Actual Drive	Fh EQ Soil	Fh EQ Water
	(FxResist/FxDrive)	(Mresist/Mdrive)	(Embedment/ToeFS=1)	(FxPassive/FxPas_Mobili	/ Theory Active		
Stage 0	11909.98/6246.589	383794.66/21475	92/40.4	N/A	N/A	N/A	N/A
Stage 1	10391.992/6246.58	336745.42/21475	92/47.5	N/A	N/A	N/A	N/A
Stage 2	9380/6246.589	305379.27/21475	92/54.59	N/A	N/A	N/A	N/A
Stage 3	11617.197/6246.58	372925.26/21475	92/47.5	N/A	N/A	N/A	N/A
Stage 4	10099.209/6246.58	325876.02/21475	92/55.88	N/A	N/A	N/A	N/A
Stage 5	9087.217/6246.589	294509.86/21475	92/63.62	N/A	N/A	N/A	N/A
Stage 6	11909.98/6572.753	383794.66/22561	92/50.08	N/A	N/A	N/A	N/A
Stage 7	10391.992/6572.75	336745.42/22561	92/58.46	N/A	N/A	N/A	N/A
Stage 8	9380/6572.753	305379.27/22561	92/66.2	N/A	N/A	N/A	N/A
Stage 9	11617.197/6572.75	372925.26/22561	92/56.53	N/A	N/A	N/A	N/A
Stage 10	10099.209/6572.75	325876.02/22561	92/64.91	N/A	N/A	N/A	N/A
Stage 11	9087.217/6572.753	294509.86/22561	92/74.58	N/A	N/A	N/A	N/A

Reinforcement Requirements

	Parameter Description
Note:	Wall does not use steel reinforcement. Section does not apply.

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 8	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 9	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 10	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 11	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	1.598	1.598	1.907
Stage 1	Simple span	N/A	1.6	1.411	1.411	1.664
Stage 2	Simple span	N/A	1.6	1.287	1.287	1.502
Stage 3	Simple span	N/A	1.6	1.532	1.532	1.86
Stage 4	Simple span	N/A	1.6	1.345	1.345	1.617
Stage 5	Simple span	N/A	1.6	1.22	1.22	1.455
Stage 6	Simple span	N/A	1.6	1.477	1.477	1.812
Stage 7	Simple span	N/A	1.6	1.304	1.304	1.581
Stage 8	Simple span	N/A	1.6	1.189	1.189	1.427
Stage 9	Simple span	N/A	1.6	1.416	1.416	1.767
Stage 10	Simple span	N/A	1.6	1.243	1.243	1.537
Stage 11	Simple span	N/A	1.6	1.128	1.128	1.383

Name=excavation stage name

Analysis method

springs = Elastoplastic spring analysis used

DR = Drained condition for CLAY model

U = Undrained condition for CLAY model for all the soils

Up = Undrained condition just for selected soil

Limit equilibrium analysis settings

Drive press:

Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,

FHWA= Federal Highway Administration apparent pressure diagrams.

Ko = At-rest lateral earth pressures.

Peck = Peck 1969 Apparent earth pressure diagrams.

2 Step rect = Two step rectangular apparent earth pressure diagram.

User def. = User defined apparent earth pressure diagram.

Ka+d (and so on) indicates that wall friction is applied

ka mult = multiplication factor for Ka when Ka-Trap is selected
Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H
Resit press = Kp (passive earth pressures)
Res Mult = Safety factor applied directly on resisting pressures (
COntle Method = cantilever analysis method for limit equilibrium analysis.
Support Model: Method for calculating support reactions in limit-equlibrium analysis.
Beam= support reactions beam analysis (uses Blum's method).
Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).
Axial Incl = Axial loads included for structural design
Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

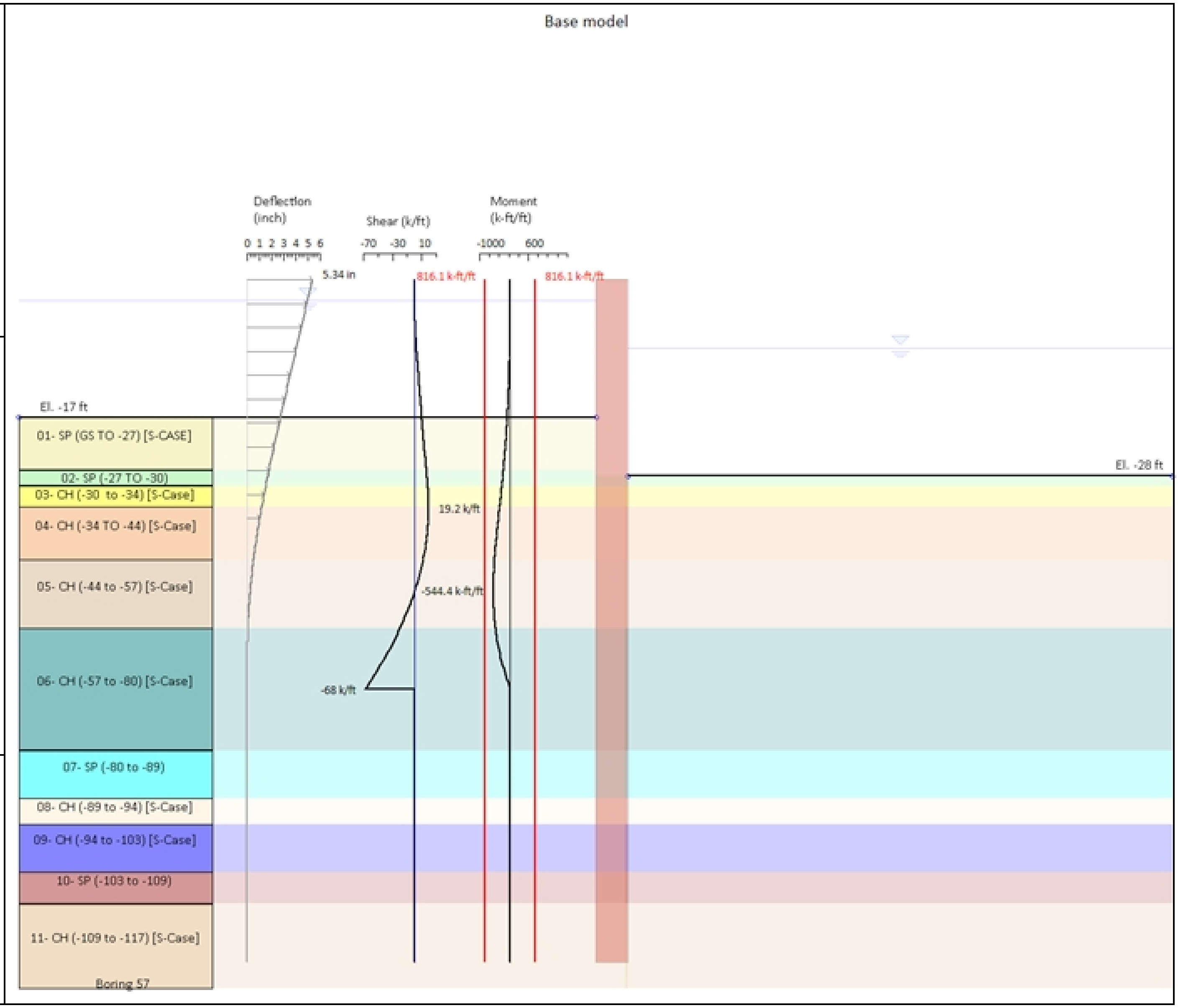
EXCAVATION STAGES SKETCHES

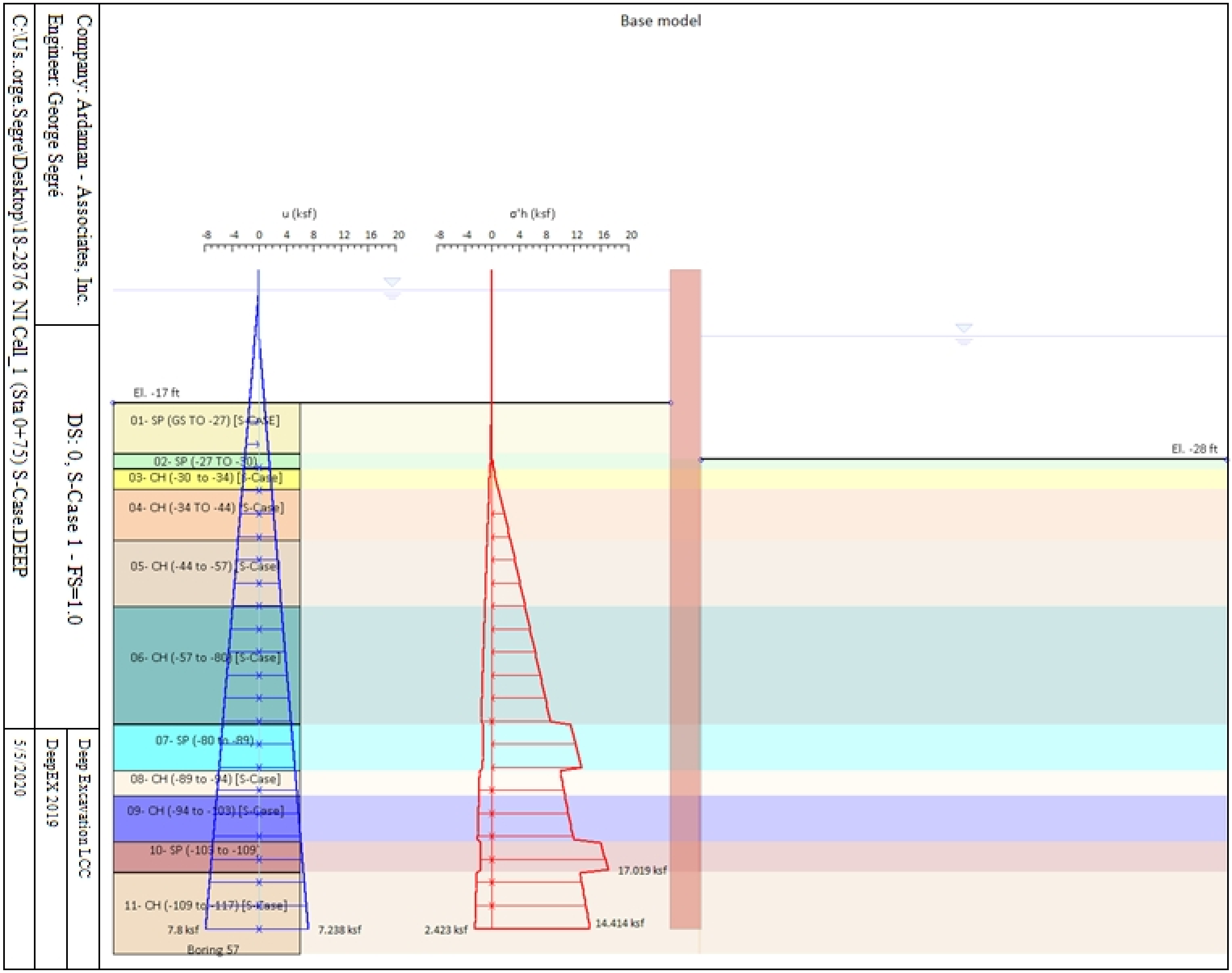
A sequence of figures for each excavation stage is reported

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 1 - FS=1.0

Deep Excavation LCC
DeepEX 2019
5/5/2020

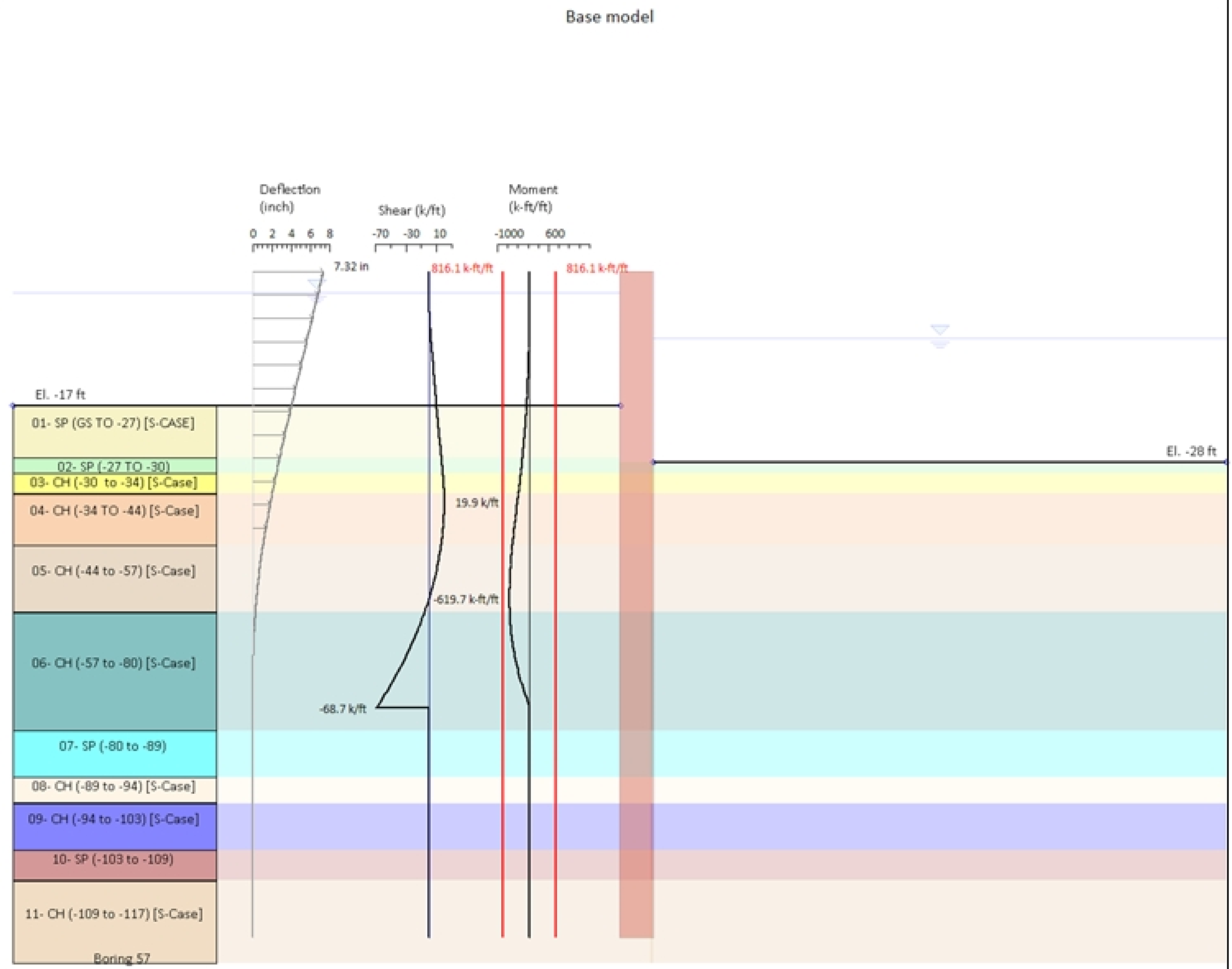


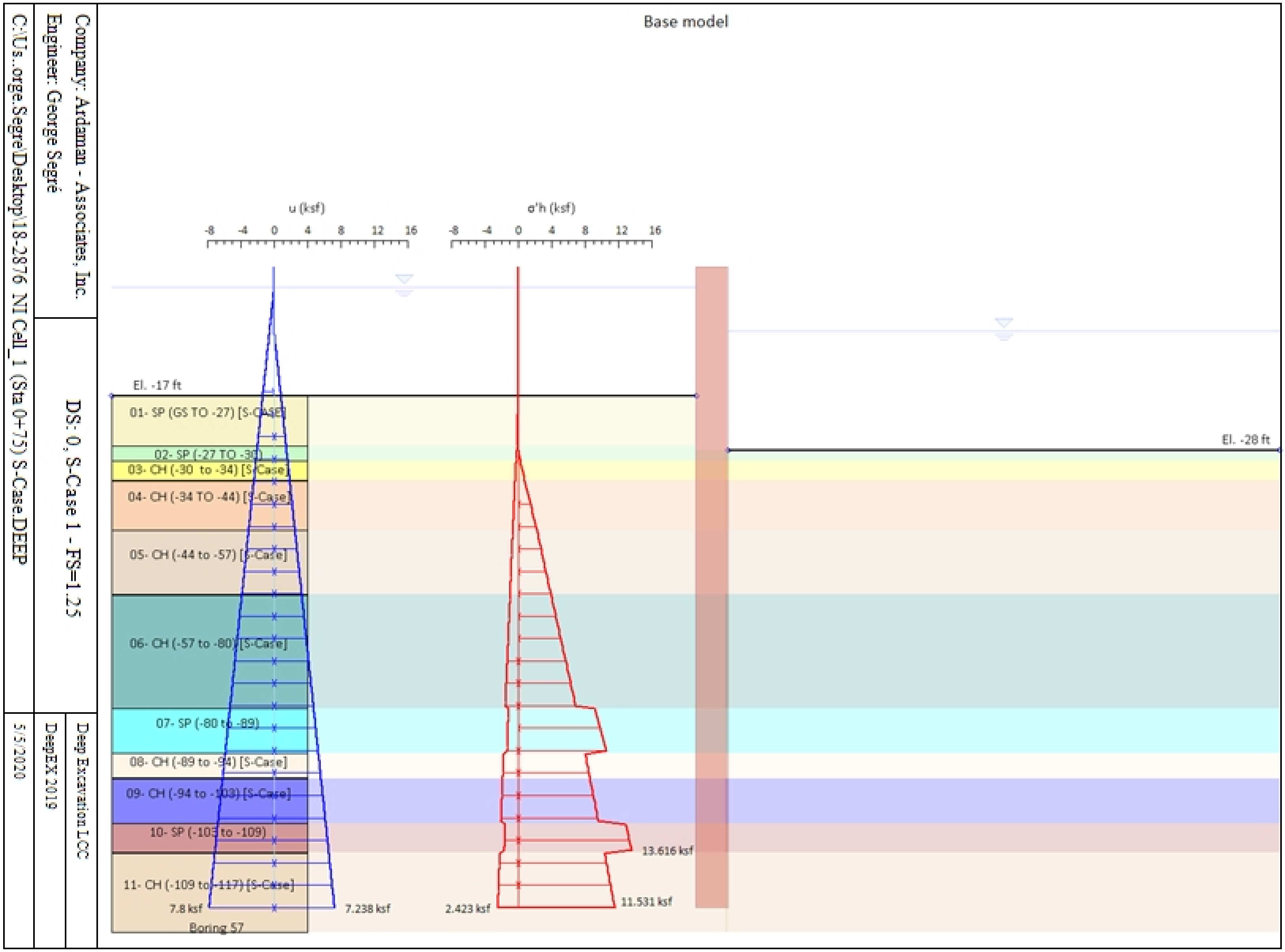

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP
DS: 0, S-Case 1 - FS=1.0
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
u (ksf)
-8 -4 0 4 8 12 16 20
σ'h (ksf)
-8 -4 0 4 8 12 16 20
El. -17 ft
El. -28 ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57
7.8 ksf
7.238 ksf
2.423 ksf
17.019 ksf
14.414 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 1 - FS=1.25

Deep Excavation LCC
DeepEX 2019
5/5/2020





Company: Ardaman - Associates, Inc.
Engineer: George Segré
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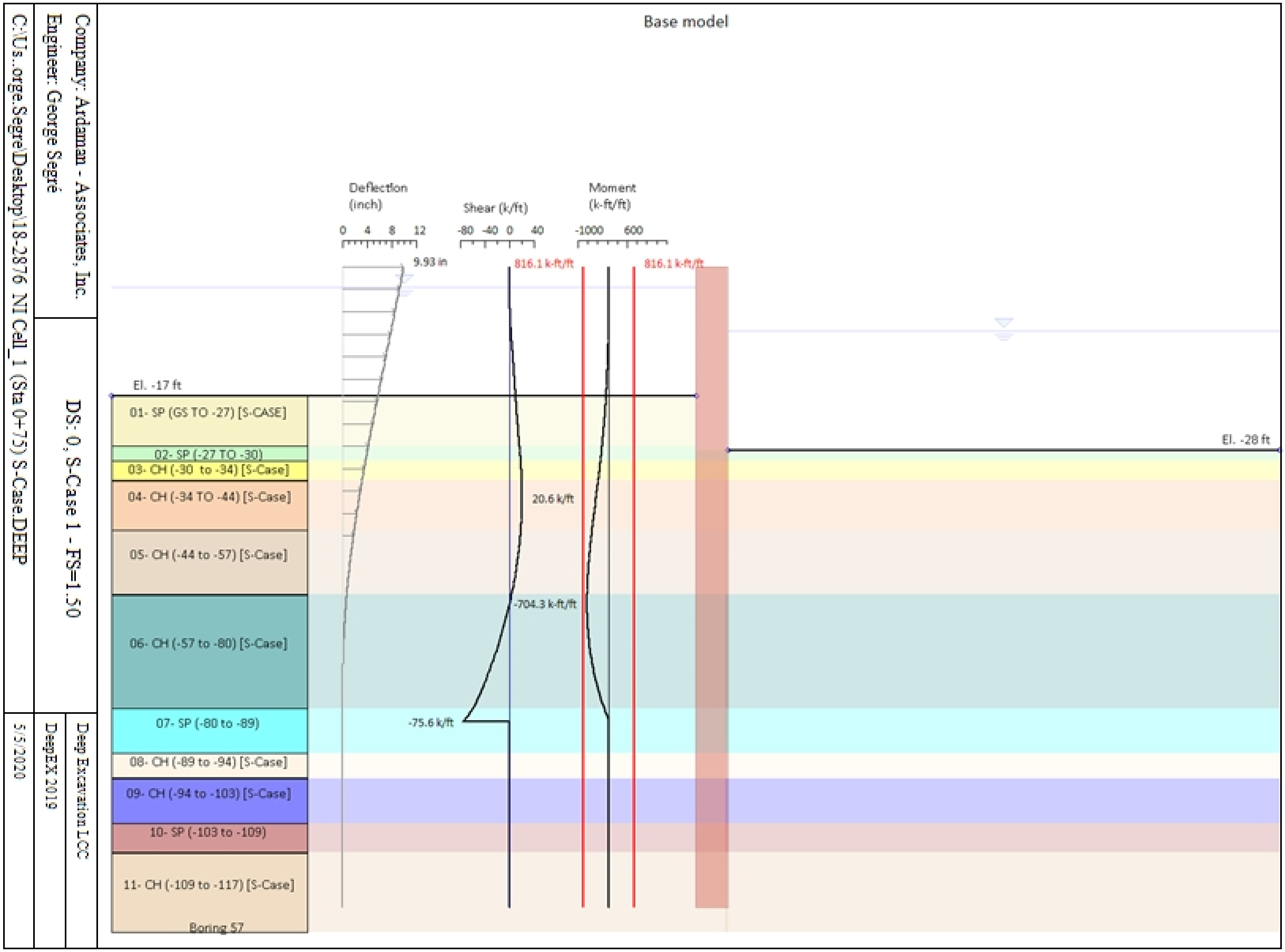
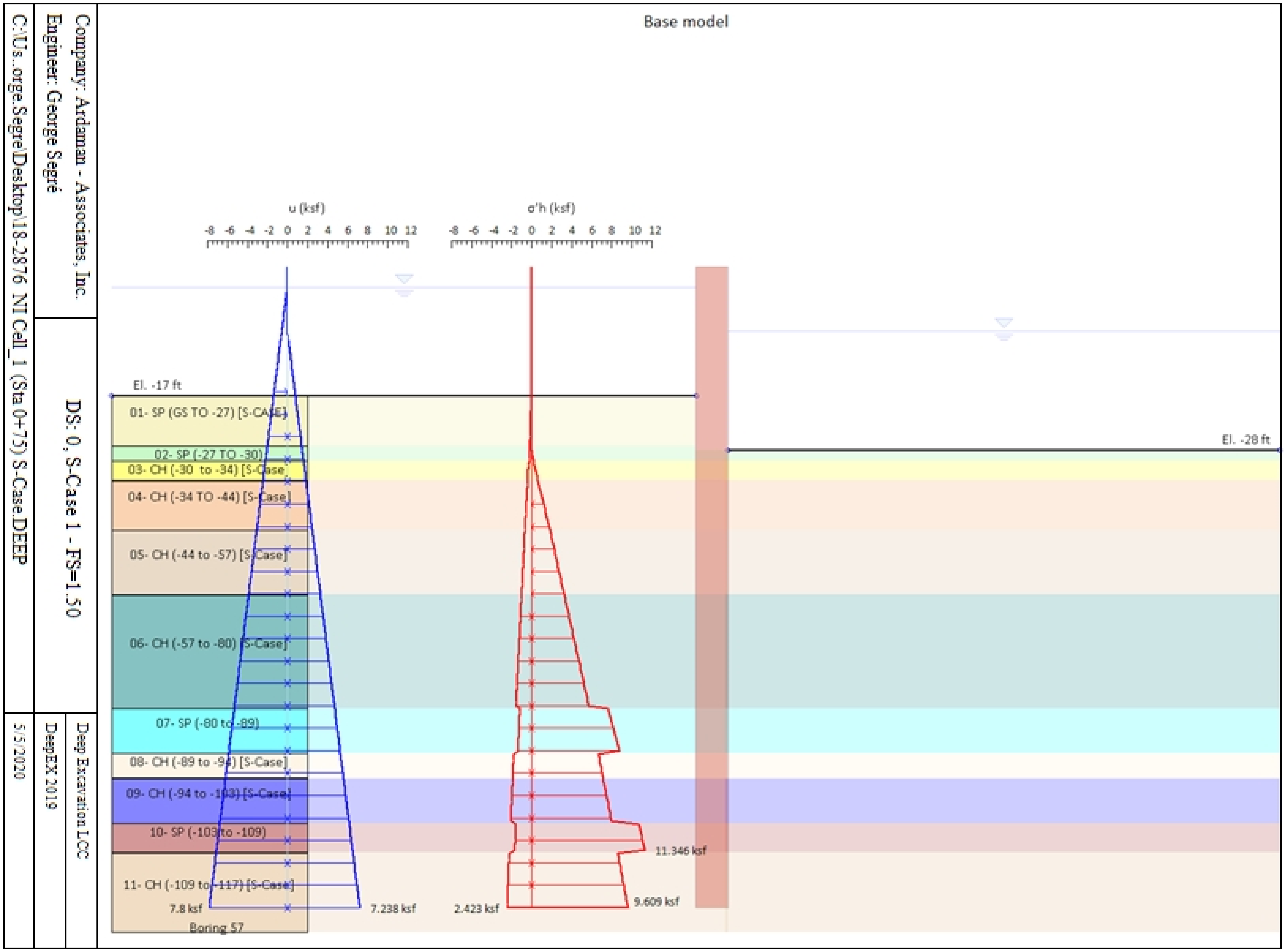
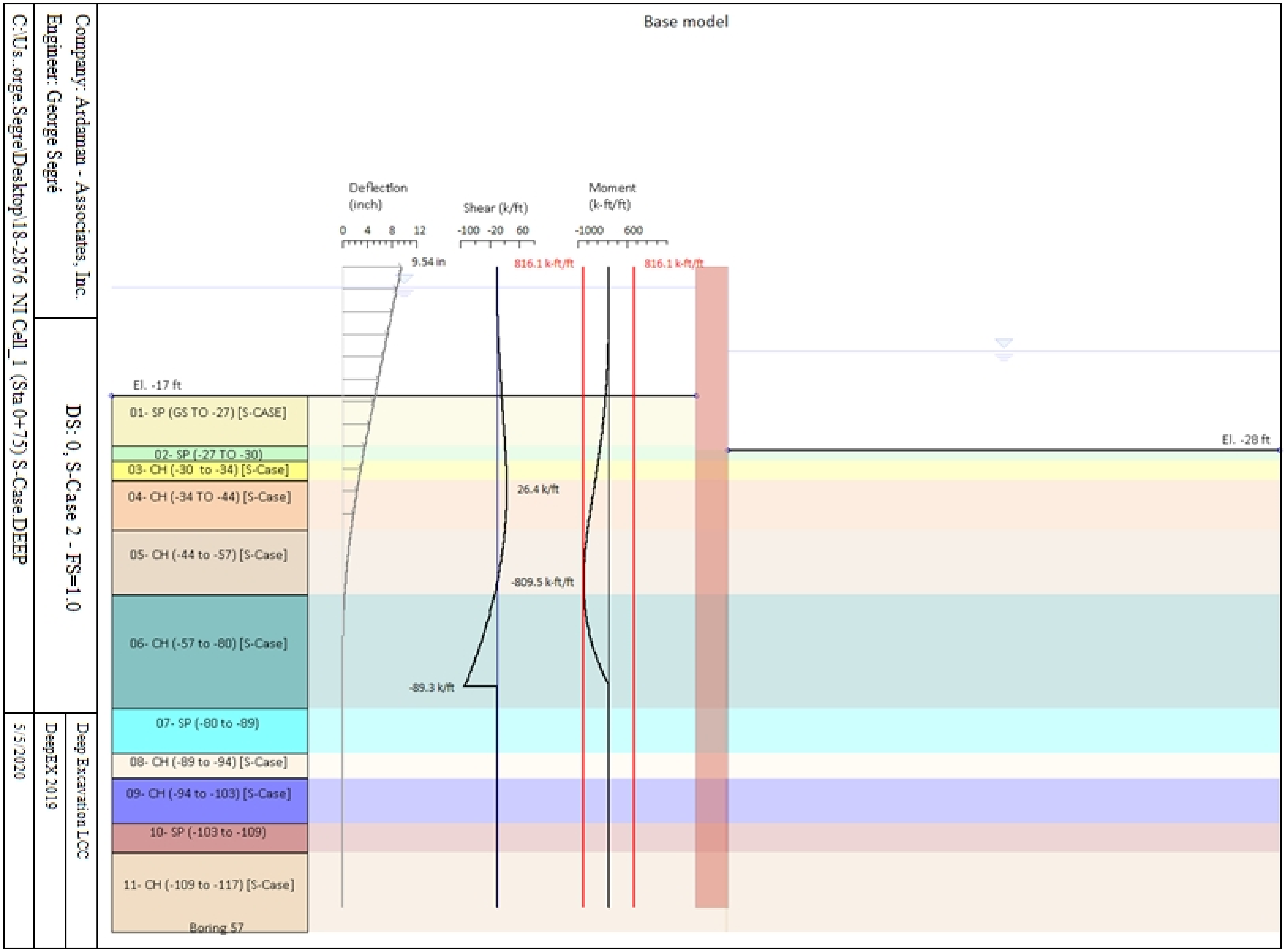
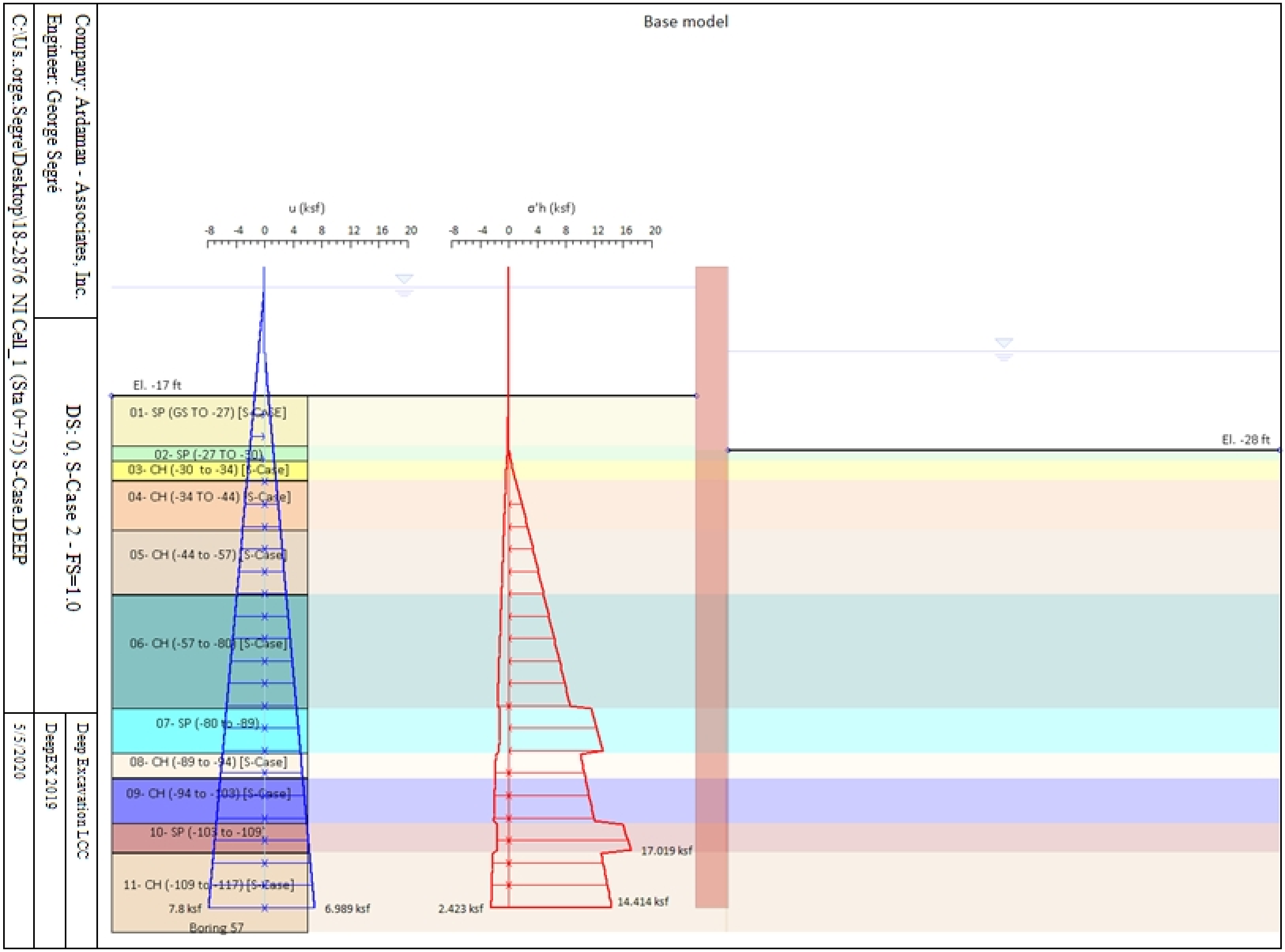
DS: 0, S-Case 1 - FS=1.25
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
u (ksf)
σ'h (ksf)
-8 -4 0 4 8 12 16
El. -17 ft
El. -28 ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57
7.8 ksf
7.238 ksf
2.423 ksf
11.531 ksf
13.616 ksf


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP
DS: 0, S-Case 1 - FS=1.50
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
Deflection (inch)
0 4 8 12
Shear (k/ft)
-80 -40 0 40
Moment (k-ft/ft)
-1000 600
9.93 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -17 ft
El. -28 ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
20.6 k/ft
05- CH (-44 to -57) [S-Case]
-704.3 k-ft/ft
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
-75.6 k/ft
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP
DS: 0, S-Case 1 - FS=1.50
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
u (ksf)
σ'h (ksf)
-8 -6 -4 -2 0 2 4 6 8 10 12
El. -17 ft
El. -28 ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
7.8 ksf
7.238 ksf
2.423 ksf
9.609 ksf
11.346 ksf
Boring 57


Base model
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP
DS: 0, S-Case 2 - FS=1.0
Deep Excavation LCC
DeepEX 2019
5/5/2020
Deflection (inch)
0 4 8 12
9.54 in
Shear (k/ft)
-100 -20 60
Moment (k-ft/ft)
-1000 600
816.1 k-ft/ft
816.1 k-ft/ft
26.4 k/ft
-809.5 k-ft/ft
-89.3 k/ft
El. -17 ft
El. -28 ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57

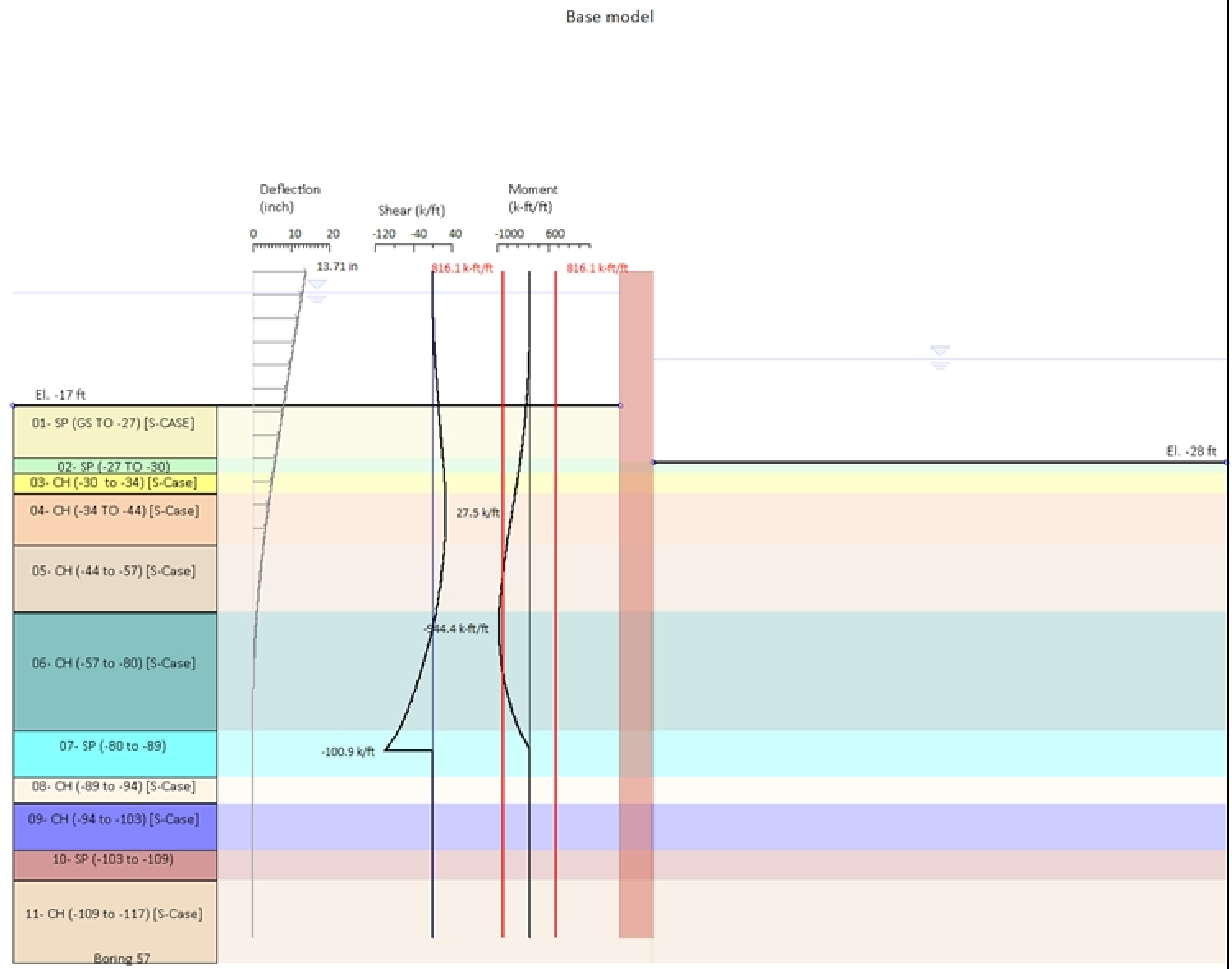


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP
DS: 0, S-Case 2 - FS=1.0
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
u (ksf)
σ'h (ksf)
El. -17 ft
El. -28 ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57
7.8 ksf
6.989 ksf
2.423 ksf
14.414 ksf
17.019 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 2 FS=1.25

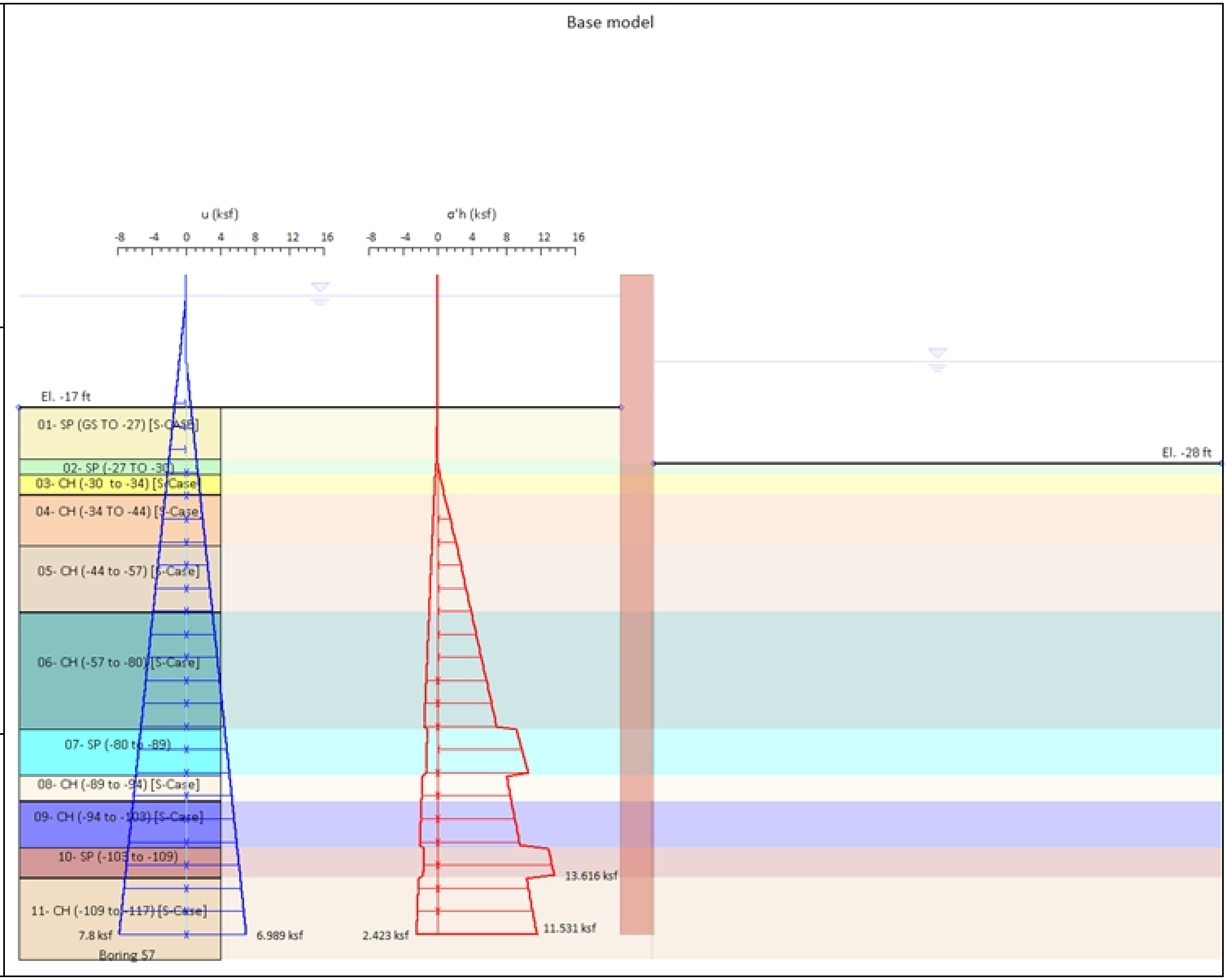
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 2 FS=1.25

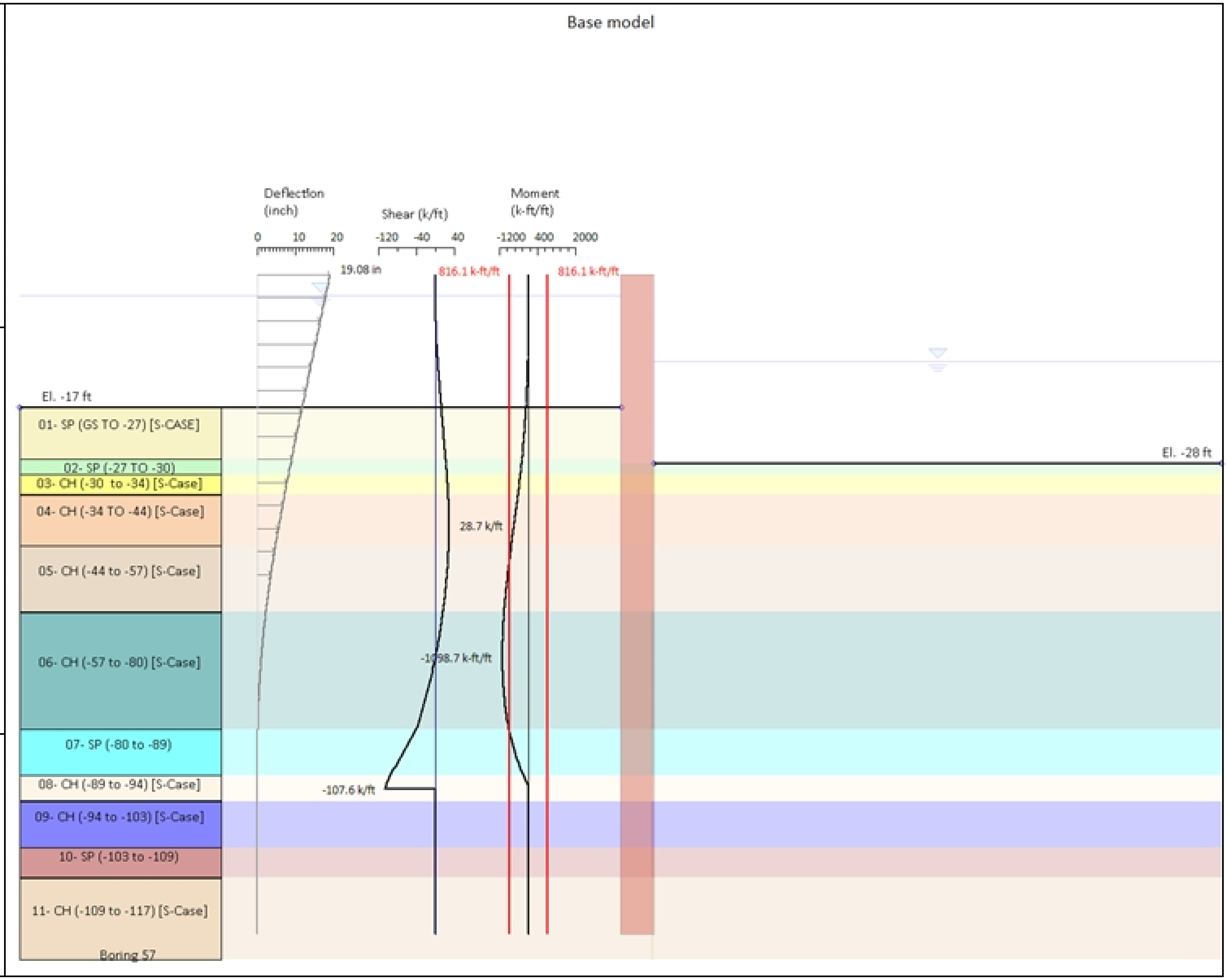
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 2 FS=1.5

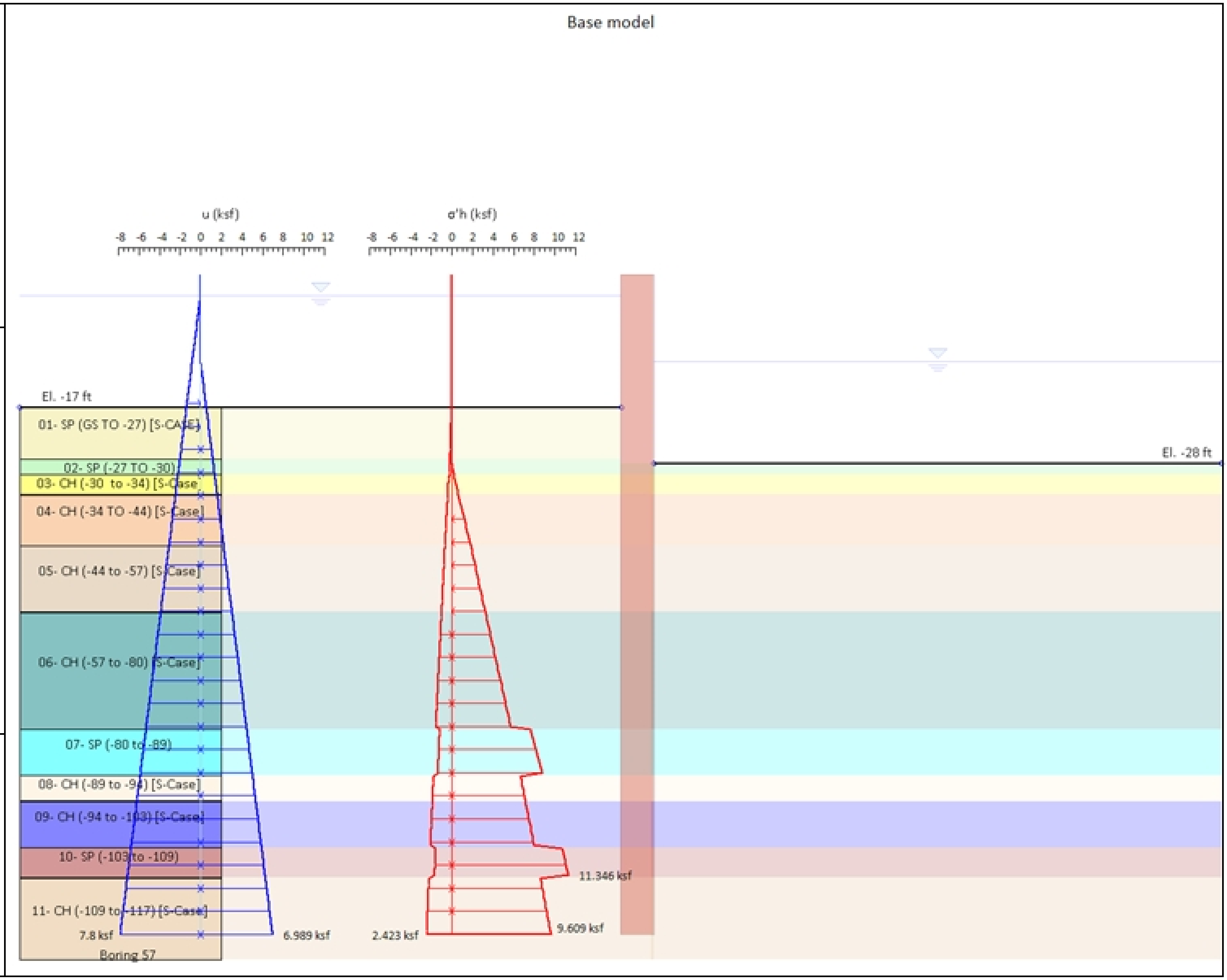
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 2 FS=1.5

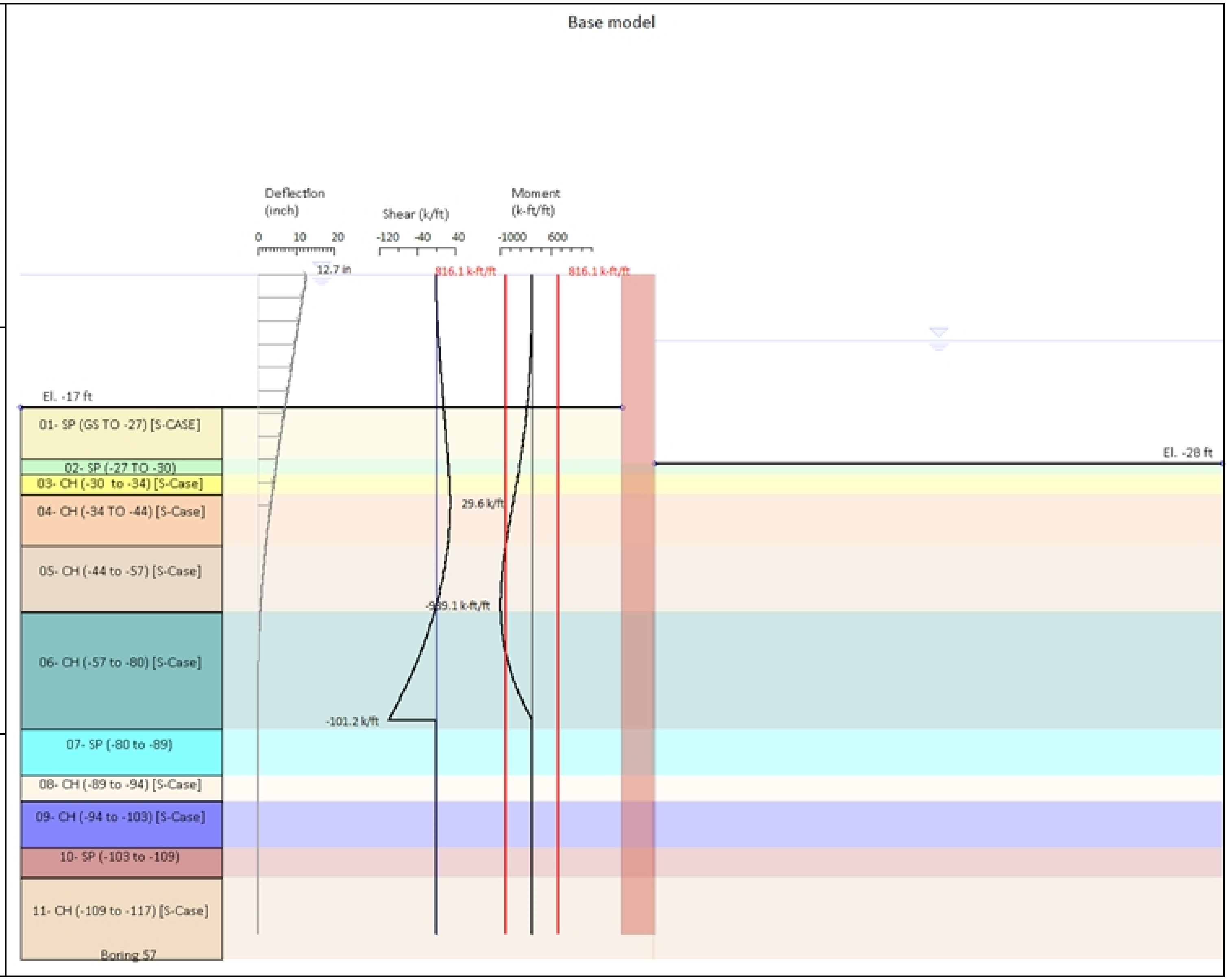
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 3 FS=1.0

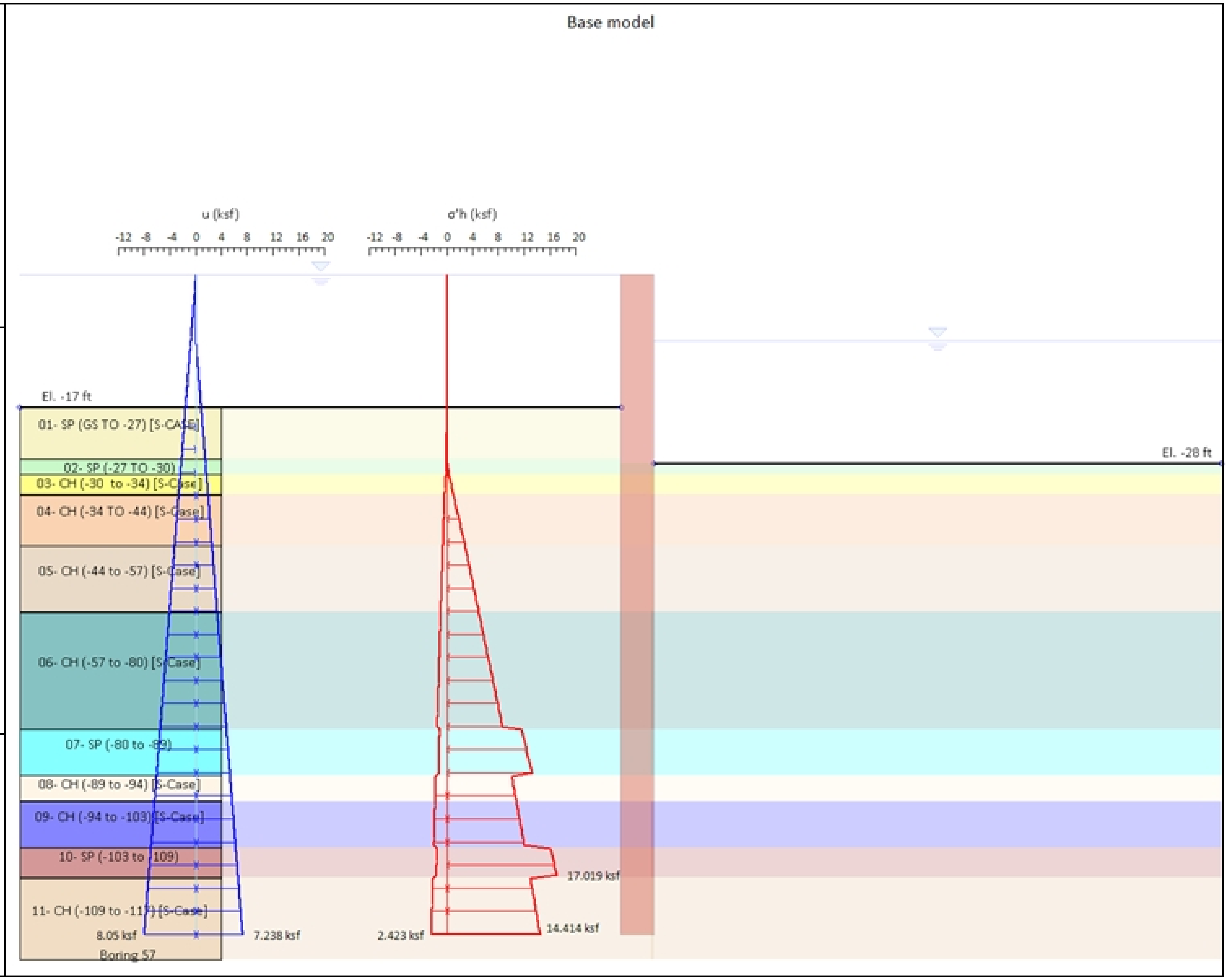
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 3 FS=1.0

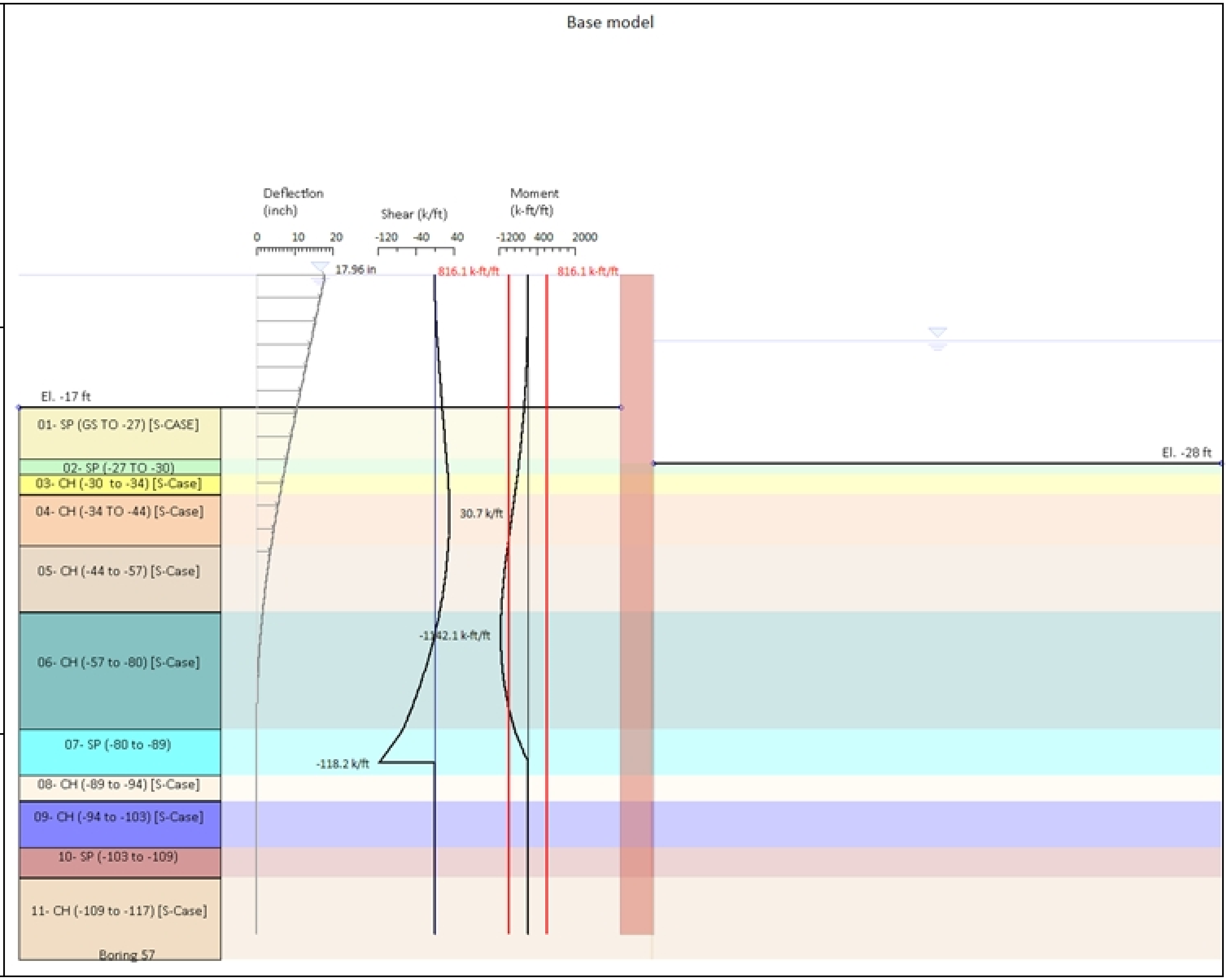
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 3 FS=1.25

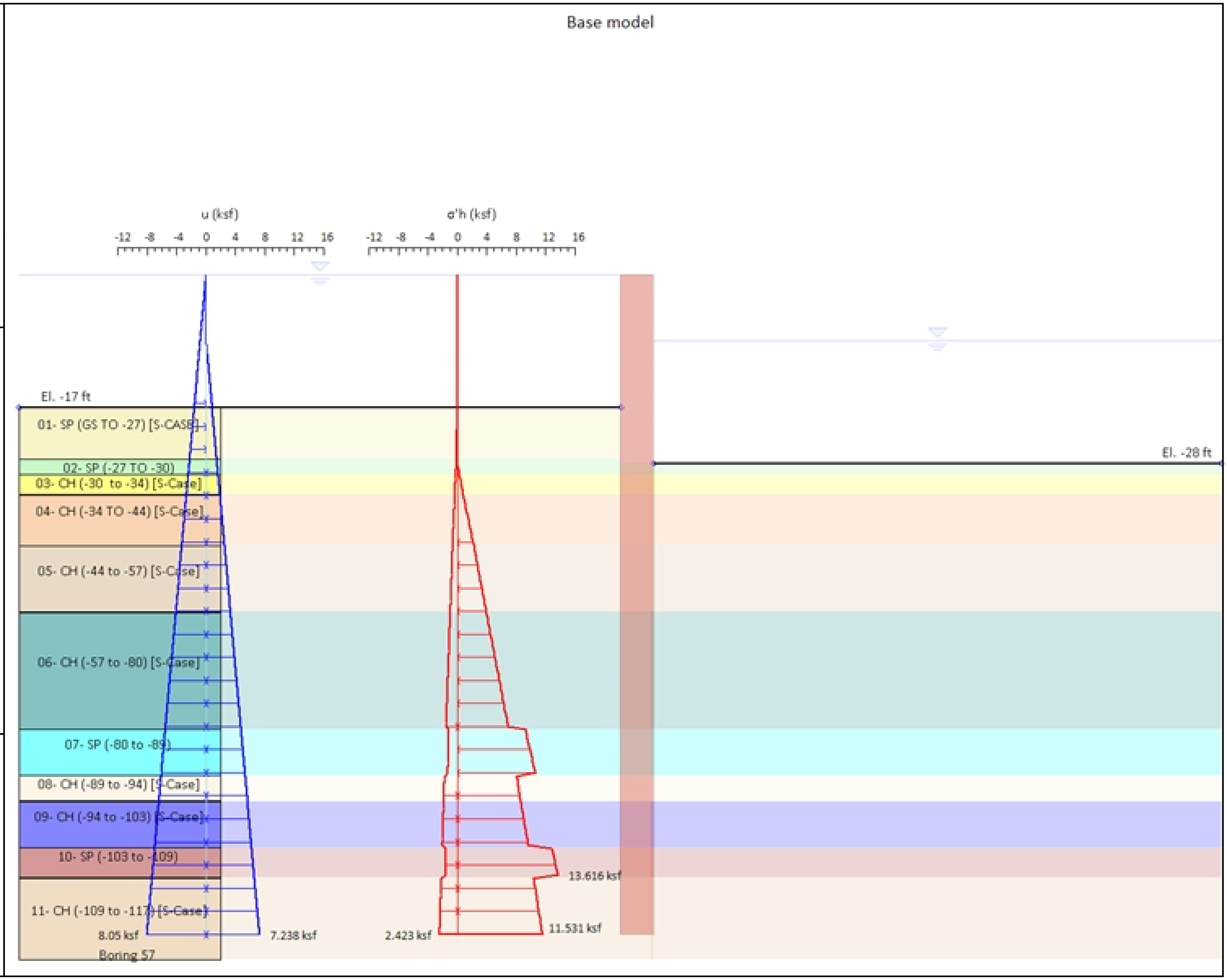
Deep Excavation LCC
DeepEX 2019
5/5/2020

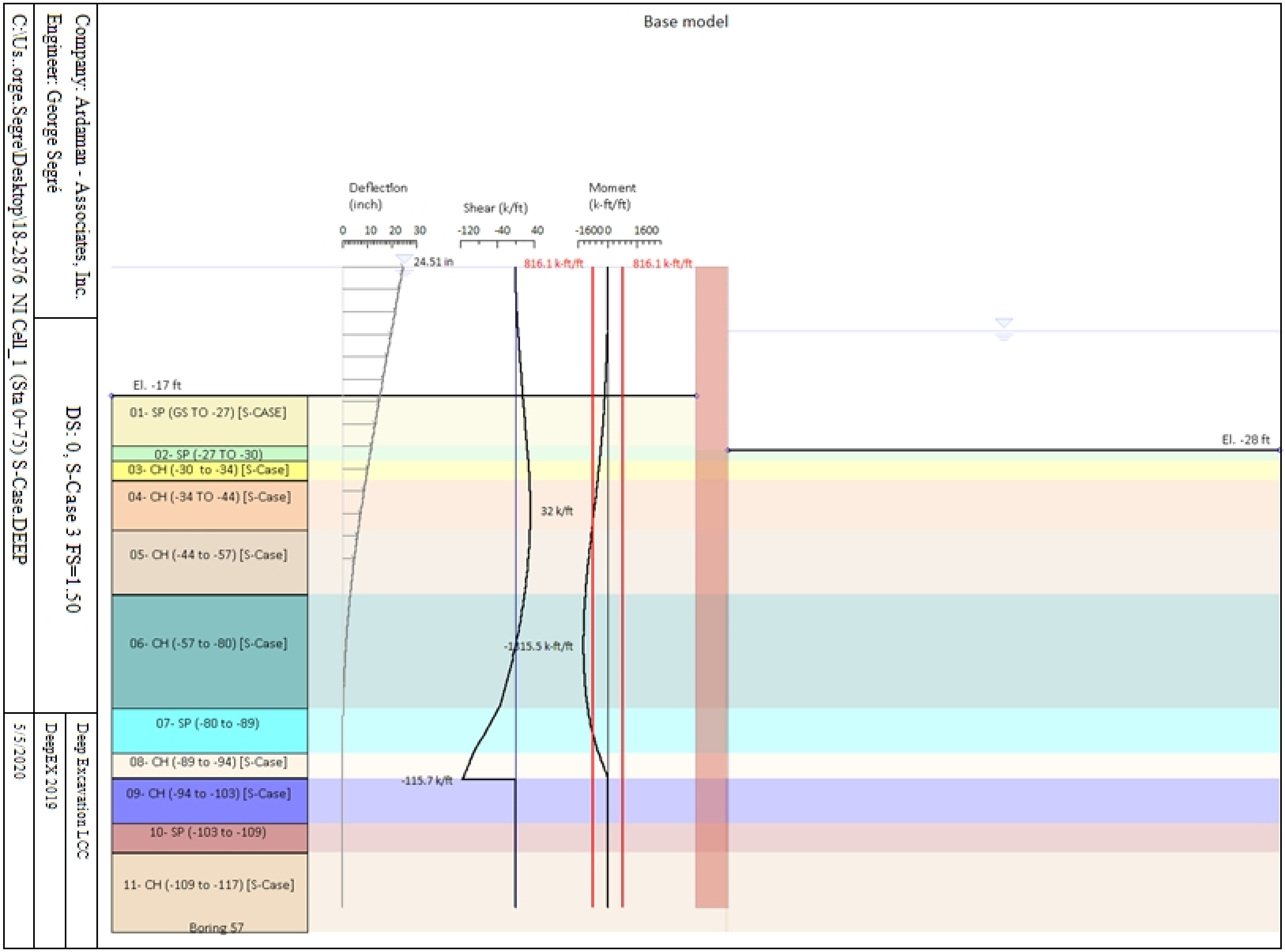


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 3 FS=1.25

Deep Excavation LCC
DeepEX 2019
5/5/2020

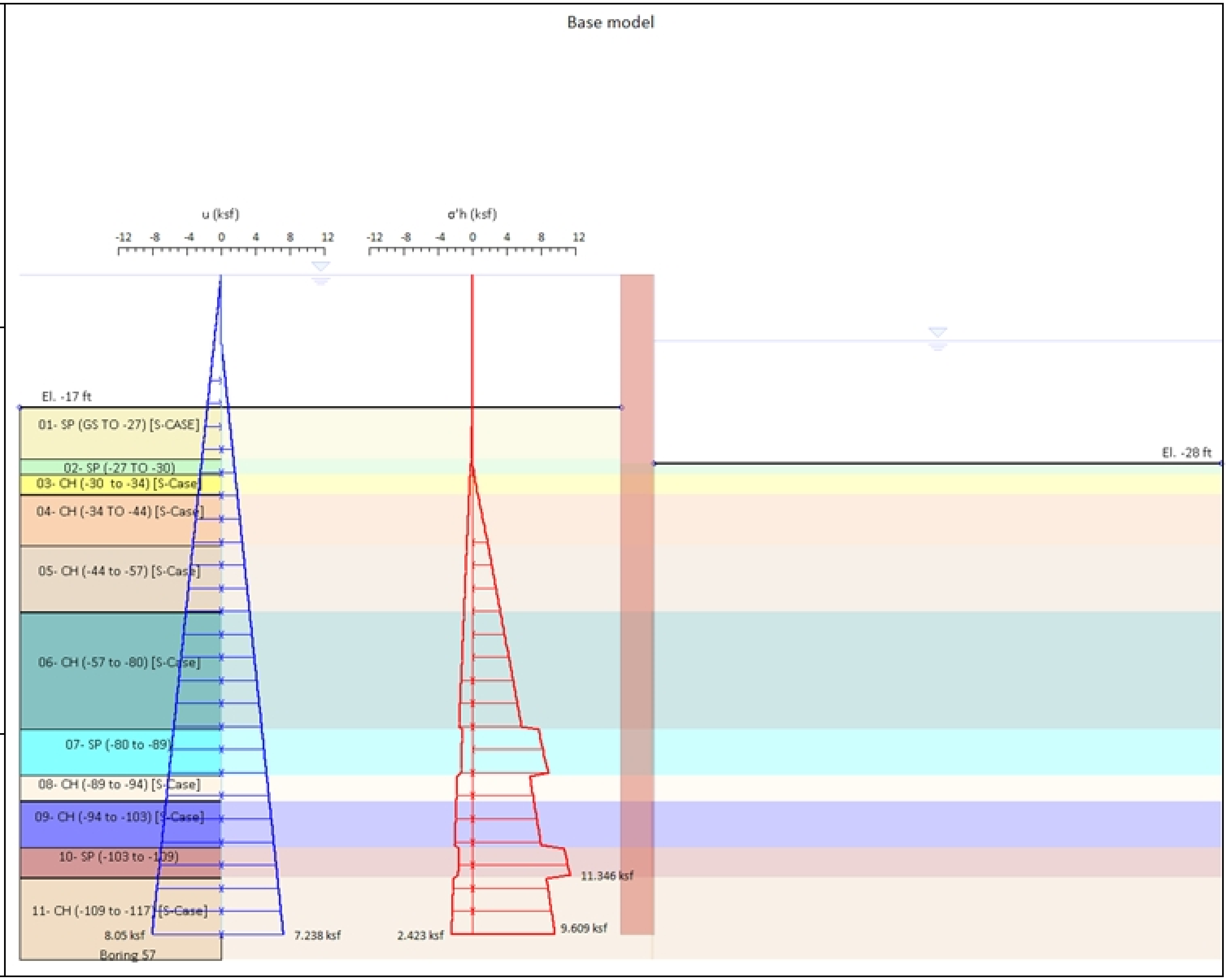


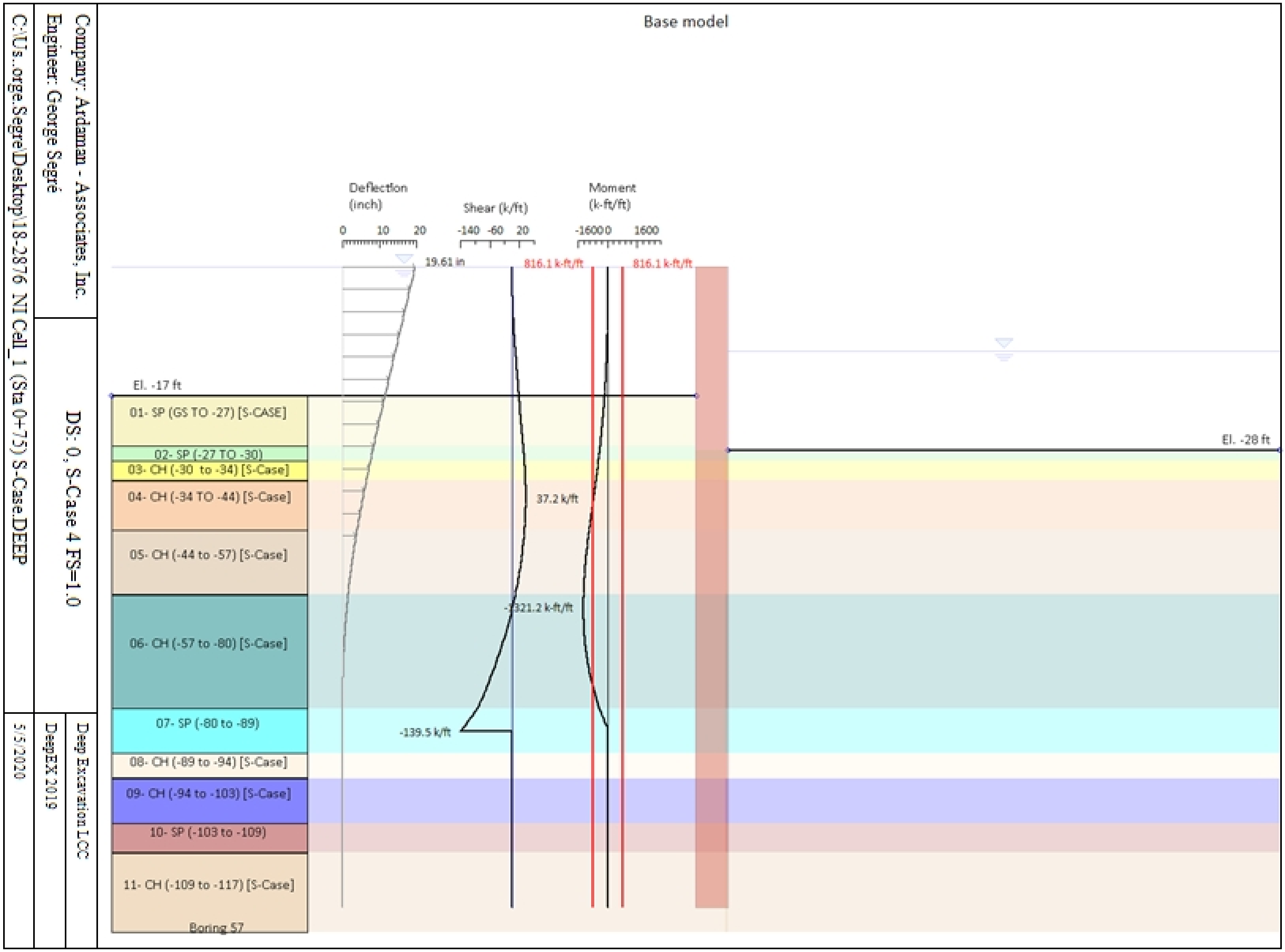

Base model
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP
DS: 0, S-Case 3 FS=1.50
Deep Excavation LCC
DeepEX 2019
5/5/2020
Deflection (inch)
0 10 20 30
Shear (k/ft)
-120 -40 40
Moment (k-ft/ft)
-1600 0 1600
24.51 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -17 ft
El. -28 ft
32 k/ft
-1115.5 k-ft/ft
-115.7 k/ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 3 FS=1.50

Deep Excavation LCC
DeepEX 2019
5/5/2020



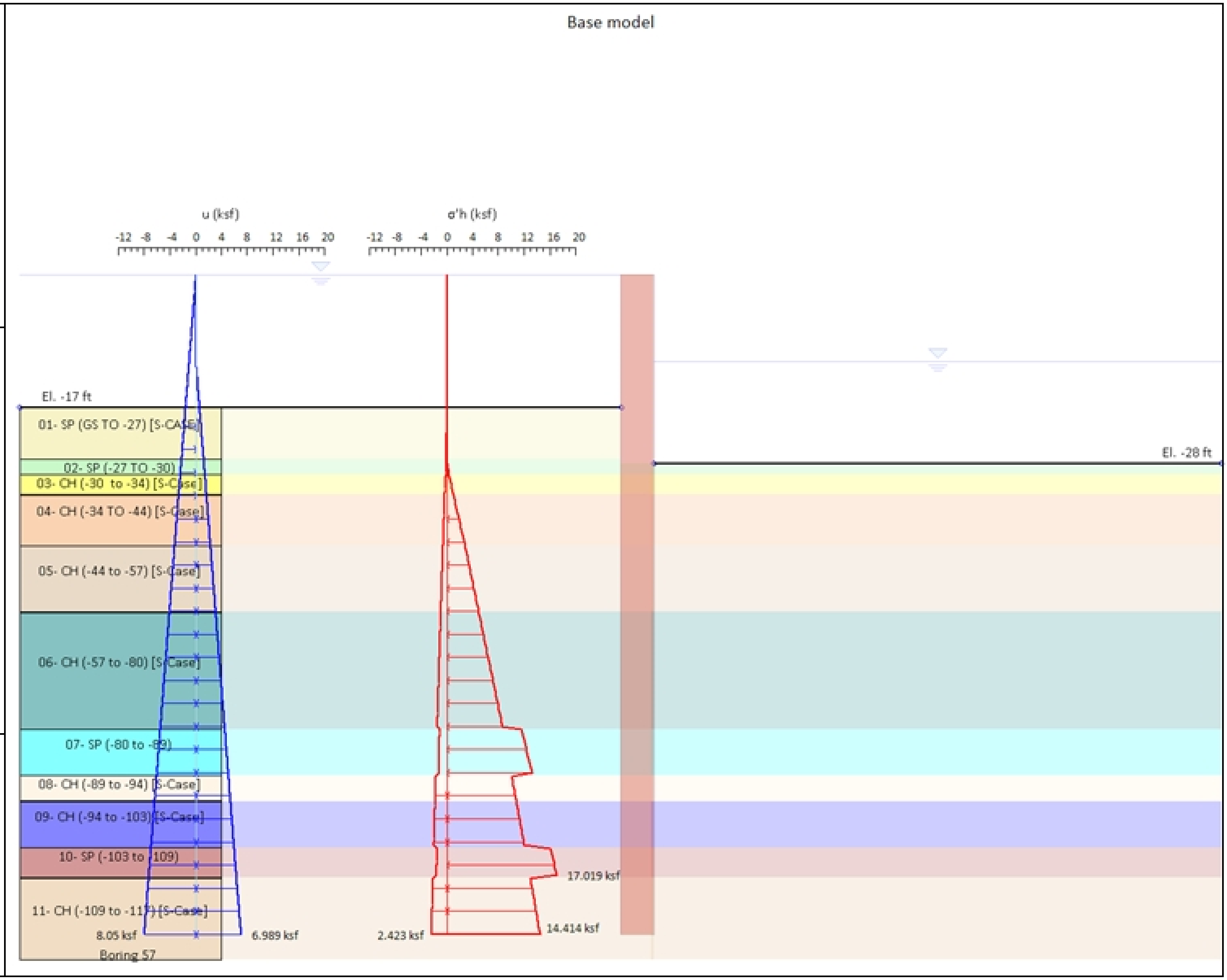


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP
DS: 0, S-Case 4 FS=1.0
Deep Excavation LCC
DeepEX 2019
5/5/2020
Base model
Deflection (inch)
0 10 20
Shear (k/ft)
-140 -60 20
Moment (k-ft/ft)
-1600 0 1600
19.61 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -17 ft
El. -28 ft
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57
37.2 k/ft
-1321.2 k-ft/ft
-139.5 k/ft

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 4 FS=1.0

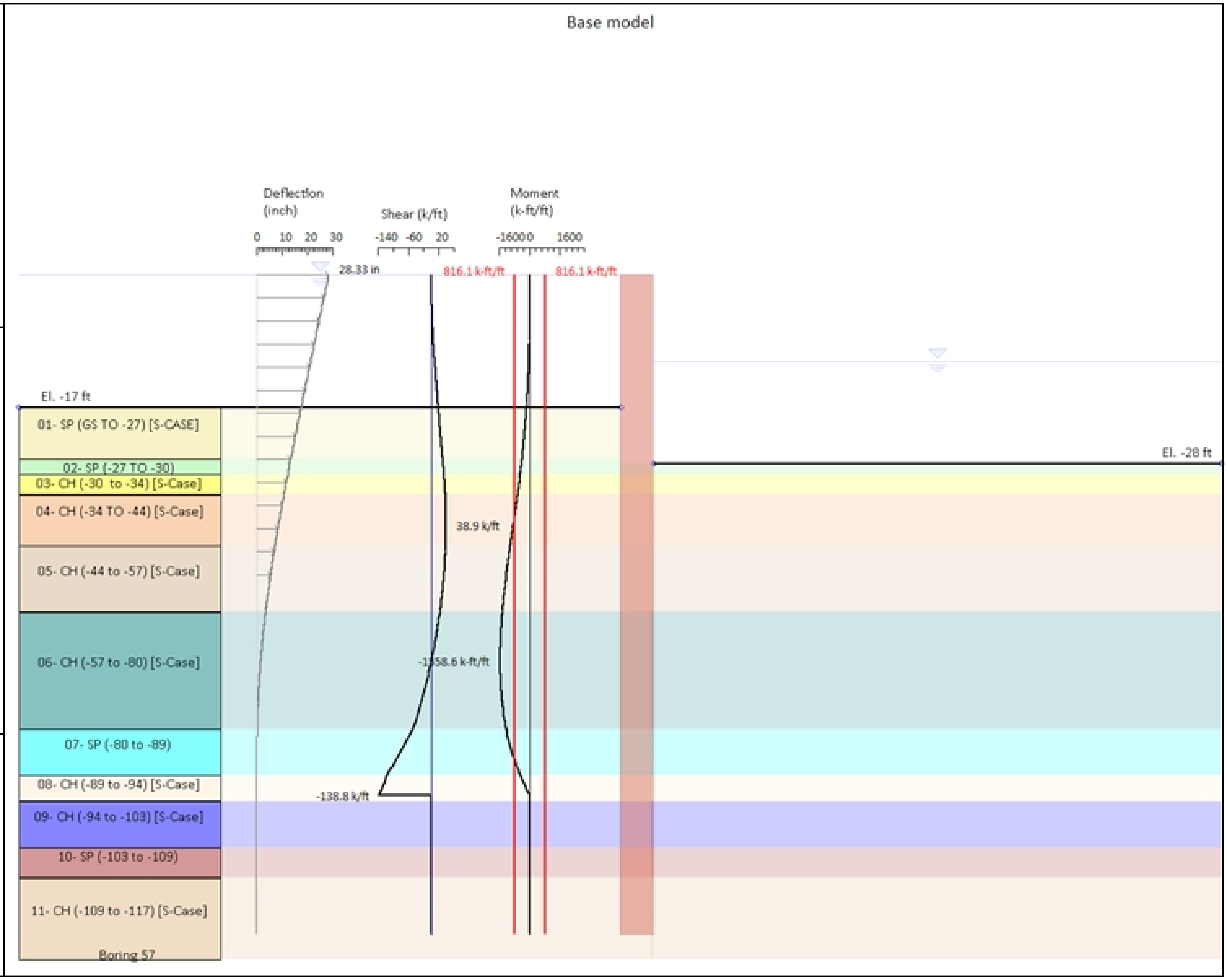
Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 4 FS=1.25

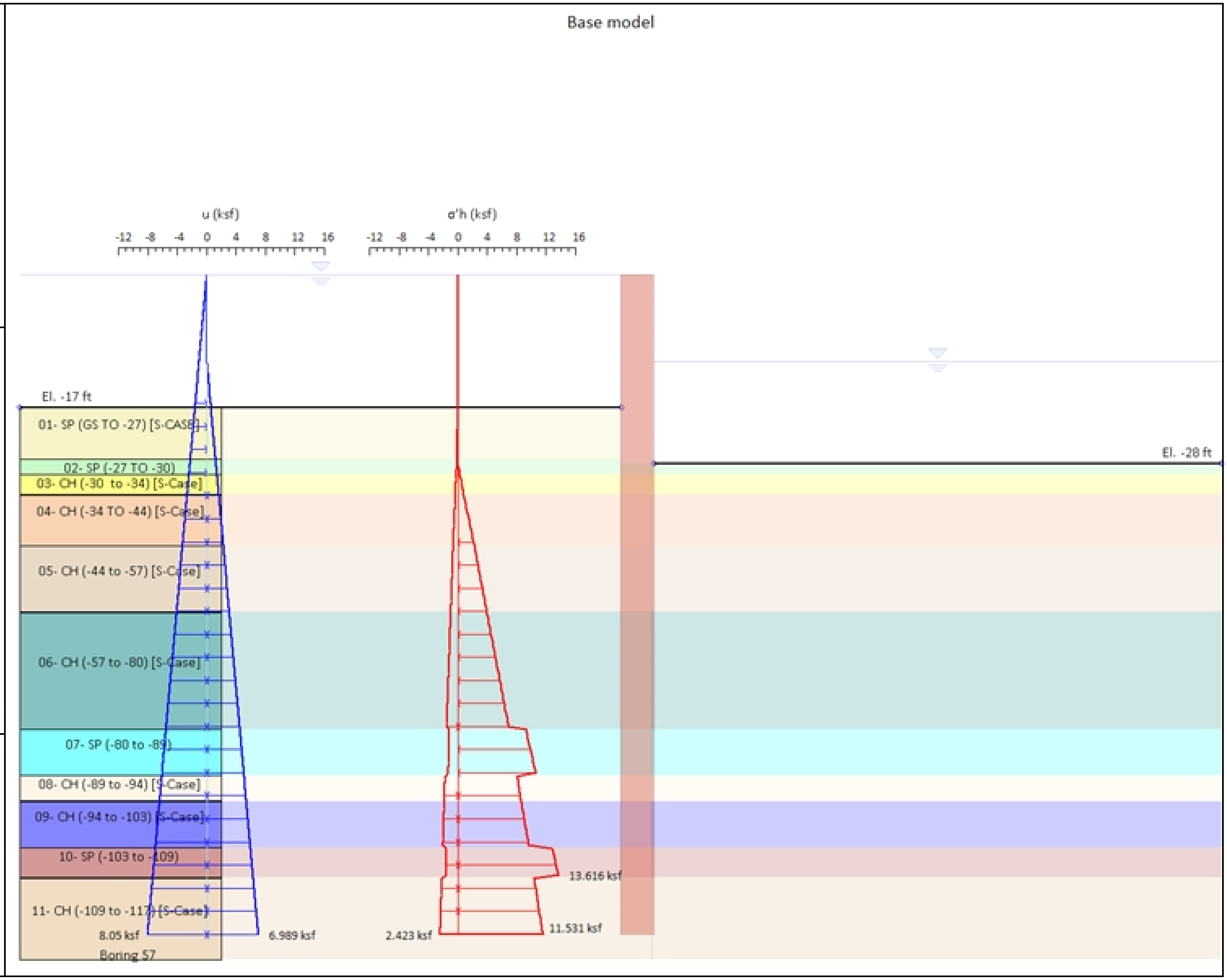
Deep Excavation LCC
DeepEX 2019
5/5/2020

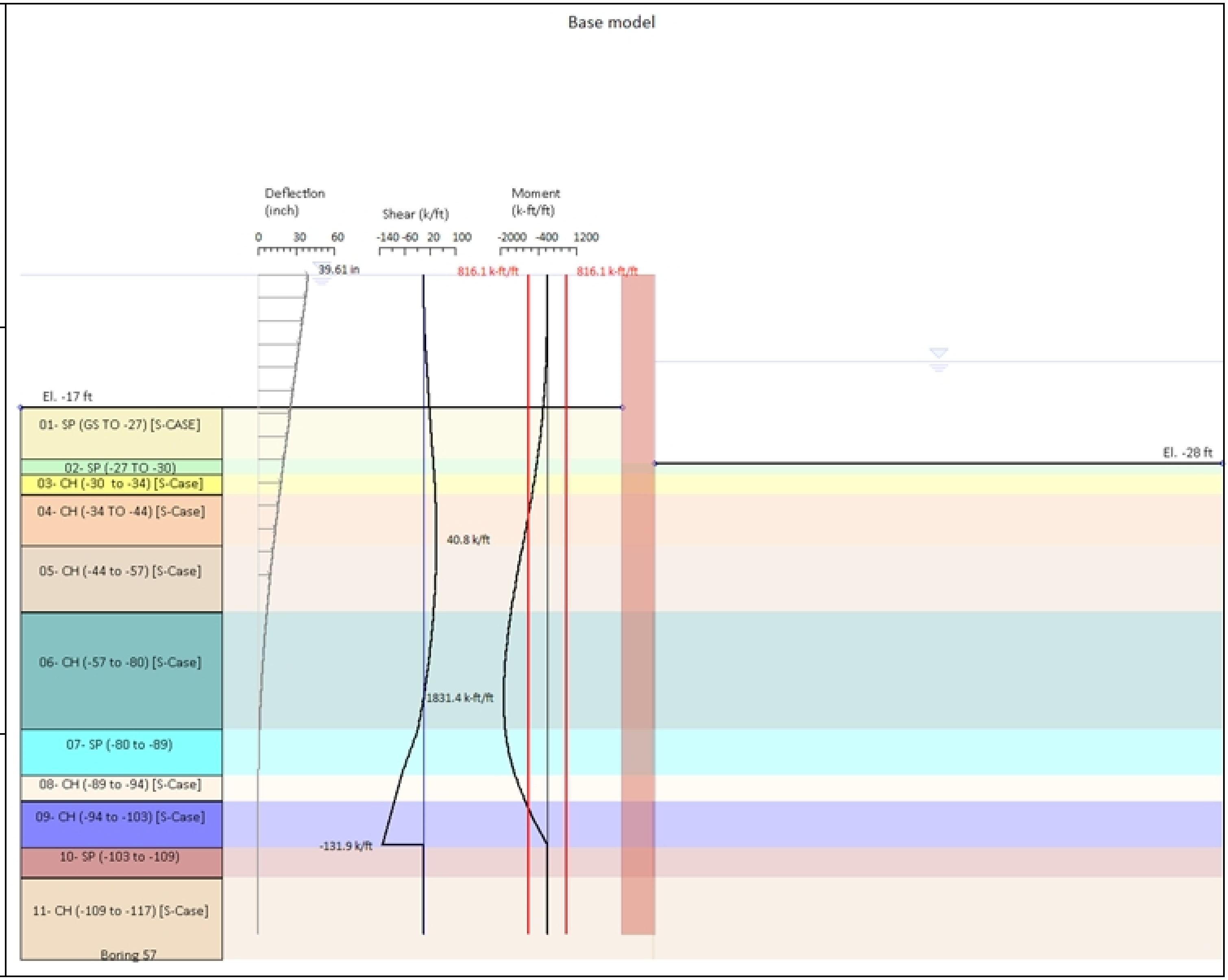


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 4 FS=1.25

Deep Excavation LCC
DeepEX 2019
5/5/2020



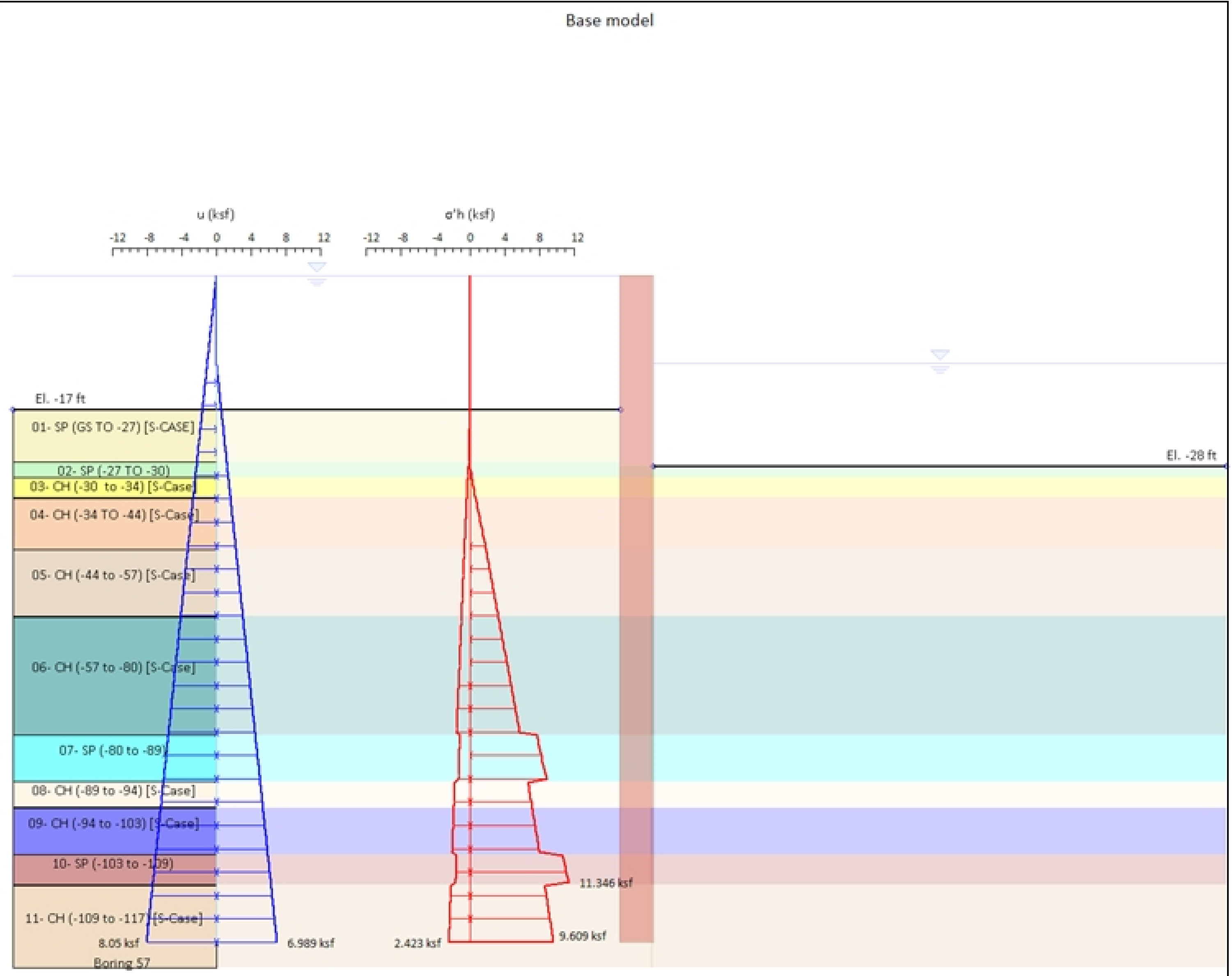


Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, S-Case 4 FS = 1.50

C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

Deep Excavation LCC
DeepEX 2019
5/5/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..orge.Segre\Desktop\18-2876 NI Cell_1 (Sta 0+75) S-Case.DEEP

DS: 0, S-Case 4 FS = 1.50

Deep Excavation LCC
DeepEX 2019
5/5/2020

DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 4/27/2020 7:56:32 PM

File: C:\Users\George.Segre\Desktop\Northern Impoundment\Cell 1 Sections\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) Q -Case.DEEP

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)
A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength

Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
14- GP Fill	120	120	34	0	N/A	N/A	N/A	300	3	0.28	3.54	N/A	N/A	True	Linear	
13- CH (GS to	112	112	0	0	800	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
12- SP (-10 to	112	112	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
01- SP (-17 T	115	115	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	EXP	
02- SP (-27 T	115	115	30	0	N/A	N/A	N/A	60	3	0.33	3	N/A	N/A	True	Linear	
03- CH (-30 t	126	126	0	0	2290	0	0	150	3	1	1	1	1	True	Linear	
04- CH (-34 T	134	134	0	0	2290	0	0	521.92	3	1	1	1	1	True	Linear	
05- CH (-44 to	126	126	0	0	2290	21.1	30	417.54	3	0.47	2.12	0.33	3	True	Linear	
06- CH (-57 to	127	127	0	0	1650	0	0	626.3	3	1	1	1	1	True	Linear	
07- SP (-80 to	122	122	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
08- CH (-89 to	115	115	0	0	1200	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
09- CH (-94 to	120	120	0	0	4000	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
10- SP (-103 t	120	120	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
11- CH (-109 t	115	115	0	0	1670	0	0	300	3	0.33	3	0.33	0.33	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
14- GP Fill	0.35	-	-	0.441	0.8	-	-	0	0	0	-
13- CH (GS to	0.35	0	0	1	0.8	-	-	0	0	0	-
12- SP (-10 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
01- SP (-17 T	0.4	-	-	0.5	0.5	1	0	7.2	4.8	20	-
02- SP (-27 T	0.4	-	-	0.5	0.5	-	-	5.1	3.4	20	-
03- CH (-30 t	0.3	0	0	1	0.5	-	-	13	8.7	20	-
04- CH (-34 T	0.3	0	0	1	0.5	-	-	21.8	14.5	30	-
05- CH (-44 to	0.45	0.1	0	0.45	0.5	-	-	18.1	12.1	30	-
06- CH (-57 to	0.35	0	0	1	0.5	-	-	29	19.3	70	-
07- SP (-80 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
08- CH (-89 to	0.3	0	0	1	0.8	-	-	0	0	0	-
09- CH (-94 to	0.25	0	0	1	0.8	-	-	0	0	0	-
10- SP (-103 t	0.35	-	-	0.5	0.8	-	-	0	0	0	-
11- CH (-109 t	0.35	0	0	1	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction
SIMC= Simplified Clay mode

SOIL BORINGS

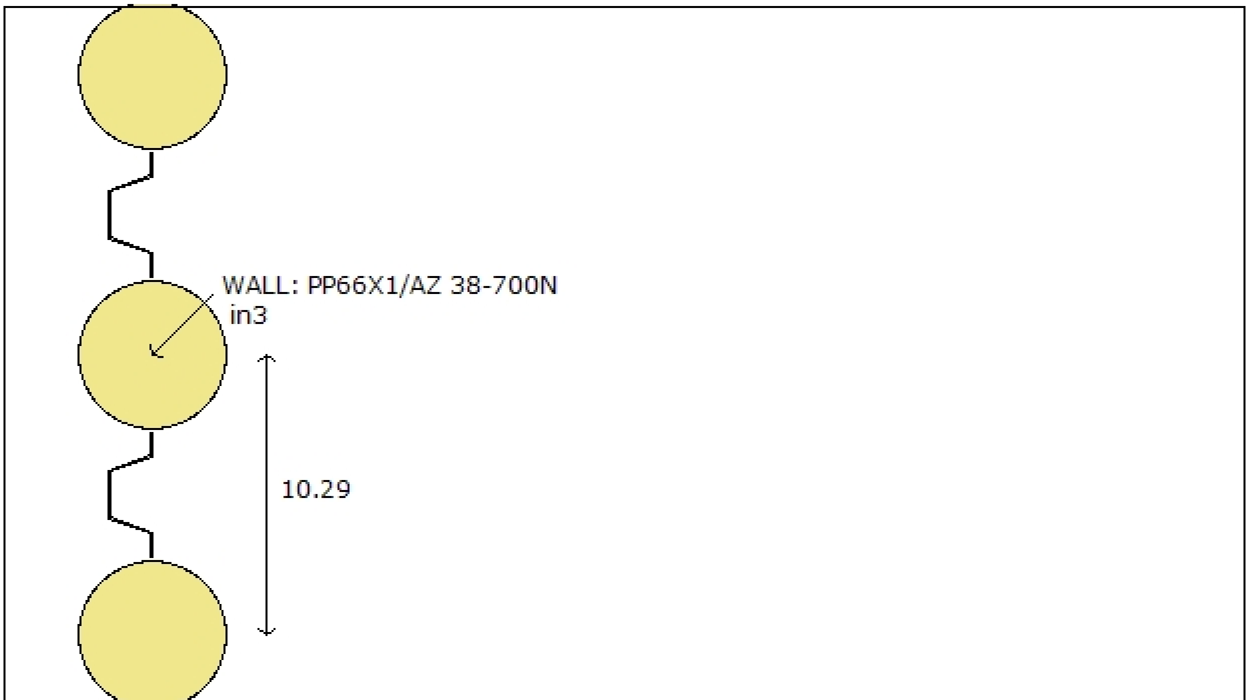
Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Boring 57, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
5	14- GP Fill	1	0.44
0	13- CH (GS to -	1	1
-10	12- SP (-10 to -	1	0.5
-17	01- SP (-17 TO	1	0.5
-27	02- SP (-27 TO	1	0.5
-30	03- CH (-30 to	1	1
-34	04- CH (-34 TO	1	1
-44	05- CH (-44 to	1	0.45
-57	06- CH (-57 to	1	1
-80	07- SP (-80 to -	1	0.5
-89	08- CH (-89 to	1	1
-94	09- CH (-94 to	1	1
-103	10- SP (-103 to	1	0.5
-109	11- CH (-109 t	1	1

WALL DATA

Wall section 0: Wall 1



Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP		4/27/2020

Wall uses wall section 0: Wall 1
Wall type: Combined sheet pile wall
Top wall El: 9 ft   Bottom wall El: -70 ft
Hor. wall spacing: 10.29 ft   Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft   Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi   Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.
Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

GENERAL WALL DATA
Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk

F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	1.912	2.962	7.188
Stage 1	Simple span	N/A	1.6	1.739	2.423	5.808
Stage 2	Simple span	N/A	1.6	2.059	3.154	7.49
Stage 3	Simple span	N/A	1.6	1.885	2.599	6.072
Stage 4	Simple span	N/A	1.6	2.193	3.712	8.71
Stage 5	Simple span	N/A	1.6	1.885	2.586	5.922
Stage 6	Simple span	N/A	1.6	2.431	3.952	9.076
Stage 7	Simple span	N/A	1.6	2.091	2.795	6.211

Name=excavation stage name
Analysis method
springs = Elastoplastic spring analysis used
DR = Drained condition for CLAY model
U = Undrained condition for CLAY model for all the soils
Up = Undrained condition just for selected soil
Limit equilibrium analysis settings
Drive press:
Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,
FHWA= Federal Highway Administration apparent pressure diagrams.
Ko = At-rest lateral earth pressures.
Peck = Peck 1969 Apparent earth pressure diagrams.
2 Step rect = Two step rectangular apparent earth pressure diagram.
User def. = User defined apparent earth pressure diagram.
Ka+d (and so on) indicates that wall friction is applied
ka mult = multiplication factor for Ka when Ka-Trap is selected
Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H
Resit press = Kp (passive earth pressures)
Res Mult = Safety factor applied directly on resisting pressures (
COntle Method = cantilever analysis method for limit equilibrium analysis.
Support Model: Method for calculating support reactions in limit-equlibrium analysis.
Beam= support reactions beam analysis (uses Blum's method).
Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).
Axial Incl = Axial loads included for structural design

Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

EXCAVATION STAGES SKETCHES

A sequence of figures for each excavation stage is reported

Company: Ardaman - Associates, Inc.

Engineer: George Segré

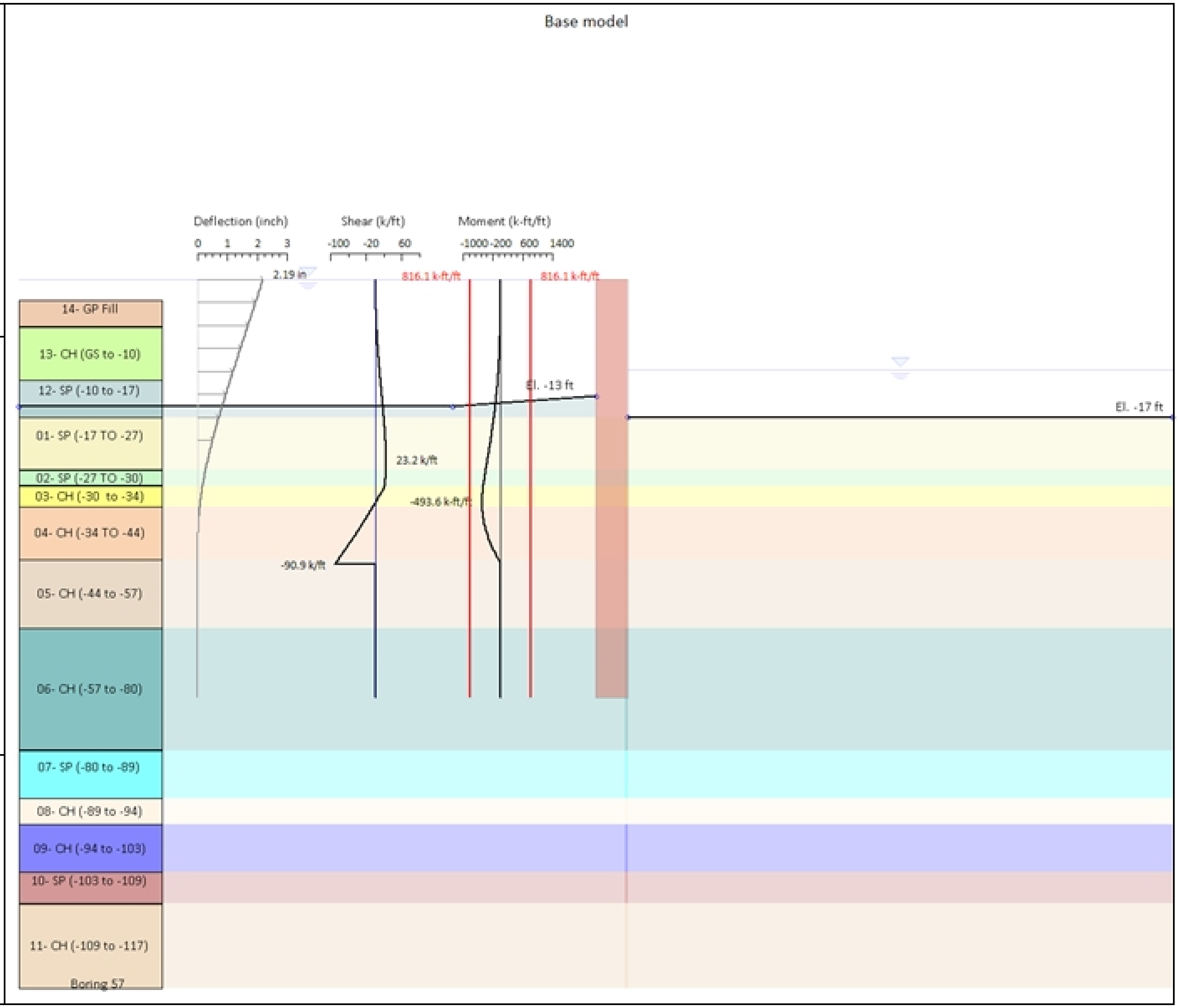
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C1 FS = 1.0

Deep Excavation LCC

DeepEX 2019

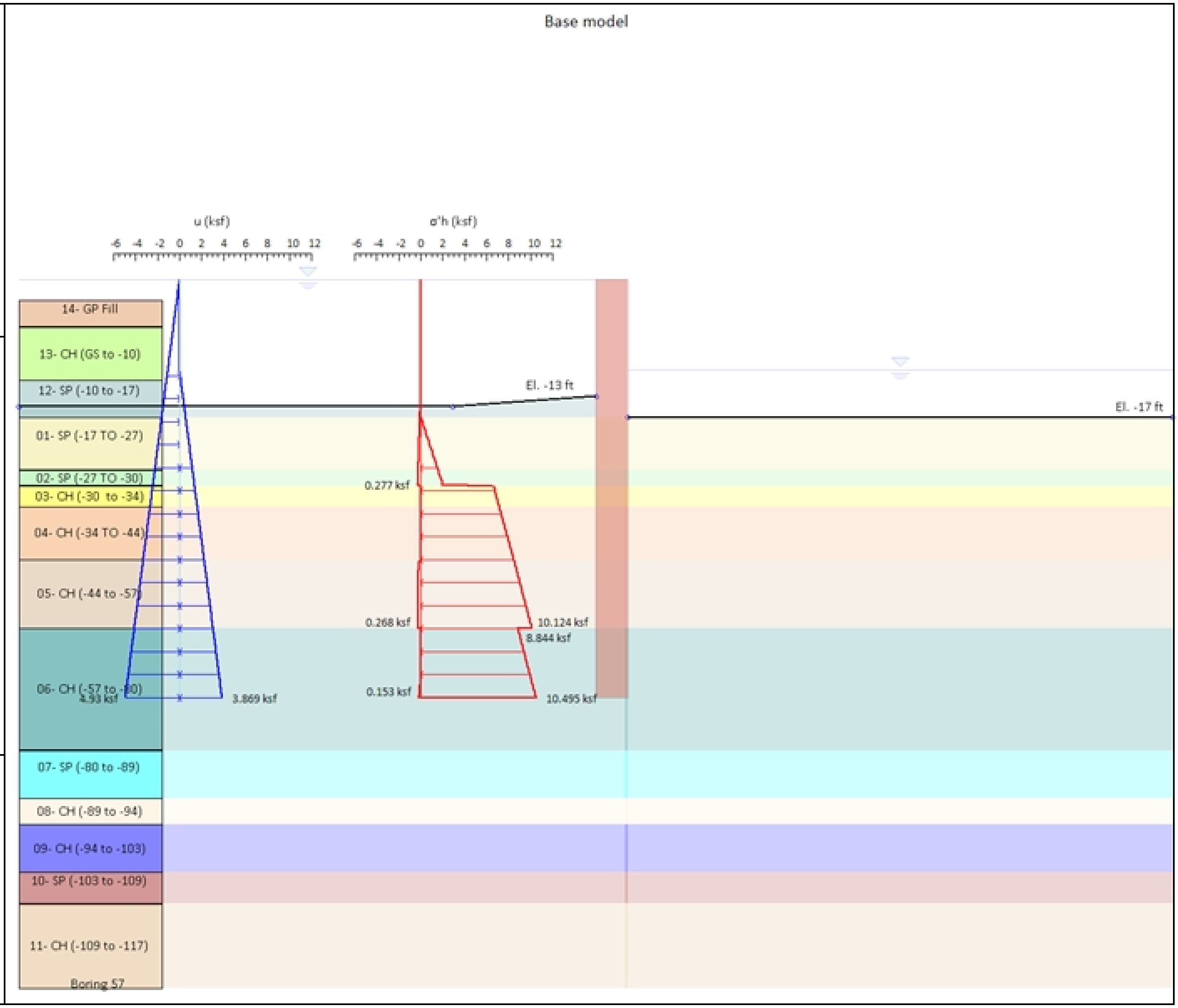
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C1 FS = 1.0

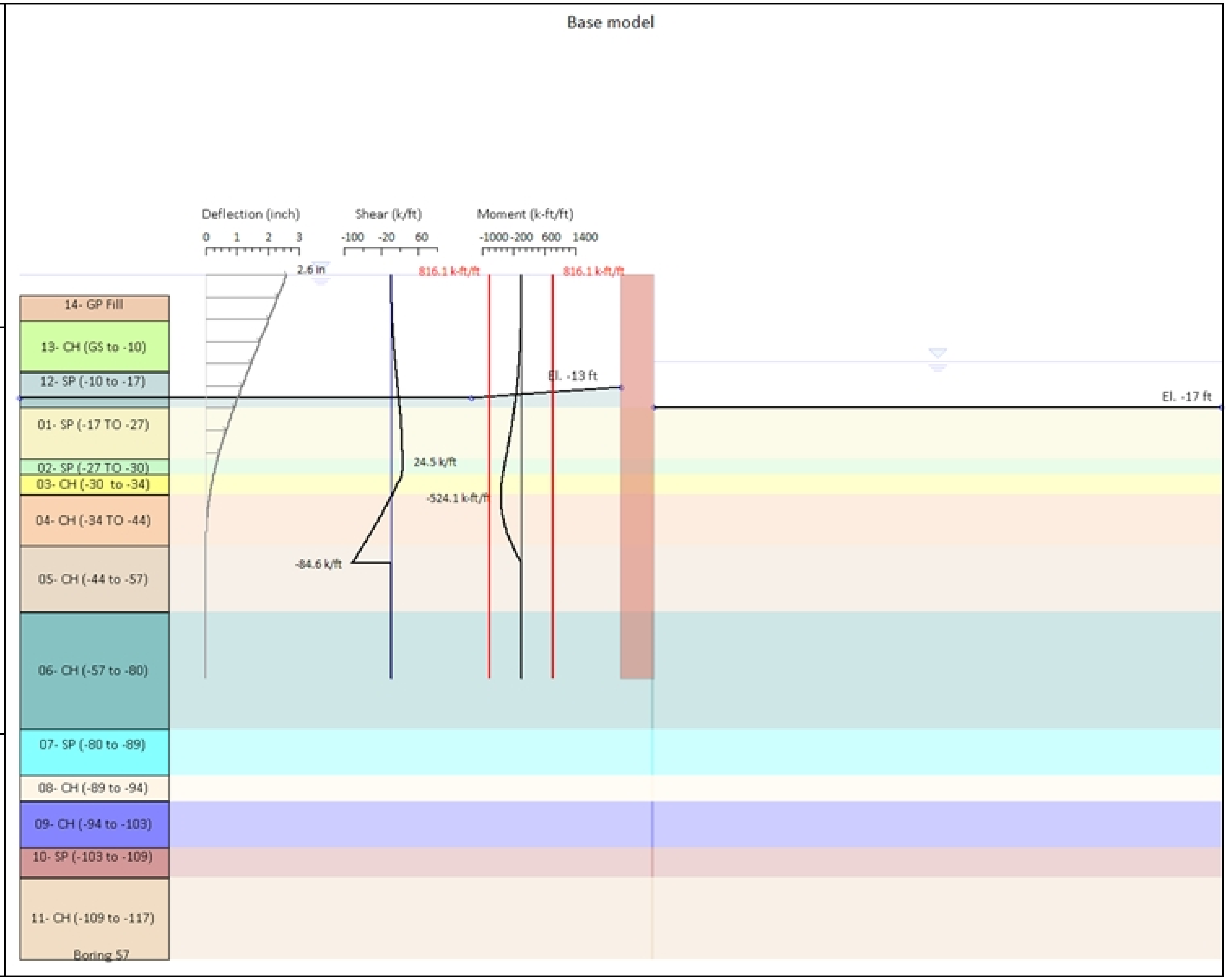
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C1 FS = 1.25

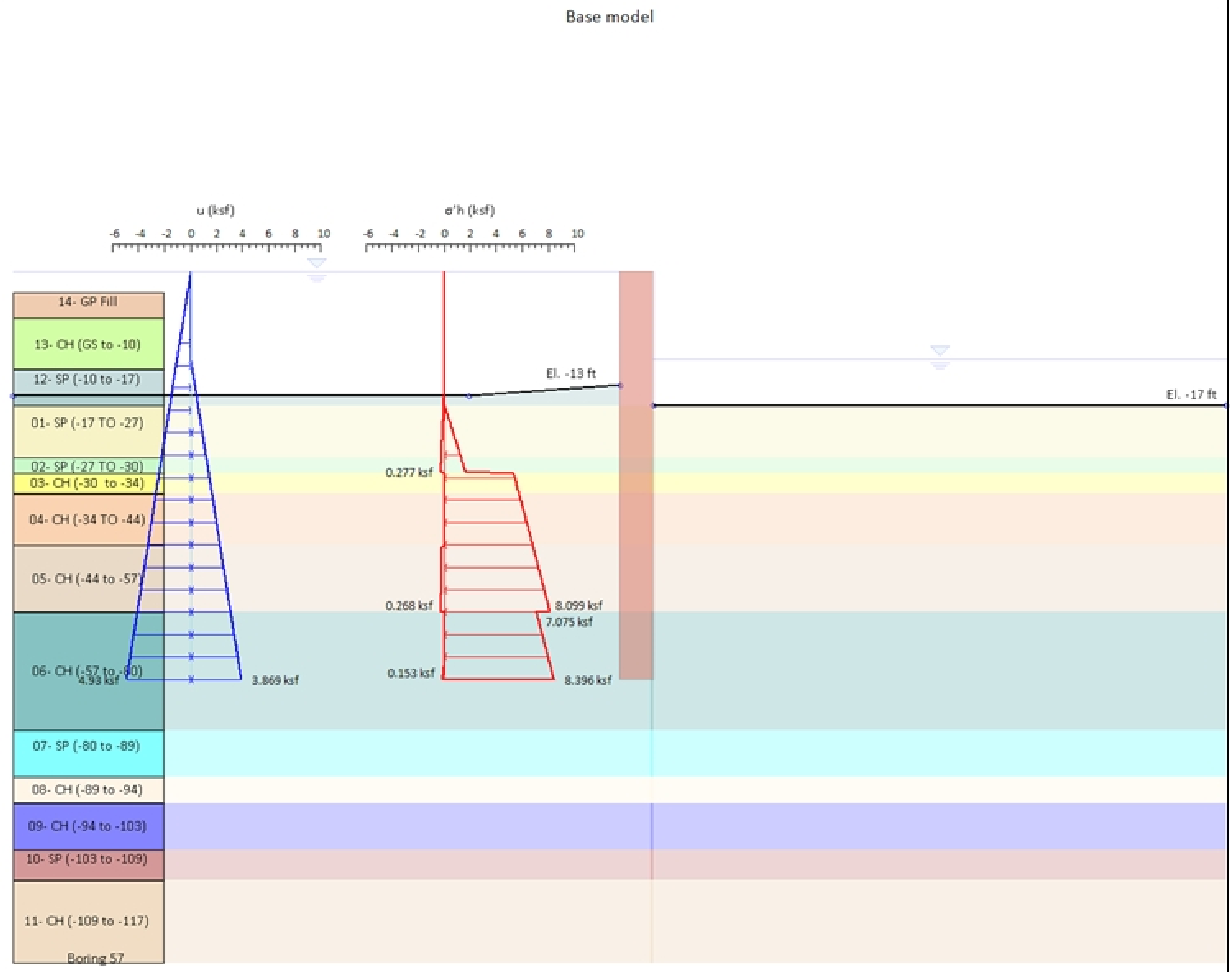
Deep Excavation LCC
DeepEX 2019
4/27/2020

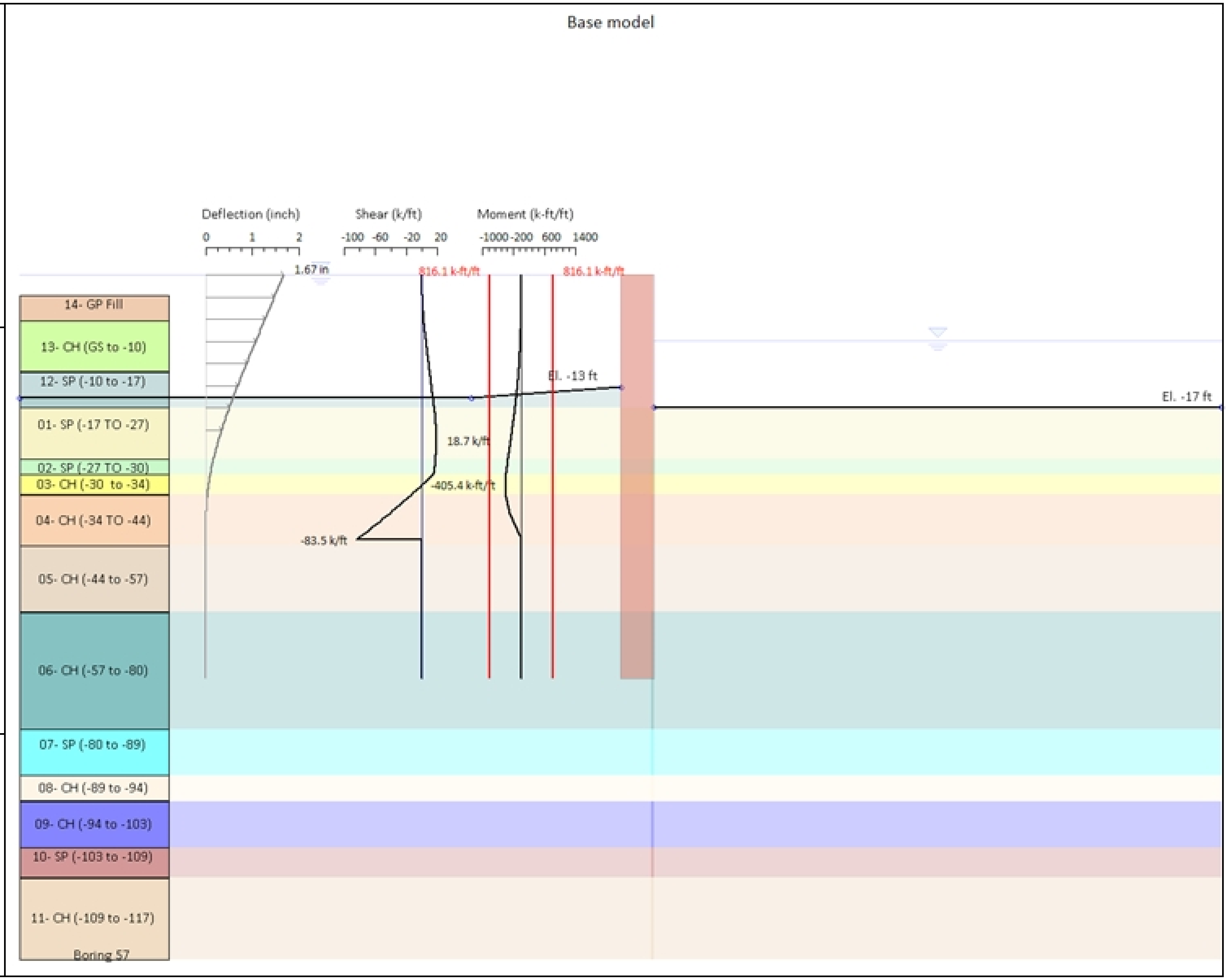


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C1 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/27/2020





Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C2 FS = 1.0

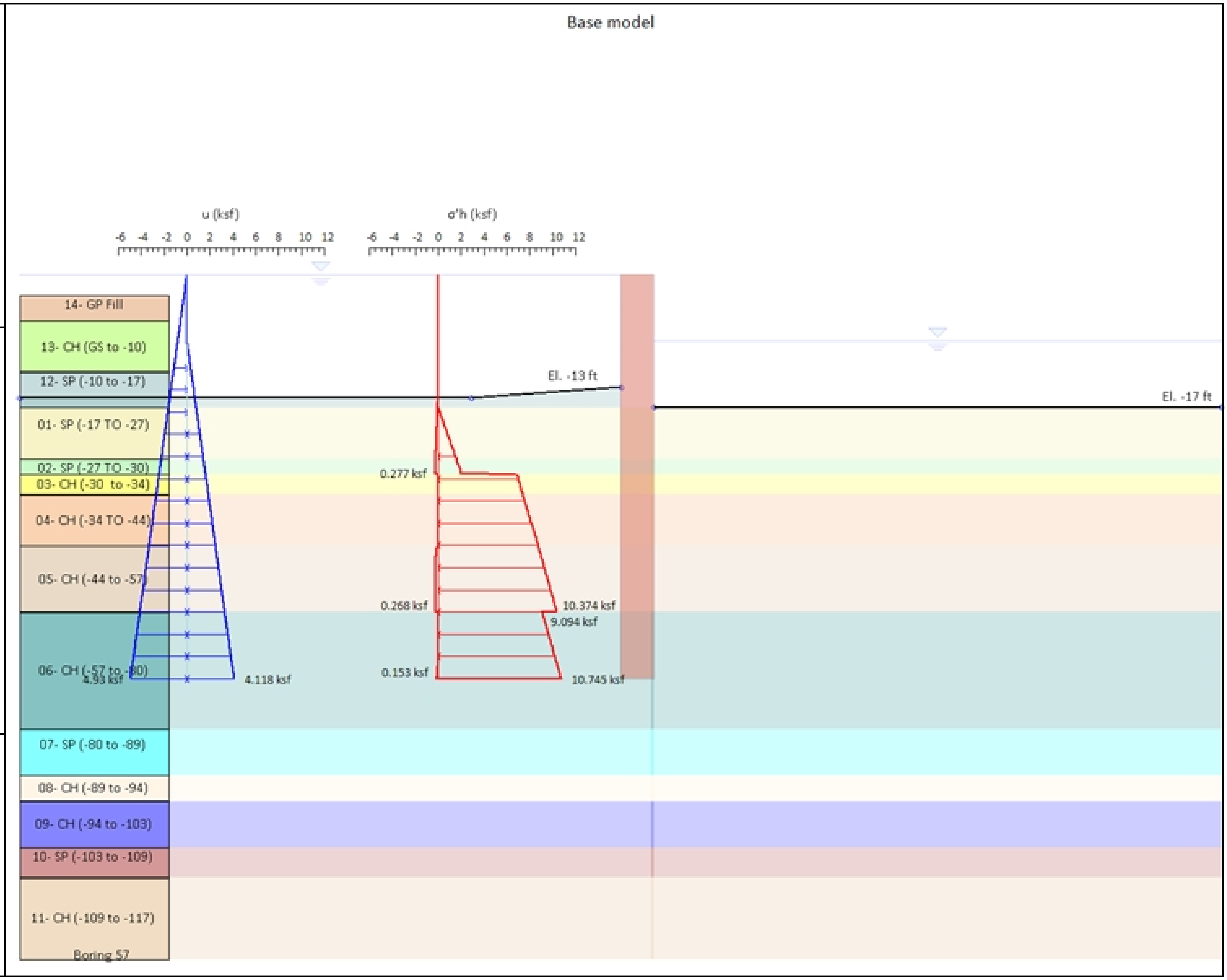
Deep Excavation LCC
DeepEX 2019
4/27/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C2 FS = 1.0

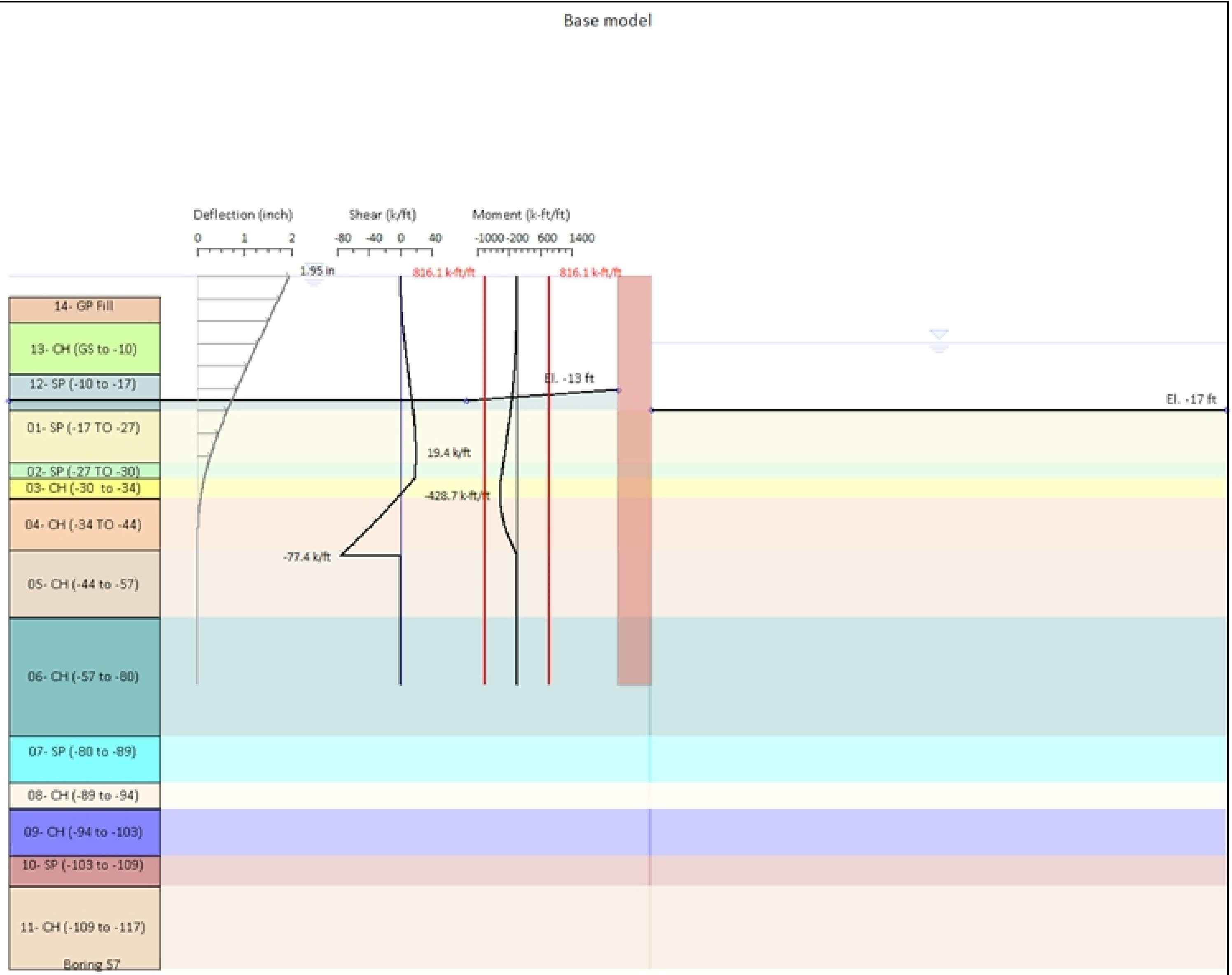
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C2 FS = 1.25

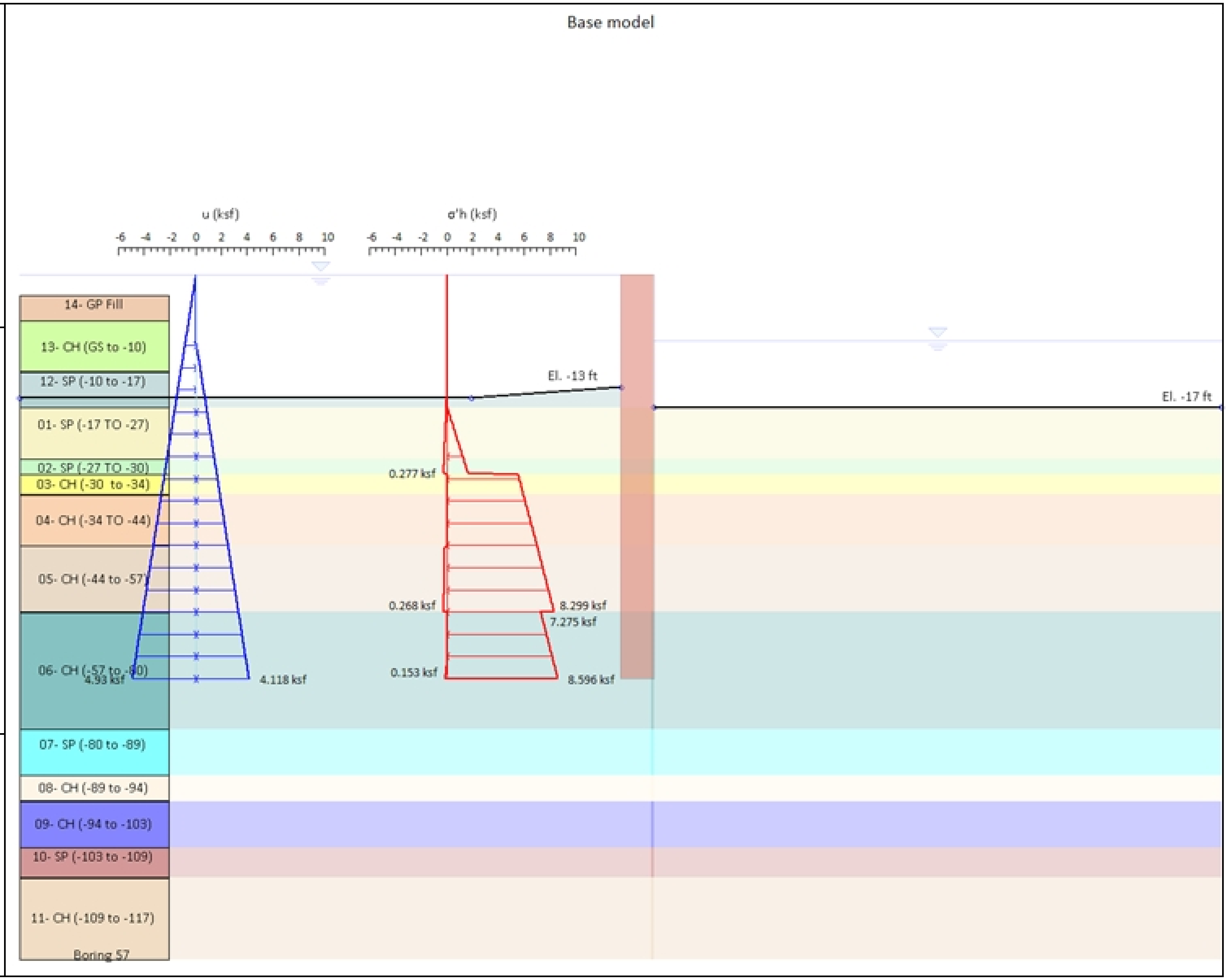
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C2 FS = 1.25

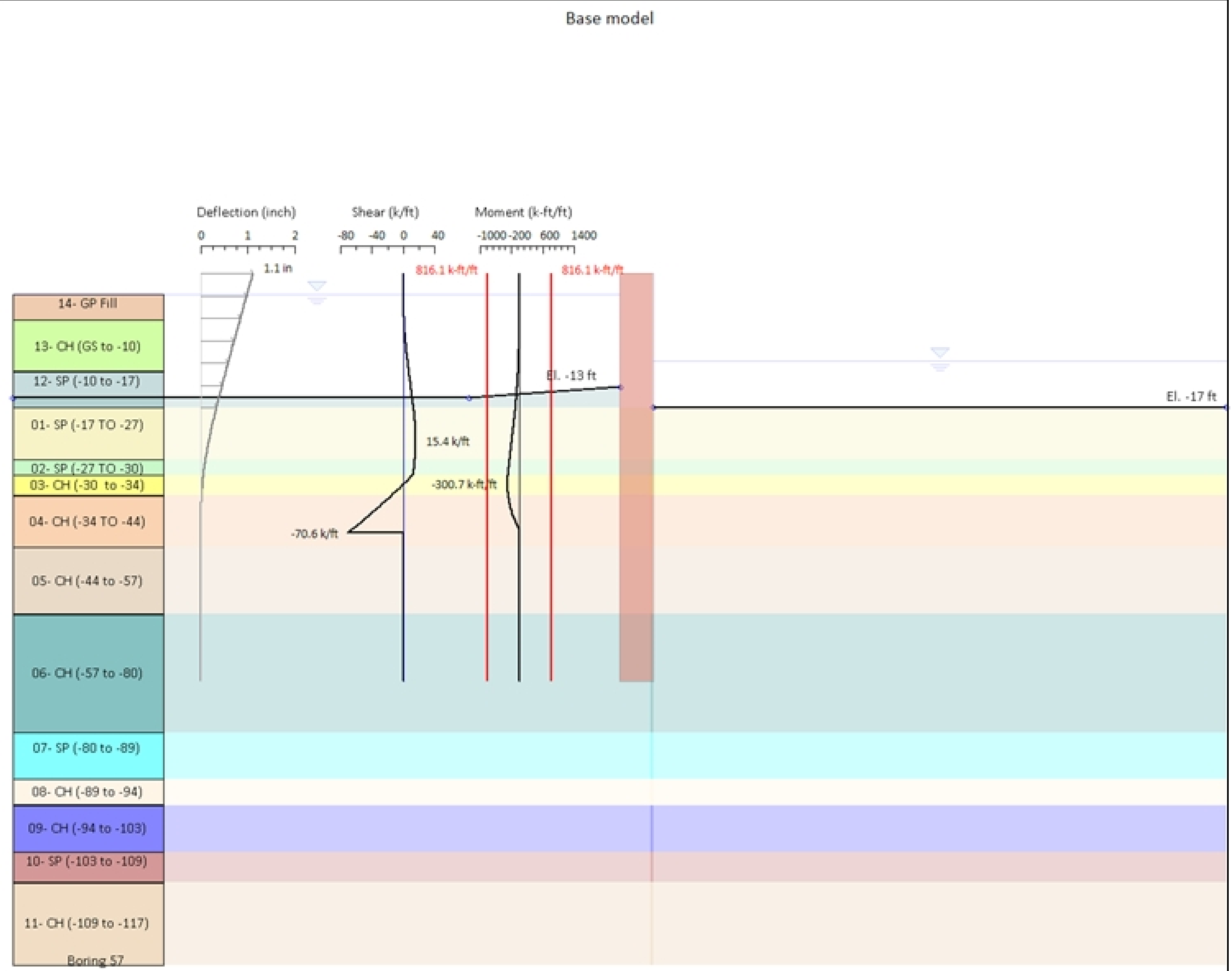
Deep Excavation LCC
DeepEX 2019
4/27/2020

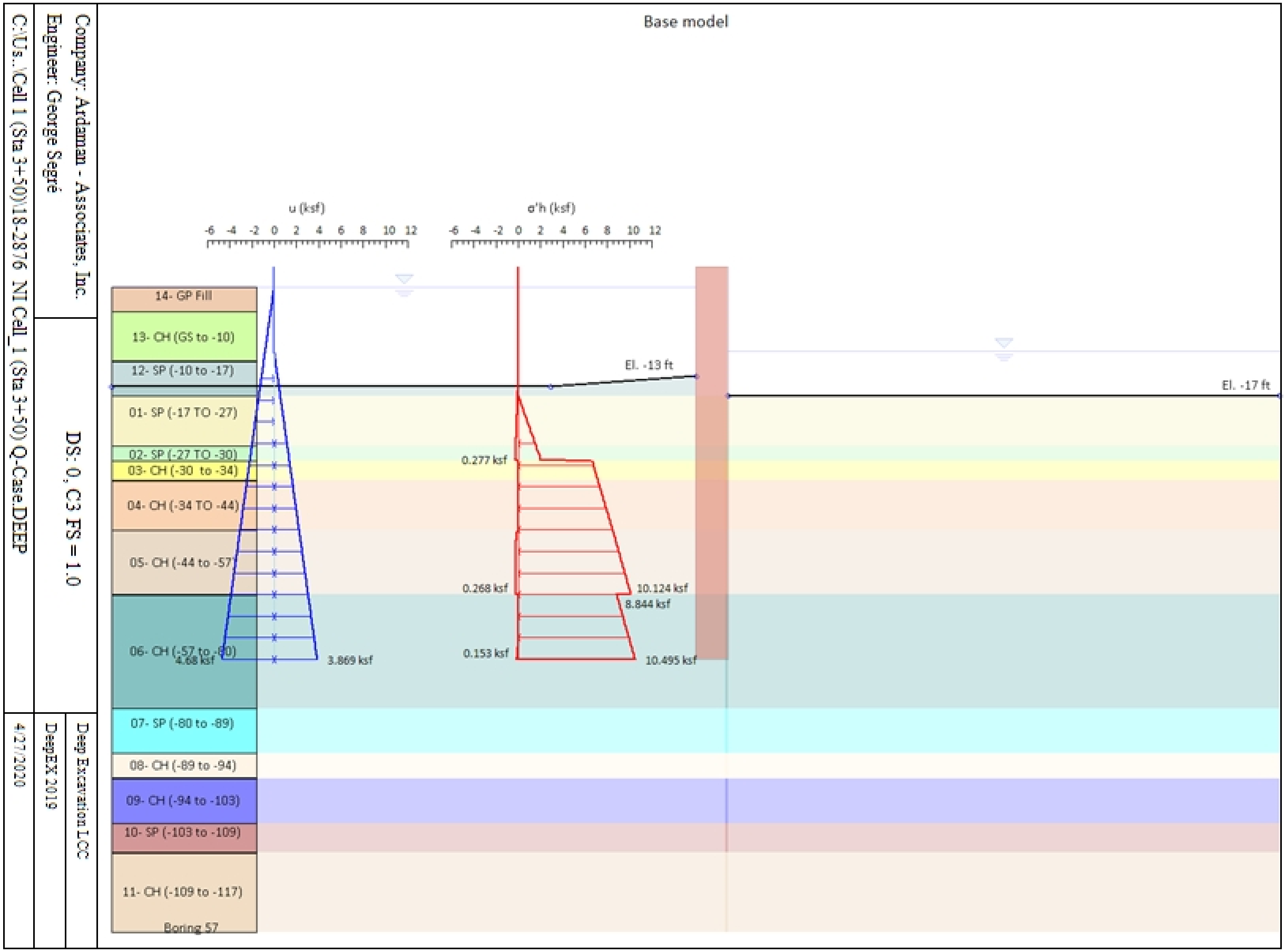


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C3 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

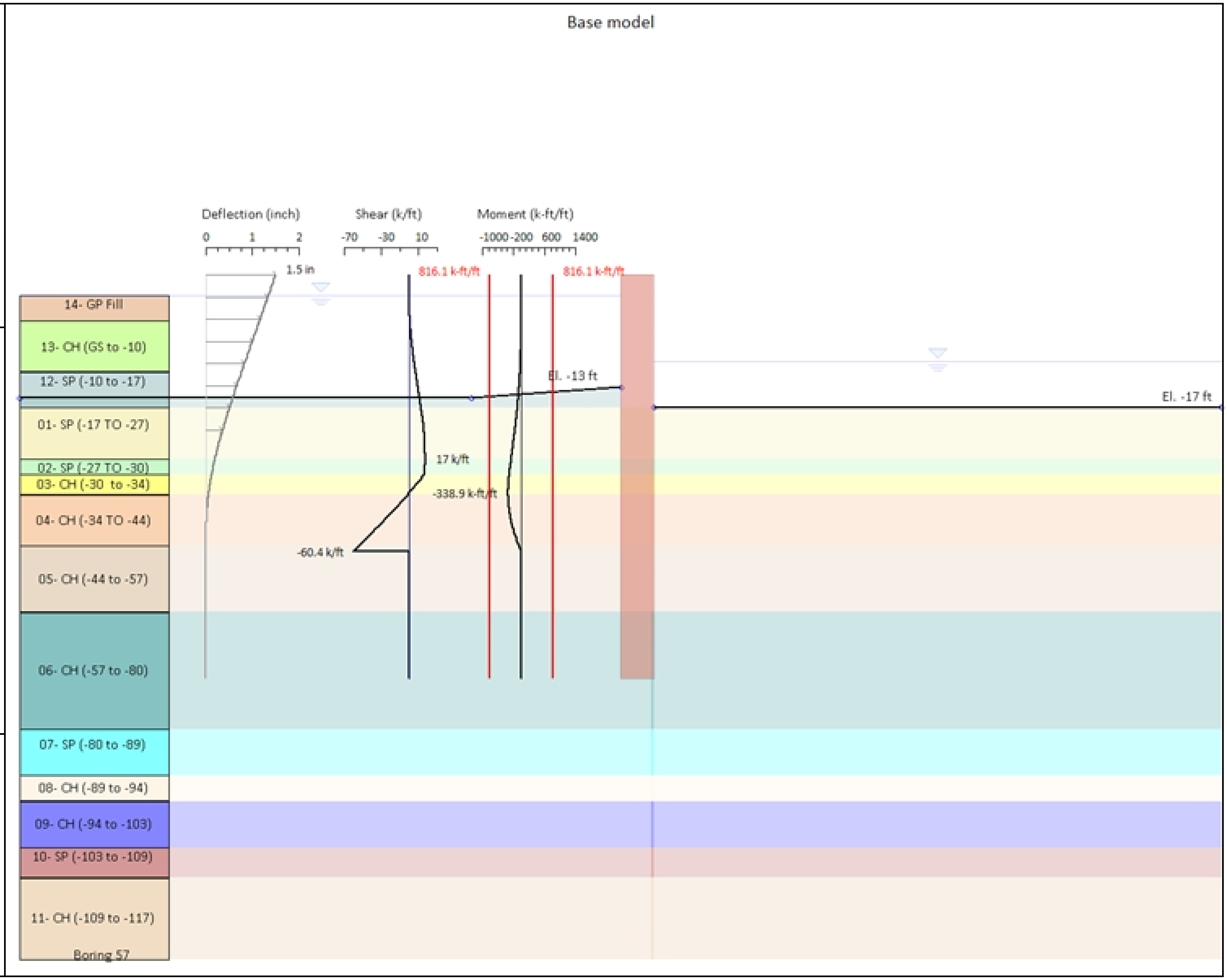


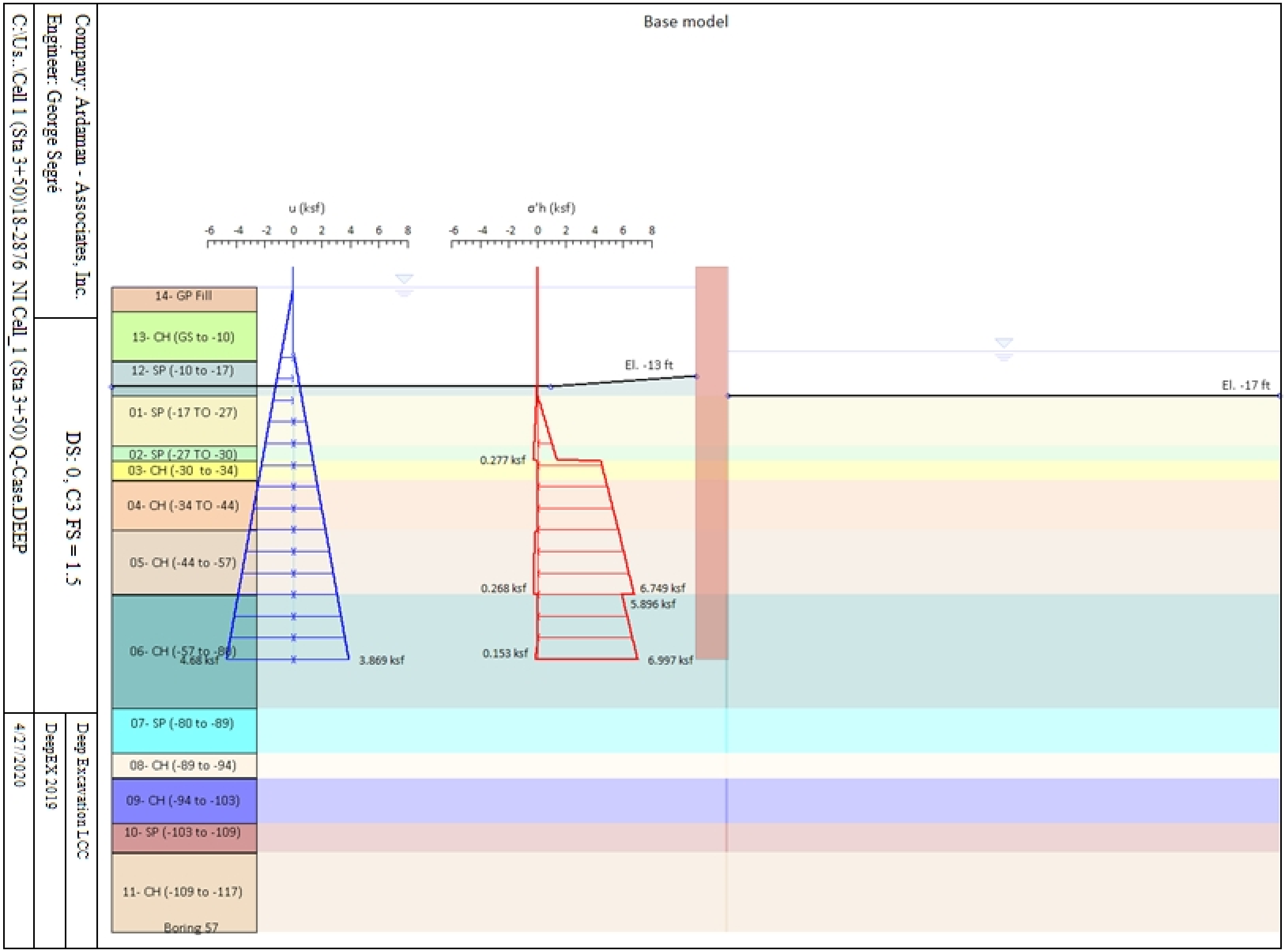

Base model
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP
DS: 0, C3 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/27/2020
u (ksf)
σ'h (ksf)
14- GP Fill
13- CH (GS to -10)
12- SP (-10 to -17)
01- SP (-17 TO -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57
El. -13 ft
El. -17 ft
0.277 ksf
0.268 ksf
10.124 ksf
8.844 ksf
0.153 ksf
10.495 ksf
4.68 ksf
3.869 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

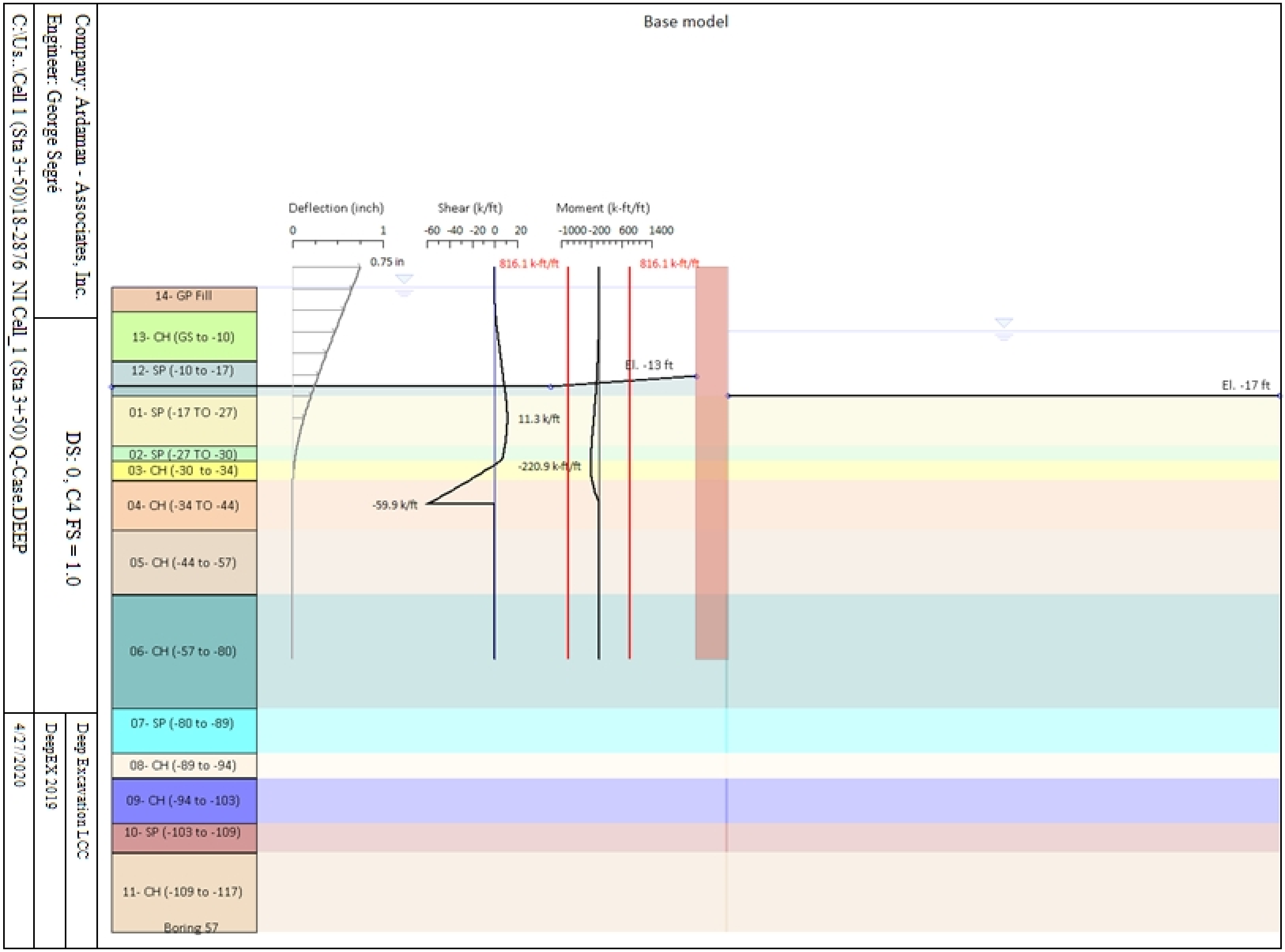
DS: 0, C3 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/27/2020





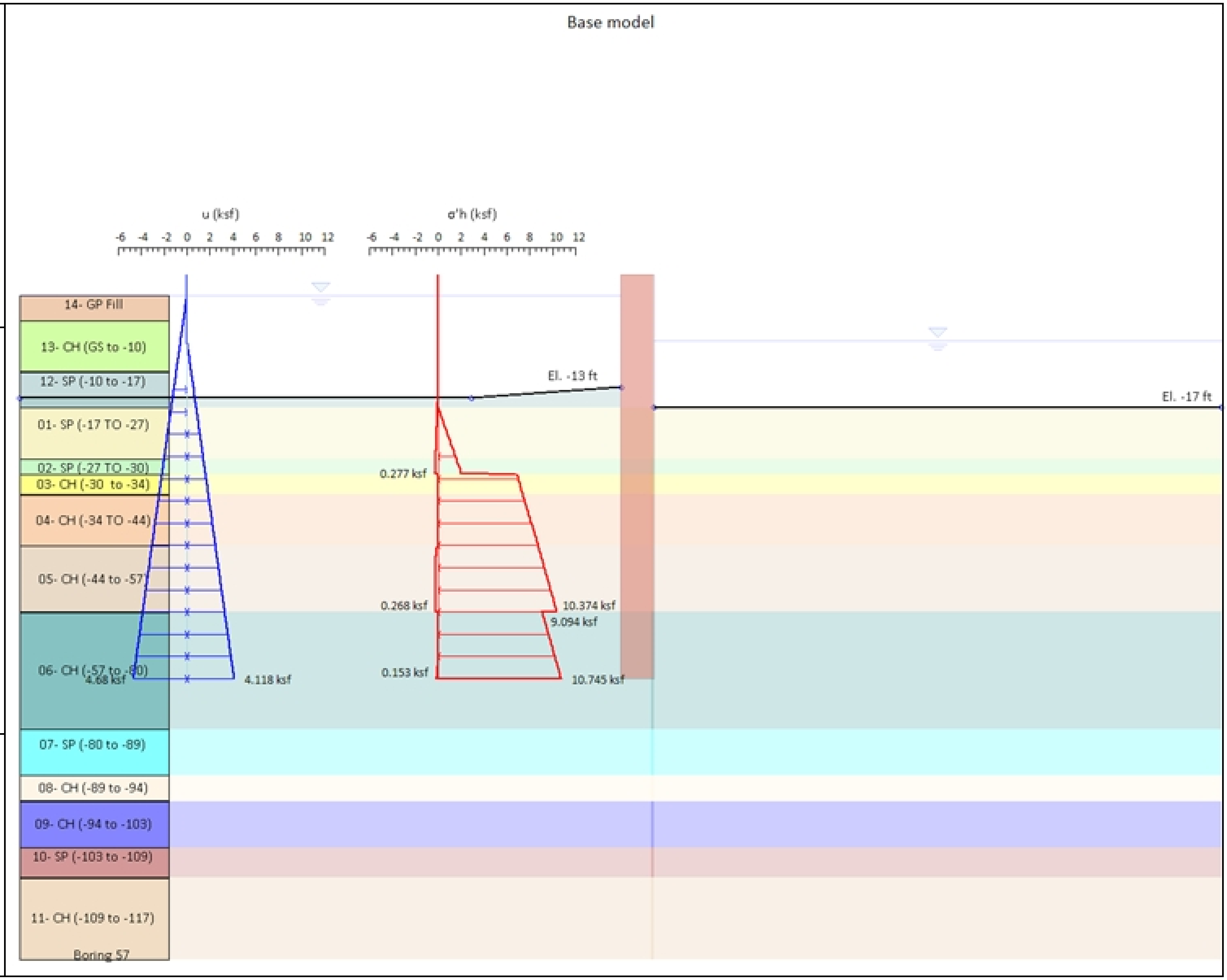
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP
DS: 0, C3 FS = 1.5
Deep Excavation LCC
DeepEX 2019
4/27/2020
Base model
u (ksf)
σ'h (ksf)
-6 -4 -2 0 2 4 6 8
14- GP Fill
13- CH (GS to -10)
12- SP (-10 to -17)
01- SP (-17 TO -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57
El. -13 ft
El. -17 ft
0.277 ksf
0.268 ksf
6.749 ksf
5.896 ksf
0.153 ksf
6.997 ksf
4.68 ksf
3.869 ksf


Base model
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP
DS: 0, C4 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/27/2020
Deflection (inch)
0
1
Shear (k/ft)
-60 -40 -20 0 20
Moment (k-ft/ft)
-1000 -200 600 1400
0.75 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -13 ft
El. -17 ft
11.3 k/ft
-220.9 k-ft/ft
-59.9 k/ft
14- GP Fill
13- CH (GS to -10)
12- SP (-10 to -17)
01- SP (-17 TO -27)
02- SP (-27 TO -30)
03- CH (-30 to -34)
04- CH (-34 TO -44)
05- CH (-44 to -57)
06- CH (-57 to -80)
07- SP (-80 to -89)
08- CH (-89 to -94)
09- CH (-94 to -103)
10- SP (-103 to -109)
11- CH (-109 to -117)
Boring 57

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C4 FS = 1.0

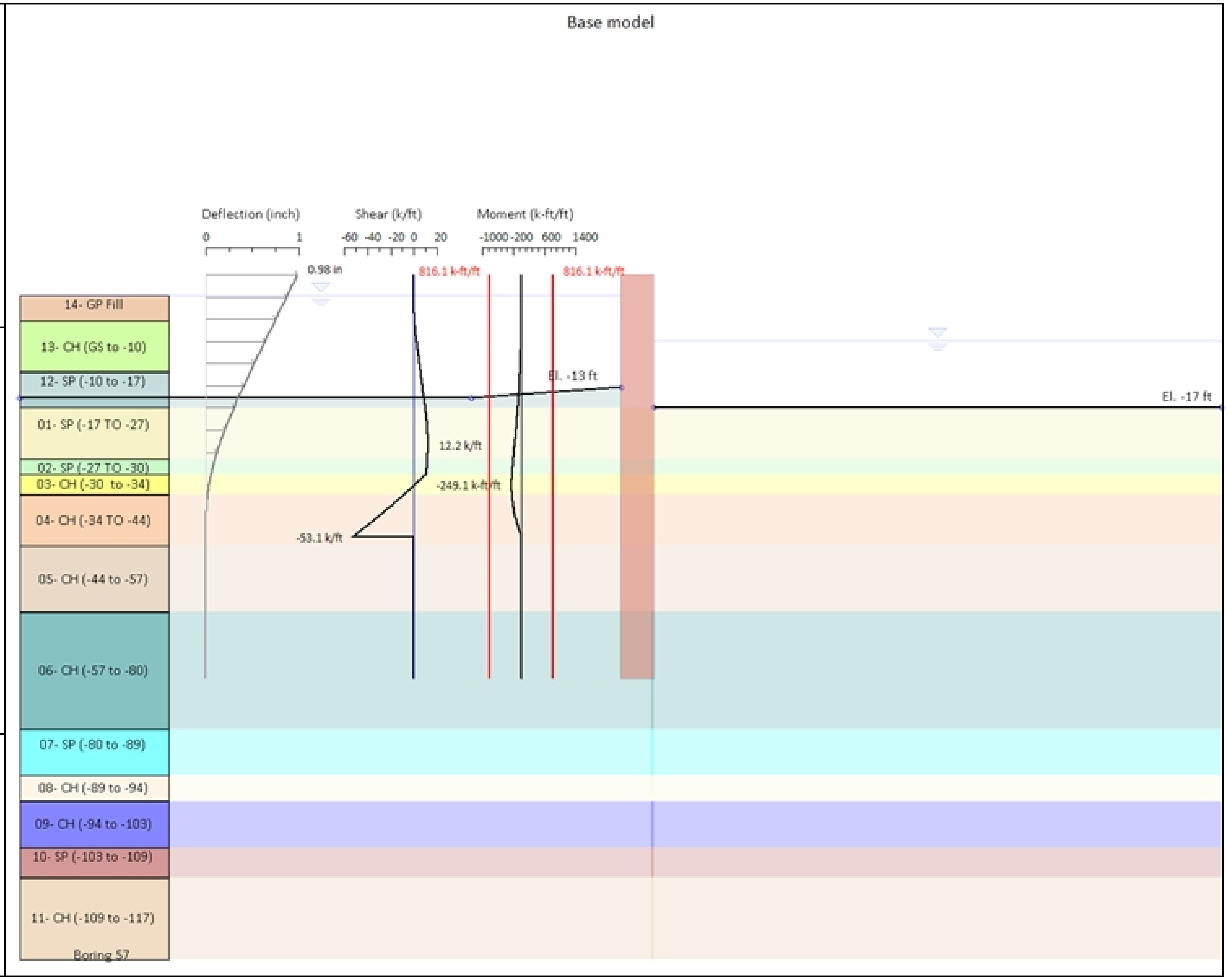
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

DS: 0, C4 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/27/2020

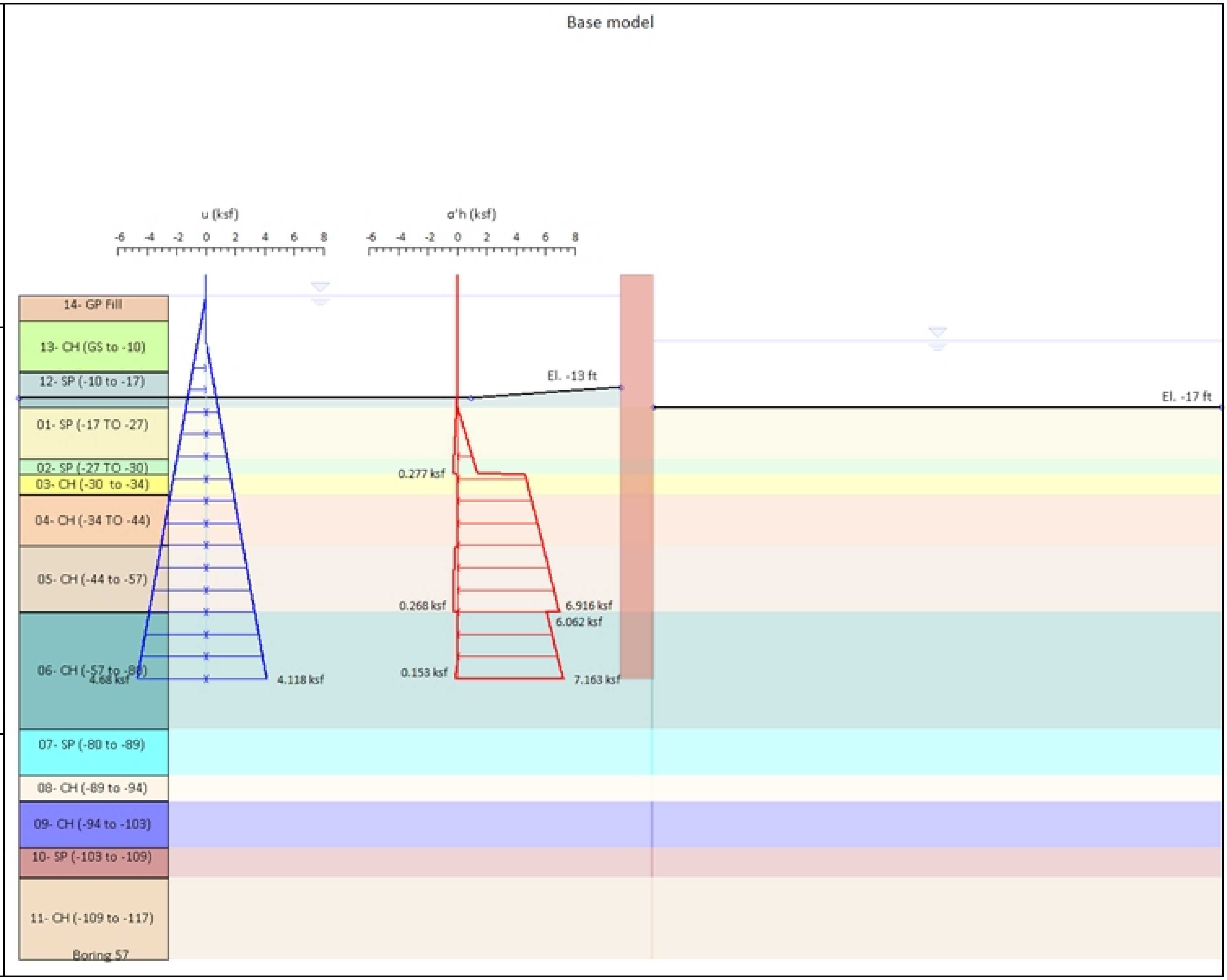


Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C4 FS = 1.5

C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) Q-Case.DEEP

Deep Excavation LCC
DeepEX 2019
4/27/2020



DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 4/27/2020 8:01:34 PM

File: C:\Users\George.Segre\Desktop\Northern Impoundment\Cell 1 Sections\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S -Case.DEEP

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)
A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength

Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
14-GP (FILL)	120	120	34	0	N/A	N/A	N/A	300	3	0.28	3.54	N/A	N/A	True	Linear	
13- CH (GS to	112	112	23	0	N/A	N/A	N/A	300	3	0.44	2.28	N/A	N/A	True	Linear	
12- SP (-10 to	112	112	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
01- SP (GS TO	115	115	33	0	N/A	N/A	N/A	300	3	0.3	3.39	N/A	N/A	True	EXP	
02- SP (-27 T	115	115	33	0	N/A	N/A	N/A	60	3	0.3	3.39	N/A	N/A	True	Linear	
03- CH (-30 t	126	126	26	0	N/A	N/A	N/A	150	3	0.39	2.56	N/A	N/A	True	Linear	
04- CH (-34 T	134	134	26	0	N/A	N/A	N/A	521.92	3	0.39	2.56	N/A	N/A	True	Linear	
05- CH (-44 to	126	126	26	0	N/A	N/A	N/A	417.54	3	0.39	2.56	N/A	N/A	True	Linear	
06- CH (-57 to	127	127	26	0	N/A	N/A	N/A	626.3	3	0.39	2.56	N/A	N/A	True	Linear	
07- SP (-80 to	122	122	33	0	N/A	N/A	N/A	300	3	0.3	3.39	N/A	N/A	True	Linear	
08- CH (-89 to	115	115	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	
09- CH (-94 to	120	120	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	
10- SP (-103 t	120	120	33	0	N/A	N/A	N/A	300	3	0.3	3.39	N/A	N/A	True	Linear	
11- CH (-109 t	115	115	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
14-GP (FILL)	0.35	-	-	0.441	0.8	-	-	0	0	0	-
13- CH (GS to	0.35	-	-	0.609	0.8	-	-	0	0	0	-
12- SP (-10 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
01- SP (GS TO	0.4	-	-	0.455	0.5	1	0	7.2	4.8	20	-
02- SP (-27 T	0.4	-	-	0.455	0.5	-	-	5.1	3.4	20	-
03- CH (-30 t	0.3	-	-	0.562	0.5	-	-	13	8.7	20	-
04- CH (-34 T	0.3	-	-	0.562	0.5	-	-	21.8	14.5	30	-
05- CH (-44 to	0.45	-	-	0.562	0.5	-	-	18.1	12.1	30	-
06- CH (-57 to	0.35	-	-	0.562	0.5	-	-	29	19.3	70	-
07- SP (-80 to	0.35	-	-	0.455	0.8	-	-	0	0	0	-
08- CH (-89 to	0.3	-	-	0.562	0.8	-	-	0	0	0	-
09- CH (-94 to	0.25	-	-	0.562	0.8	-	-	0	0	0	-
10- SP (-103 t	0.35	-	-	0.455	0.8	-	-	0	0	0	-
11- CH (-109 t	0.35	-	-	0.562	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction
SIMC= Simplified Clay mode

SOIL BORINGS

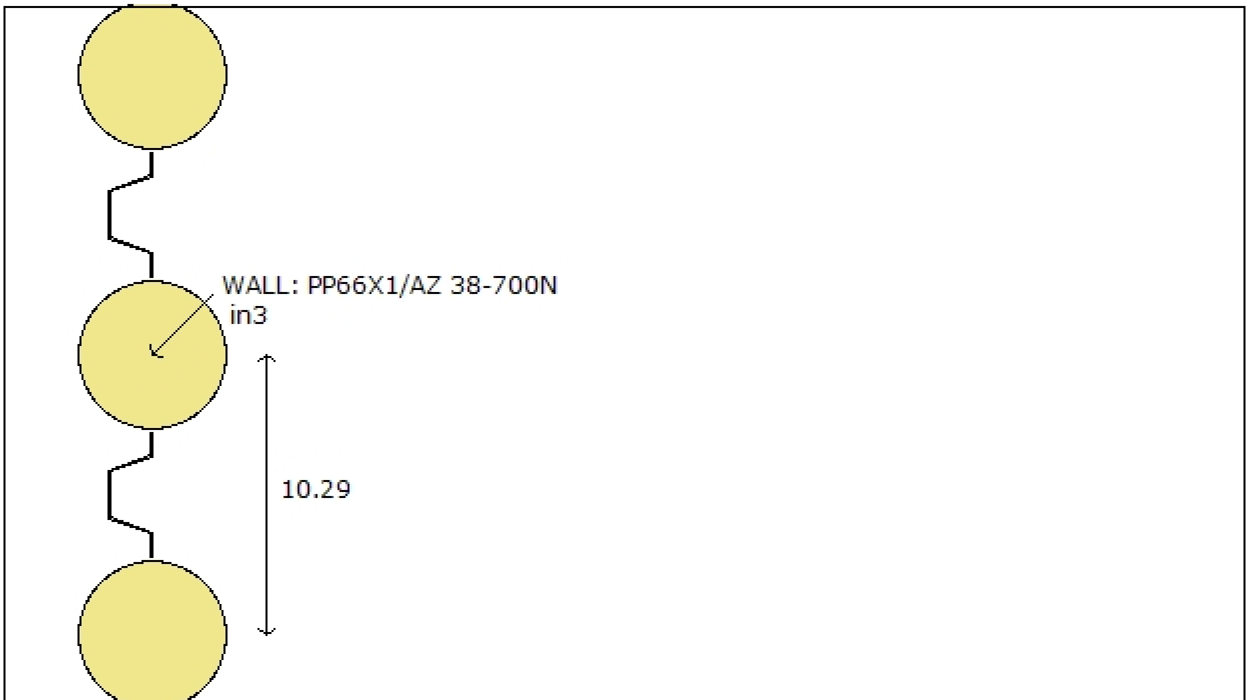
Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Boring 57, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
5	14-GP (FILL)	1	0.44
0	13- CH (GS to -	1	0.61
-10	12- SP (-10 to -	1	0.5
-17	01- SP (GS TO	1	0.46
-27	02- SP (-27 TO	1	0.46
-30	03- CH (-30 to	1	0.56
-34	04- CH (-34 TO	1	0.56
-44	05- CH (-44 to	1	0.56
-57	06- CH (-57 to	1	0.56
-80	07- SP (-80 to -	1	0.46
-89	08- CH (-89 to	1	0.56
-94	09- CH (-94 to	1	0.56
-103	10- SP (-103 to	1	0.46
-109	11- CH (-109 t	1	1

WALL DATA

Wall section 0: Wall 1



Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP		4/27/2020

Wall uses wall section 0: Wall 1
Wall type: Combined sheet pile wall
Top wall El: 9 ft Bottom wall El: -85 ft
Hor. wall spacing: 10.29 ft Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.
Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

GENERAL WALL DATA
Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk

F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	1.307	1.307	1.702
Stage 1	Simple span	N/A	1.6	1.14	1.14	1.472
Stage 2	Simple span	N/A	1.6	1.385	1.385	1.761
Stage 3	Simple span	N/A	1.6	1.218	1.218	1.532
Stage 4	Simple span	N/A	1.6	1.461	1.461	1.828
Stage 5	Simple span	N/A	1.6	1.151	1.151	1.417
Stage 6	Simple span	N/A	1.6	1.548	1.548	1.891
Stage 7	Simple span	N/A	1.6	1.238	1.238	1.48

Name=excavation stage name
Analysis method
springs = Elastoplastic spring analysis used
DR = Drained condition for CLAY model
U = Undrained condition for CLAY model for all the soils
Up = Undrained condition just for selected soil
Limit equilibrium analysis settings
Drive press:
Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,
FHWA= Federal Highway Administration apparent pressure diagrams.
Ko = At-rest lateral earth pressures.
Peck = Peck 1969 Apparent earth pressure diagrams.
2 Step rect = Two step rectangular apparent earth pressure diagram.
User def. = User defined apparent earth pressure diagram.
Ka+d (and so on) indicates that wall friction is applied
ka mult = multiplication factor for Ka when Ka-Trap is selected
Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H
Resit press = Kp (passive earth pressures)
Res Mult = Safety factor applied directly on resisting pressures (
COntle Method = cantilever analysis method for limit equilibrium analysis.
Support Model: Method for calculating support reactions in limit-equlibrium analysis.
Beam= support reactions beam analysis (uses Blum's method).
Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).
Axial Incl = Axial loads included for structural design

Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

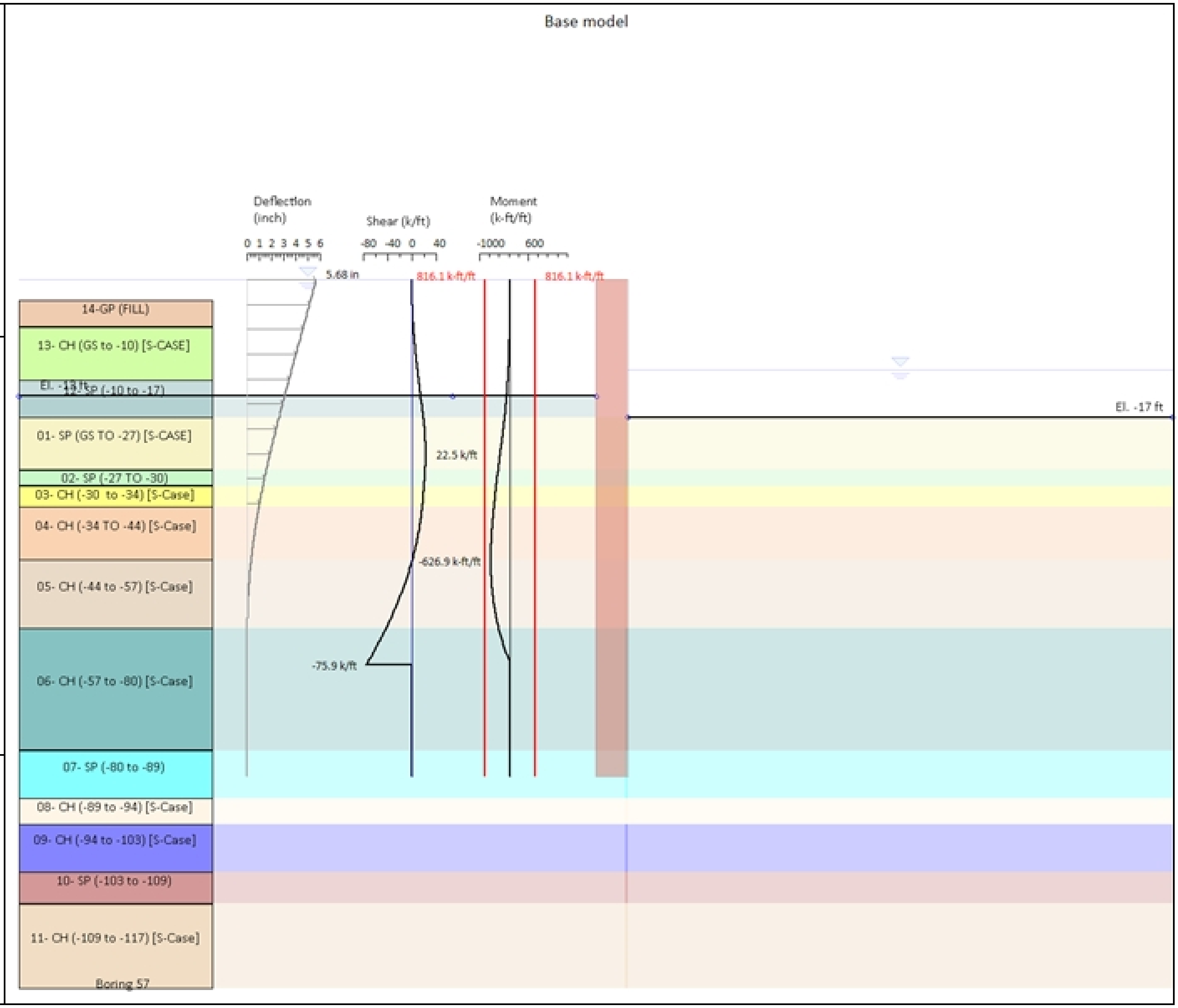
EXCAVATION STAGES SKETCHES

A sequence of figures for each excavation stage is reported

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C1 FS = 1.0

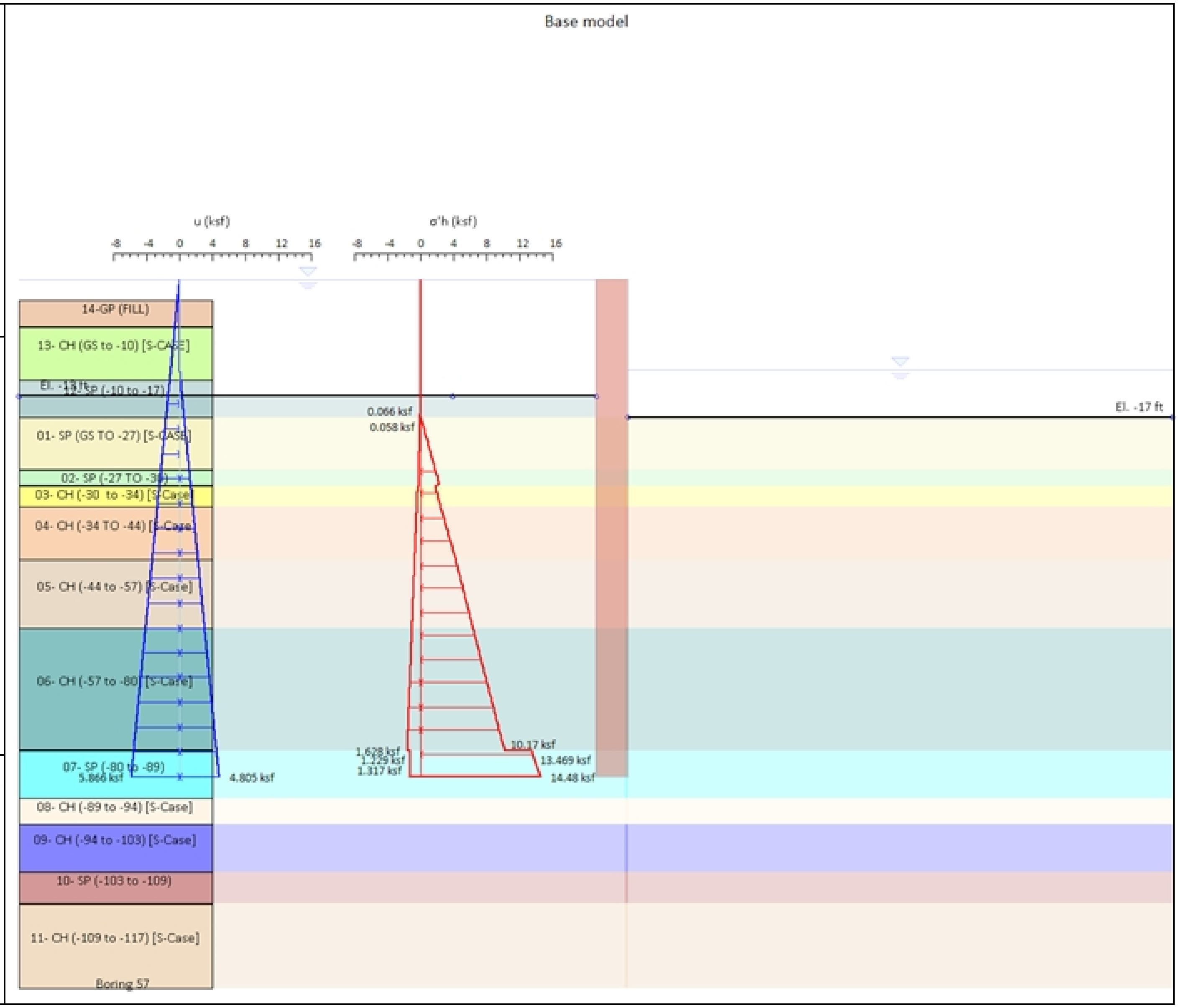
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C1 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

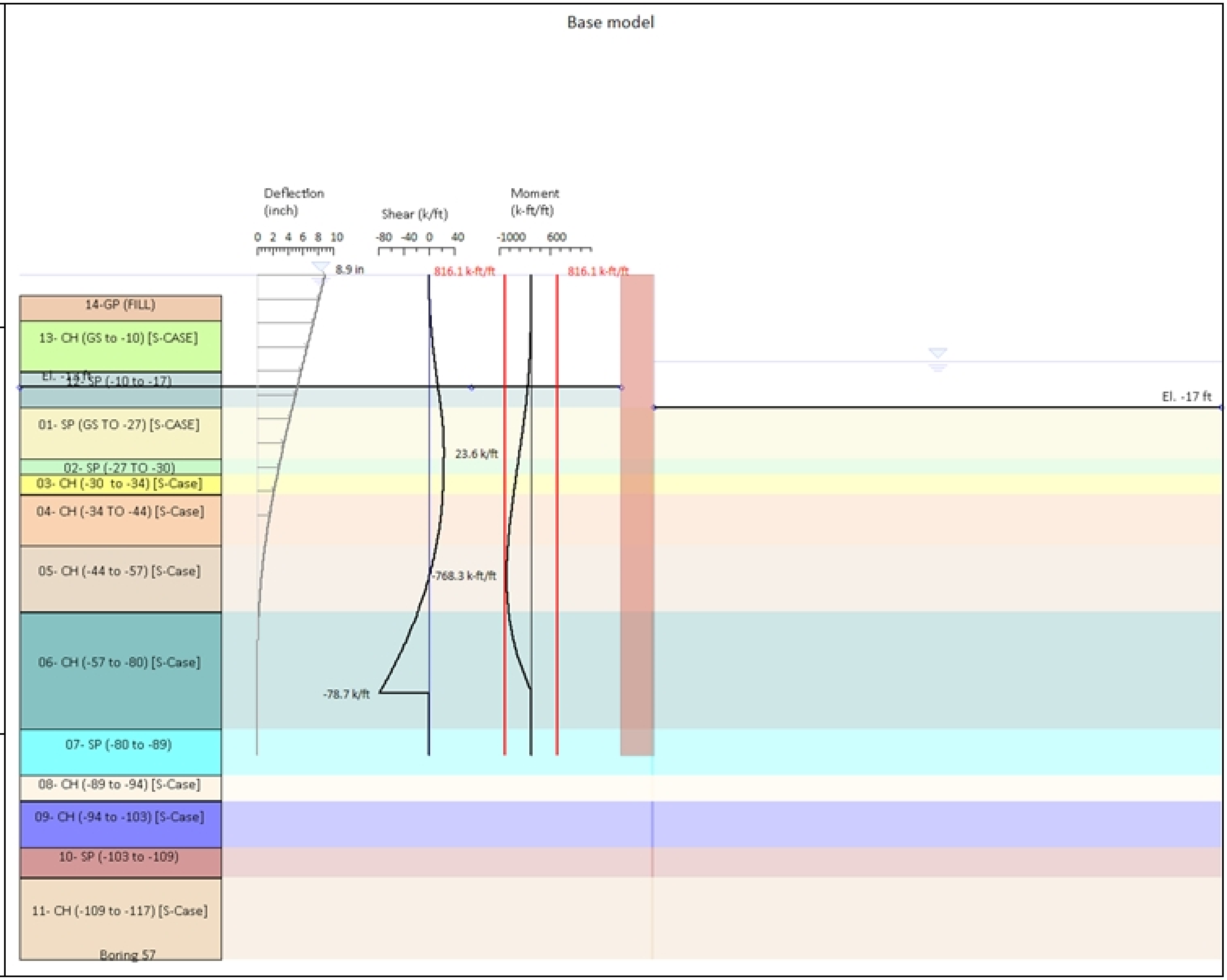


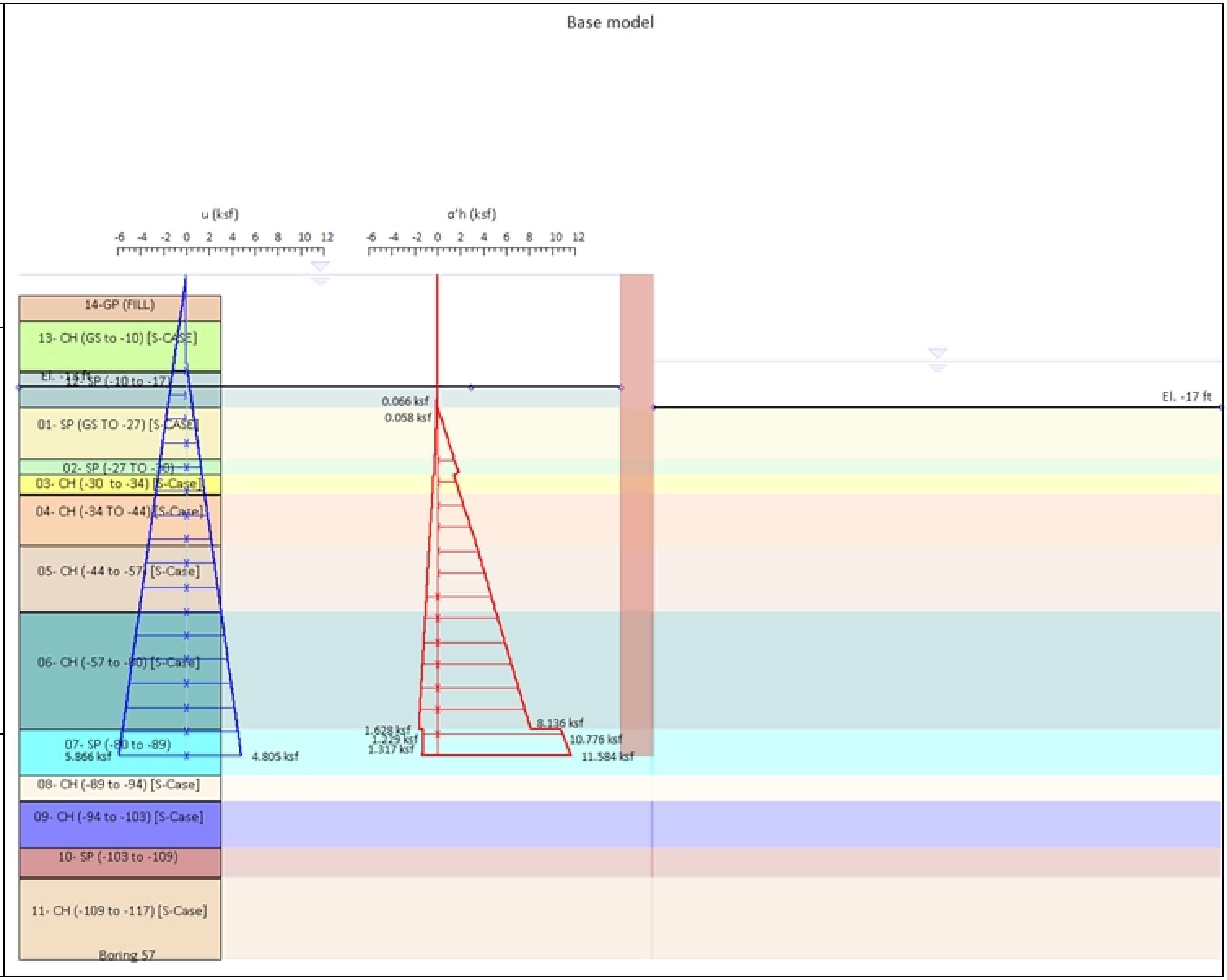
Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C1 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/27/2020



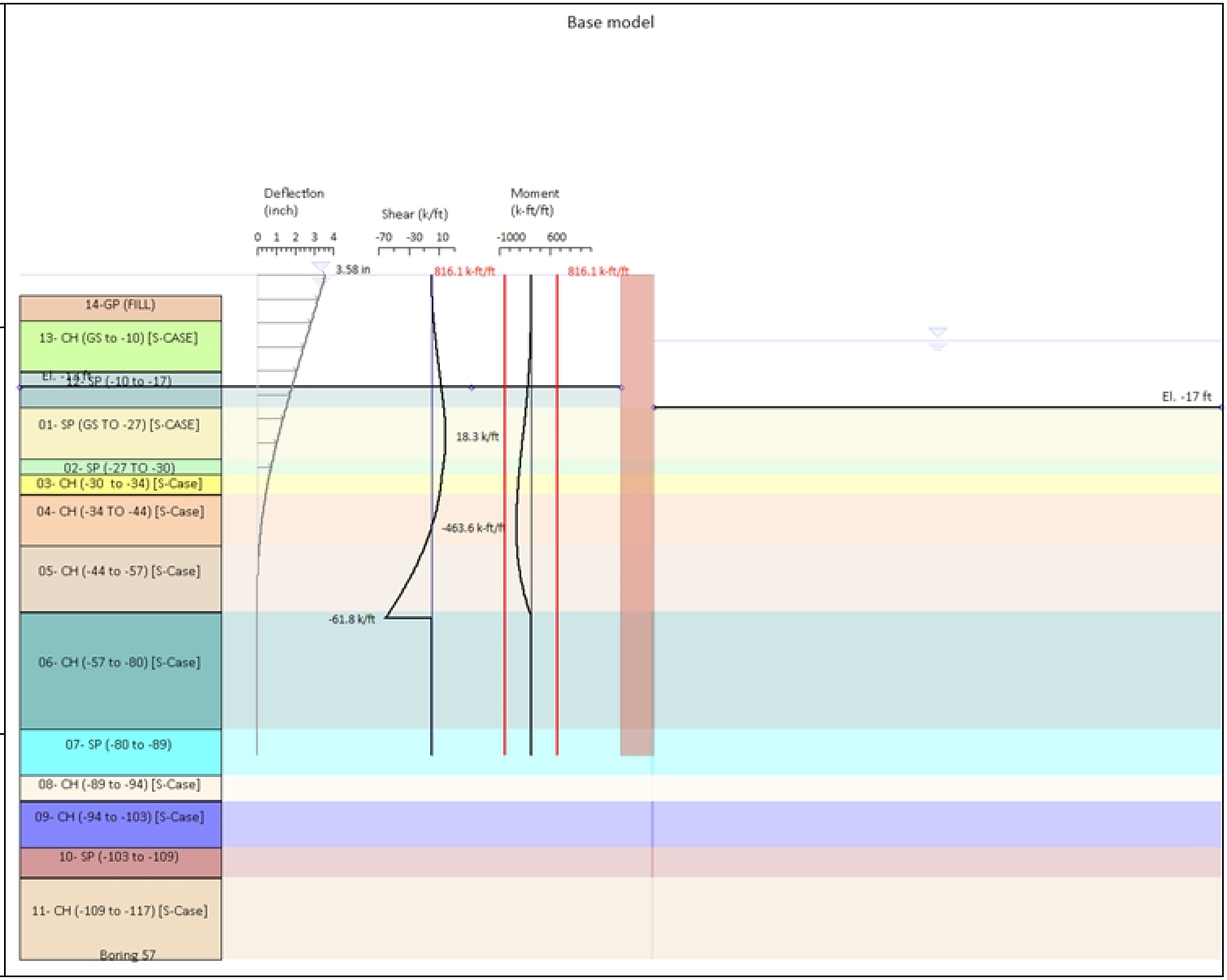


Company: Ardaman - Associates, Inc.
Engineer: George Segré
DS: 0, C1 FS = 1.25
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP
Deep Excavation LCC
DeepEX 2019
4/27/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C2 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

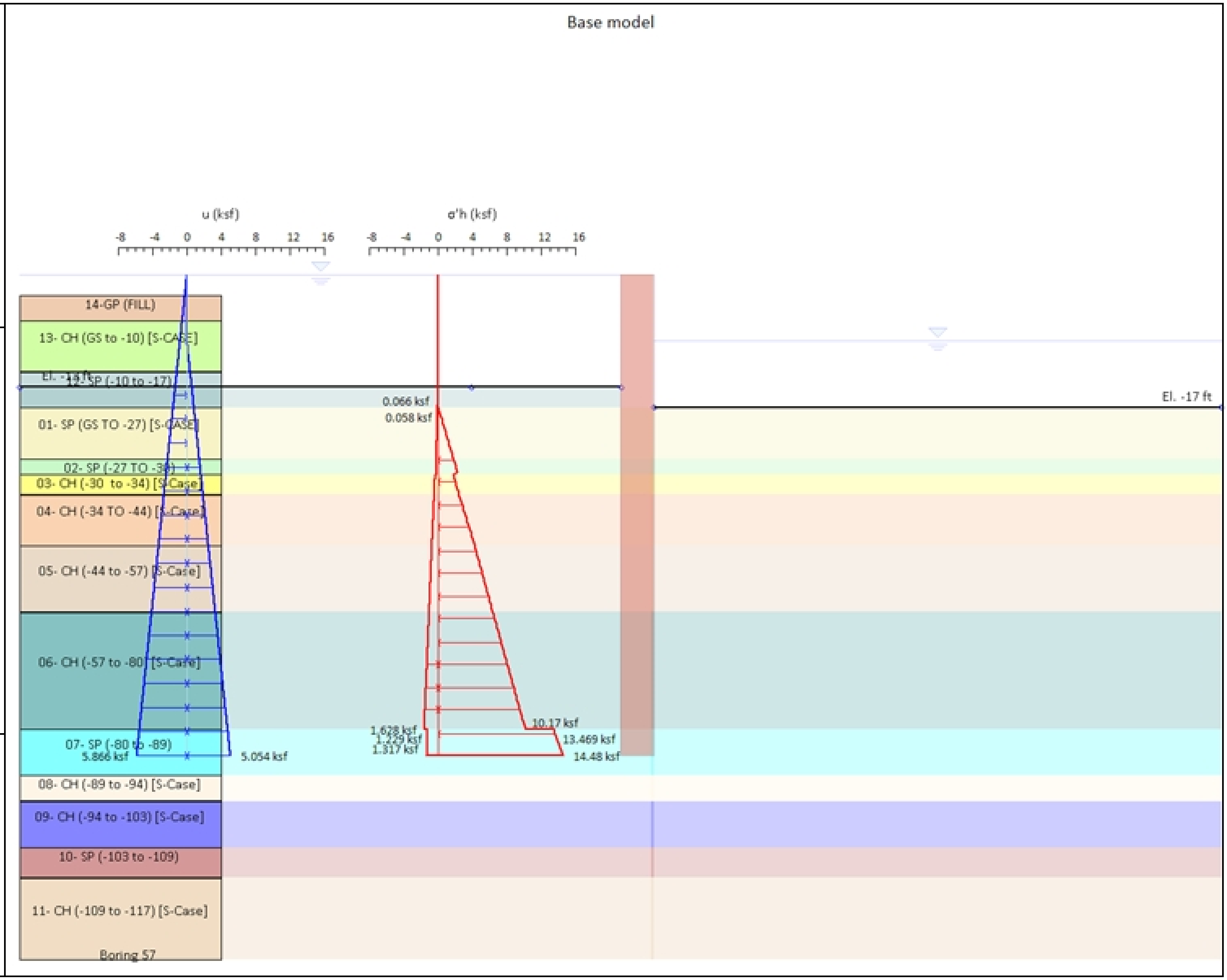


Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C2 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

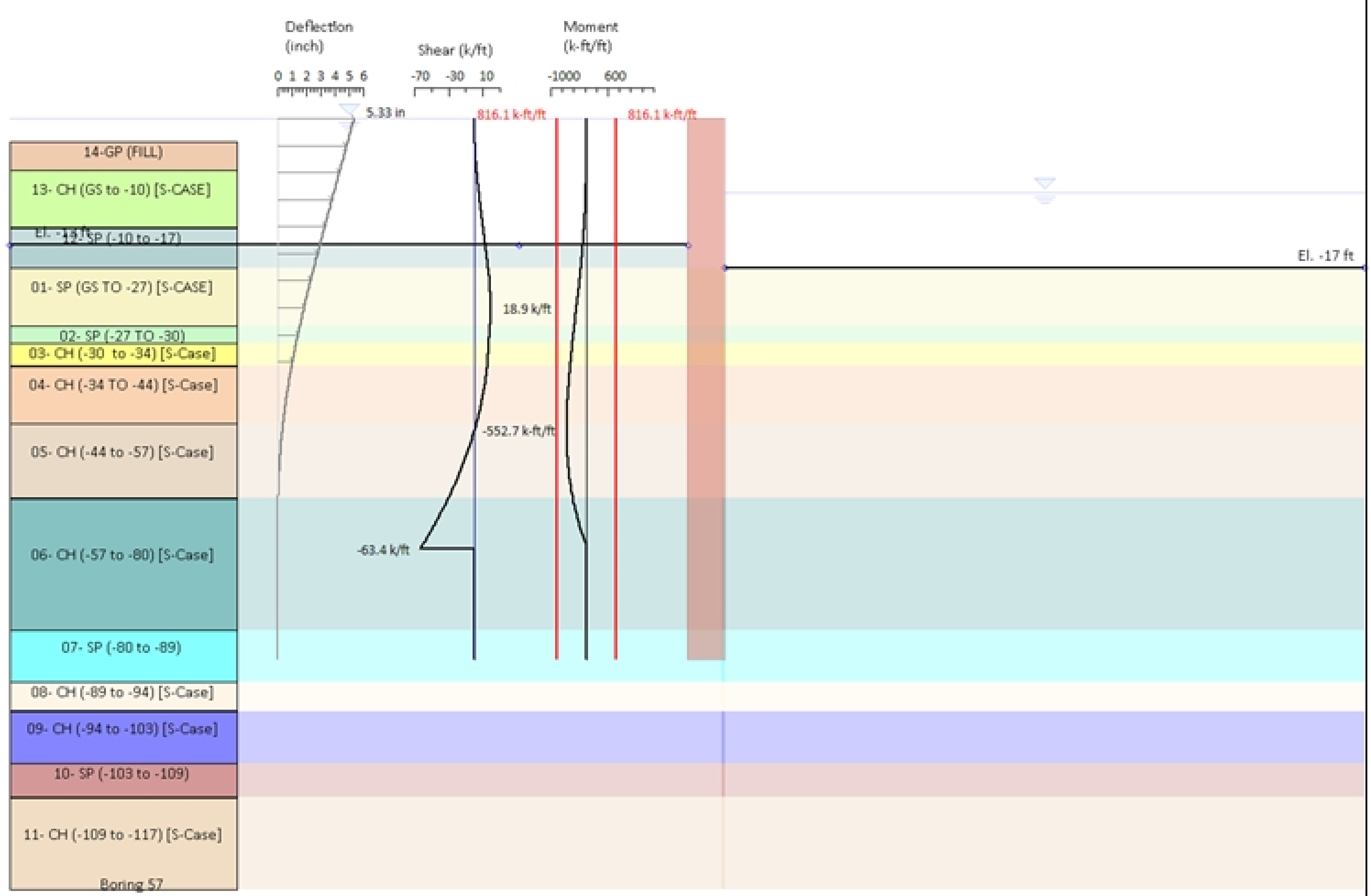


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C2 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/27/2020

Base model

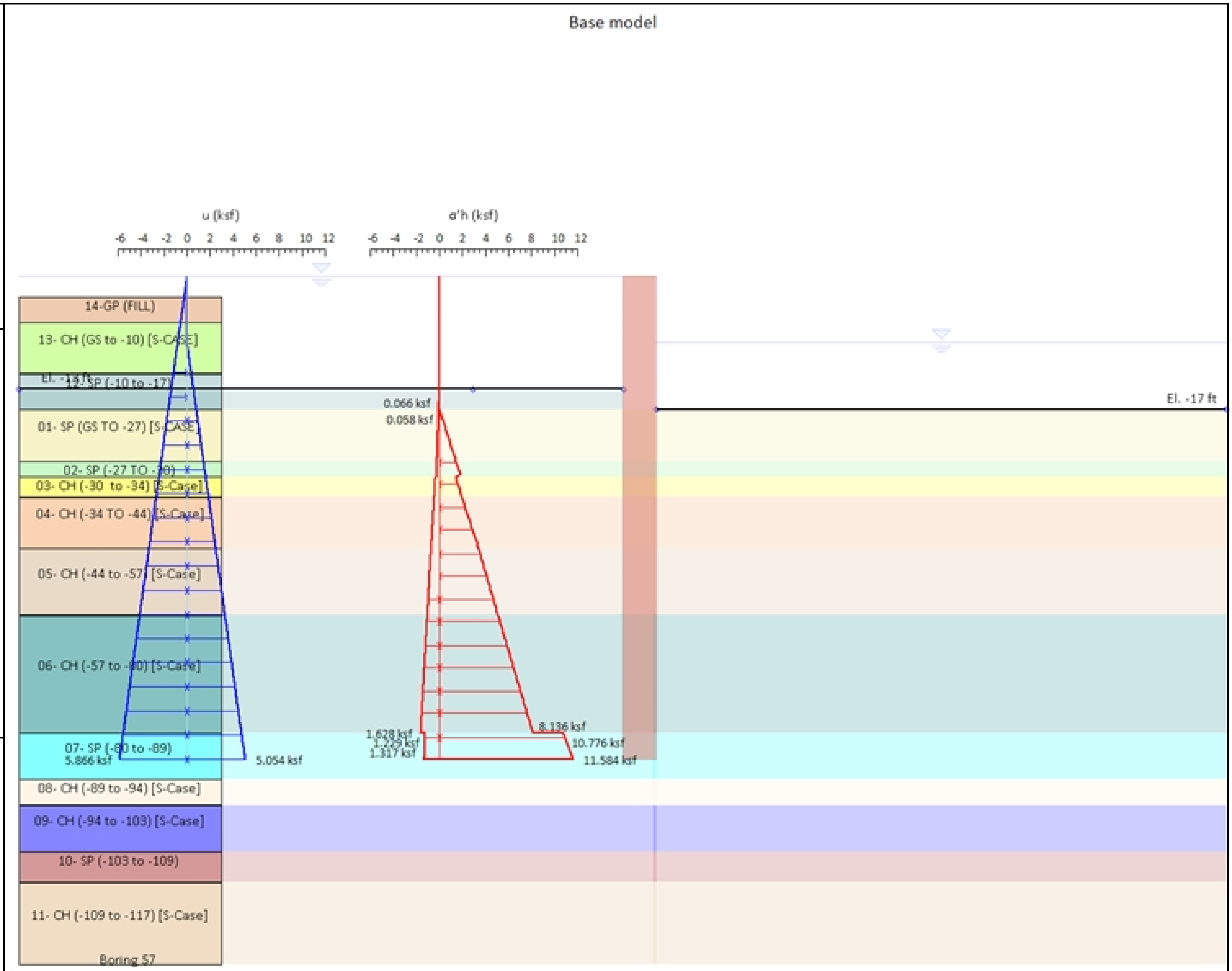


Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C2 FS = 1.25

C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

Deep Excavation LCC
DeepEX 2019
4/27/2020

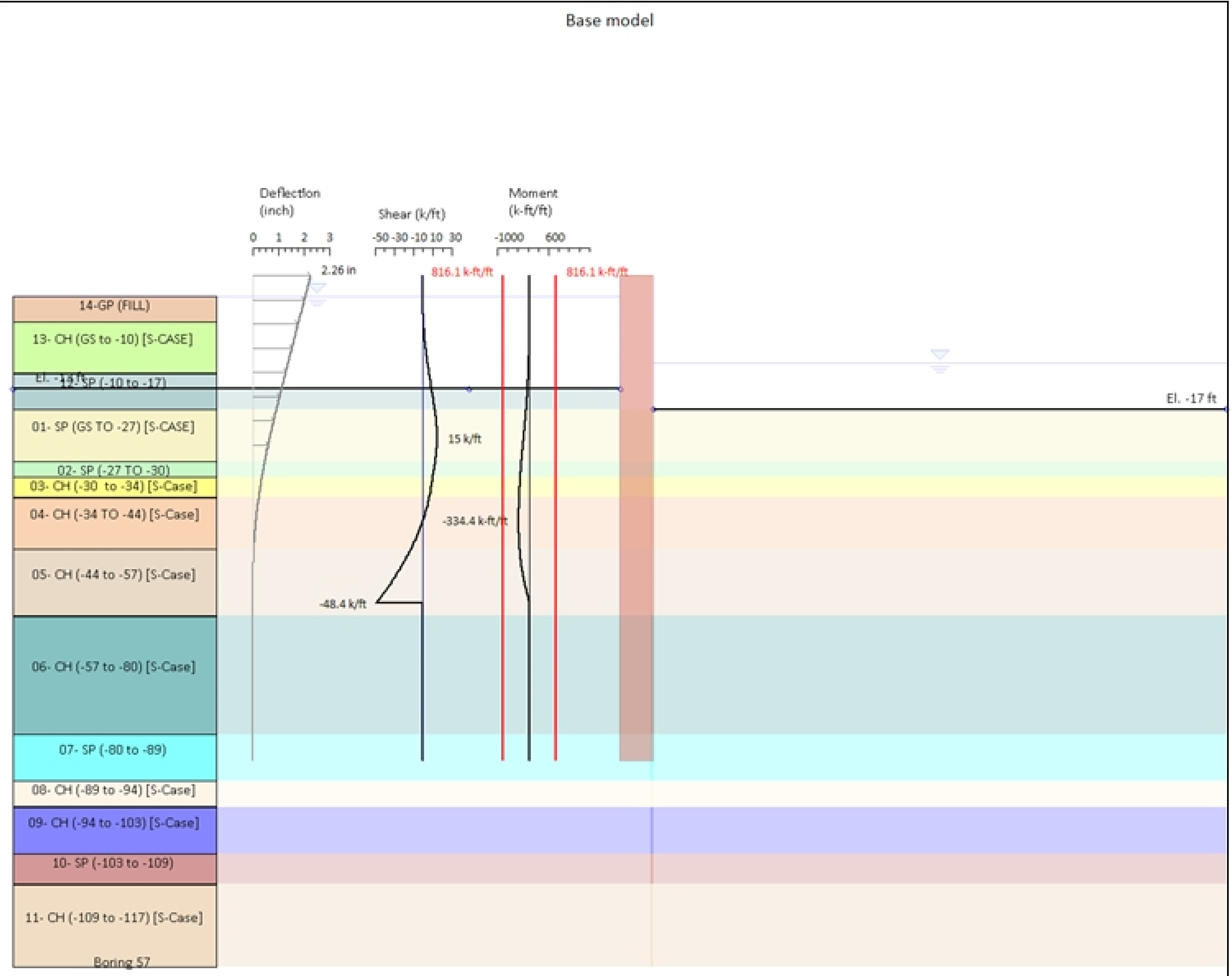


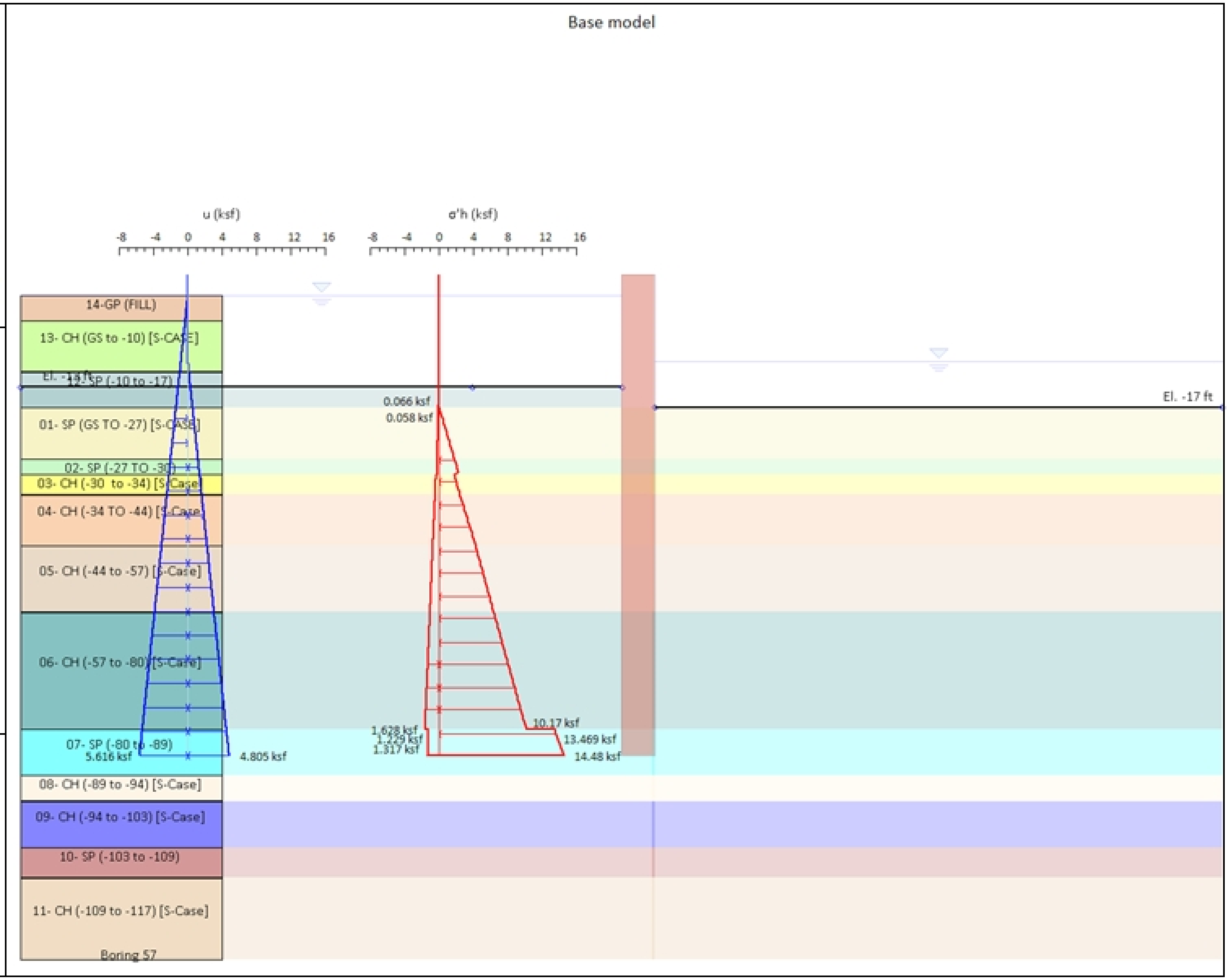
18/26

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C3 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020





Company: Ardaman - Associates, Inc.

Engineer: George Segré

C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C3 FS = 1.0

Deep Excavation LCC

DeepEX 2019

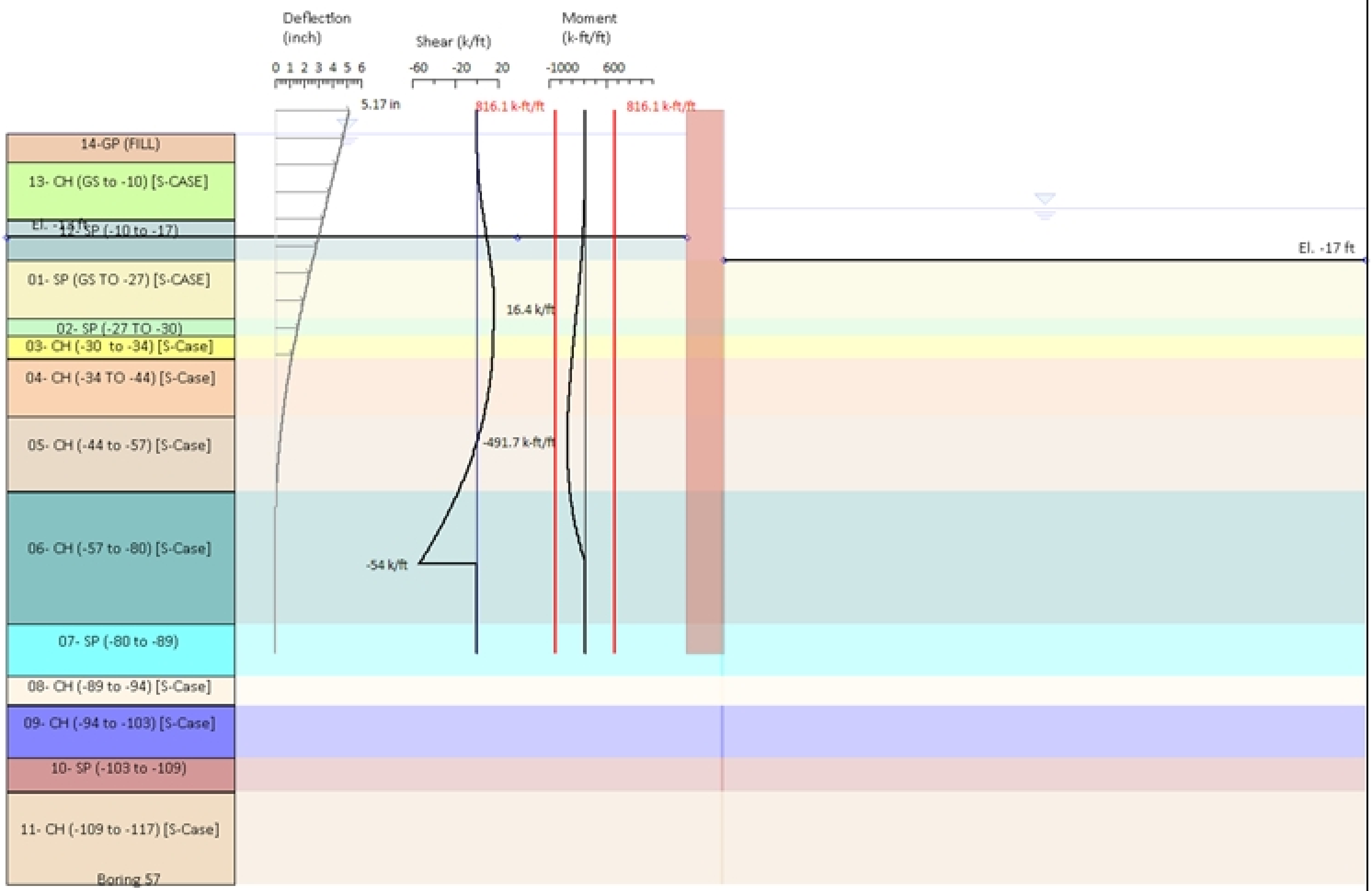
4/27/2020

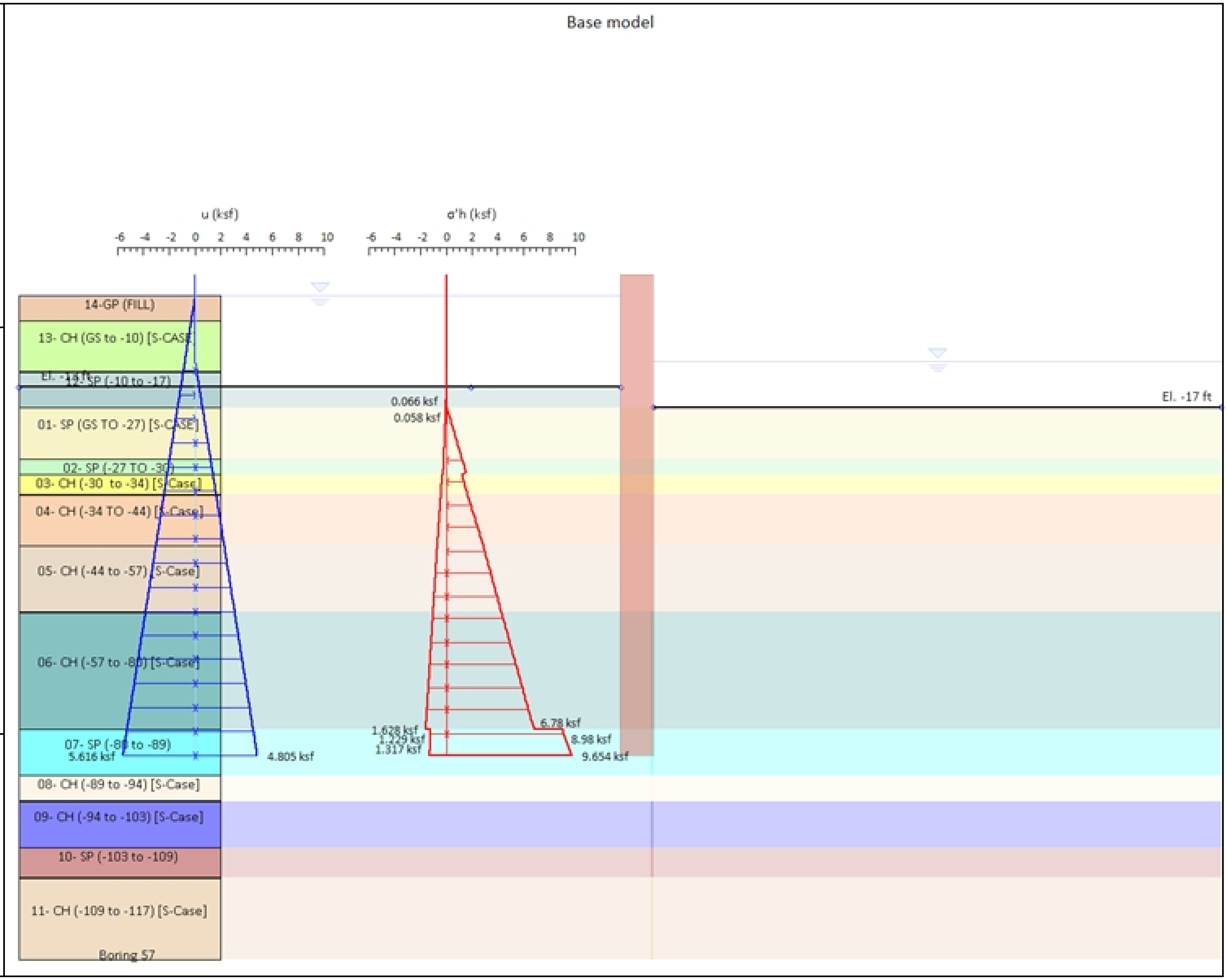
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C3 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/27/2020

Base model





Company: Ardaman - Associates, Inc.

Engineer: George Segré

C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C3 FS = 1.5

Deep Excavation LCC

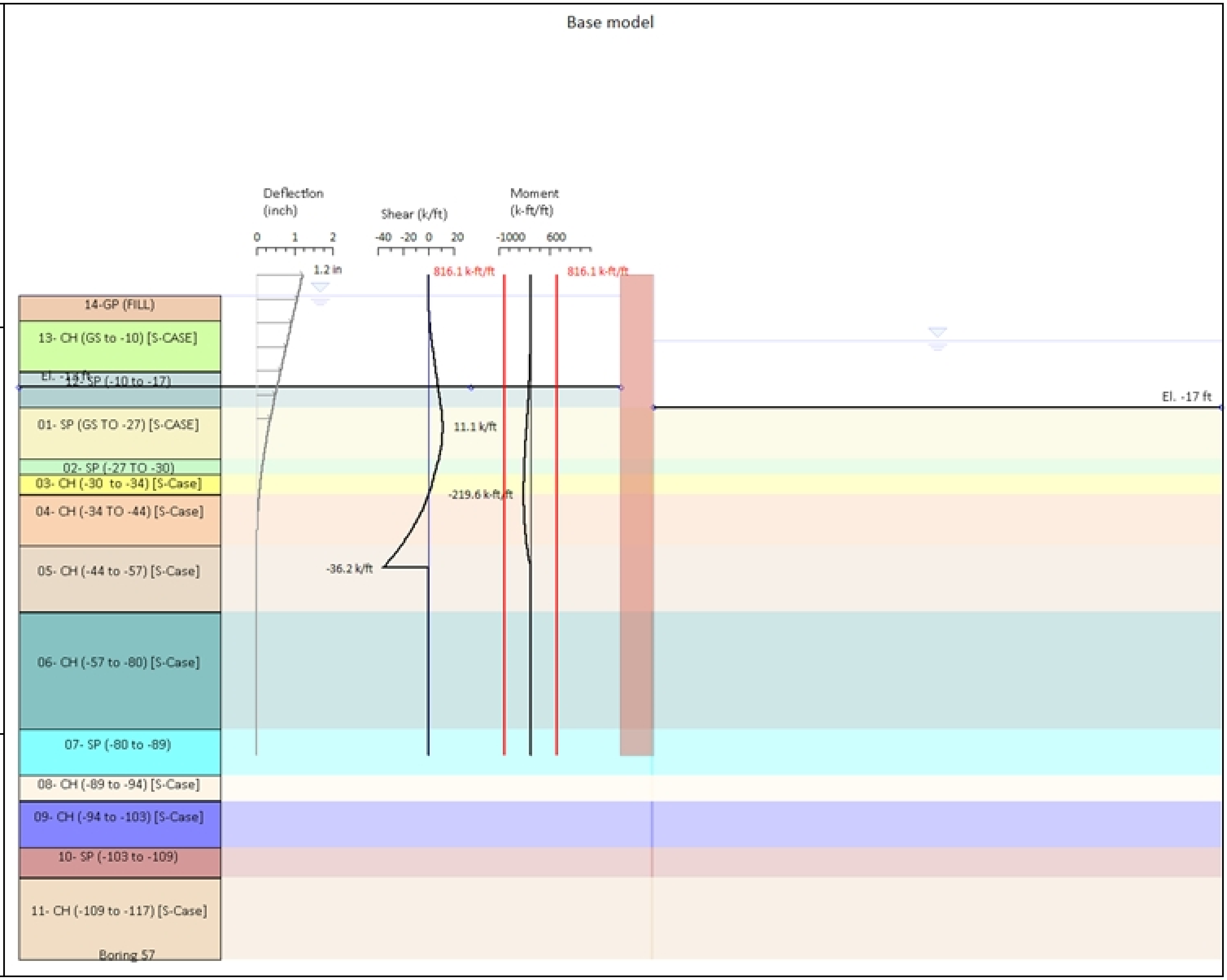
DeepEX 2019

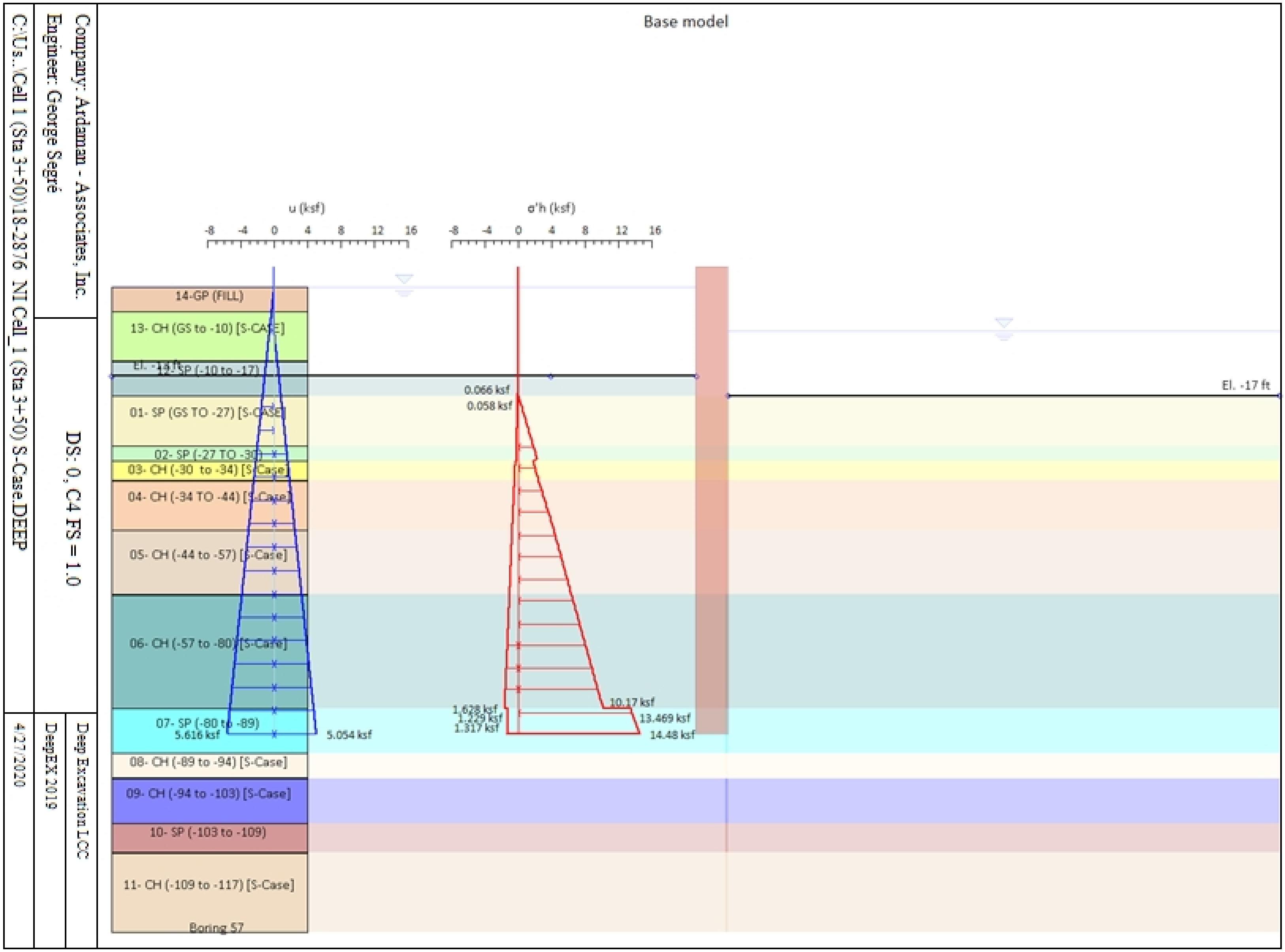
4/27/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C4 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020



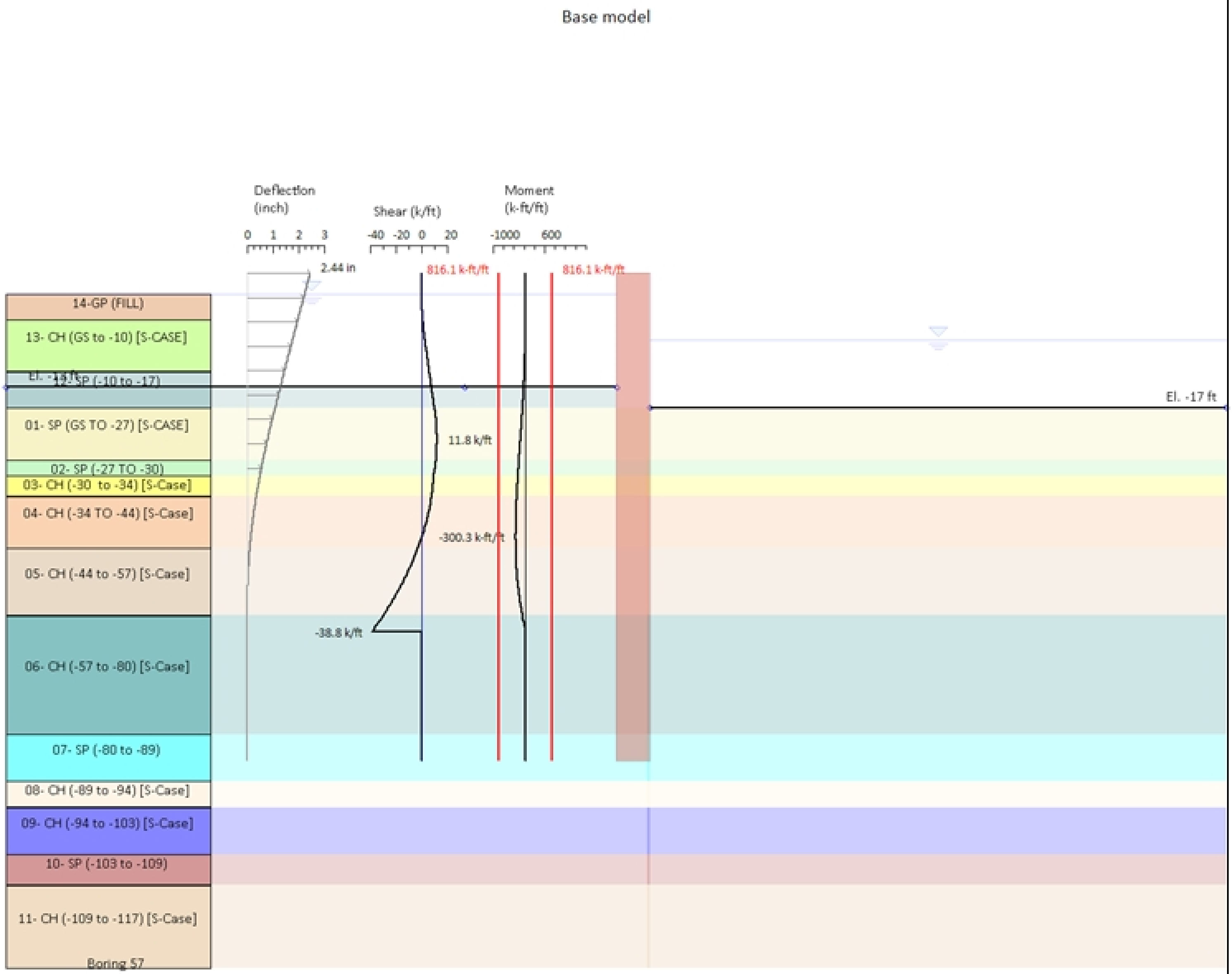


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP
DS: 0, C4 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/27/2020
Base model
u (ksf)
σ'h (ksf)
14-GP (FILL)
13- CH (GS to -10) [S-CASE]
El. -13 ft
12- SP (-10 to -17)
01- SP (GS TO -27) [S-CASE]
02- SP (-27 TO -30)
03- CH (-30 to -34) [S-Case]
04- CH (-34 TO -44) [S-Case]
05- CH (-44 to -57) [S-Case]
06- CH (-57 to -80) [S-Case]
07- SP (-80 to -89)
08- CH (-89 to -94) [S-Case]
09- CH (-94 to -103) [S-Case]
10- SP (-103 to -109)
11- CH (-109 to -117) [S-Case]
Boring 57
0.066 ksf
0.058 ksf
10.17 ksf
1.628 ksf
1.229 ksf
1.317 ksf
13.469 ksf
14.48 ksf
5.616 ksf
5.054 ksf
El. -17 ft

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 1 (Sta 3+50)18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

DS: 0, C4 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/27/2020



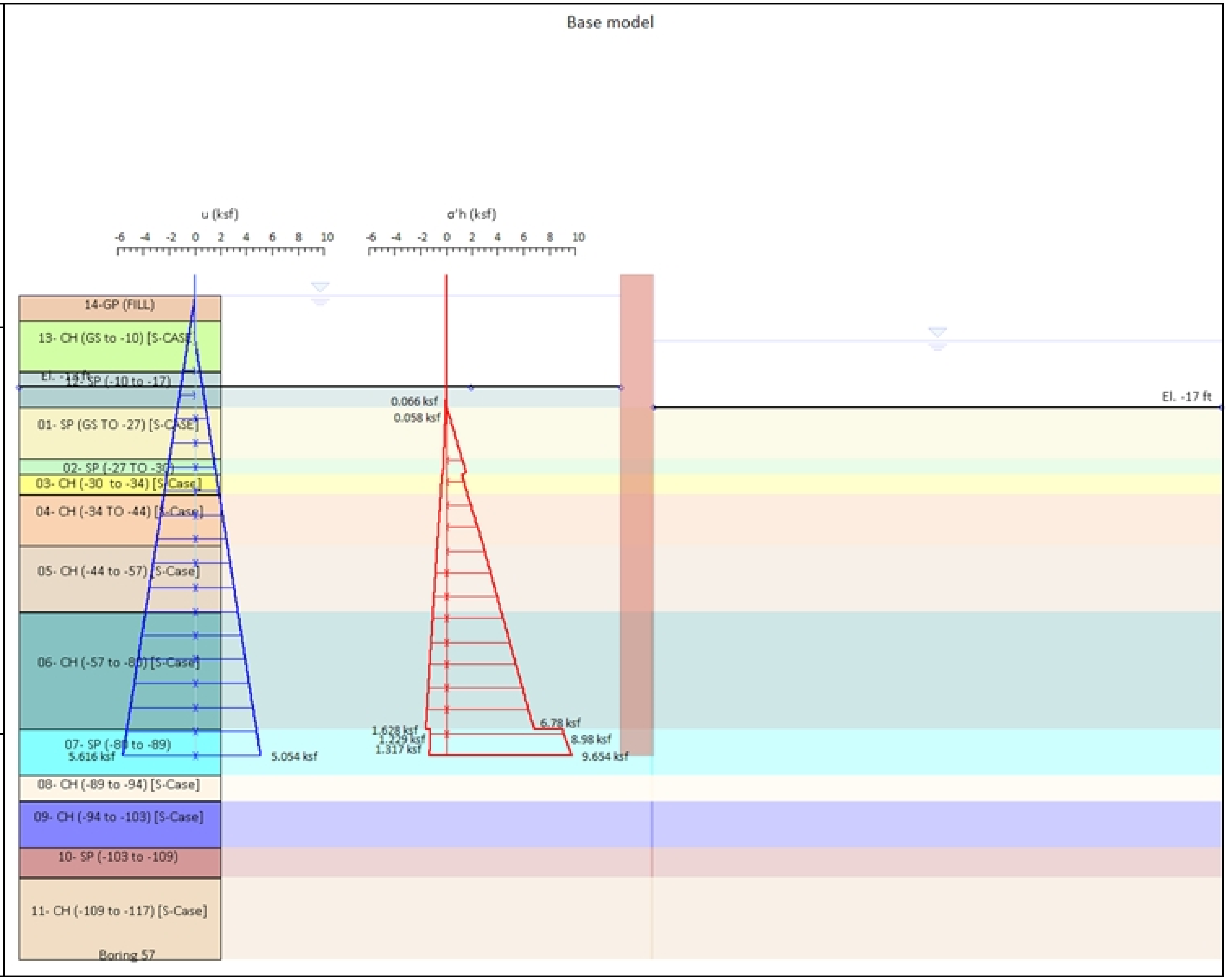
Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C4 FS = 1.5

Deep Excavation LCC
DeepEX 2019

C:\Us..\Cell 1 (Sta 3+50)\18-2876 NI Cell_1 (Sta 3+50) S-Case.DEEP

4/27/2020



DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 4/27/2020 8:56:36 PM

File: C:\Users\George.Segre\Desktop\Northern Impoundment\Cell 2 Sections\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q -Case.DEEP

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)
A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength

Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
01- SM (+5 T	120	120	25	0	N/A	N/A	N/A	300	3	0.41	2.46	N/A	N/A	True	EXP	
02- CH (+0 TO	112	112	0	0	500	18	26	60	3	0.33	3	0.39	2.56	True	Linear	
03- CH (-11 t	112	112	0	0	1000	0	0	150	3	1	1	1	1	True	Linear	
04- SM (-23 T	120	120	25	0	N/A	N/A	N/A	521.92	3	0.41	2.46	N/A	N/A	True	Linear	
05- CH (-27 to	120	120	0	0	3300	21.1	30	417.54	3	0.47	2.12	0.33	3	True	Linear	
06- CH (-41 to	116	116	0	0	1400	0	0	626.3	3	1	1	1	1	True	Linear	
07- CH (-50 t	116	116	0	0	1850	0	0	300	3	0.31	3.26	0.33	0.33	True	Linear	
08- CH (-58 to	116	116	0	0	1900	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
09- SM (-67 t	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
10- CH (-74 to	116	116	0	0	2000	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
11- SM (-80 t	130	130	32	0	N/A	N/A	N/A	300	3	0.31	3.26	N/A	N/A	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
01- SM (+5 T	0.4	-	-	0.577	0.5	1	0	7.2	4.8	20	-
02- CH (+0 TO	0.4	0.1	0	1	0.5	-	-	5.1	3.4	20	-
03- CH (-11 t	0.4	0	0	0.95	0.5	-	-	13	8.7	20	-
04- SM (-23 T	0.4	-	-	0.577	0.5	-	-	21.8	14.5	30	-
05- CH (-27 to	0.45	0.1	0	1	0.5	-	-	18.1	12.1	30	-
06- CH (-41 to	0.35	0	0	1	0.5	-	-	29	19.3	70	-
07- CH (-50 t	0.35	0	0	1	0.8	-	-	0	0	0	-
08- CH (-58 to	0.3	0	0	1	0.8	-	-	0	0	0	-
09- SM (-67 t	0.25	-	-	0.5	0.8	-	-	0	0	0	-
10- CH (-74 to	0.35	0	0	1	0.8	-	-	0	0	0	-
11- SM (-80 t	0.35	-	-	0.47	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction
SIMC= Simplified Clay mode

SOIL BORINGS

Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Boring 57, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
5	01- SM (+5 TO	1	0.58
0	02- CH (+0 TO	1	1
-11	03- CH (-11 to	1	0.95
-23	04- SM (-23 T	1	0.58
-27	05- CH (-27 to	1	1
-41	06- CH (-41 to	1	1
-50	07- CH (-50 to	1	1
-58	08- CH (-58 to	1	1
-67	09- SM (-67 to	1	0.5
-74	10- CH (-74 to	1	1
-80	11- SM (-80 to	1	1

WALL DATA

Wall section 0: Wall 1

Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP		4/27/2020

Wall uses wall section 0: Wall 1
Wall type: Combined sheet pile wall
Top wall El: 9 ft   Bottom wall El: -70 ft
Hor. wall spacing: 10.29 ft   Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft   Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi   Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.

Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

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Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk
F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	3.548	3.86	3.548
Stage 1	Simple span	N/A	1.6	2.869	3.111	2.869
Stage 2	Simple span	N/A	1.6	3.684	4.065	3.684
Stage 3	Simple span	N/A	1.6	2.984	3.29	2.984
Stage 4	Simple span	N/A	1.6	4.023	4.86	4.023
Stage 5	Simple span	N/A	1.6	2.739	3.29	2.739
Stage 6	Simple span	N/A	1.6	4.177	5.119	4.177
Stage 7	Simple span	N/A	1.6	2.854	3.493	2.854

Name=excavation stage name

Analysis method

springs = Elastoplastic spring analysis used

DR = Drained condition for CLAY model

U = Undrained condition for CLAY model for all the soils

Up = Undrained condition just for selected soil

Limit equilibrium analysis settings

Drive press:

Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,

FHWA= Federal Highway Administration apparent pressure diagrams.

Ko = At-rest lateral earth pressures.

Peck = Peck 1969 Apparent earth pressure diagrams.

2 Step rect = Two step rectangular apparent earth pressure diagram.

User def. = User defined apparent earth pressure diagram.

Ka+d (and so on) indicates that wall friction is applied

ka mult = multiplication factor for Ka when Ka-Trap is selected

Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H

Resit press = Kp (passive earth pressures)

Res Mult = Safety factor applied directly on resisting pressures (

COntle Method = cantilever analysis method for limit equilibrium analysis.

Support Model: Method for calculating support reactions in limit-equlibrium analysis.

Beam= support reactions beam analysis (uses Blum's method).

Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).

Axial Incl = Axial loads included for structural design

Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

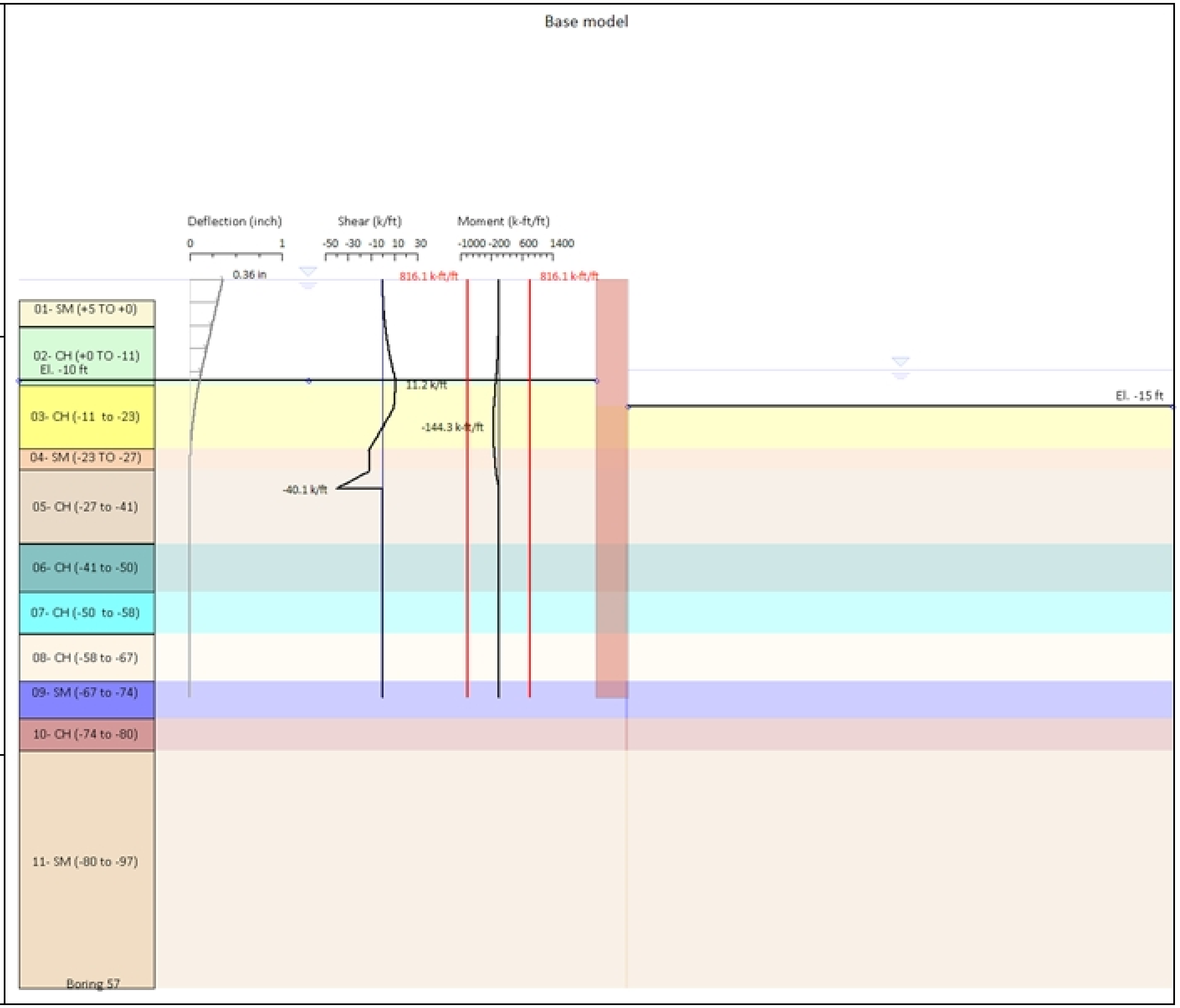
EXCAVATION STAGES SKETCHES

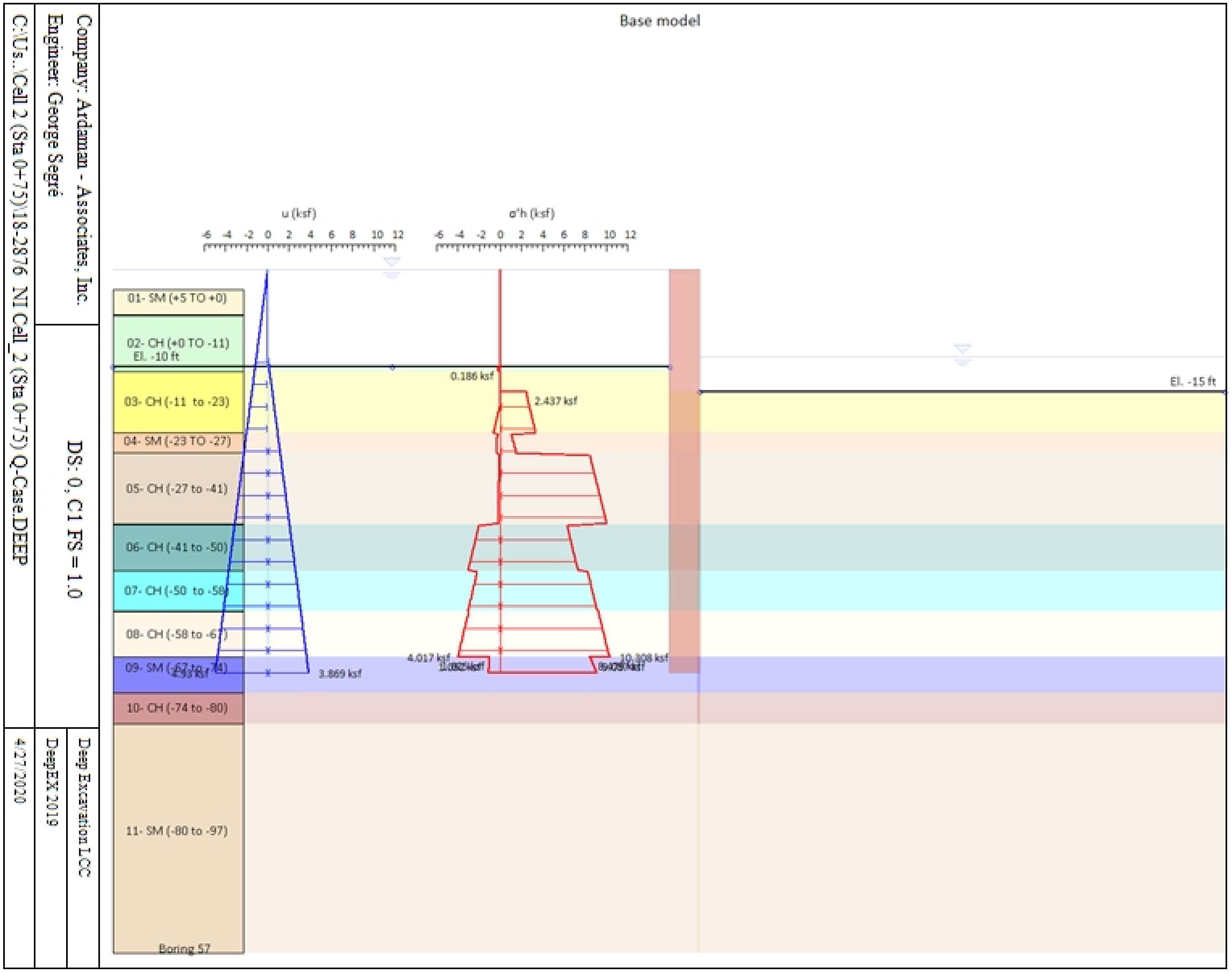
A sequence of figures for each excavation stage is reported

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C1 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

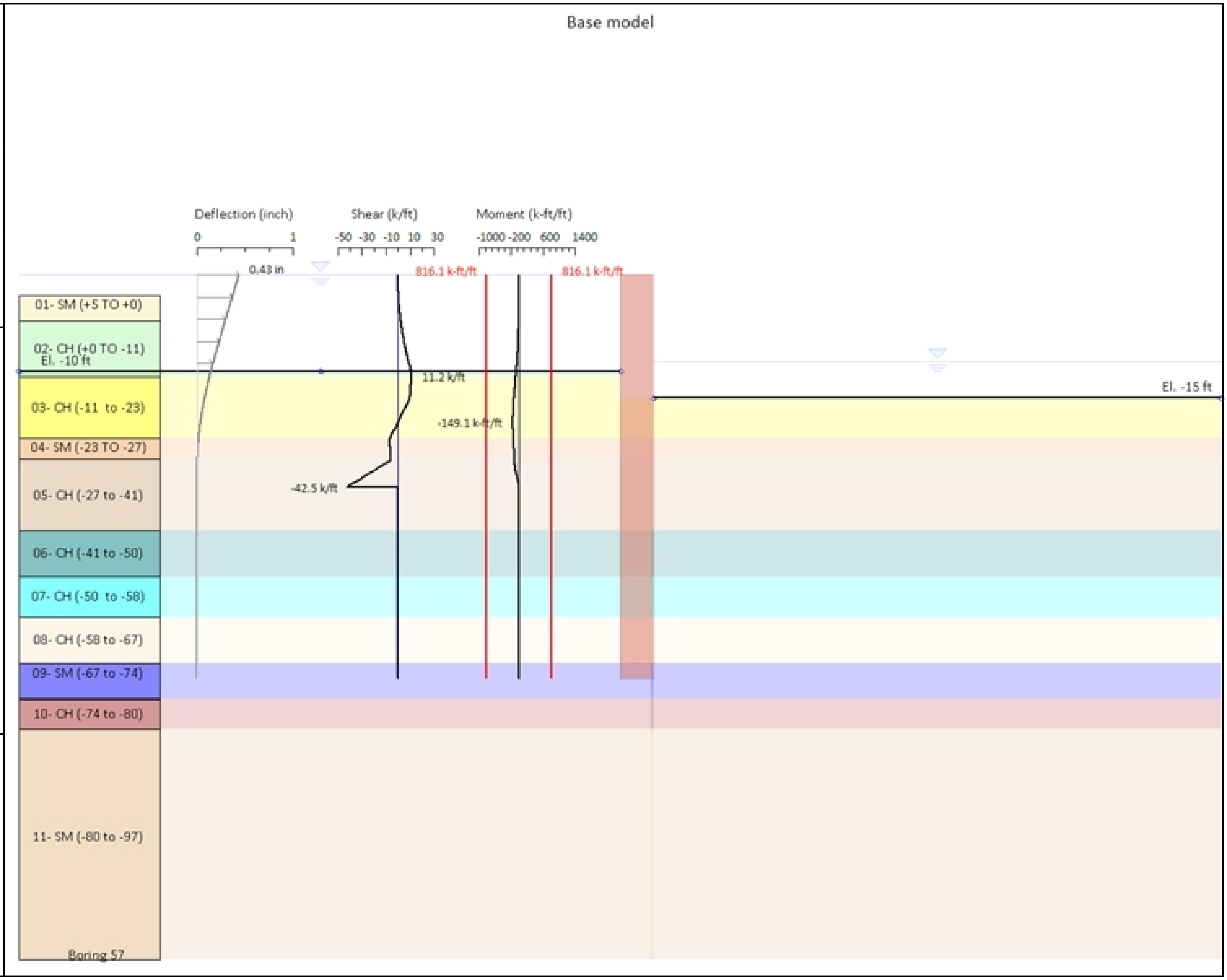


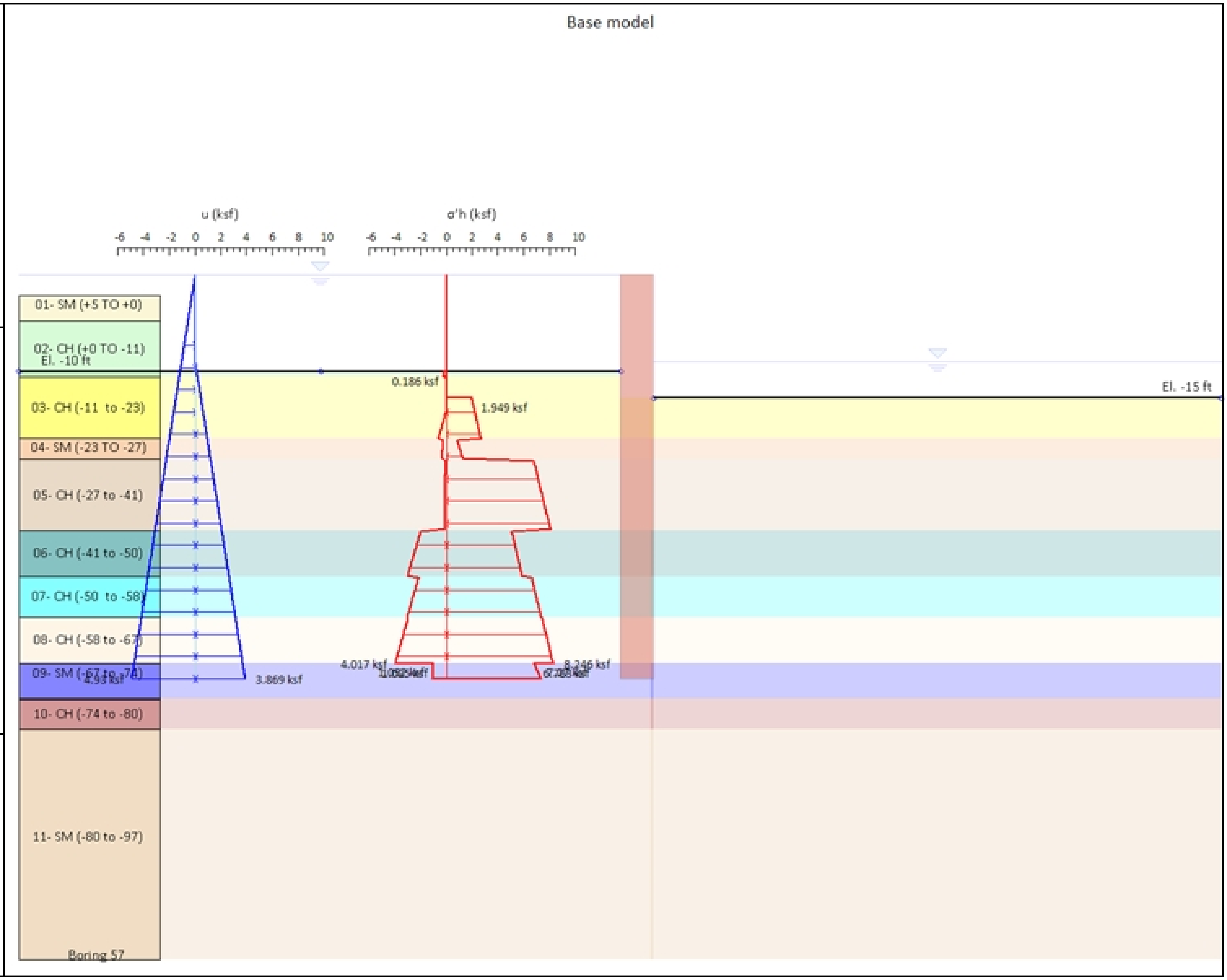

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP
DS: 0, C1 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/27/2020
Base model
u (ksf)
σ'h (ksf)
01- SM (+5 TO +0)
02- CH (+0 TO -11)
El. -10 ft
03- CH (-11 to -23)
04- SM (-23 TO -27)
05- CH (-27 to -41)
06- CH (-41 to -50)
07- CH (-50 to -58)
08- CH (-58 to -67)
09- SM (-67 to -74)
10- CH (-74 to -80)
11- SM (-80 to -97)
Boring 57
0.186 ksf
2.437 ksf
4.017 ksf
10.308 ksf
3.869 ksf
El. -15 ft

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C1 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/27/2020





Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C1 FS = 1.25

Deep Excavation LCC

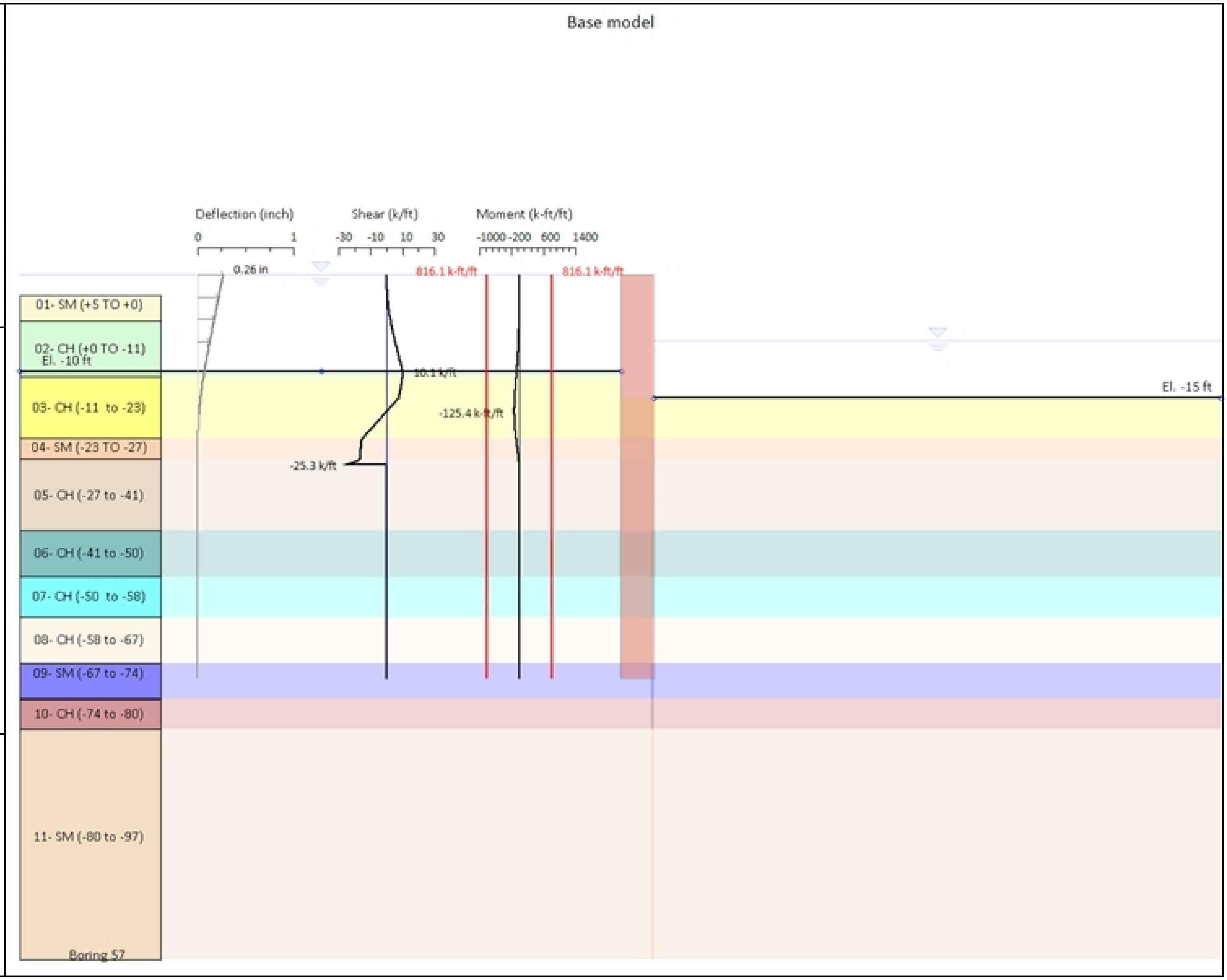
DeepEX 2019

4/27/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C2 FS = 1.0

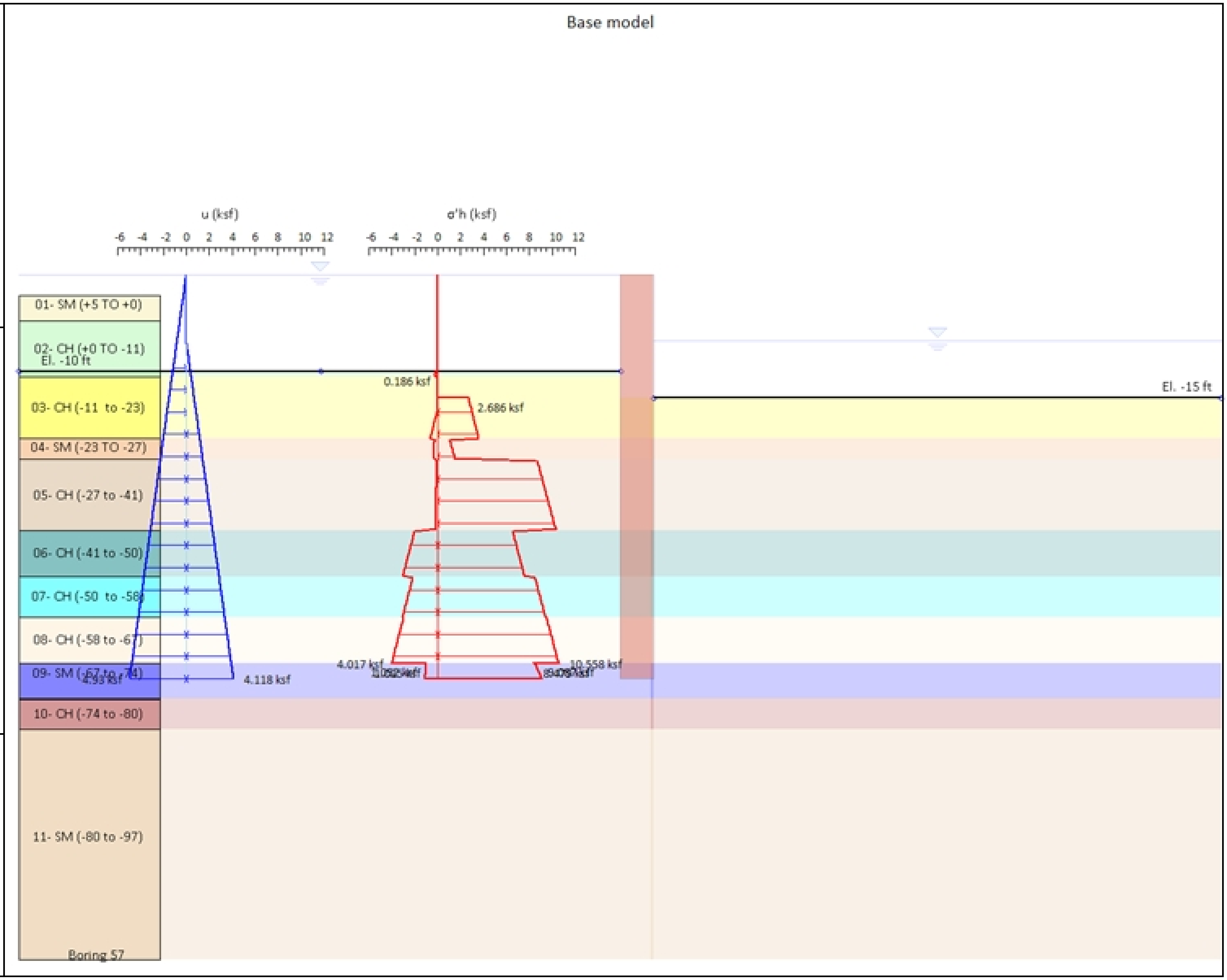
Deep Excavation LCC
DeepEX 2019
4/27/2020

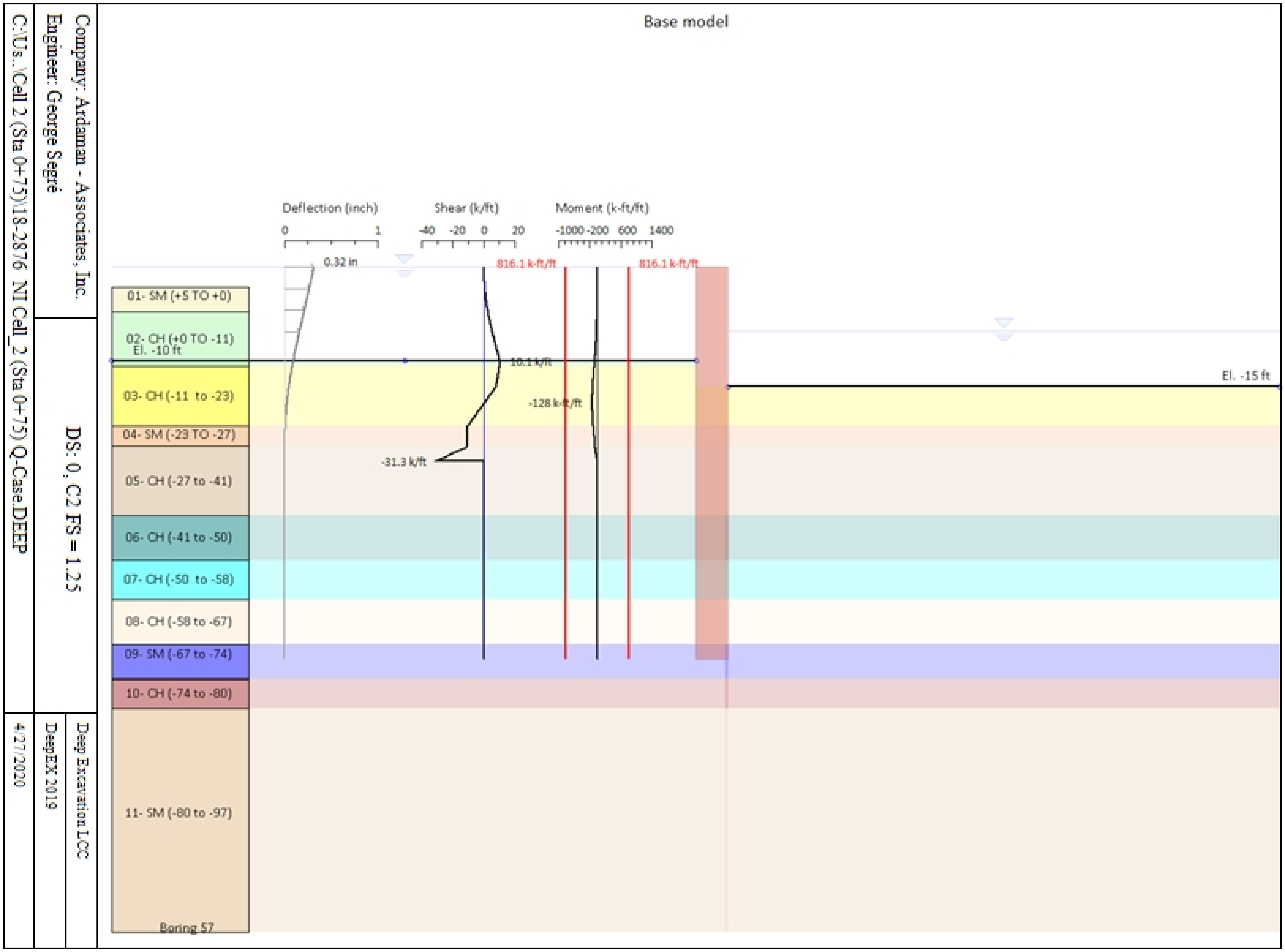


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

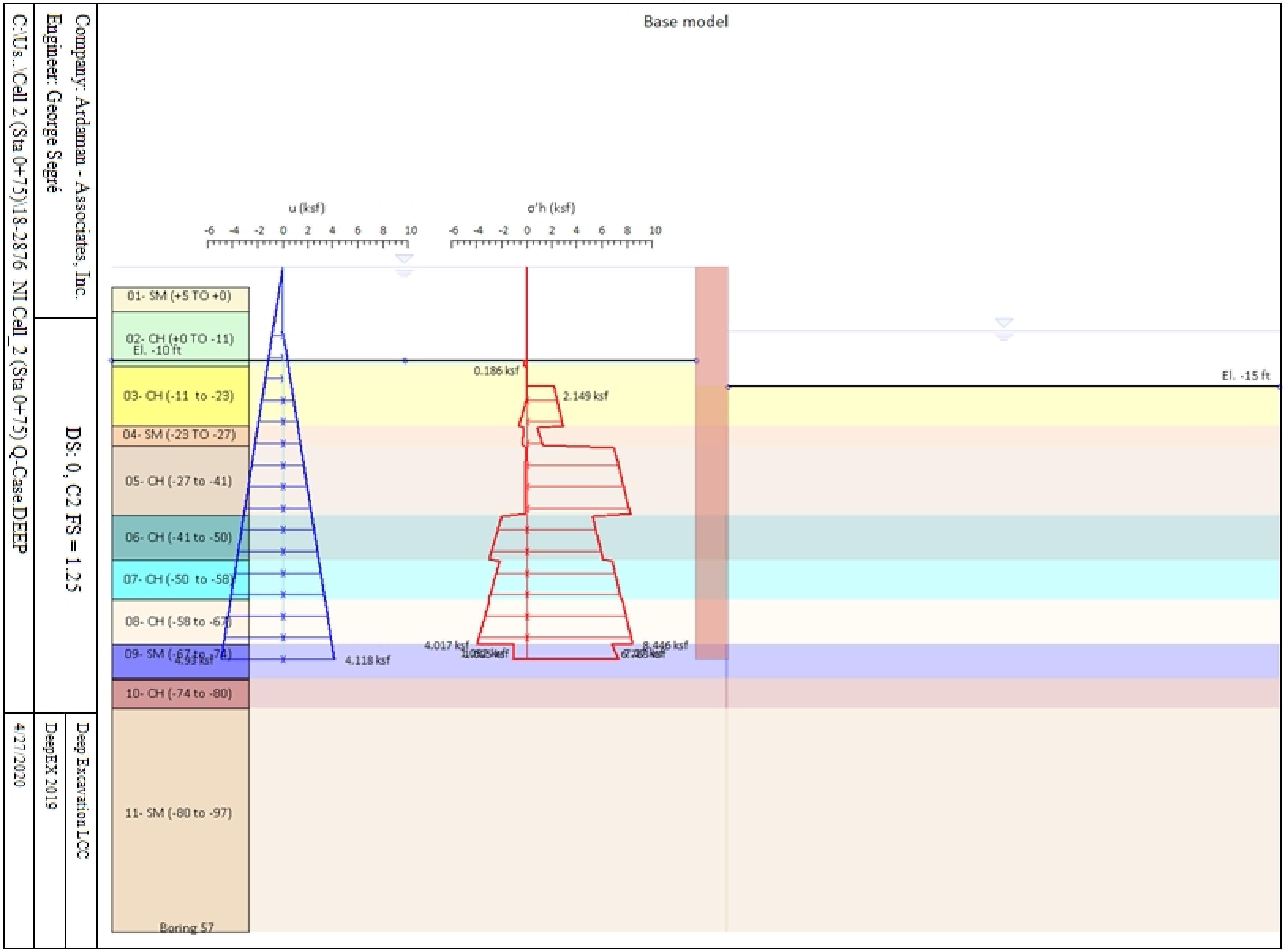
DS: 0, C2 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020





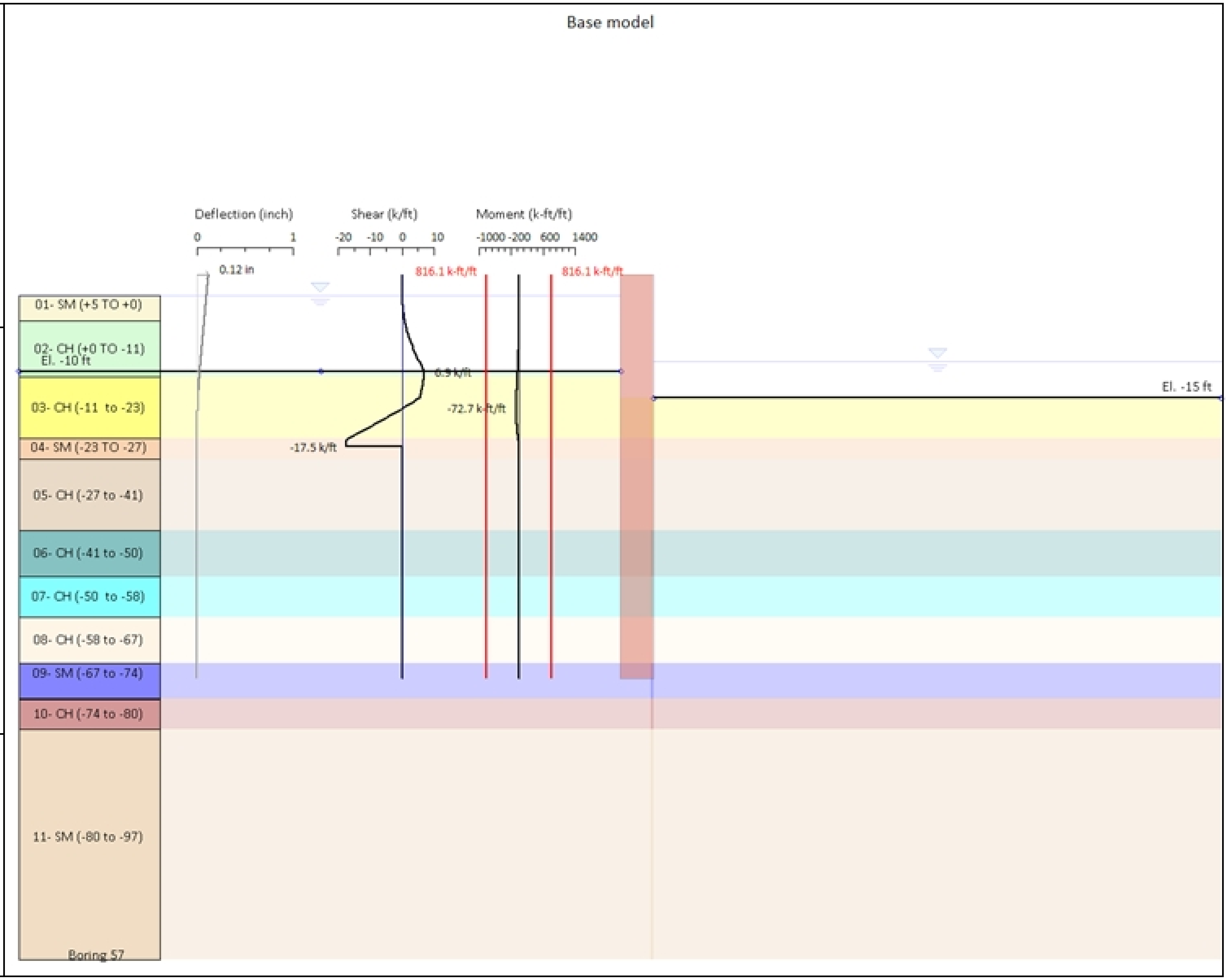
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP
DS: 0, C2 FS = 1.25
Deep Excavation LCC
DeepEX 2019
4/27/2020
Base model
Deflection (inch)
0
1
Shear (k/ft)
-40
-20
0
20
Moment (k-ft/ft)
-1000
-200
600
1400
0.32 in
816.1 k-ft/ft
816.1 k-ft/ft
10.1 k/ft
-128 k-ft/ft
-31.3 k/ft
El. -10 ft
El. -15 ft
01- SM (+5 TO +0)
02- CH (+0 TO -11)
03- CH (-11 to -23)
04- SM (-23 TO -27)
05- CH (-27 to -41)
06- CH (-41 to -50)
07- CH (-50 to -58)
08- CH (-58 to -67)
09- SM (-67 to -74)
10- CH (-74 to -80)
11- SM (-80 to -97)
Boring 57


Base model
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP
DS: 0, C2 FS = 1.25
Deep Excavation LCC
DeepEX 2019
4/27/2020
u (ksf)
σ'h (ksf)
-6 -4 -2 0 2 4 6 8 10
01- SM (+5 TO +0)
02- CH (+0 TO -11)
El. -10 ft
03- CH (-11 to -23)
04- SM (-23 TO -27)
05- CH (-27 to -41)
06- CH (-41 to -50)
07- CH (-50 to -58)
08- CH (-58 to -67)
09- SM (-67 to -74)
10- CH (-74 to -80)
11- SM (-80 to -97)
Boring 57
El. -15 ft
0.186 ksf
2.149 ksf
4.017 ksf
8.446 ksf
4.118 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C3 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

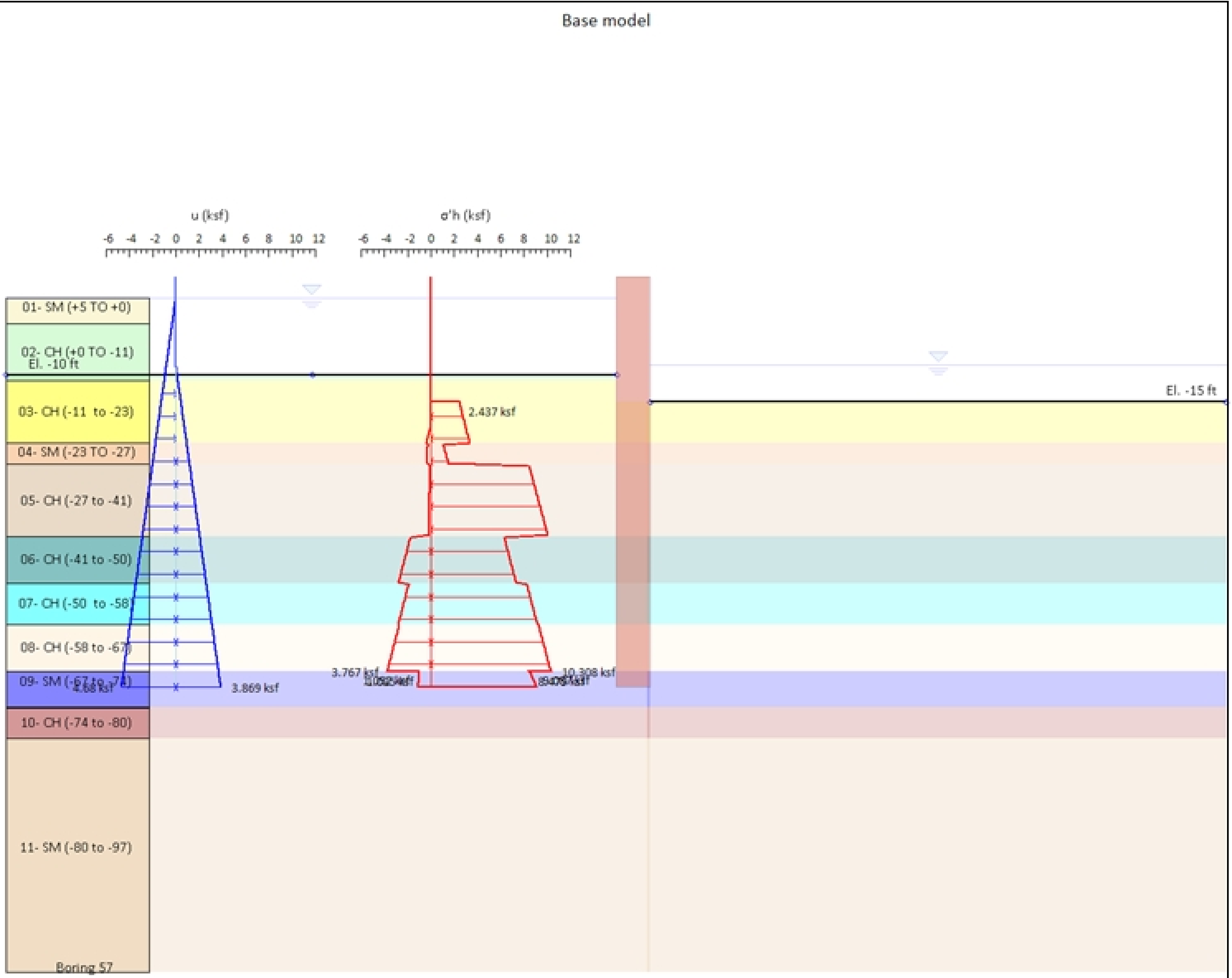


Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C3 FS = 1.0

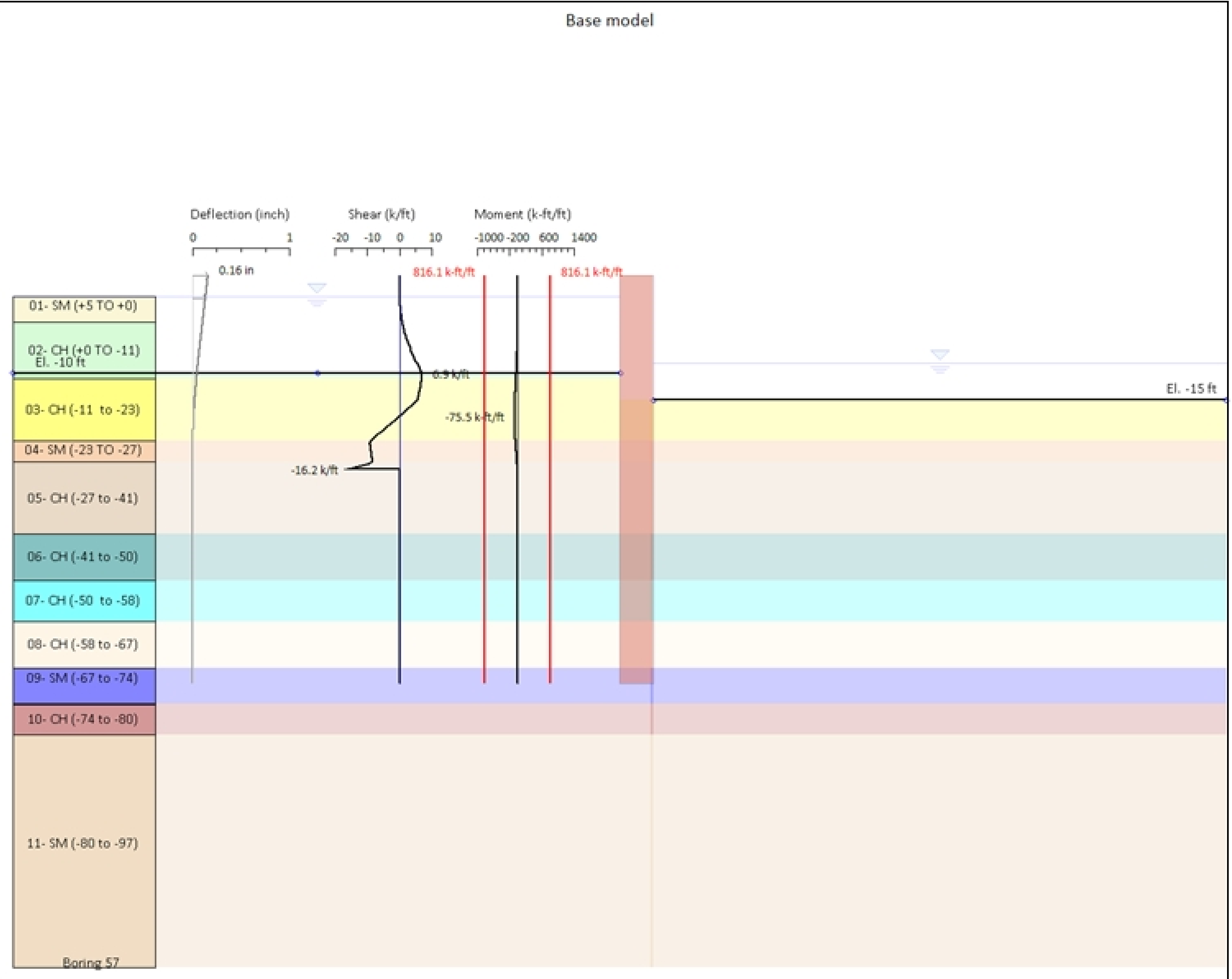
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C3 FS = 1.5

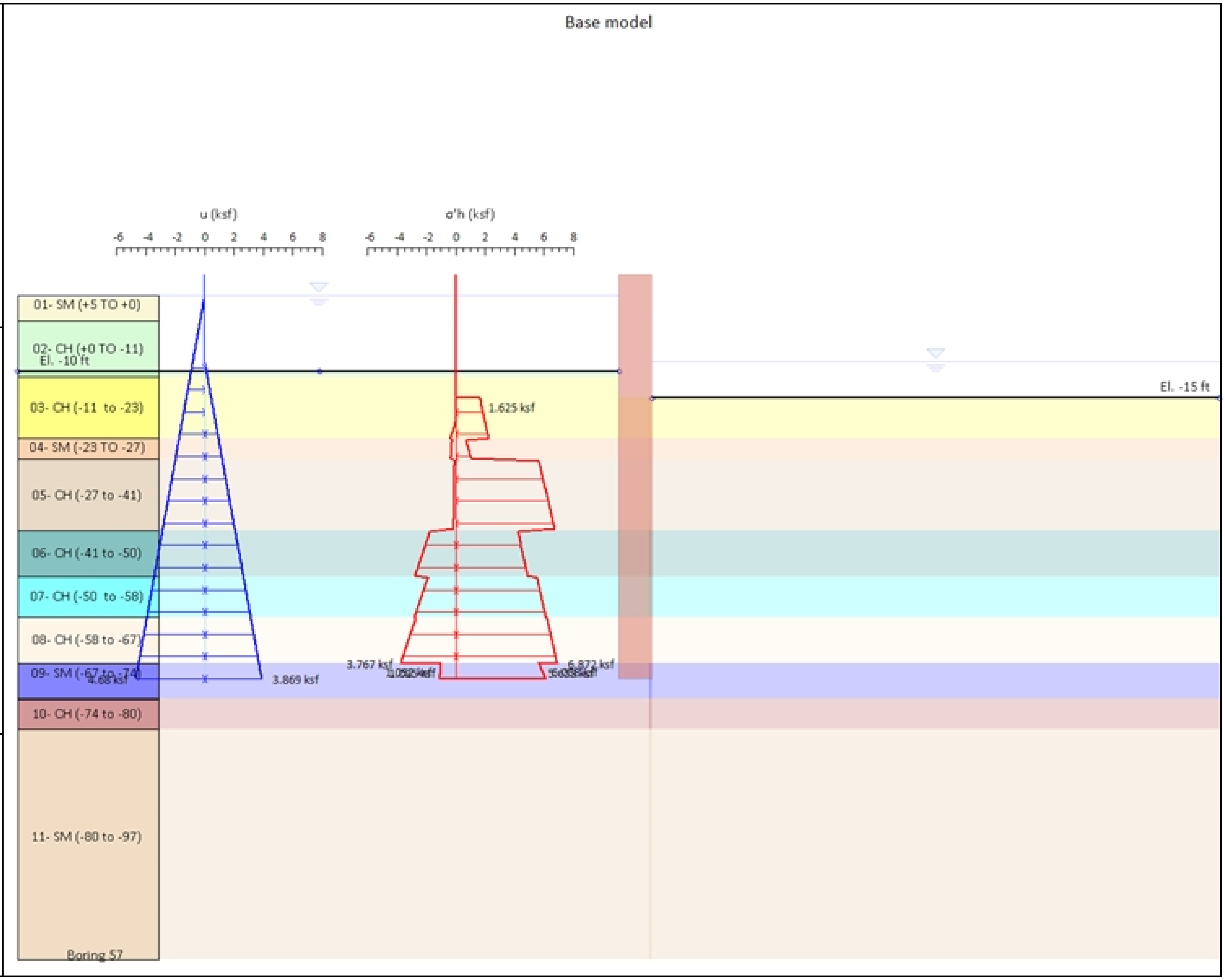
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

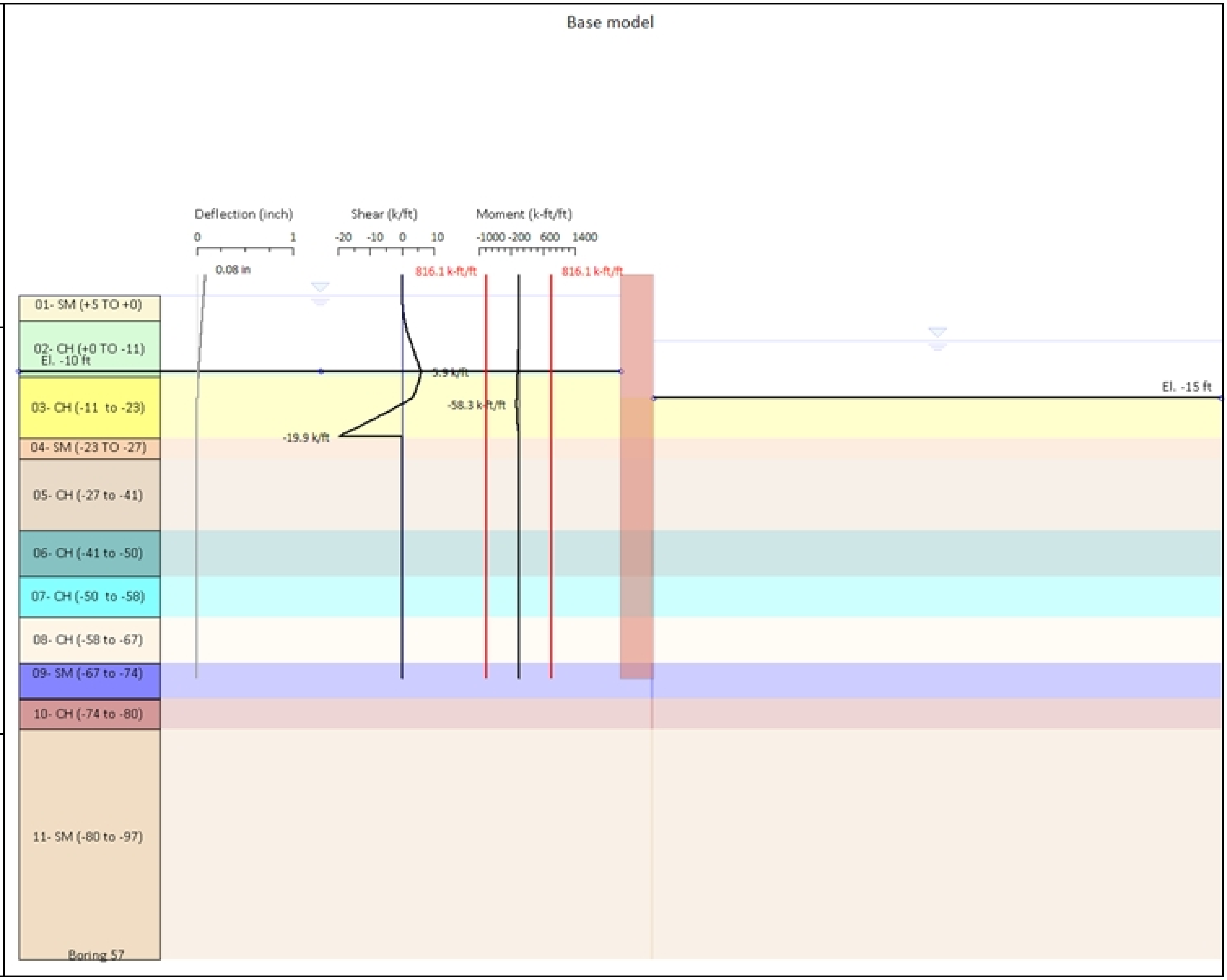
DS: 0, C3 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C4 FS = 1.0

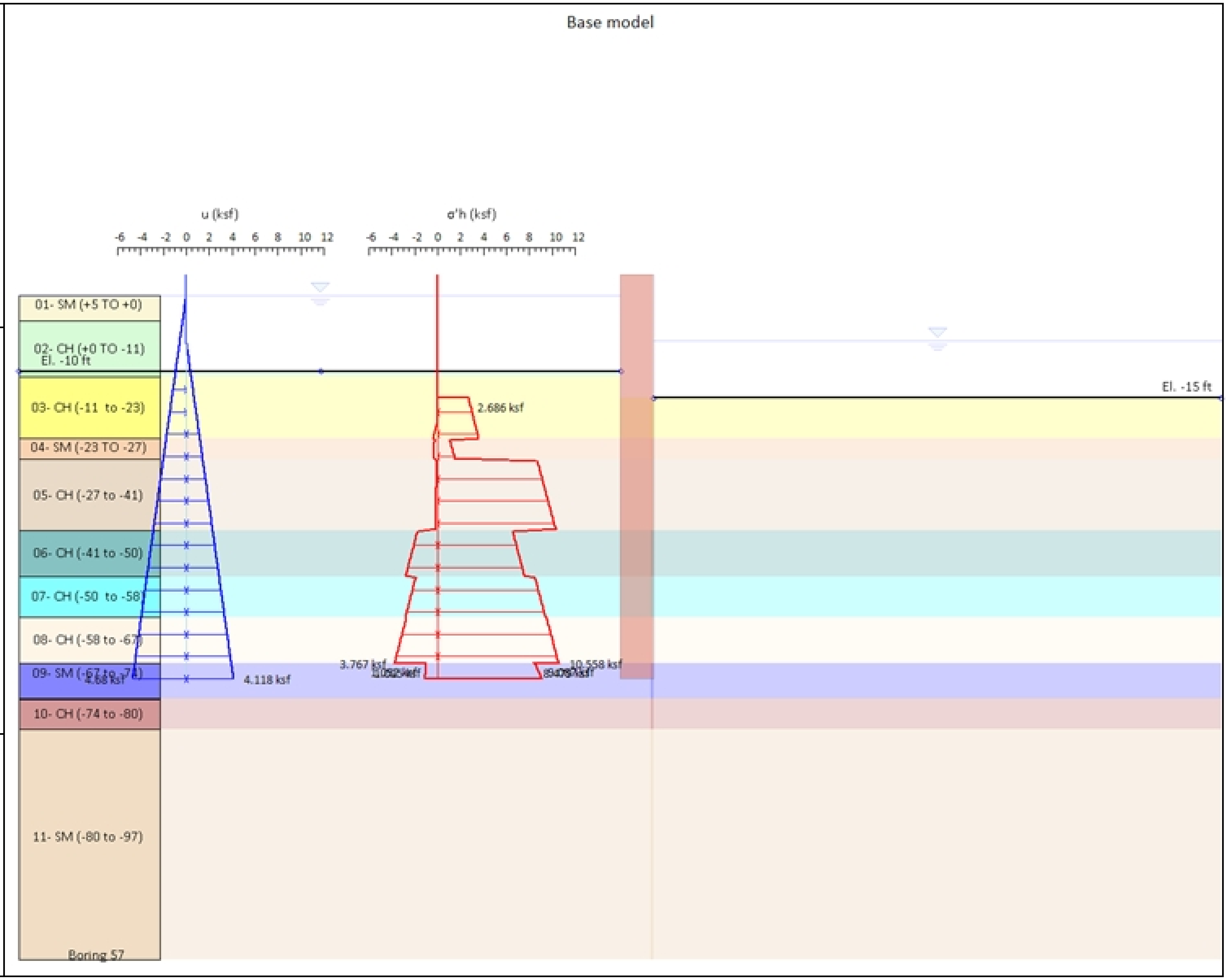


Deep Excavation LCC
DeepEX 2019
4/27/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C4 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

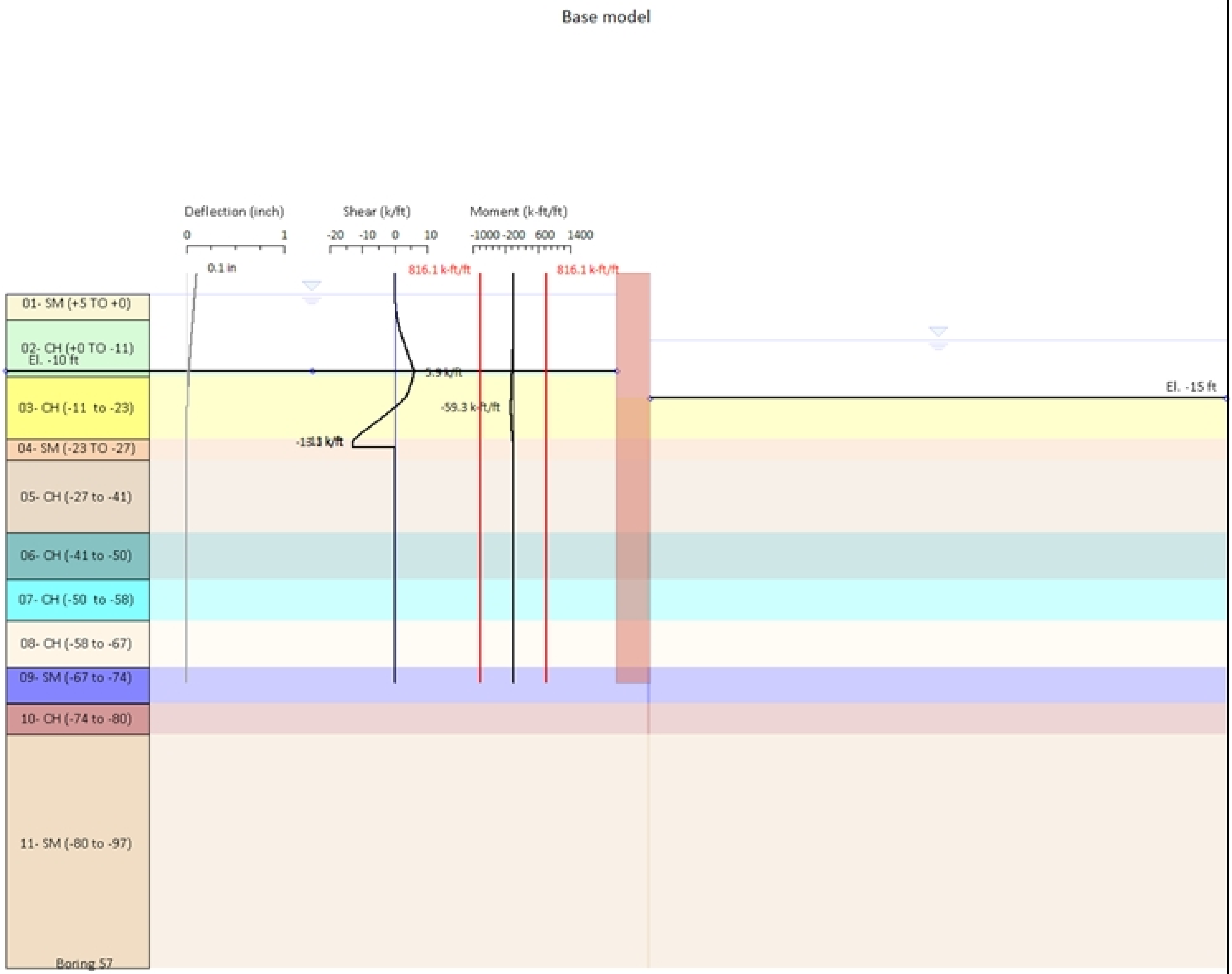
DS: 0, C4 FS = 1.5

Deep Excavation LCC

DeepEX 2019

4/27/2020

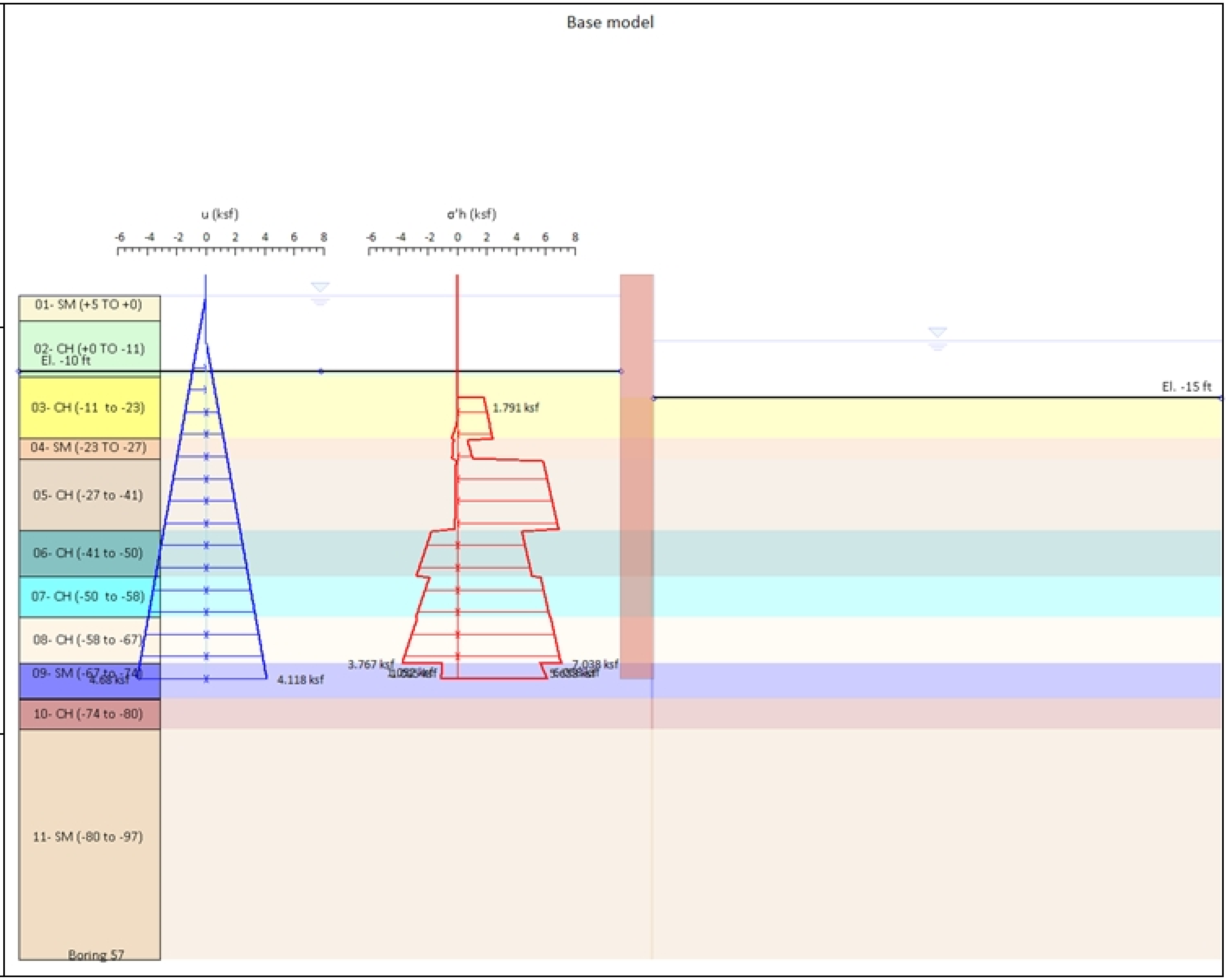
Base model



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) Q-Case.DEEP

DS: 0, C4 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/27/2020



DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 4/27/2020 9:00:26 PM

File: C:\Users\George.Segre\Desktop\Northern Impoundment\Cell 2 Sections\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S -Case.DEEP

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)
A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength

Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
01- SM (+5 T	120	120	25	0	N/A	N/A	N/A	300	3	0.41	2.46	N/A	N/A	True	EXP	
02- CH (+0 TO	112	112	23	0	N/A	N/A	N/A	60	3	0.44	2.28	N/A	N/A	True	Linear	
03- CH (-11 t	112	112	23	0	N/A	N/A	N/A	150	3	0.44	2.28	N/A	N/A	True	Linear	
04- SM (-23 T	120	120	25	0	N/A	N/A	N/A	521.92	3	0.41	2.46	N/A	N/A	True	Linear	
05- CH (-27 to	120	120	23	0	N/A	N/A	N/A	417.54	3	0.44	2.28	N/A	N/A	True	Linear	
06- CH (-41 to	116	116	23	0	N/A	N/A	N/A	626.3	3	0.44	2.28	N/A	N/A	True	Linear	
07- CH (-50 t	116	116	23	0	N/A	N/A	N/A	300	3	0.44	2.28	N/A	N/A	True	Linear	
08- CH (-58 to	116	116	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	
09- SM (-67 t	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
10- CH (-74 to	116	116	26	0	N/A	N/A	N/A	300	3	0.39	2.56	N/A	N/A	True	Linear	
11- SM (-80 t	130	130	32	0	N/A	N/A	N/A	300	3	0.31	3.26	N/A	N/A	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
01- SM (+5 T	0.4	-	-	0.577	0.5	1	0	7.2	4.8	20	-
02- CH (+0 TO	0.4	-	-	0.609	0.5	-	-	5.1	3.4	20	-
03- CH (-11 t	0.4	-	-	0.609	0.5	-	-	13	8.7	20	-
04- SM (-23 T	0.4	-	-	0.577	0.5	-	-	21.8	14.5	30	-
05- CH (-27 to	0.45	-	-	0.609	0.5	-	-	18.1	12.1	30	-
06- CH (-41 to	0.35	-	-	0.609	0.5	-	-	29	19.3	70	-
07- CH (-50 t	0.35	-	-	0.609	0.8	-	-	0	0	0	-
08- CH (-58 to	0.3	-	-	0.562	0.8	-	-	0	0	0	-
09- SM (-67 t	0.25	-	-	0.5	0.8	-	-	0	0	0	-
10- CH (-74 to	0.35	-	-	0.562	0.8	-	-	0	0	0	-
11- SM (-80 t	0.35	-	-	0.47	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction
SIMC= Simplified Clay mode

SOIL BORINGS

Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Boring 57, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
5	01- SM (+5 TO	1	0.58
0	02- CH (+0 TO	1	0.61
-11	03- CH (-11 to	1	0.61
-23	04- SM (-23 T	1	0.58
-27	05- CH (-27 to	1	0.61
-41	06- CH (-41 to	1	0.61
-50	07- CH (-50 to	1	0.61
-58	08- CH (-58 to	1	0.56
-67	09- SM (-67 to	1	0.5
-74	10- CH (-74 to	1	0.56
-80	11- SM (-80 to	1	1

WALL DATA

Wall section 0: Wall 1

Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP		4/27/2020

Wall uses wall section 0: Wall 1
Wall type: Combined sheet pile wall
Top wall El: 9 ft   Bottom wall El: -90 ft
Hor. wall spacing: 10.29 ft   Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft   Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi   Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.

Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

GENERAL WALL DATA
Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk
F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

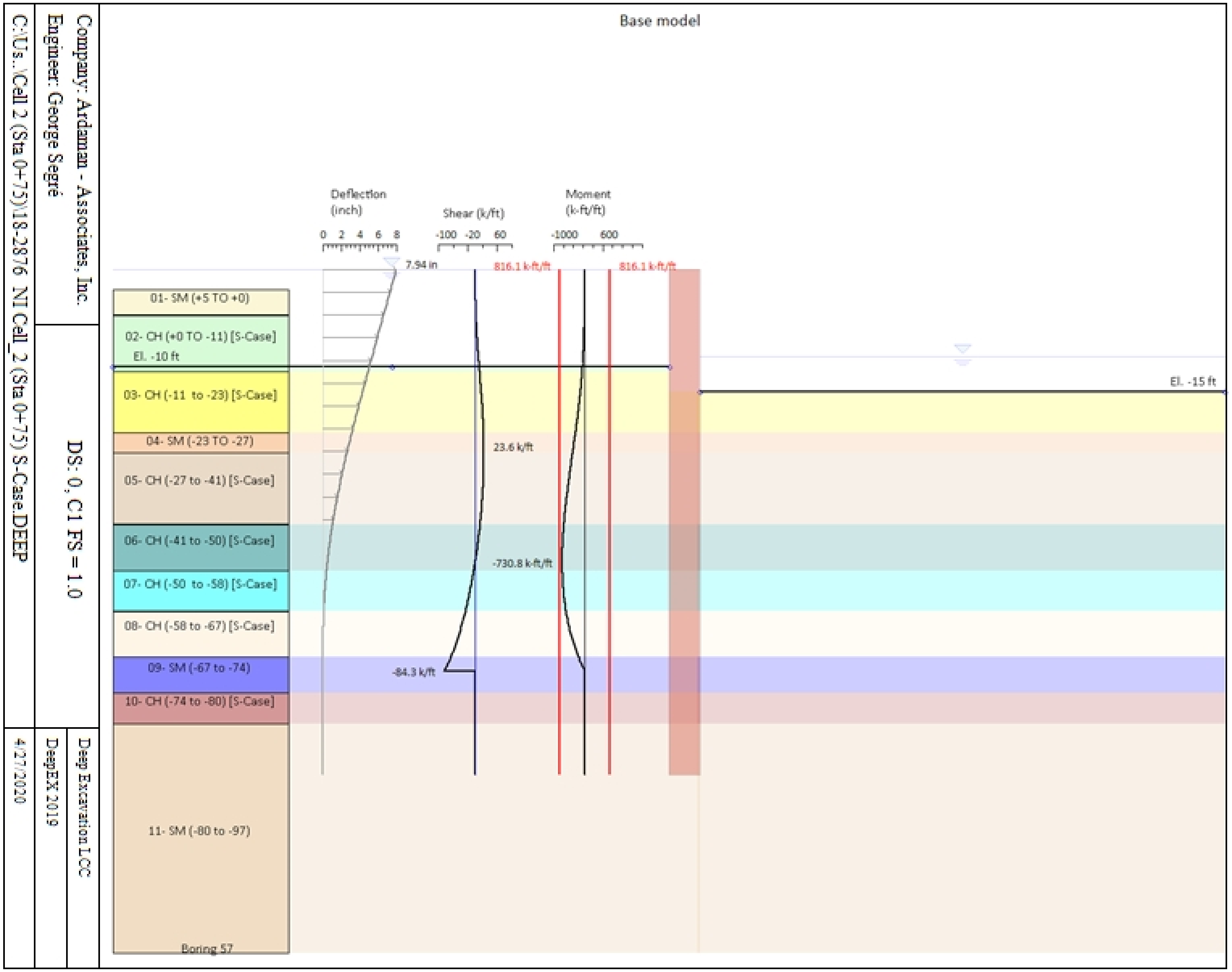
Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	1.274	1.274	1.688
Stage 1	Simple span	N/A	1.6	1.115	1.115	1.463
Stage 2	Simple span	N/A	1.6	1.348	1.348	1.744
Stage 3	Simple span	N/A	1.6	1.189	1.189	1.519
Stage 4	Simple span	N/A	1.6	1.413	1.413	1.805
Stage 5	Simple span	N/A	1.6	1.119	1.119	1.405
Stage 6	Simple span	N/A	1.6	1.494	1.494	1.866
Stage 7	Simple span	N/A	1.6	1.2	1.2	1.465

Name=excavation stage name
Analysis method
springs = Elastoplastic spring analysis used
DR = Drained condition for CLAY model
U = Undrained condition for CLAY model for all the soils
Up = Undrained condition just for selected soil
Limit equilibrium analysis settings
Drive press:
Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,
FHWA= Federal Highway Administration apparent pressure diagrams.
Ko = At-rest lateral earth pressures.
Peck = Peck 1969 Apparent earth pressure diagrams.
2 Step rect = Two step rectangular apparent earth pressure diagram.
User def. = User defined apparent earth pressure diagram.
Ka+d (and so on) indicates that wall friction is applied
ka mult = multiplication factor for Ka when Ka-Trap is selected
Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H
Resit press = Kp (passive earth pressures)
Res Mult = Safety factor applied directly on resisting pressures (
COntle Method = cantilever analysis method for limit equilibrium analysis.
Support Model: Method for calculating support reactions in limit-equlibrium analysis.
Beam= support reactions beam analysis (uses Blum's method).
Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).
Axial Incl = Axial loads included for structural design

Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

EXCAVATION STAGES SKETCHES

A sequence of figures for each excavation stage is reported

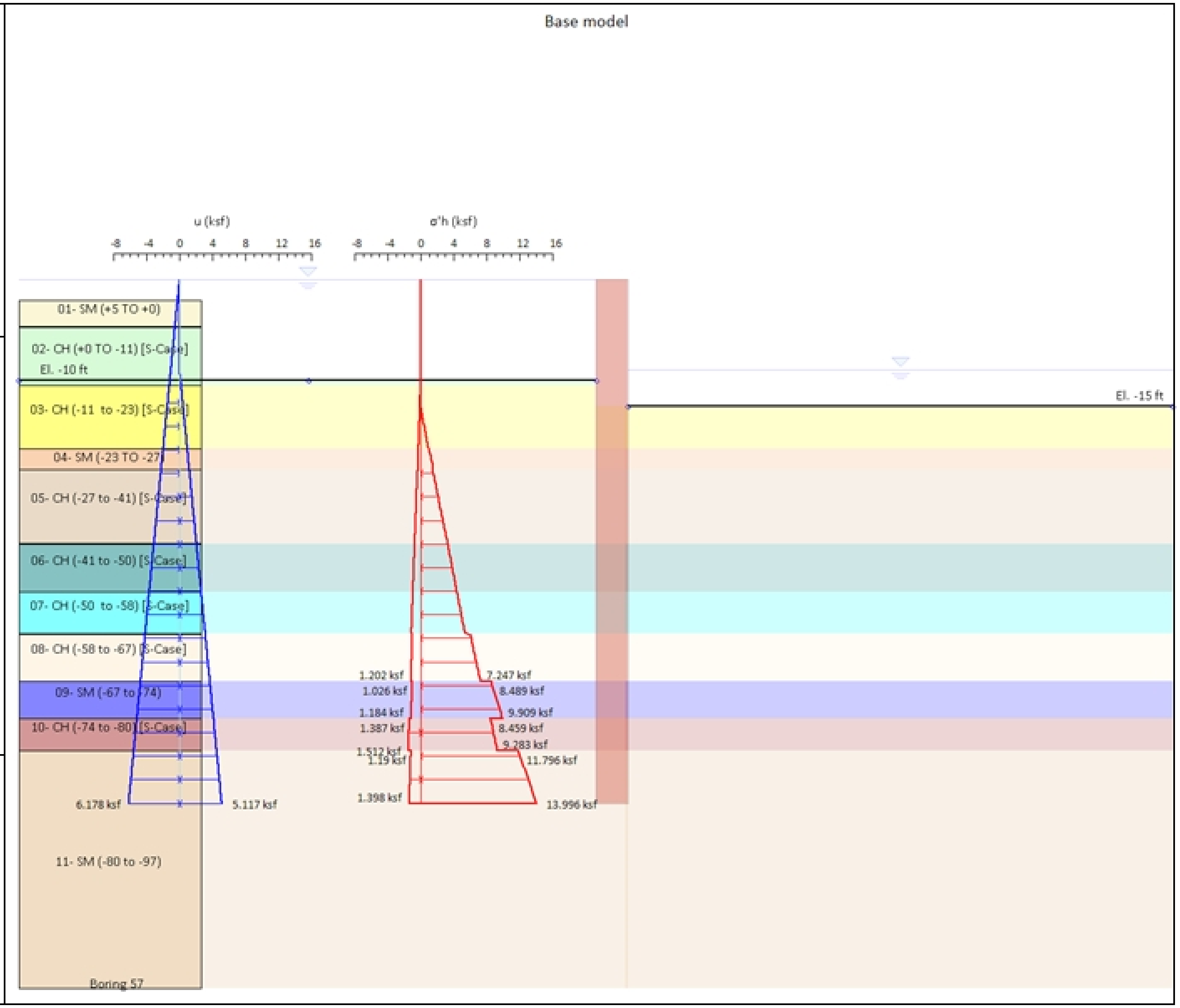


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us...\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP
DS: 0, C1 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/27/2020
Base model
Deflection (inch)
0 2 4 6 8
Shear (k/ft)
-100 -20 60
Moment (k-ft/ft)
-1000 600
7.94 in
816.1 k-ft/ft
816.1 k-ft/ft
01- SM (+5 TO +0)
02- CH (+0 TO -11) [S-Case]
El. -10 ft
03- CH (-11 to -23) [S-Case]
04- SM (-23 TO -27)
05- CH (-27 to -41) [S-Case]
06- CH (-41 to -50) [S-Case]
07- CH (-50 to -58) [S-Case]
08- CH (-58 to -67) [S-Case]
09- SM (-67 to -74)
10- CH (-74 to -80) [S-Case]
11- SM (-80 to -97)
Boring 57
23.6 k/ft
-730.8 k-ft/ft
-84.3 k/ft
El. -15 ft

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

DS: 0, C1 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

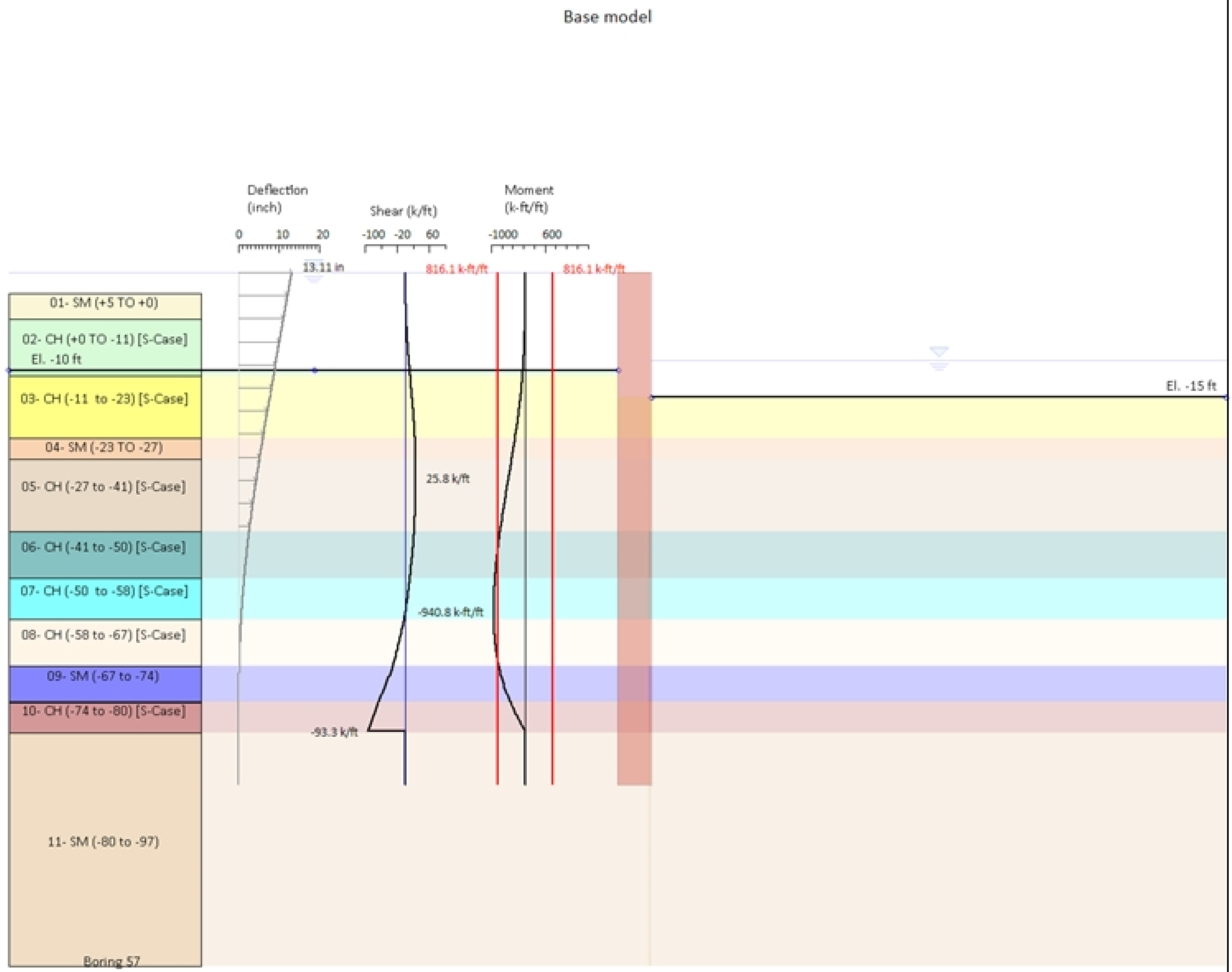


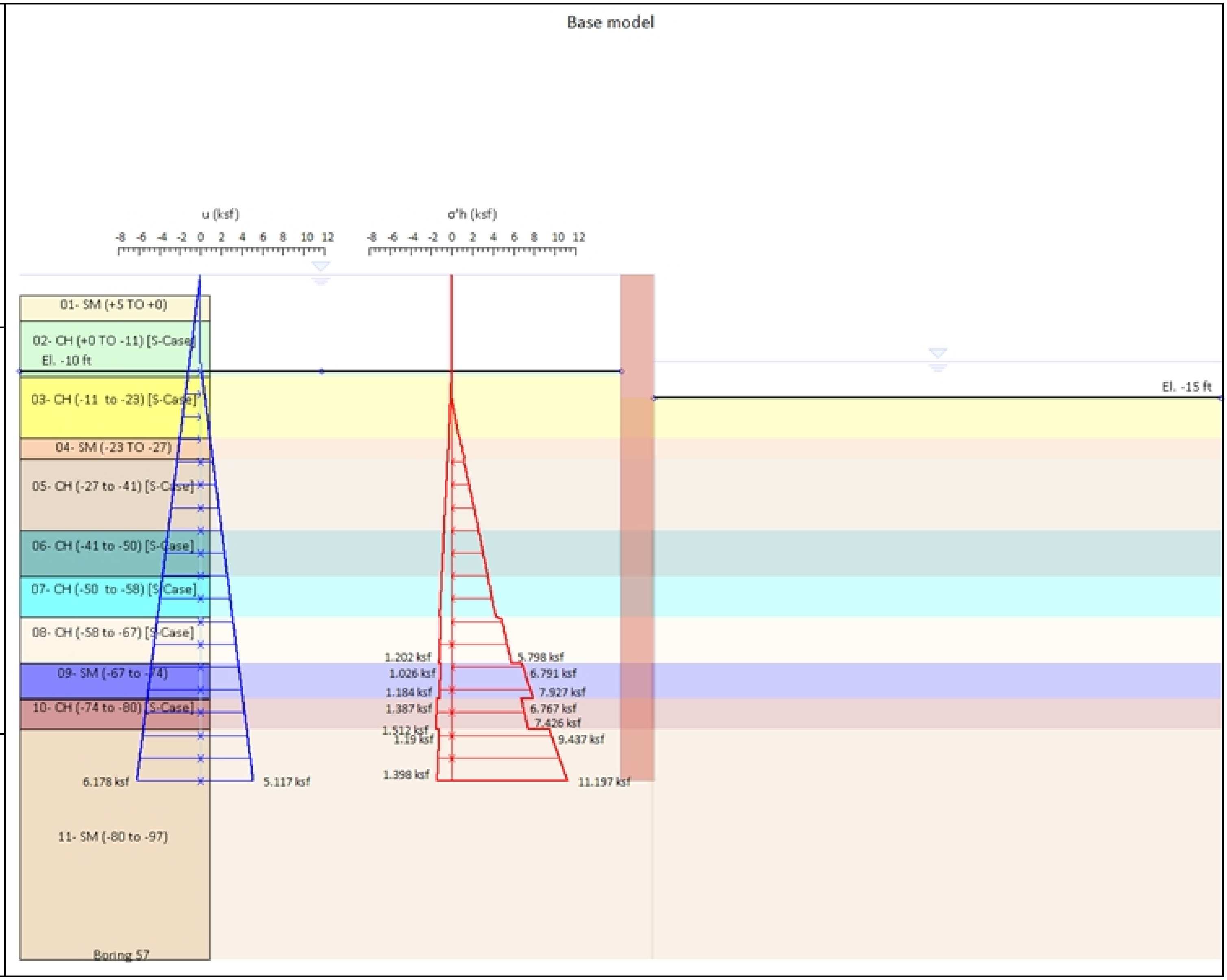
Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C1 FS = 1.25

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

Deep Excavation LCC
DeepEX 2019
4/27/2020





Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

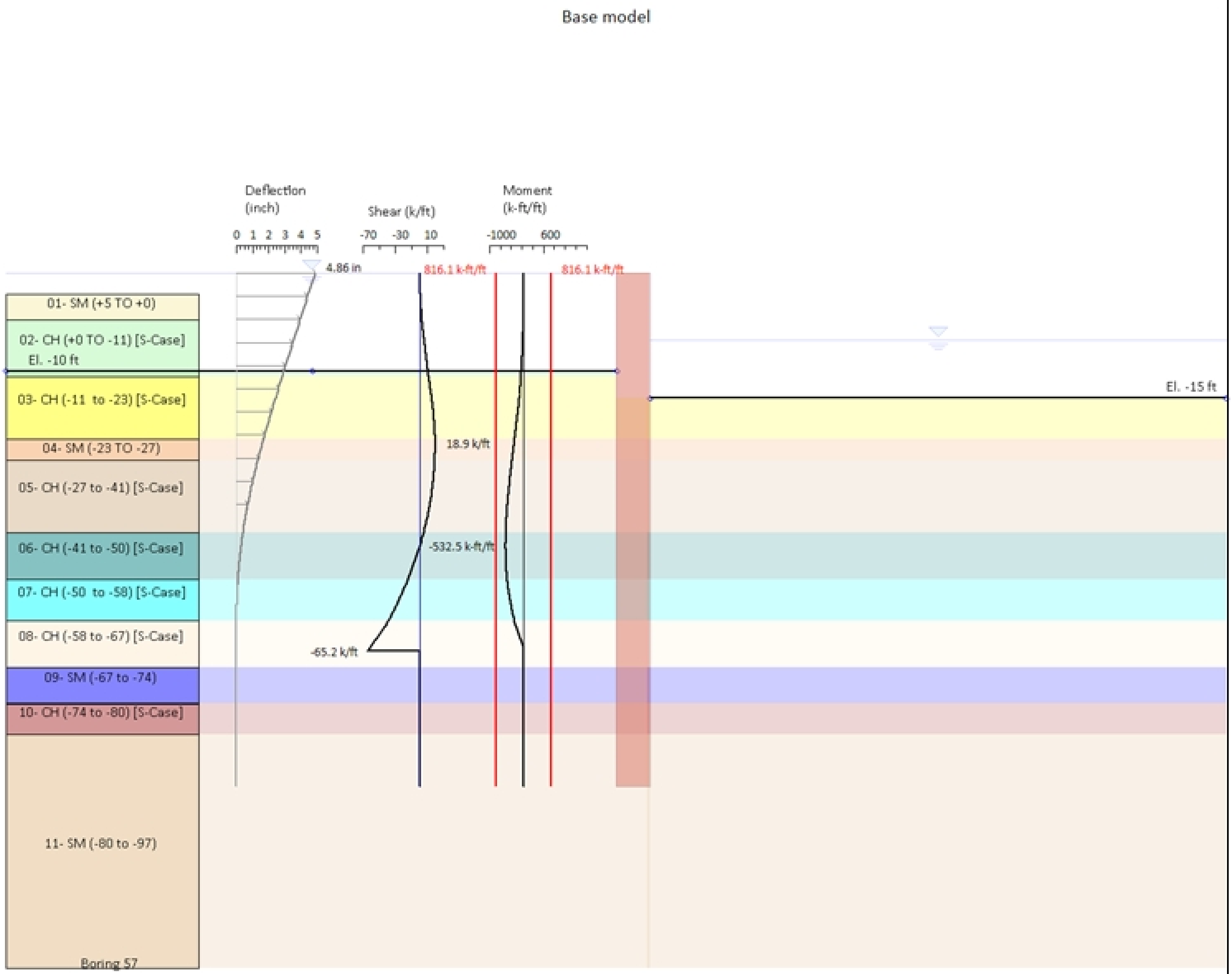
DS: 0, C1 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/27/2020

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

DS: 0, C2 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

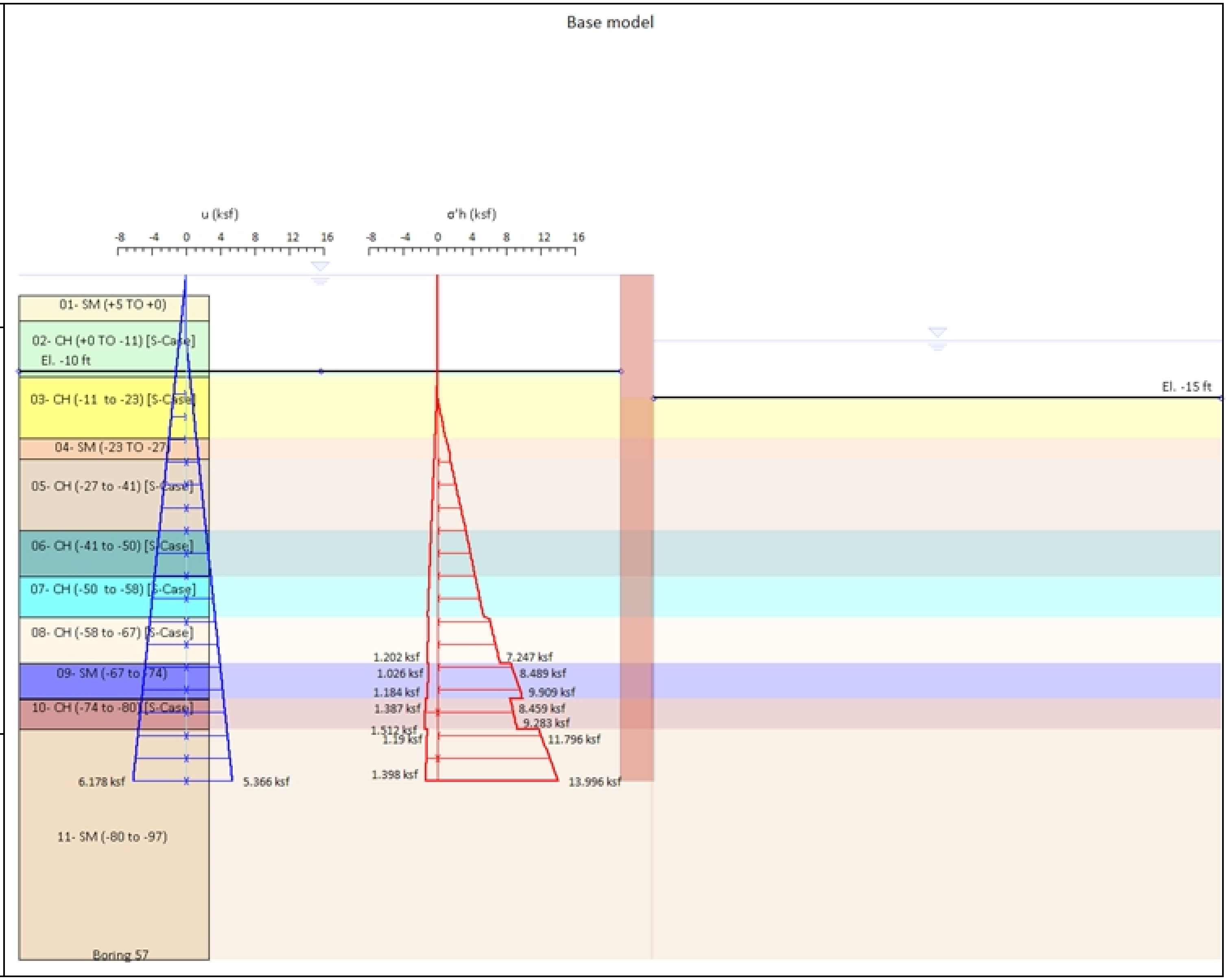


Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C2 FS = 1.0

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

Deep Excavation LCC
DeepEX 2019
4/27/2020

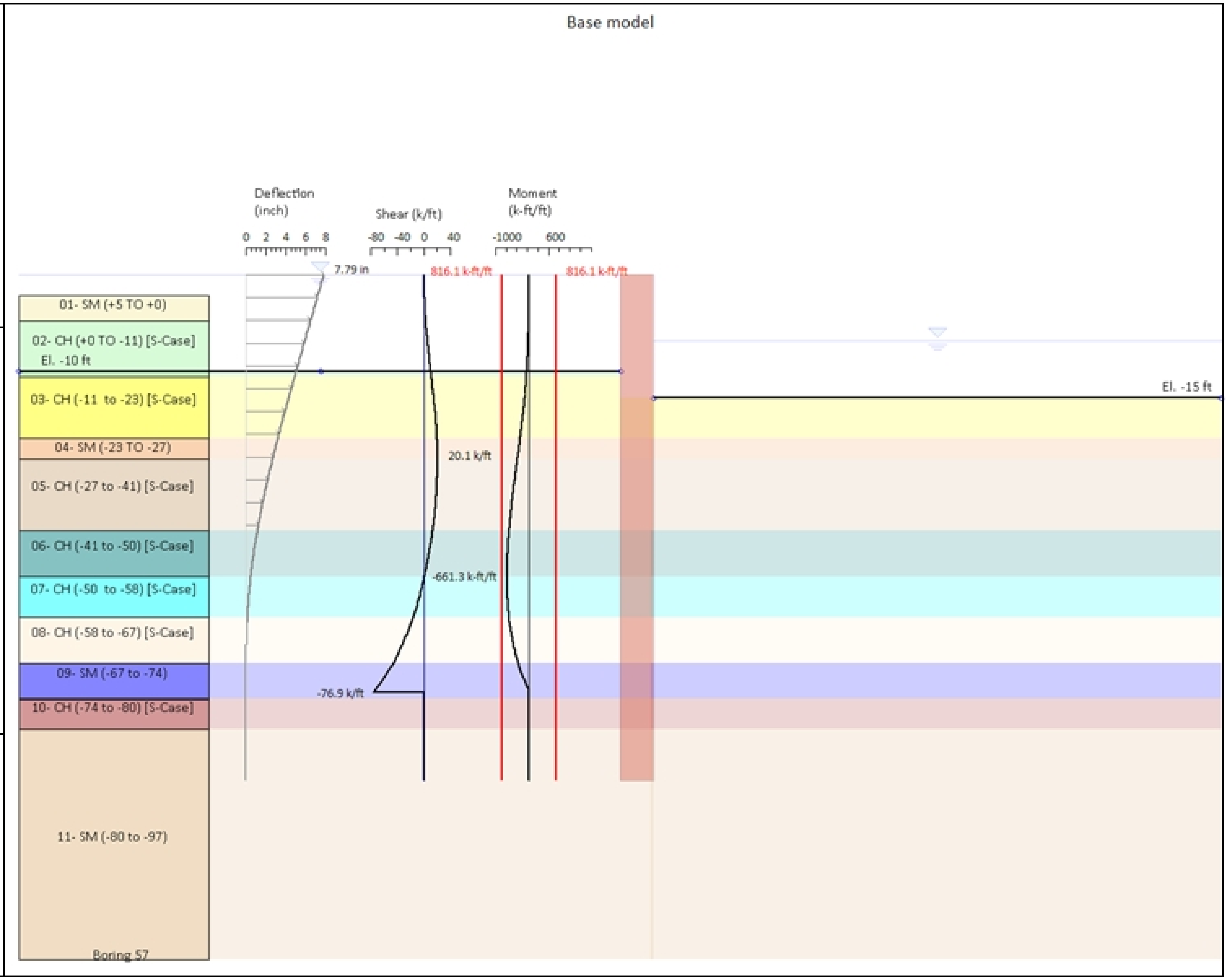


Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C2 FS = 1.25

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

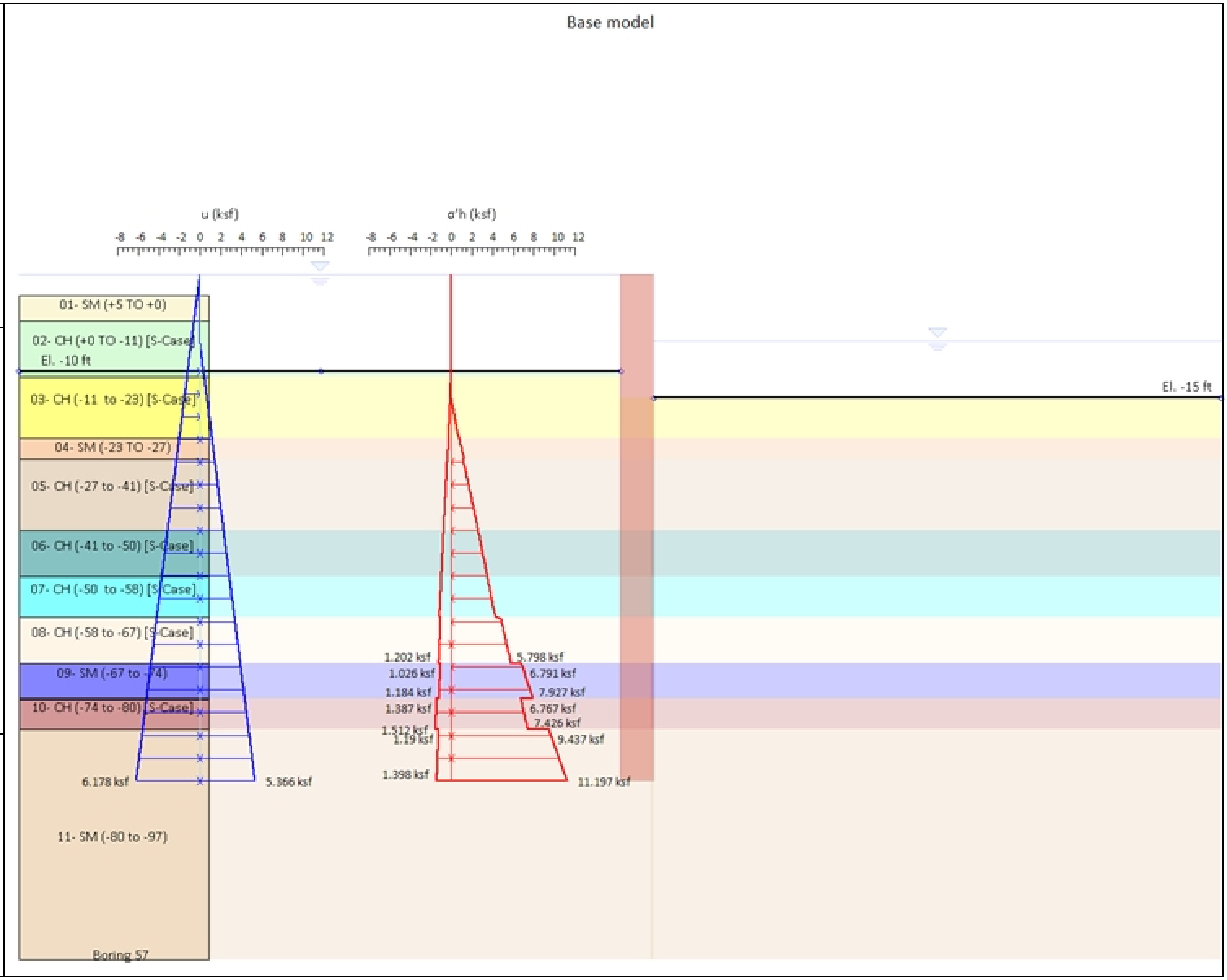
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

DS: 0, C2 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/27/2020

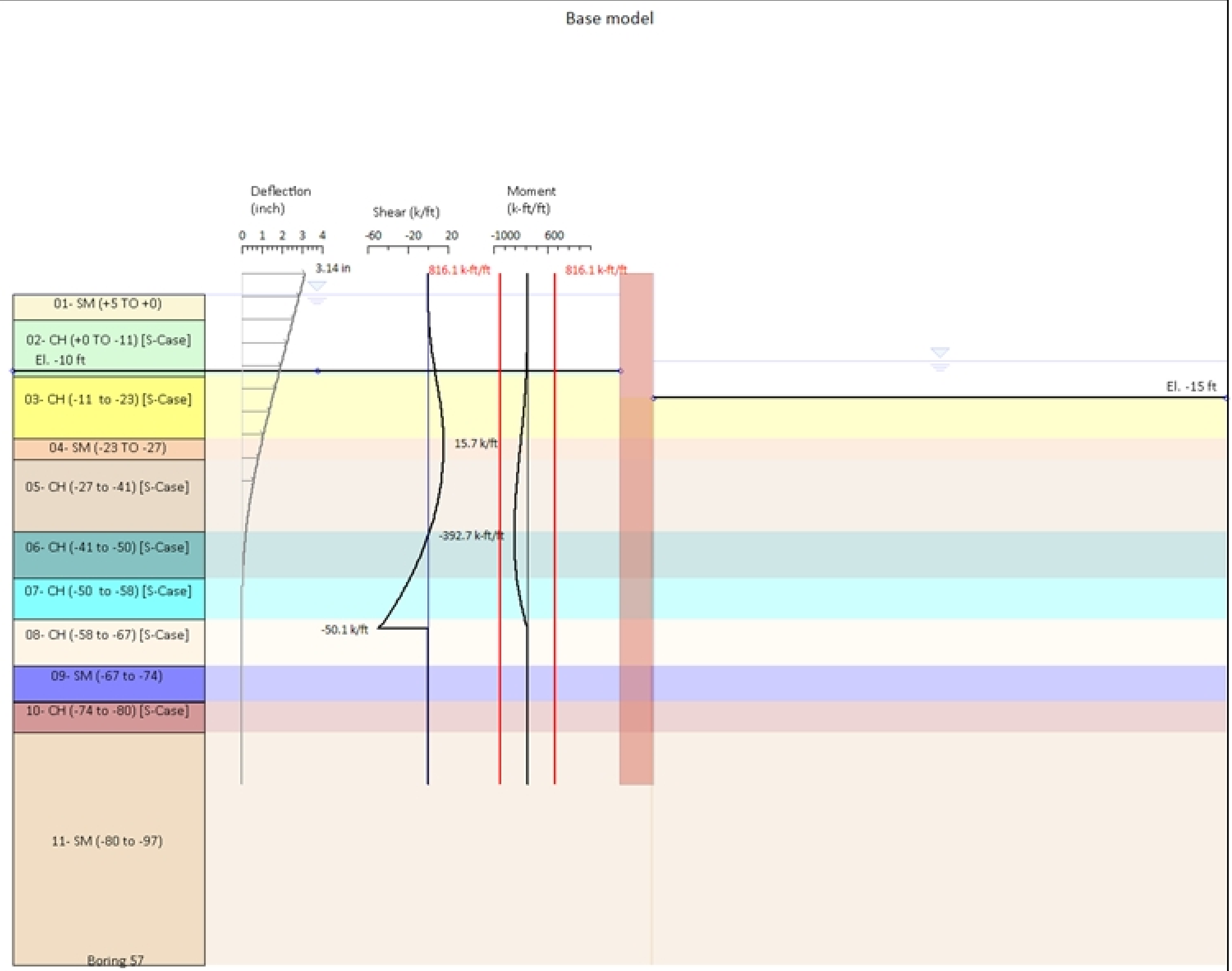


Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C3 FS = 1.0

C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

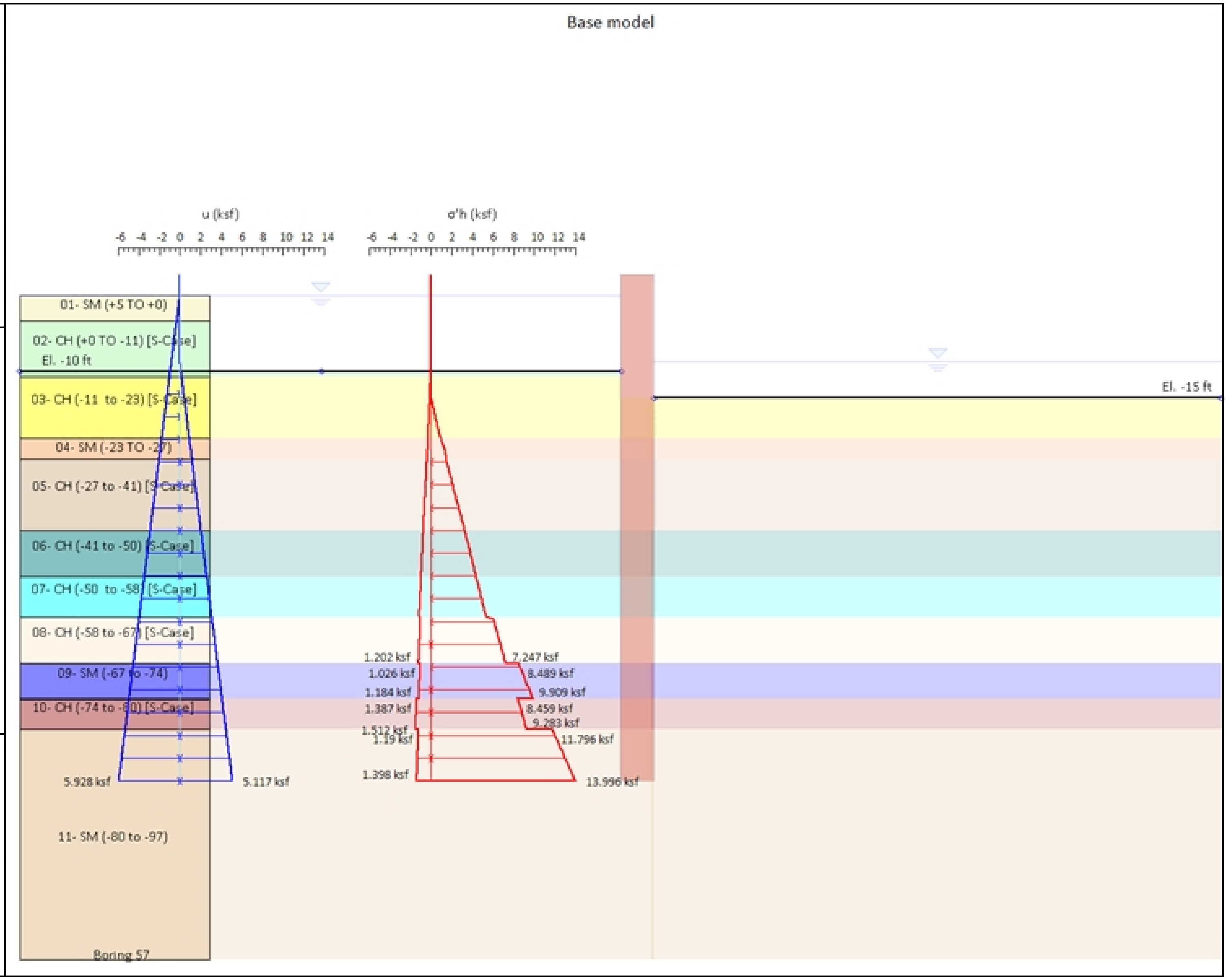
Deep Excavation LCC
DeepEX 2019
4/27/2020

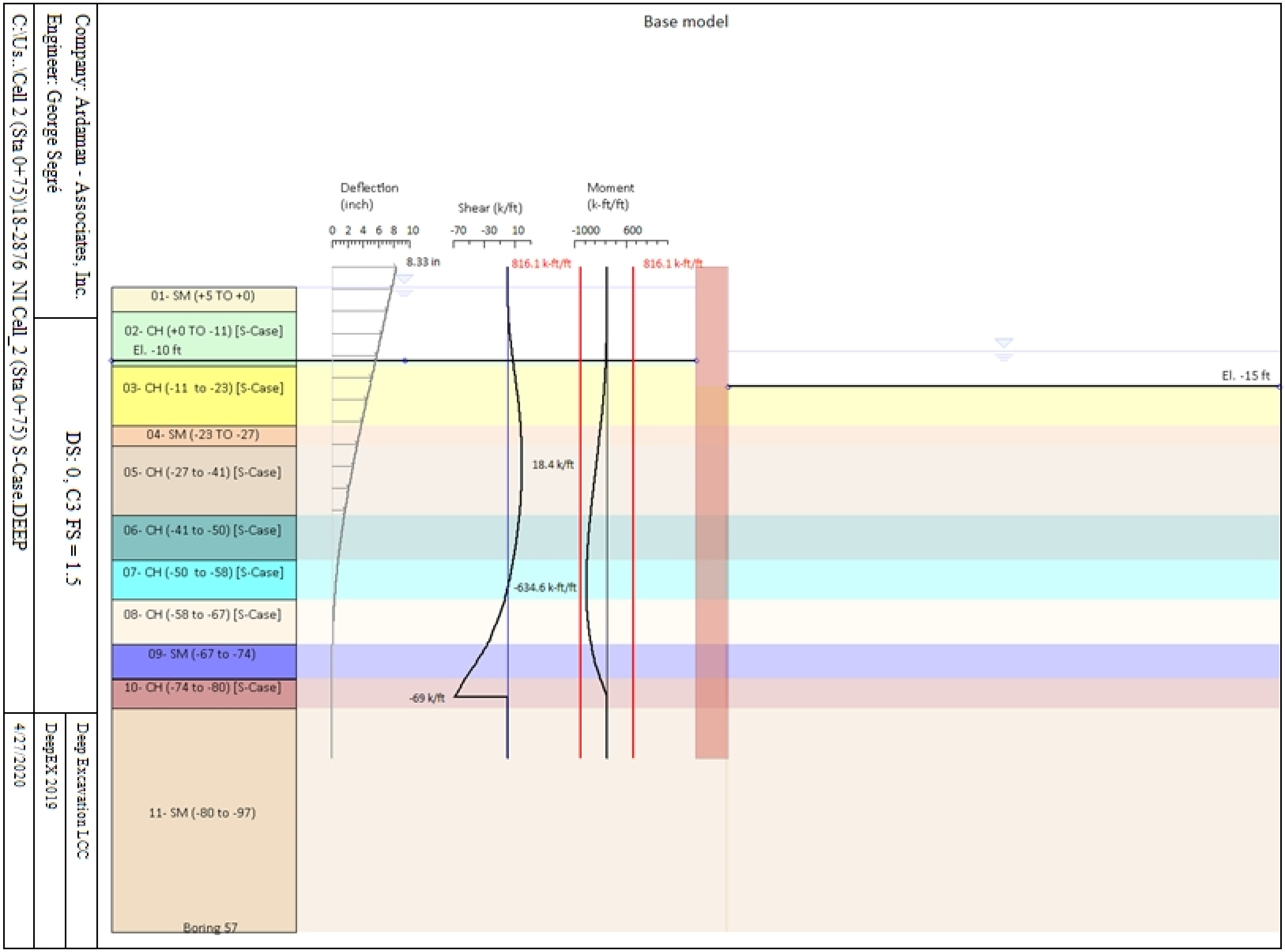


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

DS: 0, C3 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020

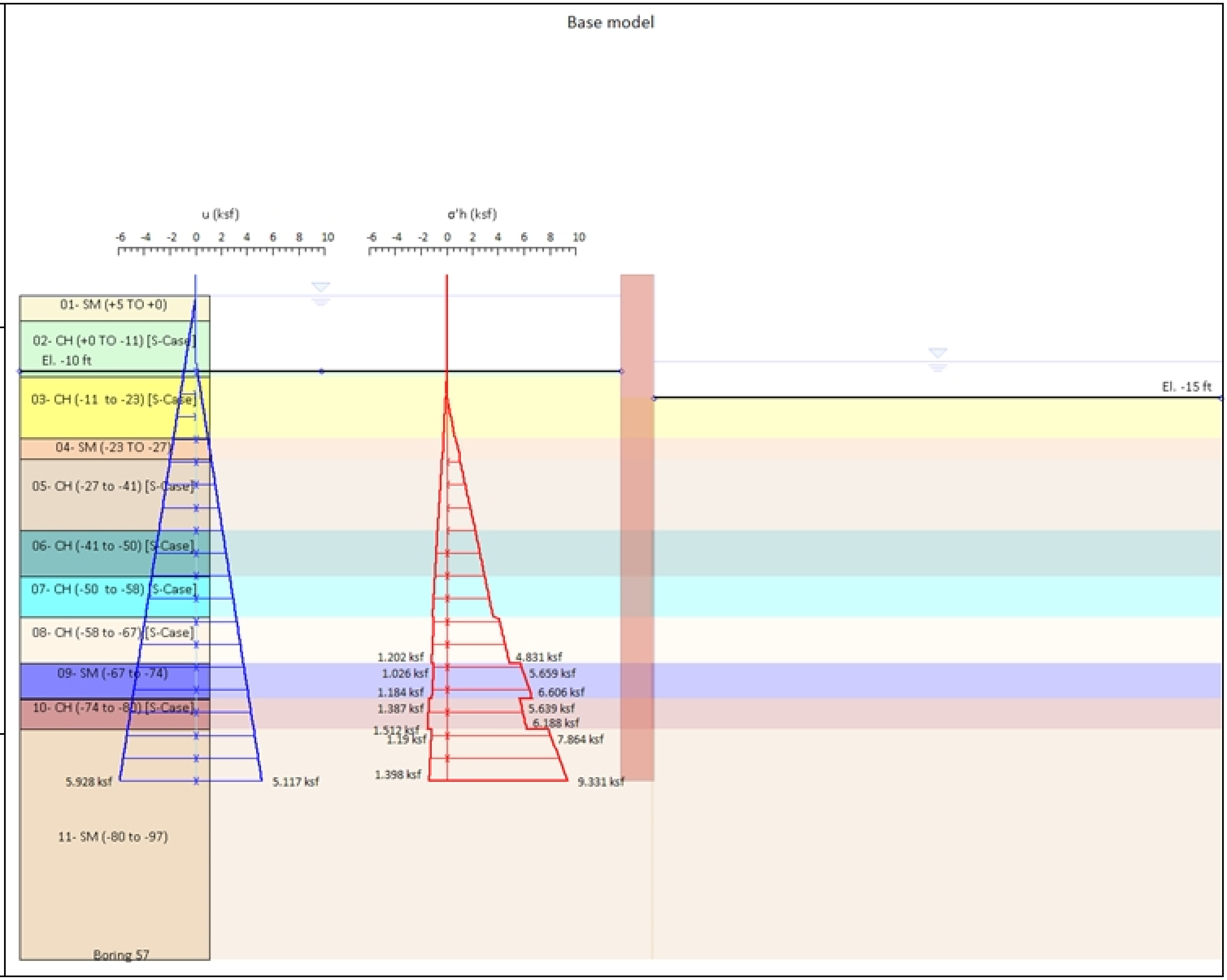



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP
DS: 0, C3 FS = 1.5
Deep Excavation LCC
DeepEX 2019
4/27/2020
Base model
Deflection (inch)
0 2 4 6 8 10
Shear (k/ft)
-70 -30 10
Moment (k-ft/ft)
-1000 600
8.33 in
816.1 k-ft/ft
816.1 k-ft/ft
01- SM (+5 TO +0)
02- CH (+0 TO -11) [S-Case]
El. -10 ft
03- CH (-11 to -23) [S-Case]
04- SM (-23 TO -27)
05- CH (-27 to -41) [S-Case]
06- CH (-41 to -50) [S-Case]
07- CH (-50 to -58) [S-Case]
08- CH (-58 to -67) [S-Case]
09- SM (-67 to -74)
10- CH (-74 to -80) [S-Case]
11- SM (-80 to -97)
Boring 57
18.4 k/ft
-634.6 k-ft/ft
-69 k/ft
El. -15 ft

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

DS: 0, C3 FS = 1.5

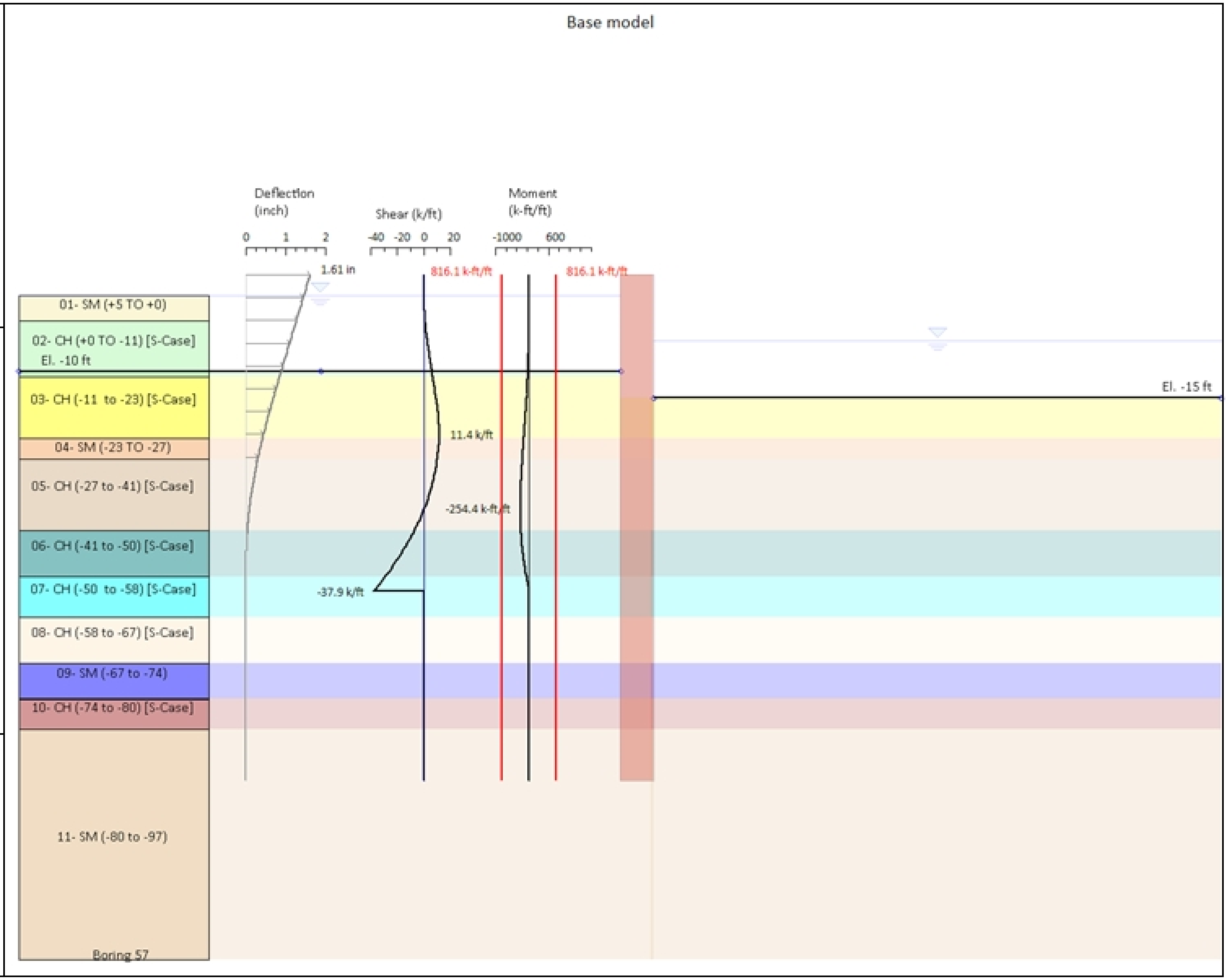
Deep Excavation LCC
DeepEX 2019
4/27/2020



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

DS: 0, C4 FS = 1.0

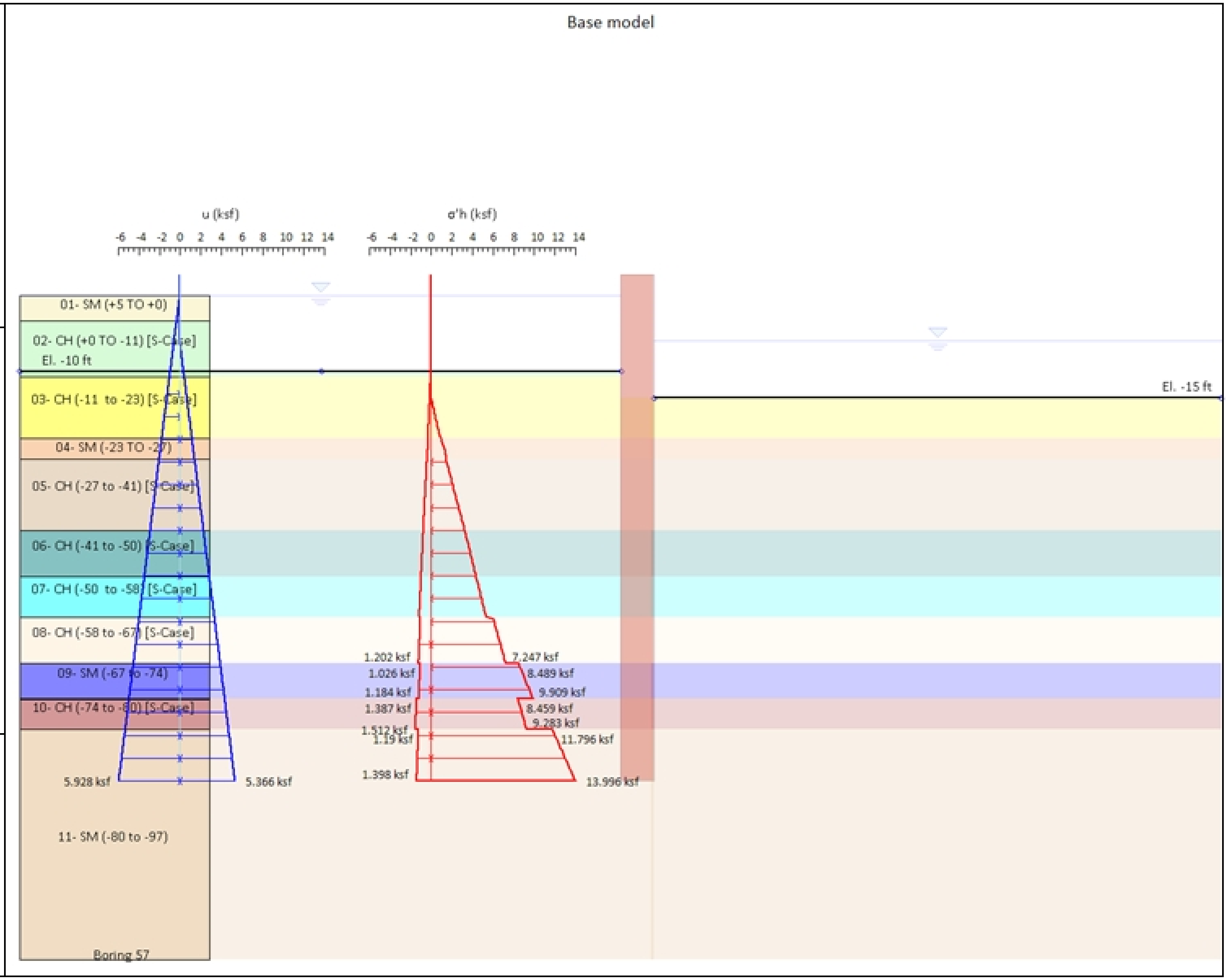
Deep Excavation LCC
DeepEX 2019
4/27/2020

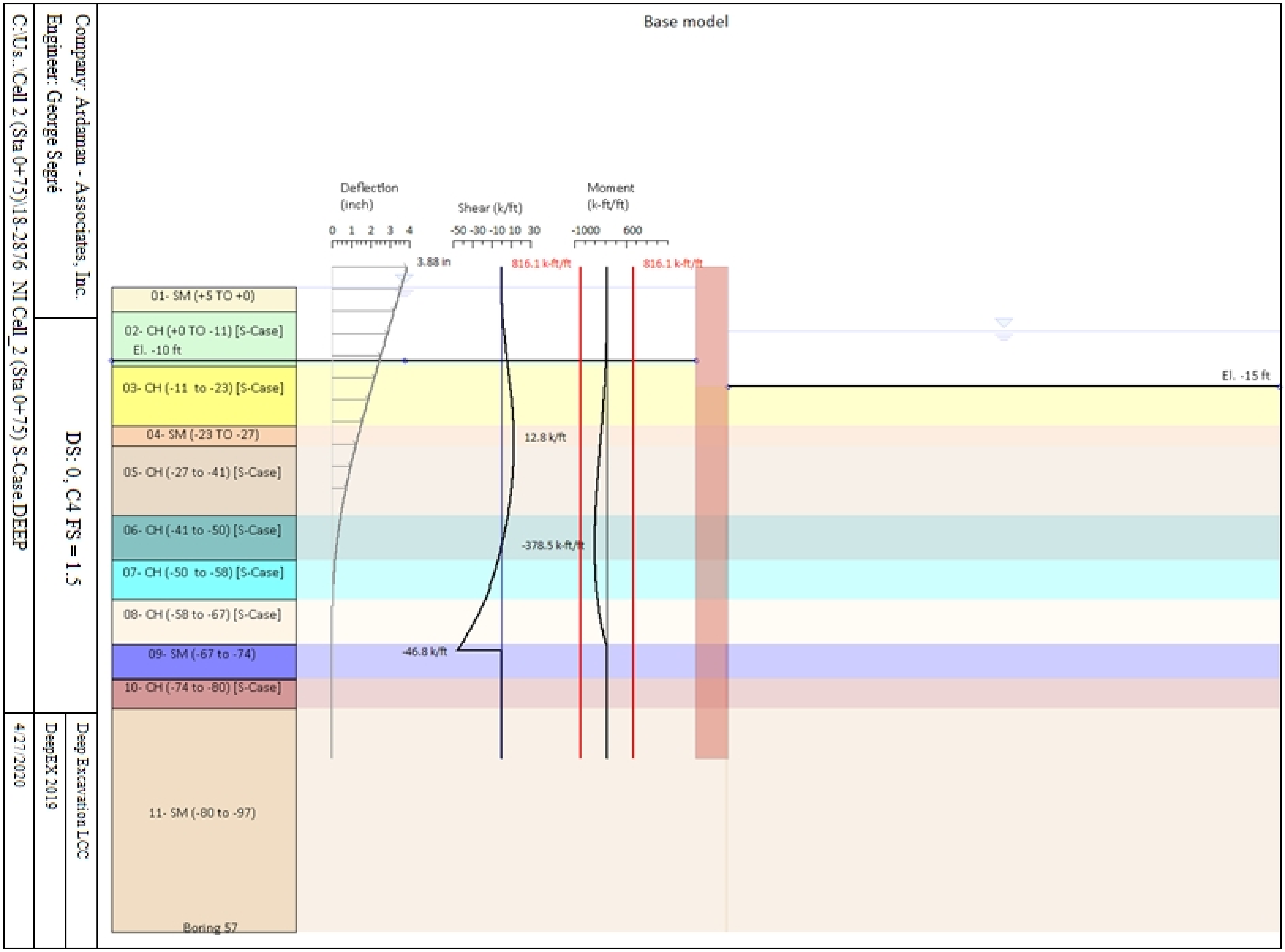


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP

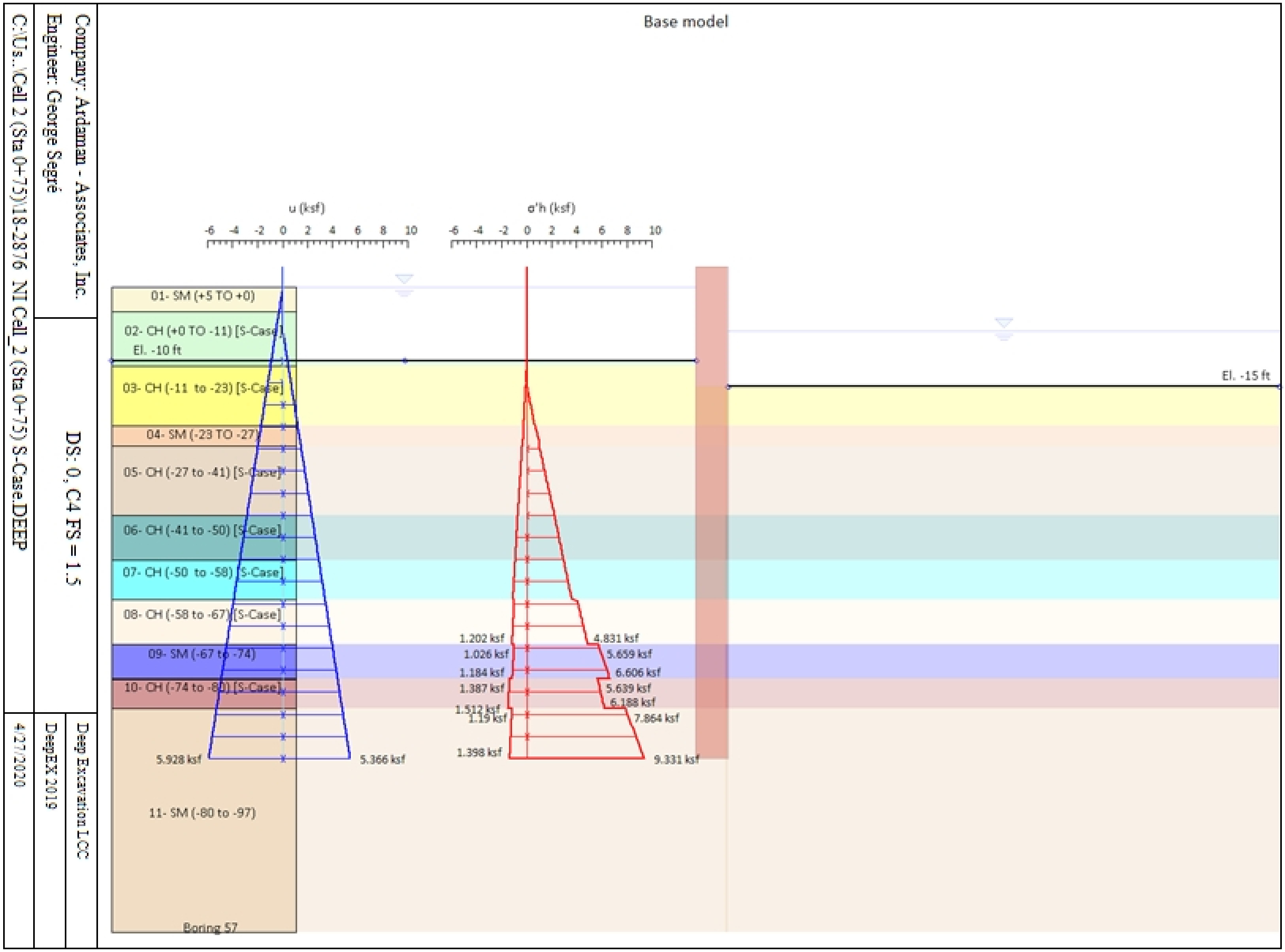
DS: 0, C4 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/27/2020





Base model
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP
DS: 0, C4 FS = 1.5
Deep Excavation LCC
DeepEX 2019
4/27/2020
Deflection (inch)
0 1 2 3 4
Shear (k/ft)
-50 -30 -10 10 30
Moment (k-ft/ft)
-1000 600
3.88 in
816.1 k-ft/ft
816.1 k-ft/ft
12.8 k/ft
-378.5 k-ft/ft
-46.8 k/ft
El. -10 ft
El. -15 ft
01- SM (+5 TO +0)
02- CH (+0 TO -11) [S-Case]
03- CH (-11 to -23) [S-Case]
04- SM (-23 TO -27)
05- CH (-27 to -41) [S-Case]
06- CH (-41 to -50) [S-Case]
07- CH (-50 to -58) [S-Case]
08- CH (-58 to -67) [S-Case]
09- SM (-67 to -74)
10- CH (-74 to -80) [S-Case]
11- SM (-80 to -97)
Boring 57


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 2 (Sta 0+75)\18-2876 NI Cell_2 (Sta 0+75) S-Case.DEEP
DS: 0, C4 FS = 1.5
Deep Excavation LCC
DeepEX 2019
4/27/2020
Base model
u (ksf)
σ'h (ksf)
-6 -4 -2 0 2 4 6 8 10
01- SM (+5 TO +0)
02- CH (+0 TO -11) [S-Case]
El. -10 ft
03- CH (-11 to -23) [S-Case]
04- SM (-23 TO -27)
05- CH (-27 to -41) [S-Case]
06- CH (-41 to -50) [S-Case]
07- CH (-50 to -58) [S-Case]
08- CH (-58 to -67) [S-Case]
09- SM (-67 to -74)
10- CH (-74 to -80) [S-Case]
11- SM (-80 to -97)
Boring 57
El. -15 ft
5.928 ksf
5.366 ksf
1.202 ksf
4.831 ksf
1.026 ksf
5.659 ksf
1.184 ksf
6.606 ksf
1.387 ksf
5.639 ksf
6.188 ksf
1.512 ksf
1.19 ksf
7.864 ksf
1.398 ksf
9.331 ksf

DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 4/28/2020 8:57:44 AM

File: C:\Users\George.Segre\Desktop\Northern Impoundment\Cell 3 Sections\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q -Case.DEEP

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)
A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength

Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
01- CH (+3 TO	115	115	0	0	500	0	0	300	3	1	1	1	1	True	EXP	
02- CH (-6 TO	110	110	0	0	250	18	26	60	3	0.33	3	0.39	2.56	True	Linear	
03- CH (-15 t	110	110	0	0	350	0	0	150	3	1	1	1	1	True	Linear	
04- CH (-26 T	124	124	0	0	1250	0	0	521.92	3	1	1	1	1	True	Linear	
05- CH (-32 to	120	120	0	0	1000	21.1	30	417.54	3	0.47	2.12	0.33	3	True	Linear	
06- CH (-40 to	125	125	0	0	1730	0	0	626.3	3	1	1	1	1	True	Linear	
07- CH (-45 t	125	125	0	0	3300	0	0	300	3	0.31	3.26	0.33	0.33	True	Linear	
08- ML (-54 t	117	117	15	200	N/A	N/A	N/A	300	3	0.59	1.7	N/A	N/A	True	Linear	
09- SP (-58 to	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
10- ML (-62 t	117	117	15	200	N/A	N/A	N/A	300	3	0.59	1.7	N/A	N/A	True	Linear	
11- SP (-68 to	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
12- ML (-71 t	117	117	15	200	N/A	N/A	N/A	300	3	0.59	1.7	N/A	N/A	True	Linear	
13- SP (-83 to	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
14- CH (-93 to	125	125	0	0	3500	0	0	300	3	0.33	3	0.33	0.33	True	Linear	
15- CH (-102 t	125	125	0	0	4000	0	0	300	3	0.33	3	0.33	0.33	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
01- CH (+3 TO	0.4	0.1	0	1	0.5	1	0	7.2	4.8	20	-
02- CH (-6 TO	0.3	0.1	0	1	0.5	-	-	5.1	3.4	20	-
03- CH (-15 t	0.4	0.1	0	1	0.5	-	-	13	8.7	20	-
04- CH (-26 T	0.35	0.1	0	1	0.5	-	-	21.8	14.5	30	-
05- CH (-32 to	0.45	0.1	0	1	0.5	-	-	18.1	12.1	30	-
06- CH (-40 to	0.35	0.1	0	1	0.5	-	-	29	19.3	70	-
07- CH (-45 t	0.35	0.1	0	1	0.8	-	-	0	0	0	-
08- ML (-54 t	0.3	-	-	0.741	0.8	-	-	0	0	0	-
09- SP (-58 to	0.25	-	-	0.5	0.8	-	-	0	0	0	-
10- ML (-62 t	0.35	-	-	0.741	0.8	-	-	0	0	0	-
11- SP (-68 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
12- ML (-71 t	0.35	-	-	0.741	0.8	-	-	0	0	0	-
13- SP (-83 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
14- CH (-93 to	0.35	0.1	0	1	0.8	-	-	0	0	0	-
15- CH (-102 t	0.35	0.1	0	1	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction

SIMC= Simplified Clay mode

SOIL BORINGS

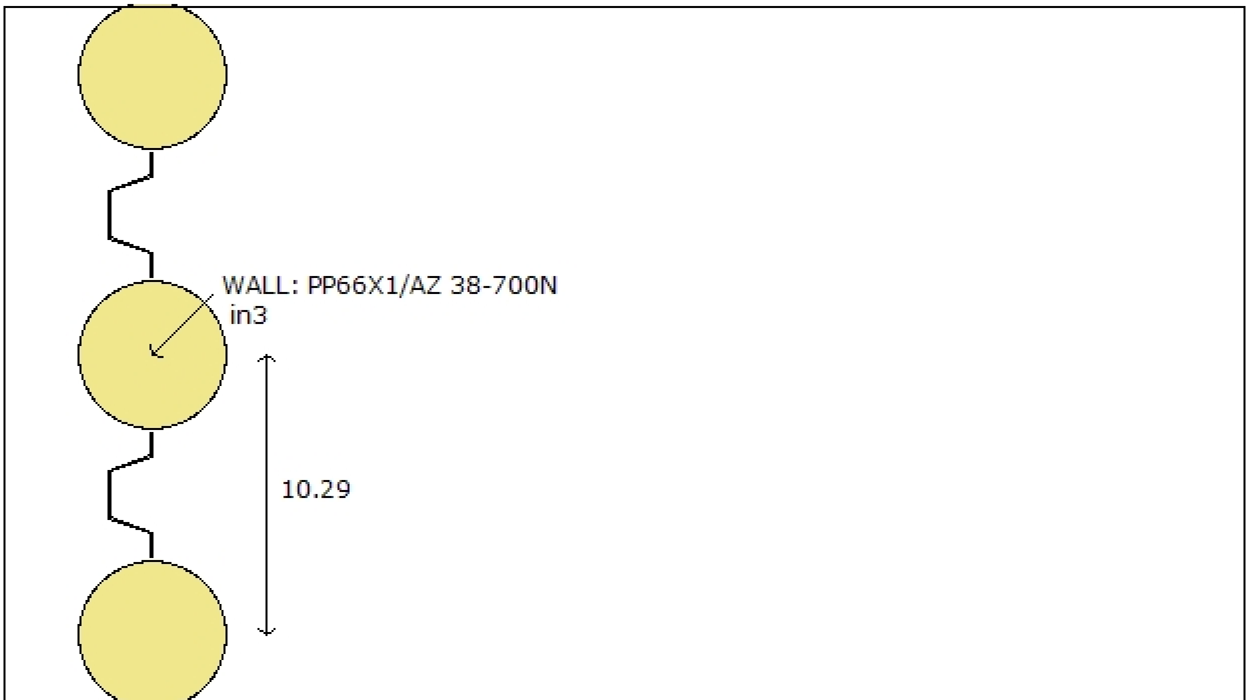
Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Cell #3, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
3	01- CH (+3 TO	1	1
-6	02- CH (-6 TO -	1	1
-15	03- CH (-15 to	1	1
-26	04- CH (-26 TO	1	1
-32	05- CH (-32 to	1	1
-40	06- CH (-40 to	1	1
-45	07- CH (-45 to	1	1
-54	08- ML (-54 to	1	0.74
-58	09- SP (-58 to -	1	0.5
-62	10- ML (-62 to	1	0.74
-68	11- SP (-68 to -	1	1
-71	12- ML (-71 to	1	0.74
-83	13- SP (-83 to -	1	0.5
-93	14- CH (-93 to	1	1
-102	15- CH (-102 t	1	1

WALL DATA

Wall section 0: Wall 1



Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP		4/28/2020

Wall type: Combined sheet pile wall
Top wall El: 9 ft Bottom wall El: -100 ft
Hor. wall spacing: 10.29 ft Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.
Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

GENERAL WALL DATA
Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk

F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	1.369	1.369	1.934
Stage 1	Simple span	N/A	1.6	1.095	1.095	1.547
Stage 2	Simple span	N/A	1.6	1.935	1.935	2.707
Stage 3	Simple span	N/A	1.6	1.548	1.548	2.166
Stage 4	Simple span	N/A	1.6	1.577	1.577	2.155
Stage 5	Simple span	N/A	1.6	1.051	1.051	1.437
Stage 6	Simple span	N/A	1.6	2.379	2.379	3.161
Stage 7	Simple span	N/A	1.6	1.586	1.586	2.108

Name=excavation stage name
Analysis method
springs = Elastoplastic spring analysis used
DR = Drained condition for CLAY model
U = Undrained condition for CLAY model for all the soils
Up = Undrained condition just for selected soil
Limit equilibrium analysis settings
Drive press:
Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,
FHWA= Federal Highway Administration apparent pressure diagrams.
Ko = At-rest lateral earth pressures.
Peck = Peck 1969 Apparent earth pressure diagrams.
2 Step rect = Two step rectangular apparent earth pressure diagram.
User def. = User defined apparent earth pressure diagram.
Ka+d (and so on) indicates that wall friction is applied
ka mult = multiplication factor for Ka when Ka-Trap is selected
Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H
Resit press = Kp (passive earth pressures)
Res Mult = Safety factor applied directly on resisting pressures (
COntle Method = cantilever analysis method for limit equilibrium analysis.
Support Model: Method for calculating support reactions in limit-equlibrium analysis.
Beam= support reactions beam analysis (uses Blum's method).
Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).
Axial Incl = Axial loads included for structural design

Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

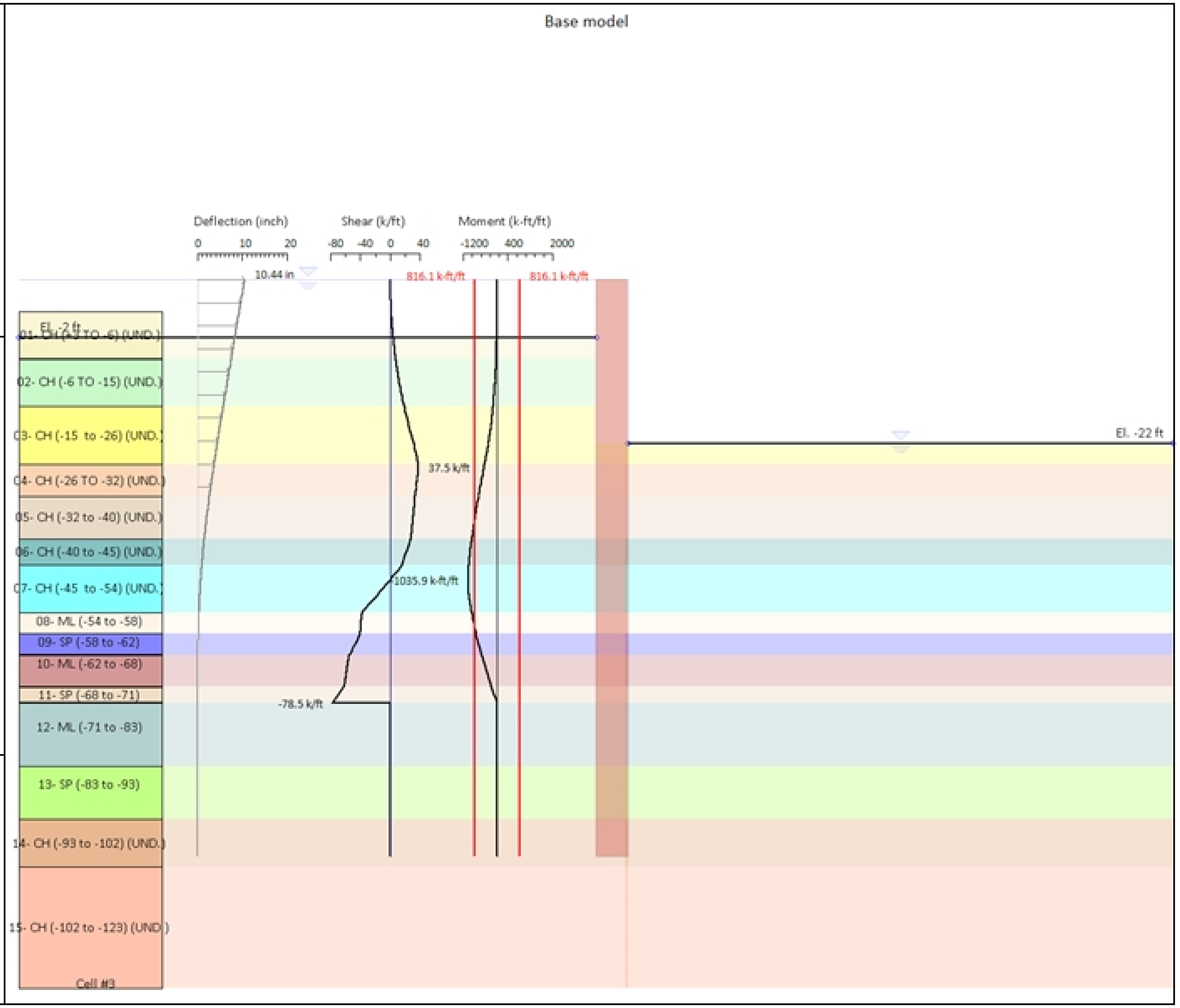
EXCAVATION STAGES SKETCHES

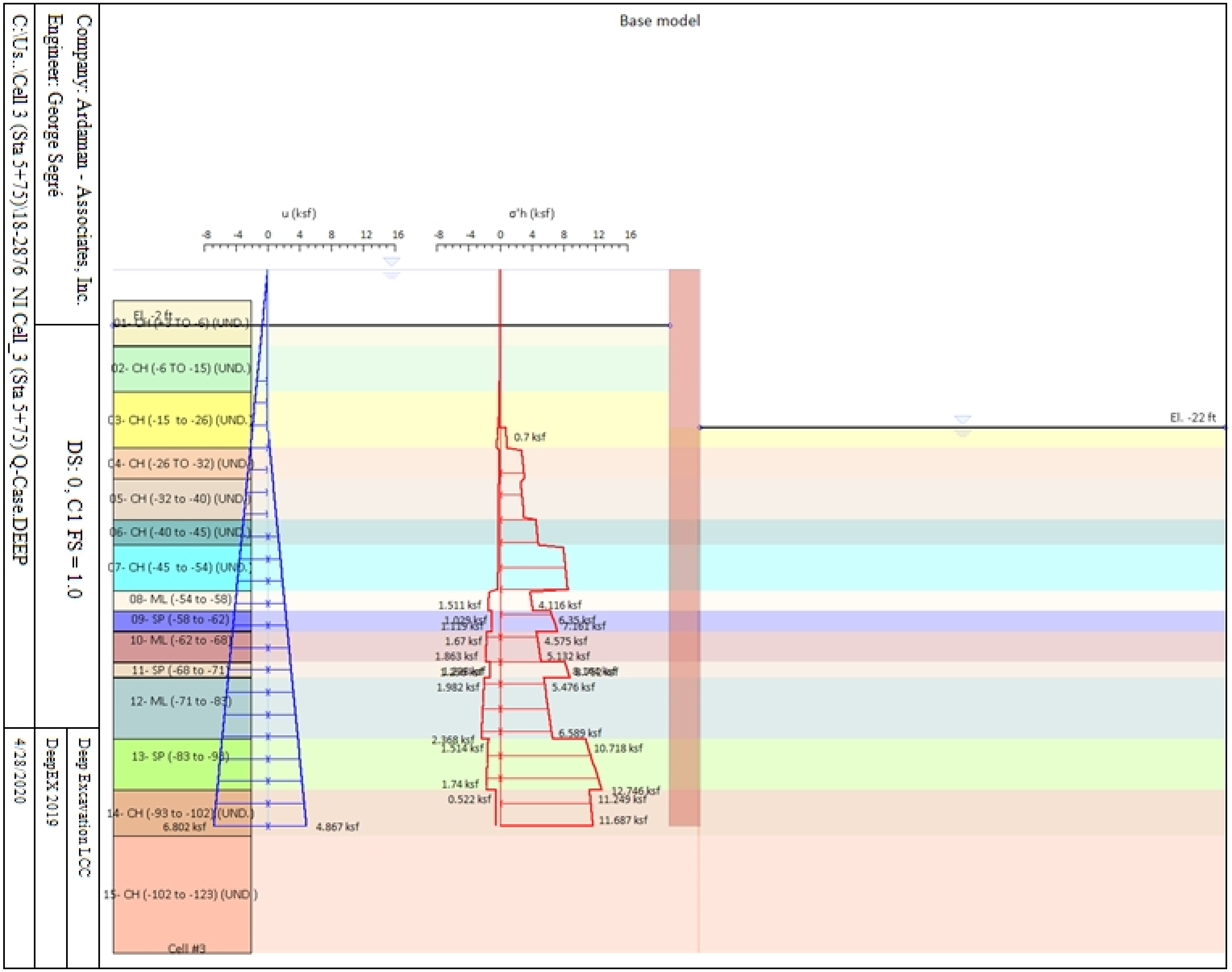
A sequence of figures for each excavation stage is reported

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP

DS: 0, C1 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/28/2020

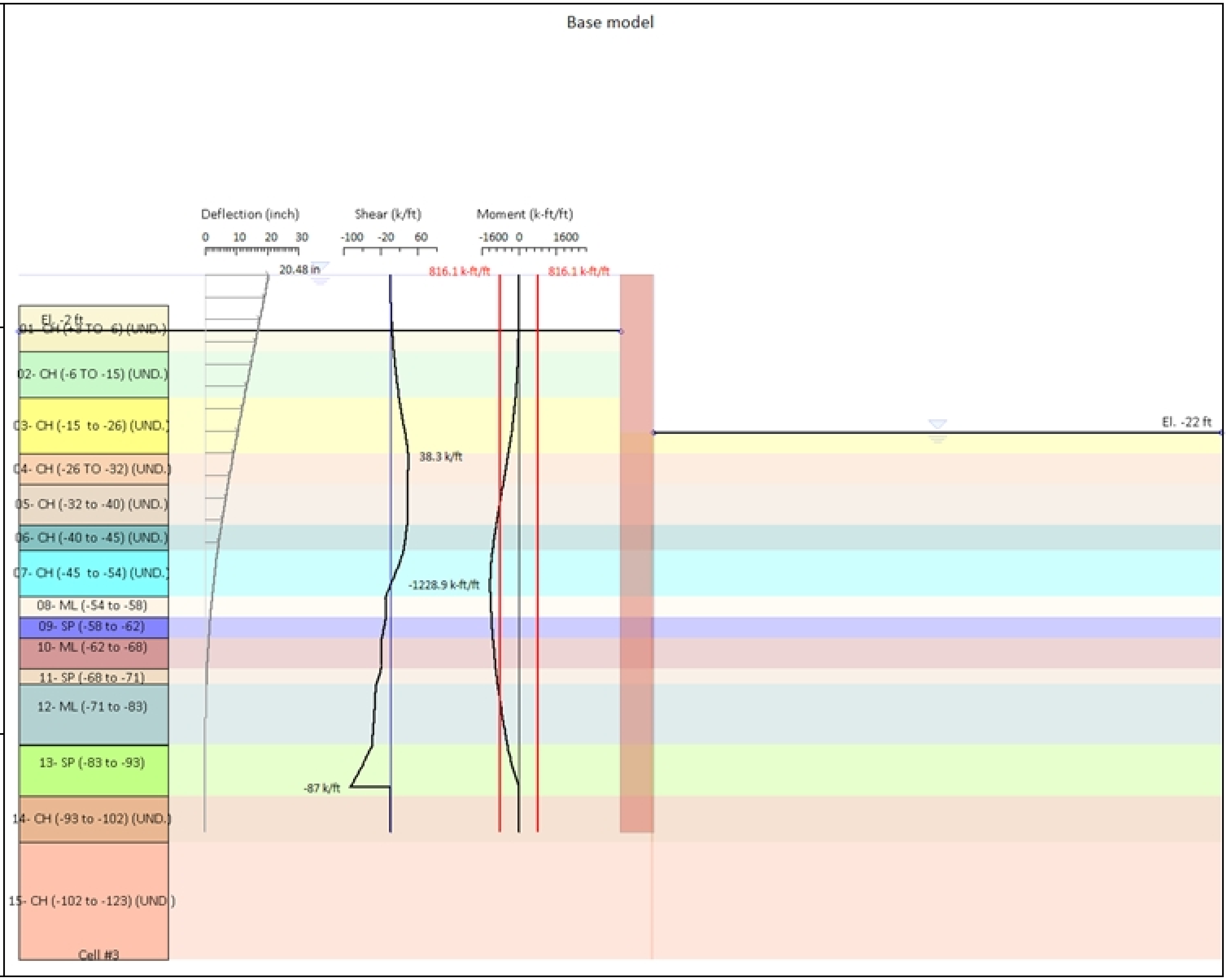



Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C1 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
u (ksf)
σ'h (ksf)
-8 -4 0 4 8 12 16
El. -2 ft
El. -22 ft
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
6.802 ksf
4.867 ksf
0.7 ksf
1.511 ksf
4.116 ksf
6.35 ksf
7.161 ksf
1.67 ksf
4.575 ksf
1.863 ksf
5.132 ksf
1.982 ksf
5.476 ksf
6.589 ksf
2.368 ksf
1.514 ksf
10.718 ksf
1.74 ksf
12.746 ksf
0.522 ksf
11.249 ksf
11.687 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP

DS: 0, C1 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/28/2020



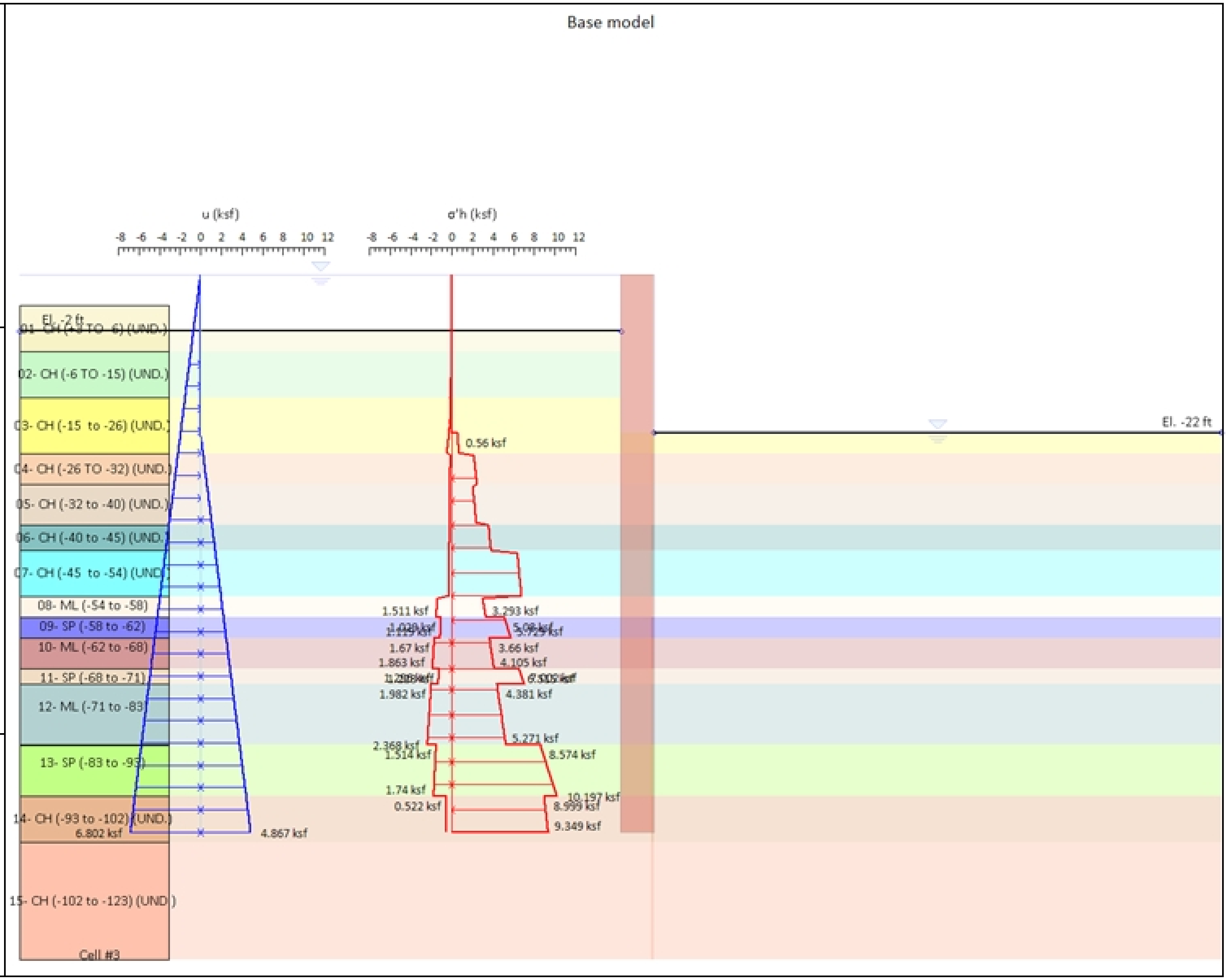
Company: Ardaman - Associates, Inc.
Engineer: George Segré

DS: 0, C1 FS = 1.25

Deep Excavation LCC
DeepEX 2019

C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP

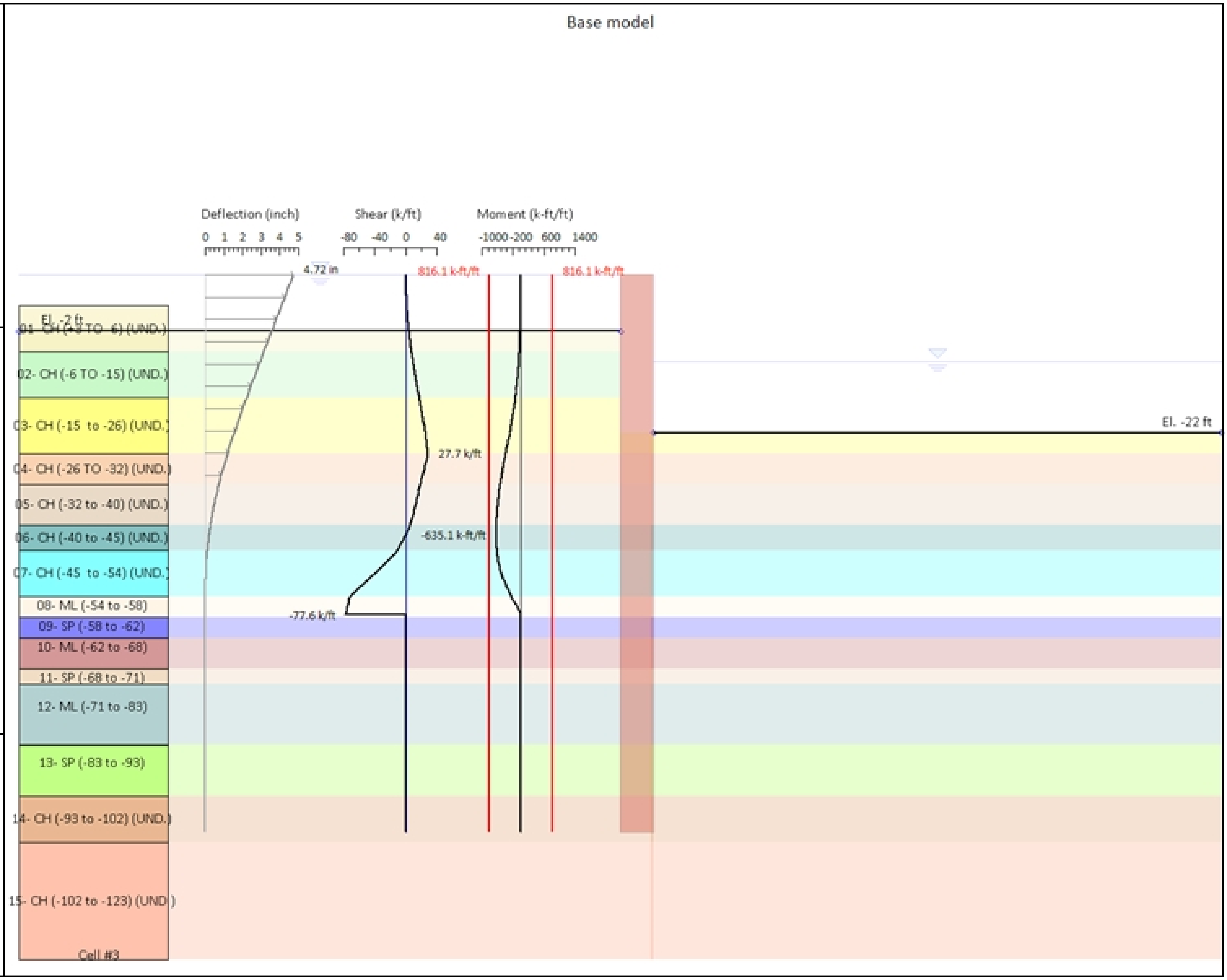
4/28/2020

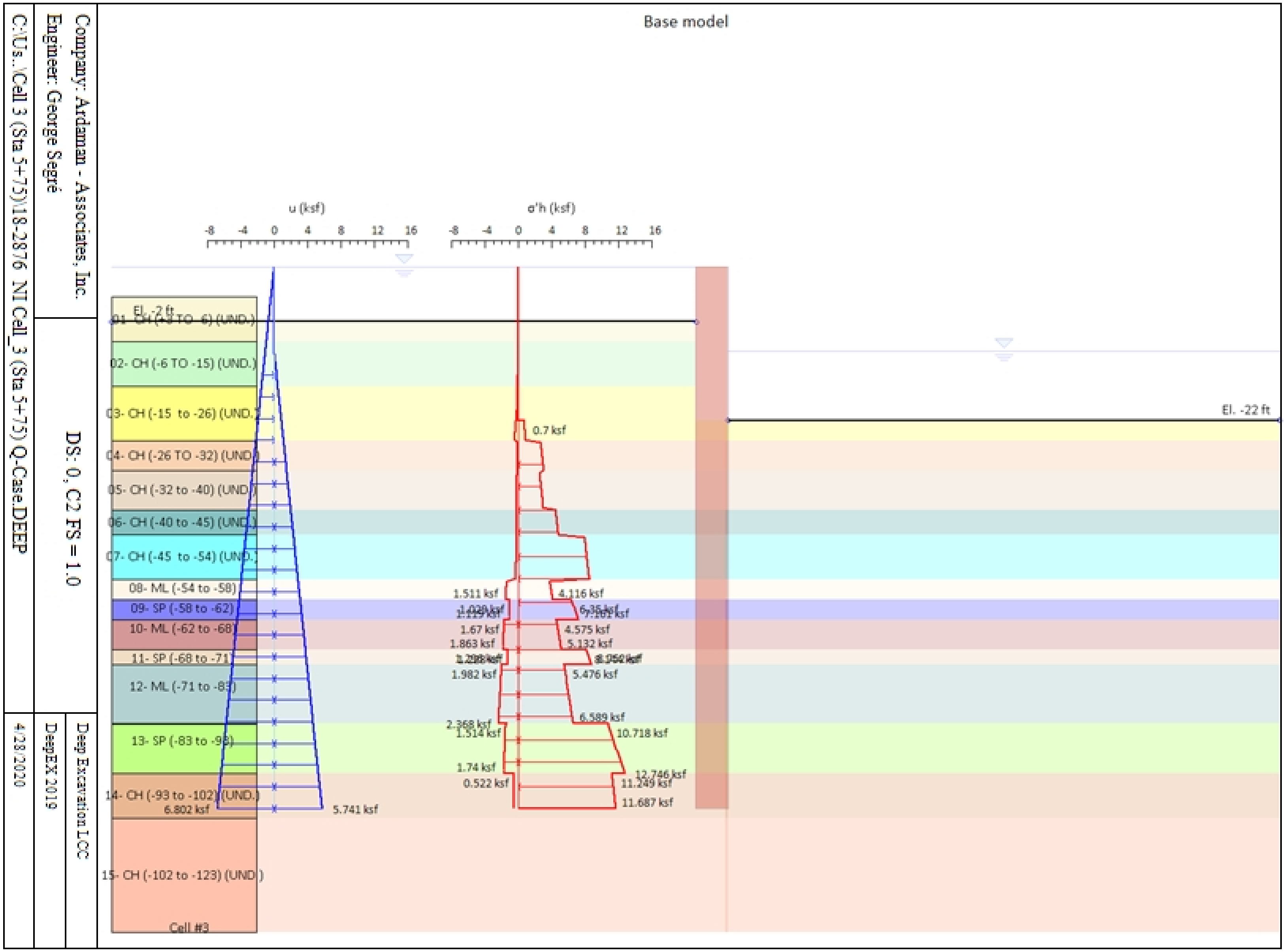


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP

DS: 0, C2 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/28/2020



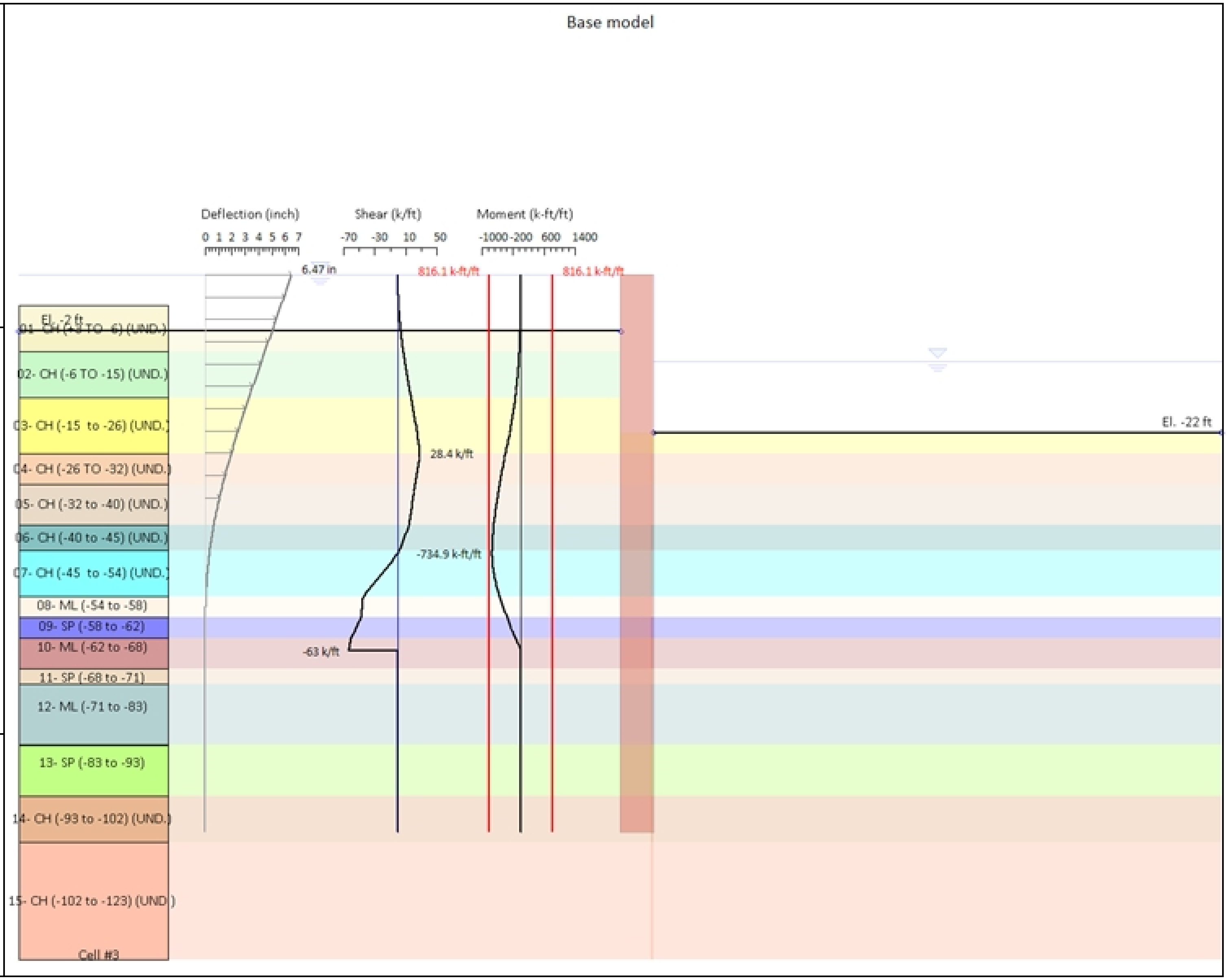


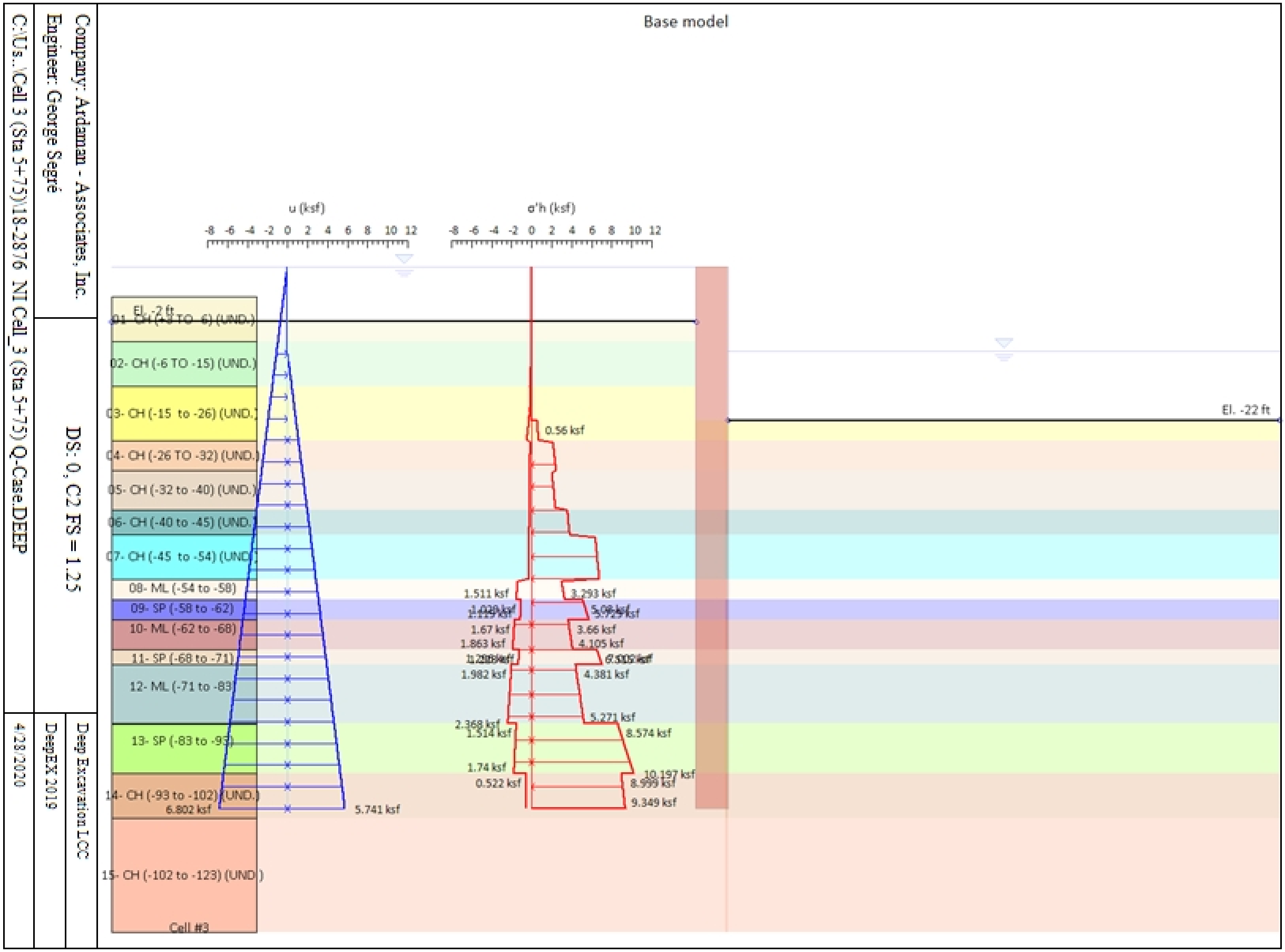
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C2 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
u (ksf)
σ'h (ksf)
-8 -4 0 4 8 12 16
El. -2 ft
01- CH (+8 TO -6) (UND.)
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
El. -22 ft
0.7 ksf
1.511 ksf
4.116 ksf
1.67 ksf
4.575 ksf
1.863 ksf
5.132 ksf
1.982 ksf
5.476 ksf
6.589 ksf
2.368 ksf
1.514 ksf
10.718 ksf
1.74 ksf
12.746 ksf
0.522 ksf
11.249 ksf
11.687 ksf
6.802 ksf
5.741 ksf

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP

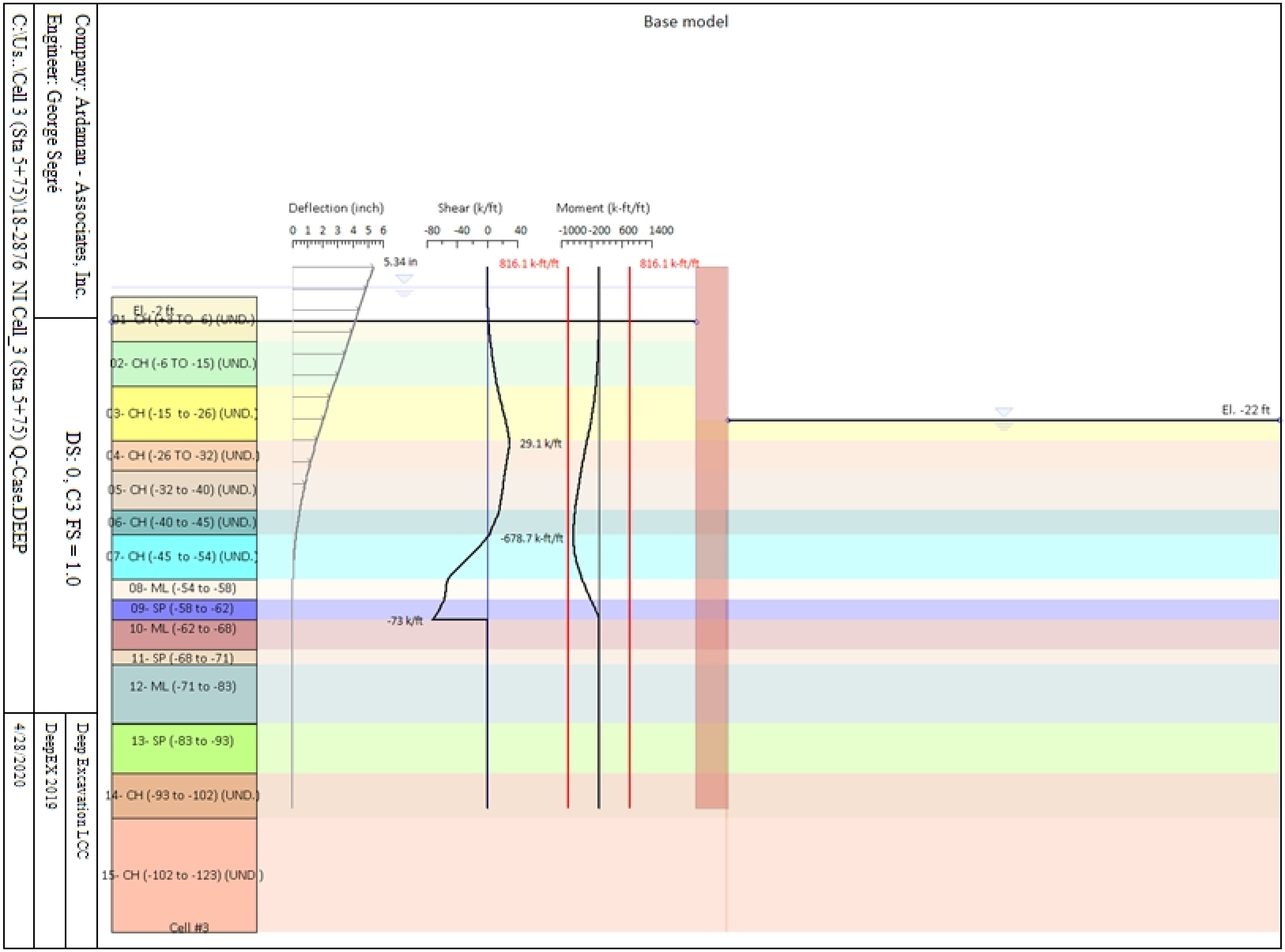
DS: 0, C2 FS = 1.25

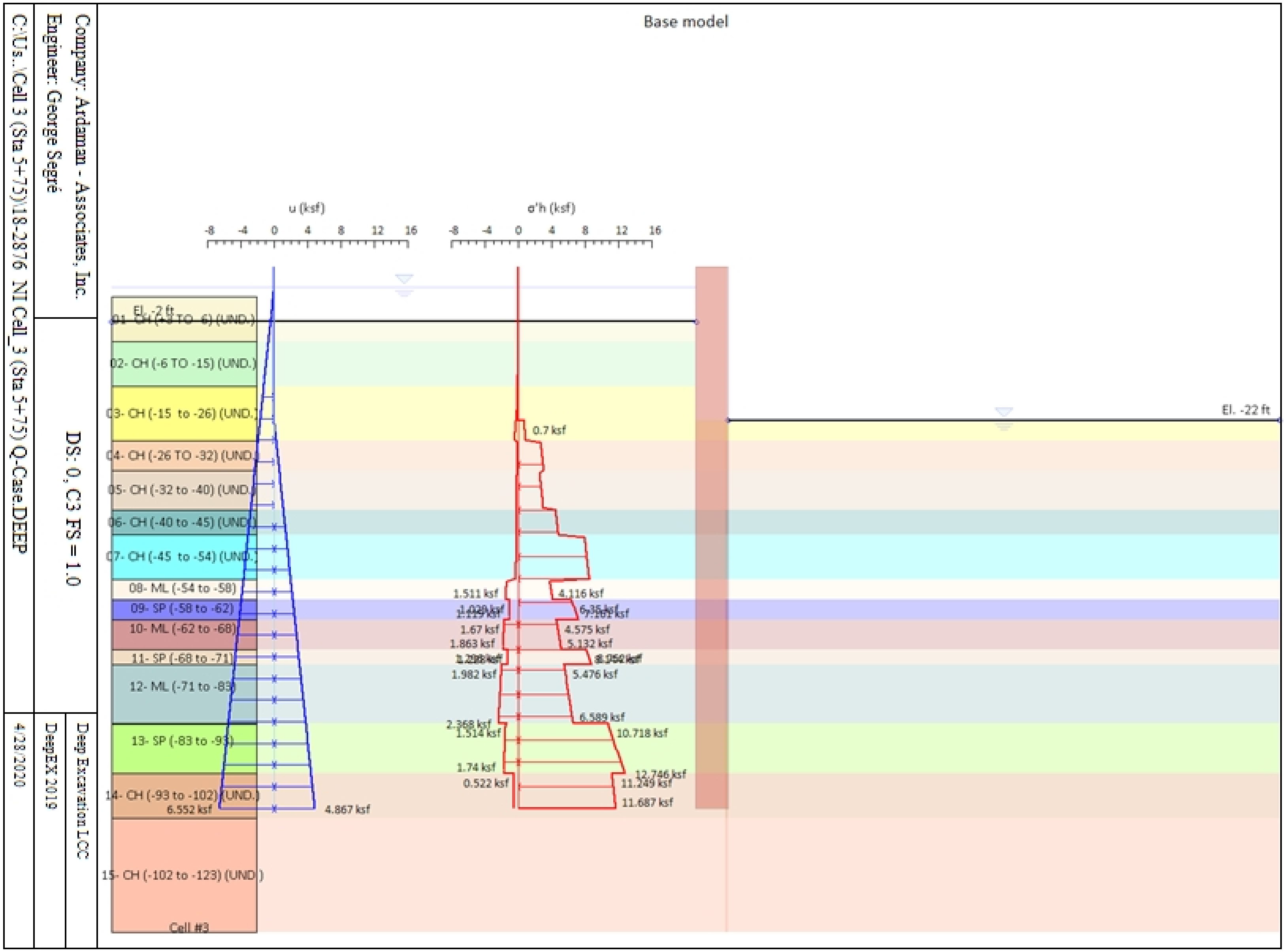
Deep Excavation LCC
DeepEX 2019
4/28/2020



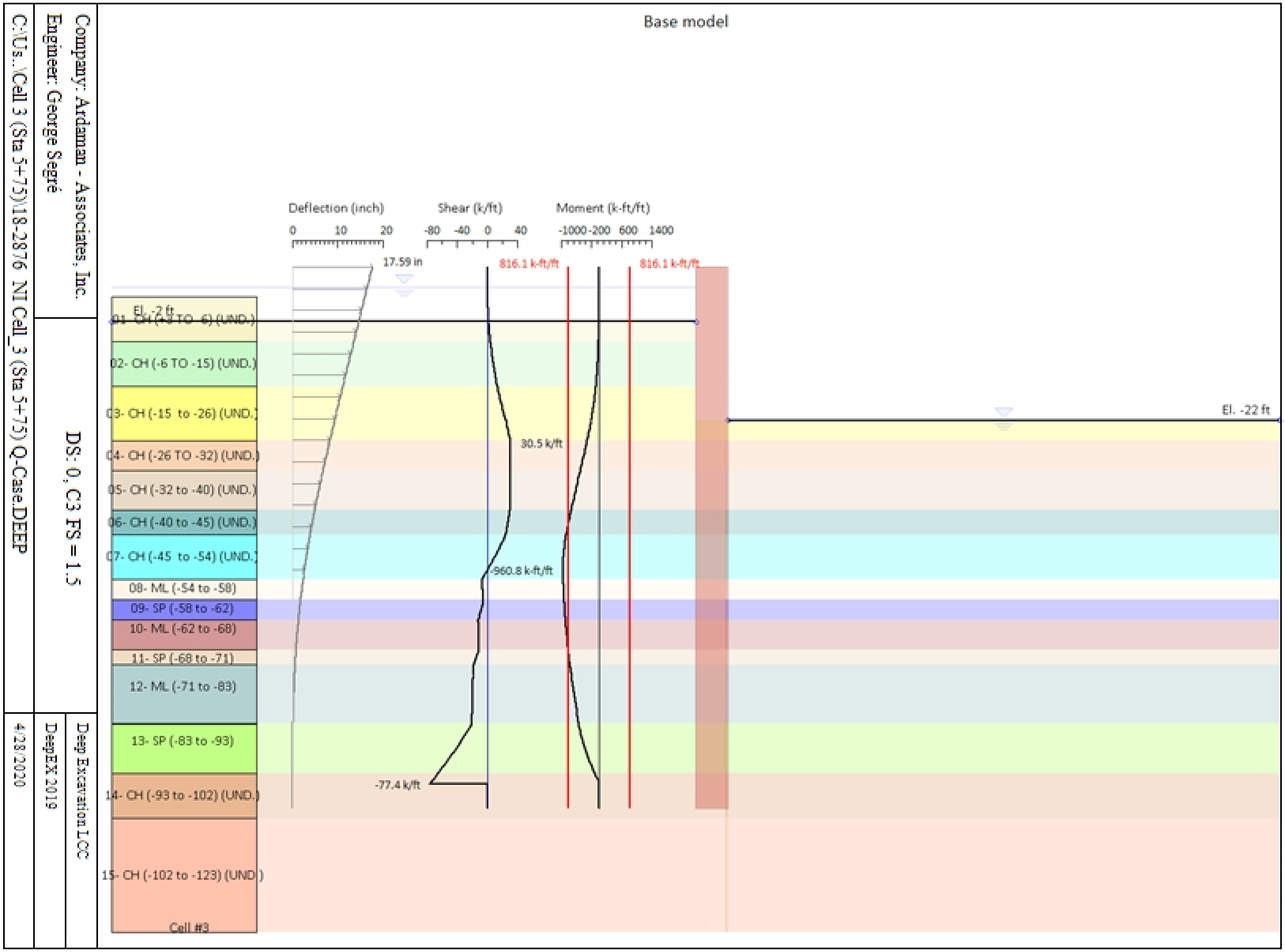


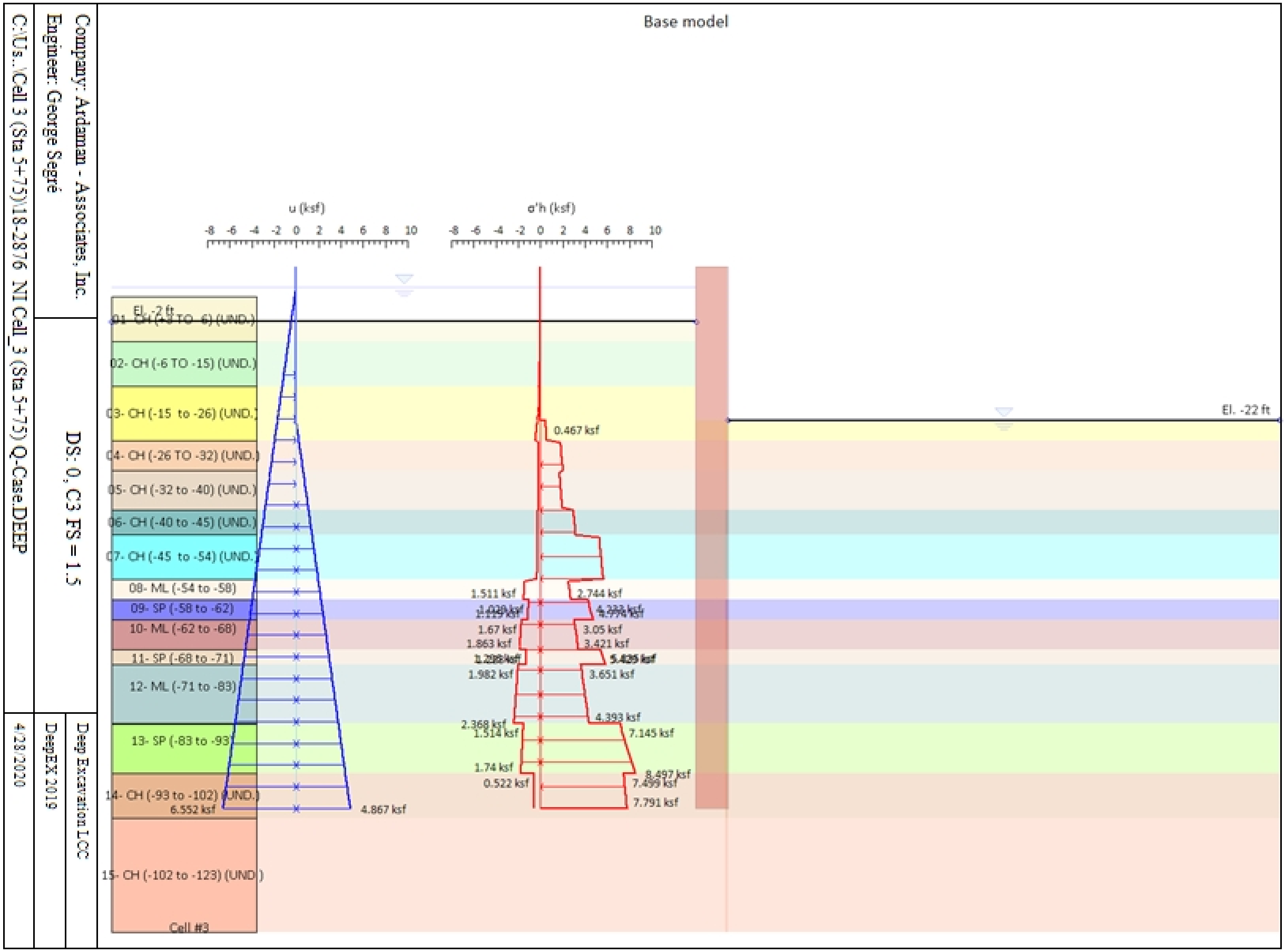
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C2 FS = 1.25
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
u (ksf)
σ'h (ksf)
-8 -6 -4 -2 0 2 4 6 8 10 12
El. -2 ft
01- CH (+3 TO -6) (UND.)
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
El. -22 ft
0.56 ksf
1.511 ksf
3.293 ksf
1.67 ksf
3.66 ksf
1.863 ksf
4.105 ksf
1.982 ksf
4.381 ksf
5.271 ksf
2.368 ksf
1.514 ksf
8.574 ksf
1.74 ksf
10.197 ksf
0.522 ksf
8.999 ksf
9.349 ksf
6.802 ksf
5.741 ksf

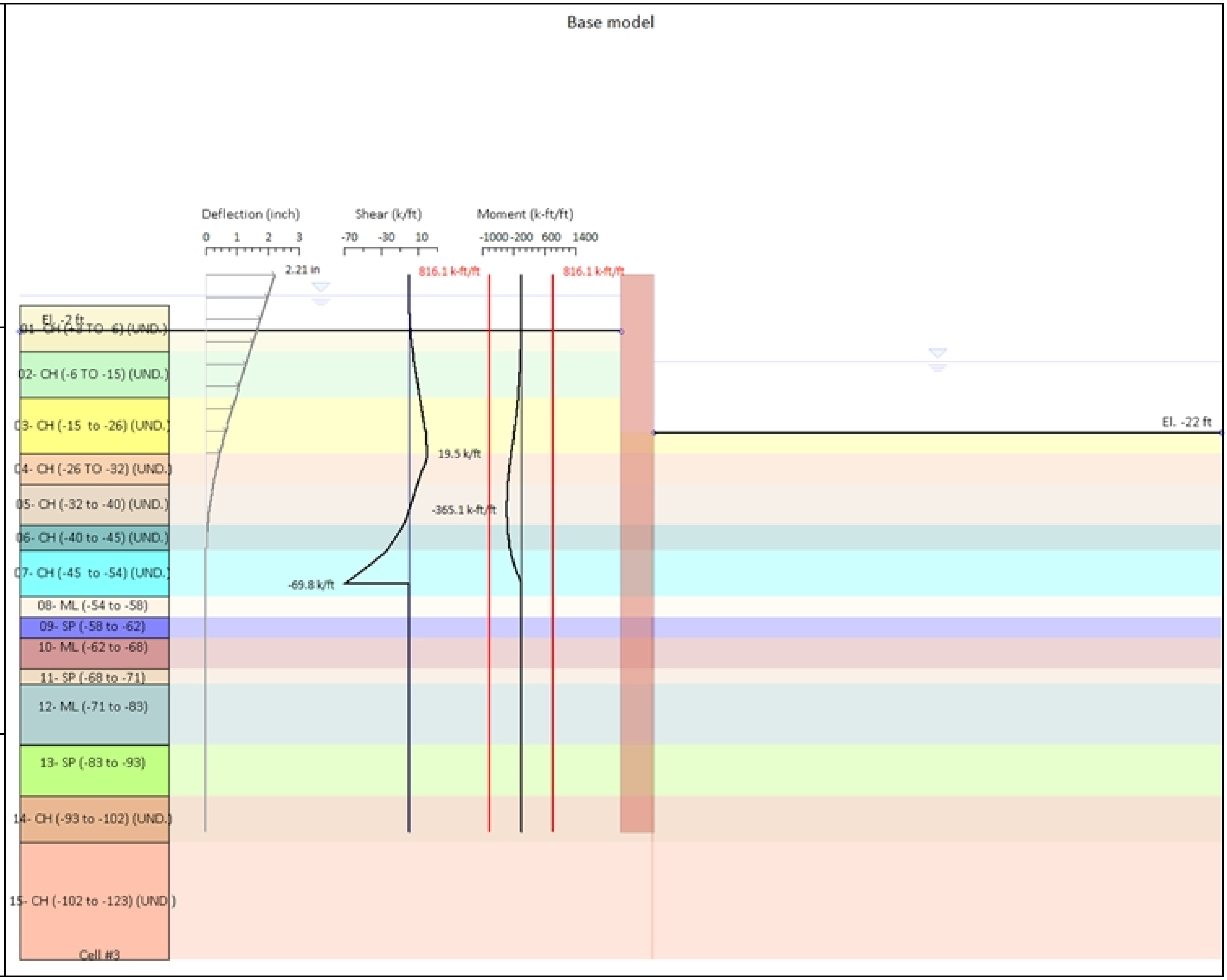

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876_NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C3 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
Deflection (inch)
0 1 2 3 4 5 6
Shear (k/ft)
-80 -40 0 40
Moment (k-ft/ft)
-1000 -200 600 1400
5.34 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -2 ft
01- CH (+8 TO -6) (UND.)
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
29.1 k/ft
-678.7 k-ft/ft
-73 k/ft
El. -22 ft



Base model
u (ksf)
σ'h (ksf)
-8 -4 0 4 8 12 16
El. -2 ft
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
6.552 ksf
4.867 ksf
El. -22 ft
0.7 ksf
1.511 ksf
4.116 ksf
1.67 ksf
4.575 ksf
1.863 ksf
5.132 ksf
1.982 ksf
5.476 ksf
6.589 ksf
2.368 ksf
1.514 ksf
10.718 ksf
1.74 ksf
12.746 ksf
0.522 ksf
11.249 ksf
11.687 ksf
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C3 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/28/2020


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C3 FS = 1.5
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
Deflection (inch)
0
10
20
Shear (k/ft)
-80
-40
0
40
Moment (k-ft/ft)
-1000
-200
600
1400
17.59 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -2 ft
01- CH (+3 TO -6) (UND.)
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
30.5 k/ft
-960.8 k-ft/ft
-77.4 k/ft
El. -22 ft

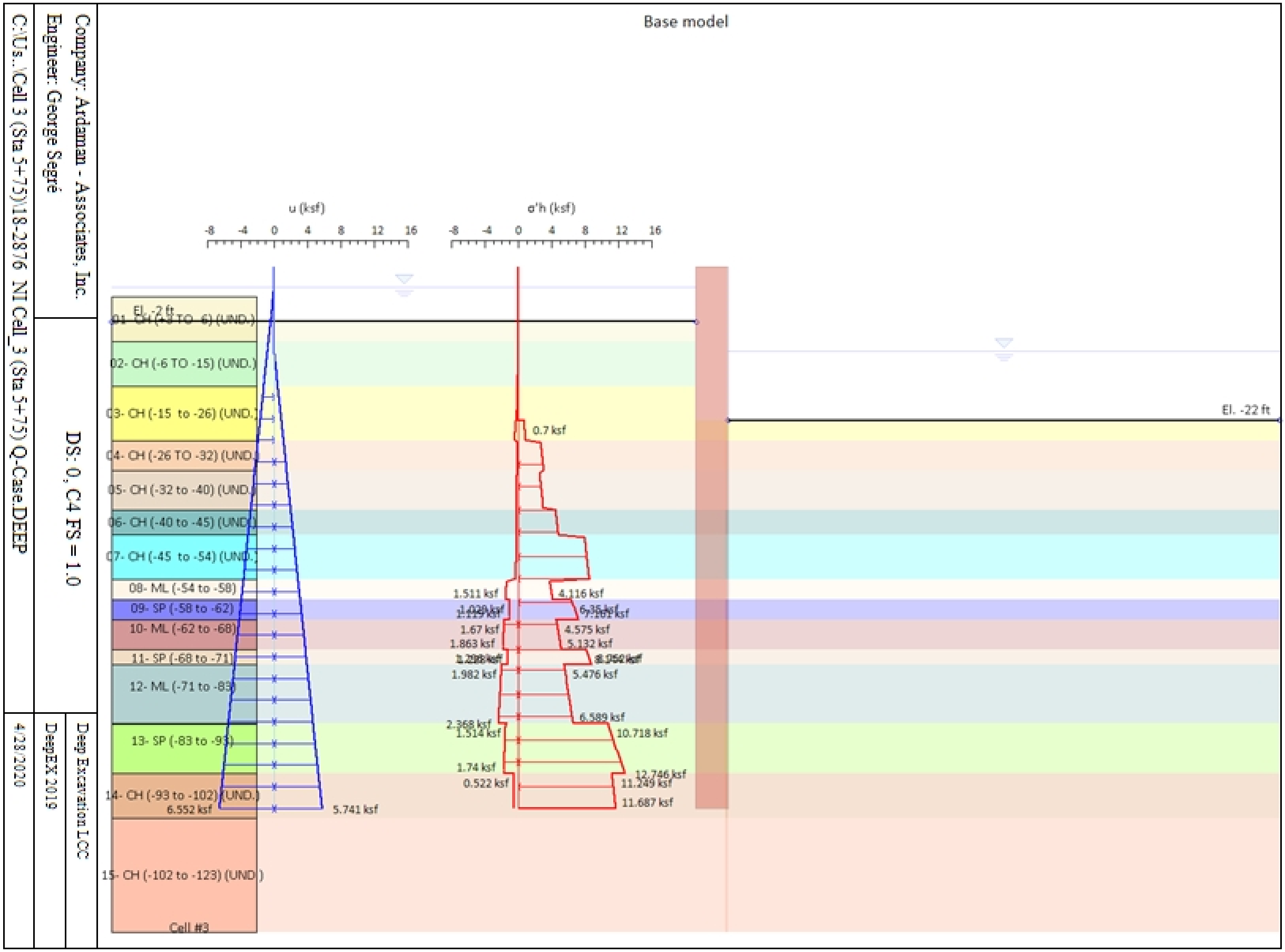

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C3 FS = 1.5
Deep Excavation LLC
DeepEX 2019
4/28/2020
Base model
u (ksf)
σ'h (ksf)
El. -2 ft
El. -22 ft
01- CH (+0 TO -6) (UND.)
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
6.552 ksf
4.867 ksf
0.467 ksf
1.511 ksf
2.744 ksf
1.67 ksf
3.05 ksf
1.863 ksf
3.421 ksf
1.982 ksf
3.651 ksf
4.393 ksf
2.368 ksf
1.514 ksf
7.145 ksf
1.74 ksf
8.497 ksf
0.522 ksf
7.499 ksf
7.791 ksf

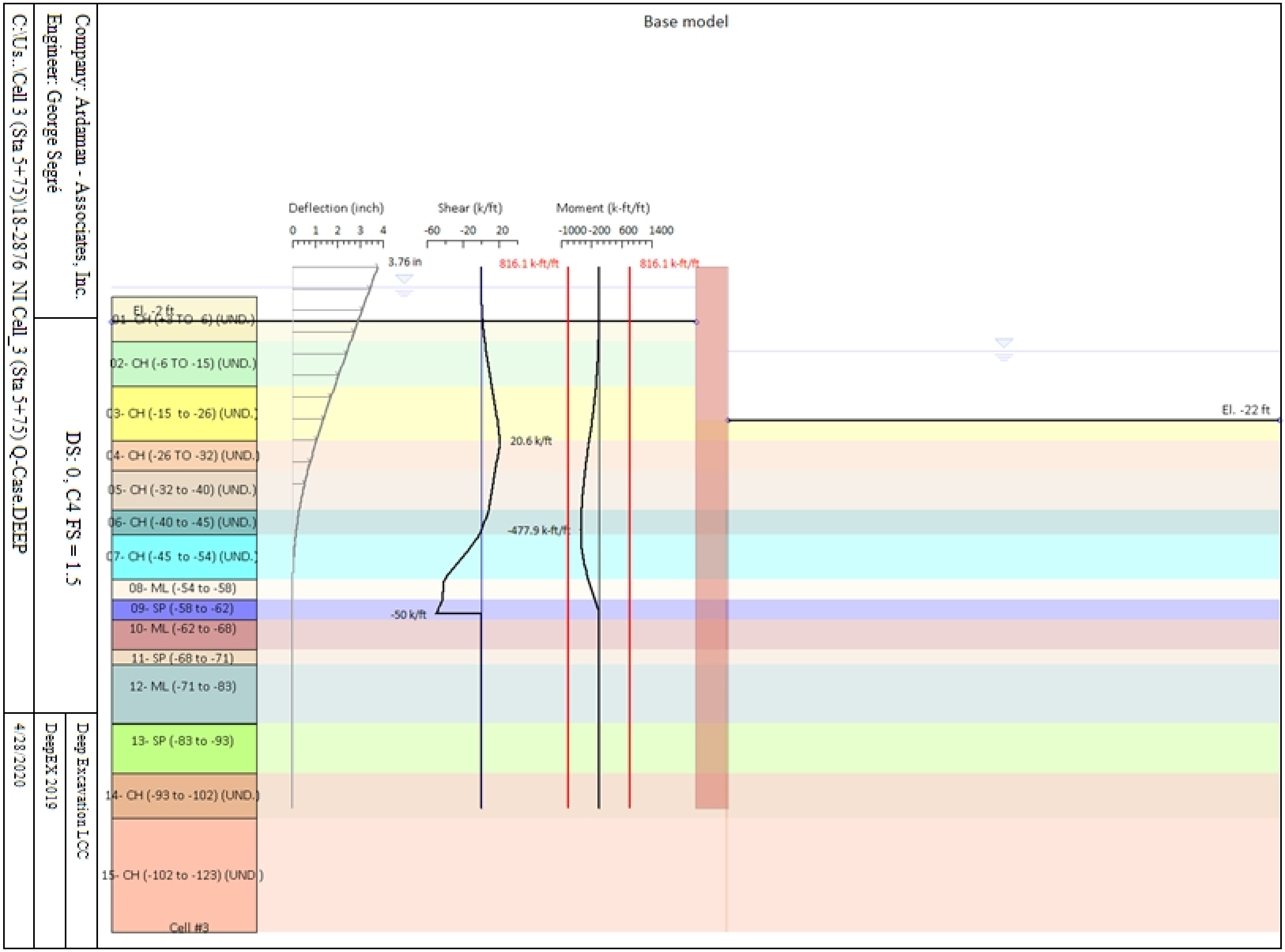


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP

DS: 0, C4 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/28/2020


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C4 FS = 1.0
Deep Excavation LLC
DeepEX 2019
4/28/2020
Base model
u (ksf)
σ'h (ksf)
-8 -4 0 4 8 12 16
El. -2 ft
El. -22 ft
01- CH (+8 TO -6) (UND.)
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
6.552 ksf
5.741 ksf
0.7 ksf
1.511 ksf
4.116 ksf
1.67 ksf
4.575 ksf
1.863 ksf
5.132 ksf
1.982 ksf
5.476 ksf
6.589 ksf
2.368 ksf
1.514 ksf
10.718 ksf
1.74 ksf
12.746 ksf
0.522 ksf
11.249 ksf
11.687 ksf

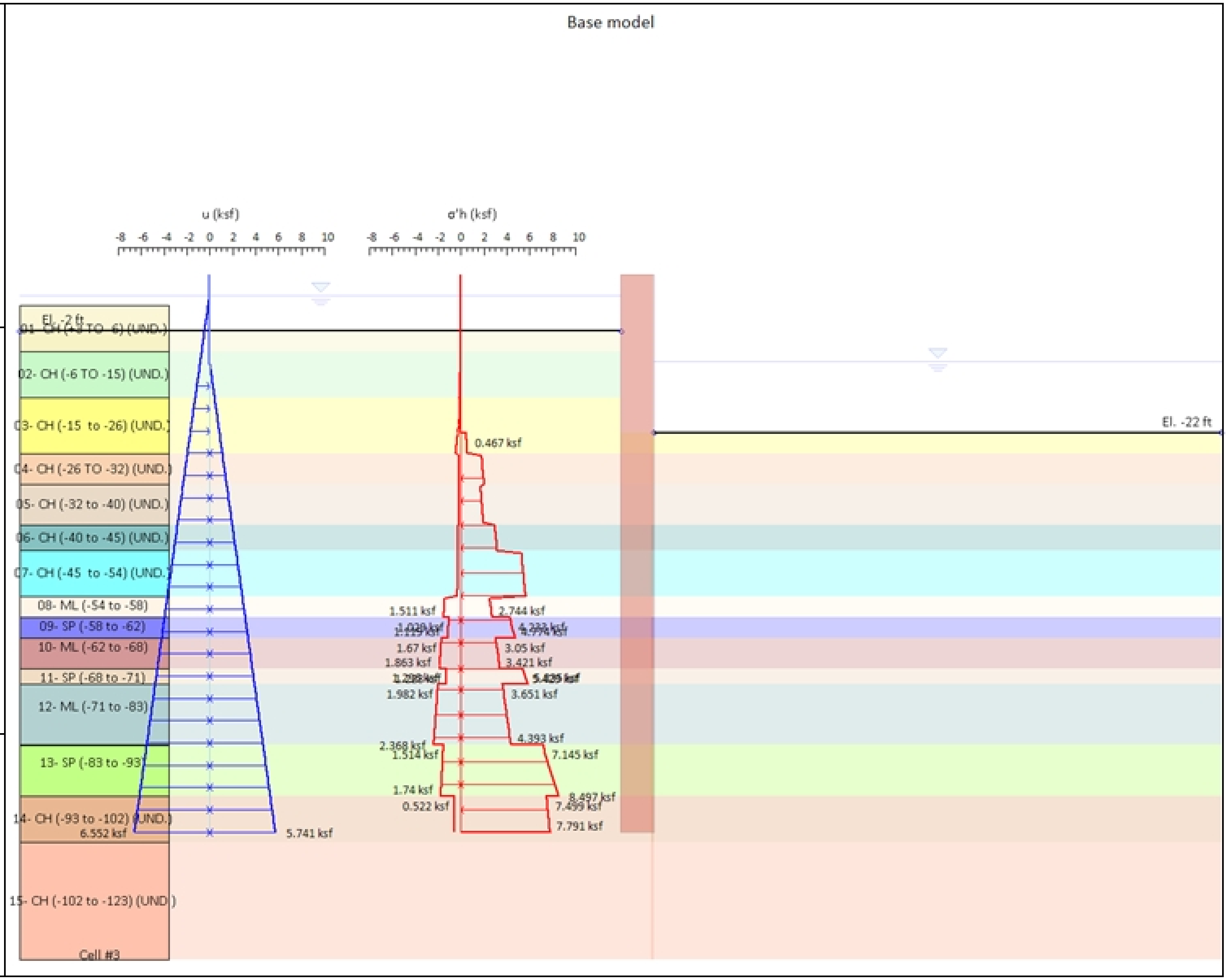

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP
DS: 0, C4 FS = 1.5
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
Deflection (inch)
Shear (k/ft)
Moment (k-ft/ft)
3.76 in
816.1 k-ft/ft
816.1 k-ft/ft
El. -2 ft
01- CH (+8 TO -6) (UND.)
02- CH (-6 TO -15) (UND.)
03- CH (-15 to -26) (UND.)
04- CH (-26 TO -32) (UND.)
05- CH (-32 to -40) (UND.)
06- CH (-40 to -45) (UND.)
07- CH (-45 to -54) (UND.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) (UND.)
15- CH (-102 to -123) (UND.)
Cell #3
20.6 k/ft
-477.9 k-ft/ft
-50 k/ft
El. -22 ft

Company: Ardaman - Associates, Inc.
Engineer: George Segré

C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) Q-Case.DEEP

DS: 0, C4 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/28/2020



26/26

DeepEX 2019: Report Output

Project: San Jacinto Waste Pits

Ardaman & Associates, Inc.

Company: Ardaman - Associates, Inc.
Prepared by engineer: George Segré
File number: 18-2876
Time: 4/28/2020 8:51:50 AM

File: C:\Users\George.Segre\Desktop\Northern Impoundment\Cell 3 Sections\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S -Case.DEEP

STRUCTURAL MATERIALS DATA

Steel

Name	Strength Fy	Fu	Elastic E	Density g
	(ksi)	(ksi)	(ksi)	(kcf)
A36	36	58	29000	0.49
A50	50	72.5	29000	0.49

Concrete

Name	Strength Fc'	Elastic E	Density g	Tension Strength Ft
	(ksi)	(ksi)	(kcf)	(% of Fc')
Fc 3ksi	3	3122	0.15	10
Fc 4ksi	4	3605	0.15	10
Fc 5ksi	5	4031	0.15	10
Fc 6ksi	6	4415	0.15	10

Steel rebar

Name	Strength Fy	Elastic E
	(ksi)	(ksi)
Grade 60	60	29000
Grade 75	75	29000
Grade 80	80	29000
Grade 150	150	29000
Strands 270 ksi	270	29000
S410	59.4	30434.8
S500	72.5	30434.8
B450C	65.2	30434.8

Wood

Name	Ultimate Bending Srtength Fbu	Ultimate Tensile Strength Ftu	Ultimate Shear Strength Fvu	Density g	Elastic E
	(ksi)	(ksi)	(ksi)	(kcf)	(ksi)
Construction Timb	1.6	1.4	0.8	0.05	1000
Regular grade	1	1	0.6	0.05	800

STEEL
Name=material name
fy=fyk= characteristc resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
CONCRETE
Name=material name
f'c=fck= cylindrical resistance for concrete (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
Tension strength=ft=fctk= characteristic tension resistance for concrete
STEEL REBARS
Name=material name
fy=fyk= characteristic resistance for steel (for all the codes)
Fu=fuk= ultimate resistence for steel (for all the codes)
Elastic E= Elastic modulus
Density g= specific weight
WOOD
Name=material name
Fb=fbk= Ultimate bending strength
Ftu=ftuk= Ultimate tensile strength

Fvu=fvuk= Ultimate shear strength
Density g= specific weight
Elastic E= Elastic modulus

Project: San Jacinto Waste Pits
Results for Design Section 0: Base model

SOIL DATA

Name	g tot	g dry	Frict	C'	Su	FRp	FRcv	Eload	rEur	kAp	kPp	kAcv	kPcv	Vary	Spring	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(deg)	(deg)	(ksf)	(-)	NL	NL	NL	NL		Model	
01- CH (+3 TO	115	115	23	0	500	23	23	300	3	0.44	2.28	0.44	2.28	True	EXP	
02- CH (-6 TO	110	110	23	0	250	18	26	60	3	0.33	3	0.39	2.56	True	Linear	
03- CH (-15 t	110	110	23	0	350	23	23	150	3	0.44	2.28	0.44	2.28	True	Linear	
04- CH (-26 T	124	124	26	0	1250	26	26	521.92	3	0.39	2.56	0.39	2.56	True	Linear	
05- CH (-32 to	120	120	26	0	1000	21.1	30	417.54	3	0.47	2.12	0.33	3	True	Linear	
06- CH (-40 to	125	125	26	0	1730	26	26	626.3	3	0.39	2.56	0.39	2.56	True	Linear	
07- CH (-45 t	125	125	26	0	3300	26	26	300	3	0.39	2.56	0.39	2.56	True	Linear	
08- ML (-54 t	117	117	28	0	N/A	N/A	N/A	300	3	0.36	2.77	N/A	N/A	True	Linear	
09- SP (-58 to	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
10- ML (-62 t	117	117	28	0	N/A	N/A	N/A	300	3	0.36	2.77	N/A	N/A	True	Linear	
11- SP (-68 to	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
12- ML (-71 t	117	117	28	0	N/A	N/A	N/A	300	3	0.36	2.77	N/A	N/A	True	Linear	
13- SP (-83 to	130	130	30	0	N/A	N/A	N/A	300	3	0.33	3	N/A	N/A	True	Linear	
14- CH (-93 to	125	125	26	0	3500	26	26	300	3	0.39	2.56	0.39	2.56	True	Linear	
15- CH (-102 t	125	125	26	0	4000	26	26	300	3	0.39	2.56	0.39	2.56	True	Linear	

Name	Poisson	Min Ka	Min sh	ko.NC	nOCR	aH.EXP	aV.EXP	qSkin	qNails	kS.nails	PL
	v	(clays)	(clays)	-	-	(0 to 1)	(0 to 1)	(psi)	(psi)	(k/ft3)	(ksi)
01- CH (+3 TO	0.4	0.1	0	0.609	0.5	1	0	7.2	4.8	20	-
02- CH (-6 TO	0.3	0.1	0	0	0.5	-	-	5.1	3.4	20	-
03- CH (-15 t	0.4	0.1	0	0.609	0.5	-	-	13	8.7	20	-
04- CH (-26 T	0.35	0.1	0	0.562	0.5	-	-	21.8	14.5	30	-
05- CH (-32 to	0.45	0.1	0	0	0.5	-	-	18.1	12.1	30	-
06- CH (-40 to	0.35	0.1	0	0.562	0.5	-	-	29	19.3	70	-
07- CH (-45 t	0.35	0.1	0	0.562	0.8	-	-	0	0	0	-
08- ML (-54 t	0.3	-	-	0.531	0.8	-	-	0	0	0	-
09- SP (-58 to	0.25	-	-	0.5	0.8	-	-	0	0	0	-
10- ML (-62 t	0.35	-	-	0.531	0.8	-	-	0	0	0	-
11- SP (-68 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
12- ML (-71 t	0.35	-	-	0.531	0.8	-	-	0	0	0	-
13- SP (-83 to	0.35	-	-	0.5	0.8	-	-	0	0	0	-
14- CH (-93 to	0.35	0.1	0	0.562	0.8	-	-	0	0	0	-
15- CH (-102 t	0.35	0.1	0	0.562	0.8	-	-	0	0	0	-

gtot = total soil specific weight
gdry = dry weigth of the soil
Frict = friction angle
C' = effective cohesion
Su = Undrained shear strength (only for CLAY soils in undrained conditions, used as a cutoff strength in NL analysis)
Evc = Virgin compression elastic modulus
Eur = unloading/reloading elastic modulus
Kap = Peak active thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kpp = Peak passive thrust coefficient (initial value, may be modified on each stage according to analysis settings).
Kacv = Constant volume active thrust coeff (only for clays, initial value)
Kpcv = Constant volume passive thrust coeff (only for clays, initial value).
Spring models= spring model (LIN= constant E over the soil layer height , EXP=exponential , SIMC=simplified winkler)
LIN= Linear-Elastic-Perfectly Plastic,
EXP: Exponential, SUB: Modulus of Subgrade Reaction

SIMC= Simplified Clay mode

SOIL BORINGS

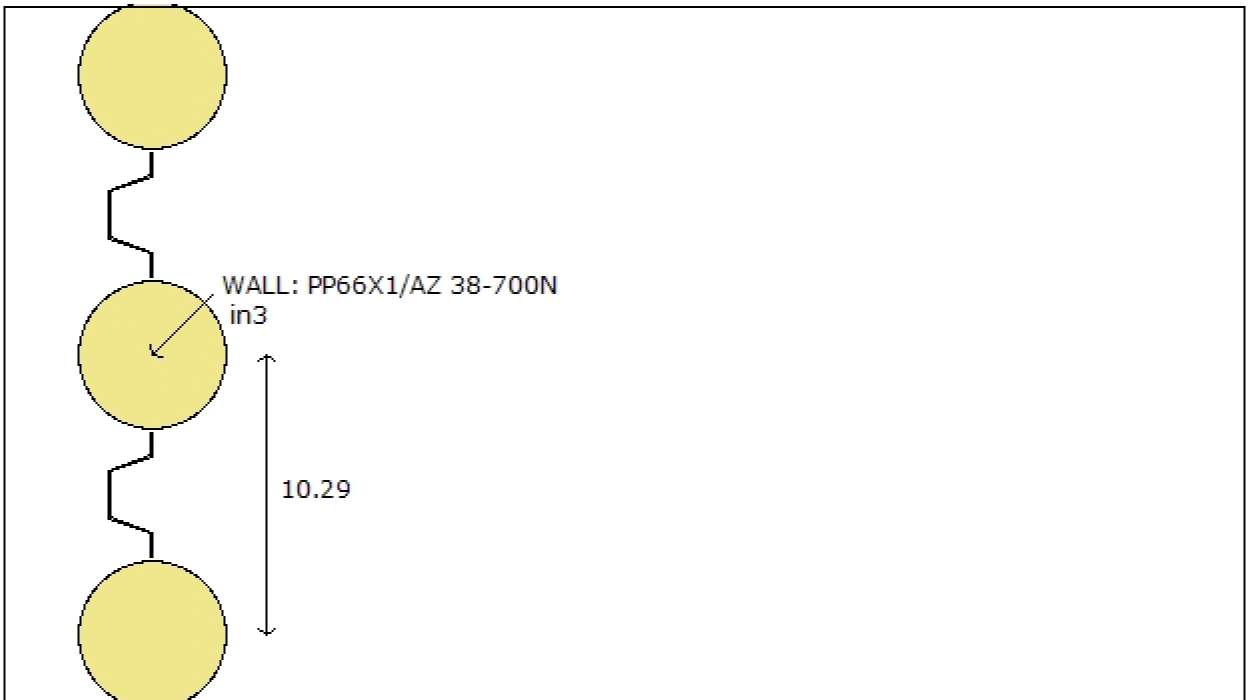
Top Elev= superior SOil level
Soil type= type of the soil (sand , clay , etc)
OCR= overconsolidation ratio
K0= at rest coefficient

Name: Cell #3, pos: (-100, 0)

Top elev.	Soil type	OCR	Ko
3	01- CH (+3 TO	1	0.61
-6	02- CH (-6 TO -	1	0
-15	03- CH (-15 to	1	0.61
-26	04- CH (-26 TO	1	0.56
-32	05- CH (-32 to	1	0
-40	06- CH (-40 to	1	0.56
-45	07- CH (-45 to	1	0.56
-54	08- ML (-54 to	1	0.53
-58	09- SP (-58 to -	1	0.5
-62	10- ML (-62 to	1	0.53
-68	11- SP (-68 to -	1	0.5
-71	12- ML (-71 to	1	0.53
-83	13- SP (-83 to -	1	0.5
-93	14- CH (-93 to	1	0.56
-102	15- CH (-102 t	1	1

WALL DATA

Wall section 0: Wall 1



Company: Ardaman - Associates, Inc. Engineer: George Segré	Wall sketch	Deep Excavation LCC DeepEX 2019
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP		4/28/2020

Wall type: Combined sheet pile wall
Top wall El: 9 ft   Bottom wall El: -131 ft
Hor. wall spacing: 10.29 ft   Wall thickness = 5.5 ft
Passive width below exc: 10.29 ft   Active width below exc: 10.29 ft Swater= 10.29 ft
Steel members fy = 50 ksi   Esteel = 29000 ksi
Wall friction: Ignored
Steel wall capacities are calculated with AISC 360-16 ALL.
Concrete capacities are calculated with ACI 318-11
Note: With ultimate capacities you may have to use a structural safety factor.
Steel sheet pile properties

Table: Steel Sheet Pile Cross Sectional Properties

DES	Sheet	Piles	A	Ixx	Sxx	Pile A	Pile Ixx	Pile Sxx	Pile D	Pile bf	Pile tf	Pile tw
			(in2/ft)	(in4/ft)	(in3/ft)	(in^2)	(in4)	(in3)	(in)	(in)	(in)	(in)
PA 60/19-700	AZ 38-700N	PP60X0.62	25.1	10793	327.1	204.2	107870.5	3268.8	66		1	

GENERAL WALL DATA
Hor wall spacing= Wall horizontal spacing
Passive width below exc= spacing for passive thrust pressure for classic analysis
f'c=fck= cylindrical concrete resistance
fyk=fy= steel rebar characteristic resistance
Econc= Concrete Elastic modulus
fctk= characteristic Concrete tension
Esteel= steel elastic modulus
TABULAR DATA (principal parameters)
1) Diaphragm wall (rectangular cross section)
N/A= data not available
Fy=fyk

F'c=fck
D=wall thickness
B=wall width
2)Steel sheet pile
DES=shape (Z or U)
W=width per unit of length
A=area
h=height
t=horizontal part thickness
b=width of the single sheet pile part
s=inclined part thickness
Ixx=strong axis inertia (per unit of length)
Sxx=strong axis section modulus (per unit of length)
3)Secant piles wall, Tangent piles wall, soldier piles, soldier piles and timber lagging
W=weight per unit of length
A=area
D=diameter
tw=web thickness
tp= pipe thickness
bf=flange width
tf= flange thickness
k= flange thickness+stem base height
Ixx= strong axis inertia modulus (per unit of length)
Sxx= strong axis section modulus (per unit of length)
rx=radius of gyration about X axis
ry=radius of gyration about Y axis
Iyy=weak axis inertia modulus (per unit of length)
Syy=weak axis section modulus (per unit of length)
rT=radius of gyration for torsion
Cw= warping constant

GENERAL ANALYSIS CRITERIA

Summary of stage assumptions

Name	Analysis	Drive	ka-Mult	Htr T/B	Resist	Res	Contle
	Method	Press		(%)	Press	Mult	Method
Stage 0	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 1	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 2	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 3	Conventional	Ka	N/A	N/A	Kp/M	1.25	Free Earth
Stage 4	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 5	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth
Stage 6	Conventional	Ka	N/A	N/A	Kp/M	1	Free Earth
Stage 7	Conventional	Ka	N/A	N/A	Kp/M	1.5	Free Earth

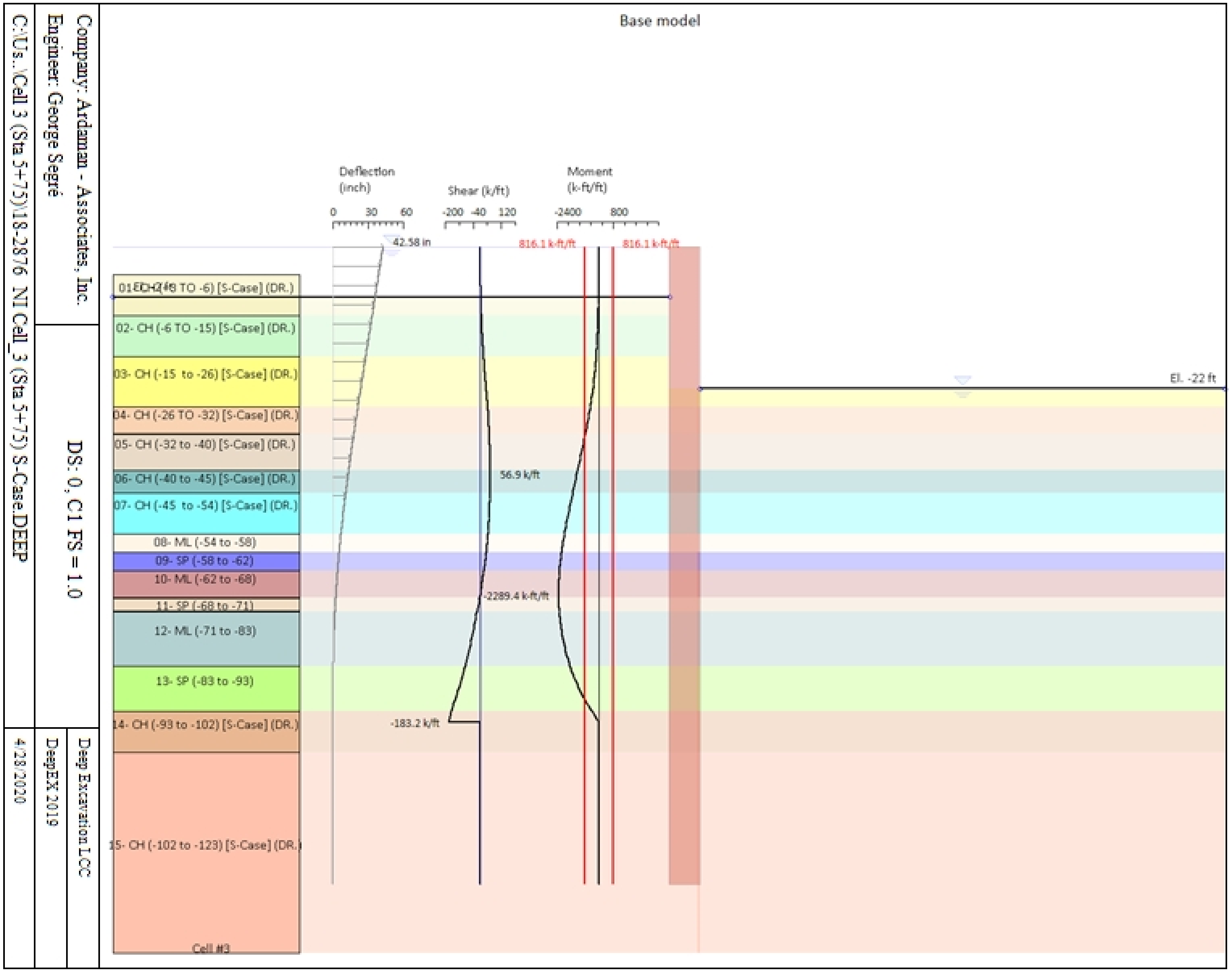
Name	Support	Axial	Used	Min Toe	Toe	Toe
	Model	Incl	FSwall	FDtoe	FSrot	FSpas
Stage 0	Simple span	N/A	1.6	1.487	1.542	2.251
Stage 1	Simple span	N/A	1.6	1.229	1.234	1.801
Stage 2	Simple span	N/A	1.6	1.86	2.09	2.972
Stage 3	Simple span	N/A	1.6	1.594	1.672	2.378
Stage 4	Simple span	N/A	1.6	1.644	1.724	2.453
Stage 5	Simple span	N/A	1.6	1.15	1.15	1.635
Stage 6	Simple span	N/A	1.6	2.141	2.439	3.335
Stage 7	Simple span	N/A	1.6	1.594	1.626	2.223

Name=excavation stage name
Analysis method
springs = Elastoplastic spring analysis used
DR = Drained condition for CLAY model
U = Undrained condition for CLAY model for all the soils
Up = Undrained condition just for selected soil
Limit equilibrium analysis settings
Drive press:
Ka (Active pressure diagram), Ka-Trap = Trapezoid apparent diagram from active pressures x multiplier,
FHWA= Federal Highway Administration apparent pressure diagrams.
Ko = At-rest lateral earth pressures.
Peck = Peck 1969 Apparent earth pressure diagrams.
2 Step rect = Two step rectangular apparent earth pressure diagram.
User def. = User defined apparent earth pressure diagram.
Ka+d (and so on) indicates that wall friction is applied
ka mult = multiplication factor for Ka when Ka-Trap is selected
Htr T/B (%) = trapezoidal pressure scheme, top and bottom triangular percentage of excavation depth H
Resit press = Kp (passive earth pressures)
Res Mult = Safety factor applied directly on resisting pressures (
COntle Method = cantilever analysis method for limit equilibrium analysis.
Support Model: Method for calculating support reactions in limit-equlibrium analysis.
Beam= support reactions beam analysis (uses Blum's method).
Trib= support reactions from tributary height calculations (Can be applied with apparent diagrams).
Axial Incl = Axial loads included for structural design

Used FS wall = Safety factor for axial+bending wall resistance to divide ultimate wall capacities.
Min FD Toe= embedded minimum safety factor (for limit equilibrium analysis)
Toe FS rot= rotation safety factor (classic for limit equilibrium analysis)
Toe FSpas= driving/resisting pressure safety factor (for limit equilibrium analysis)

EXCAVATION STAGES SKETCHES

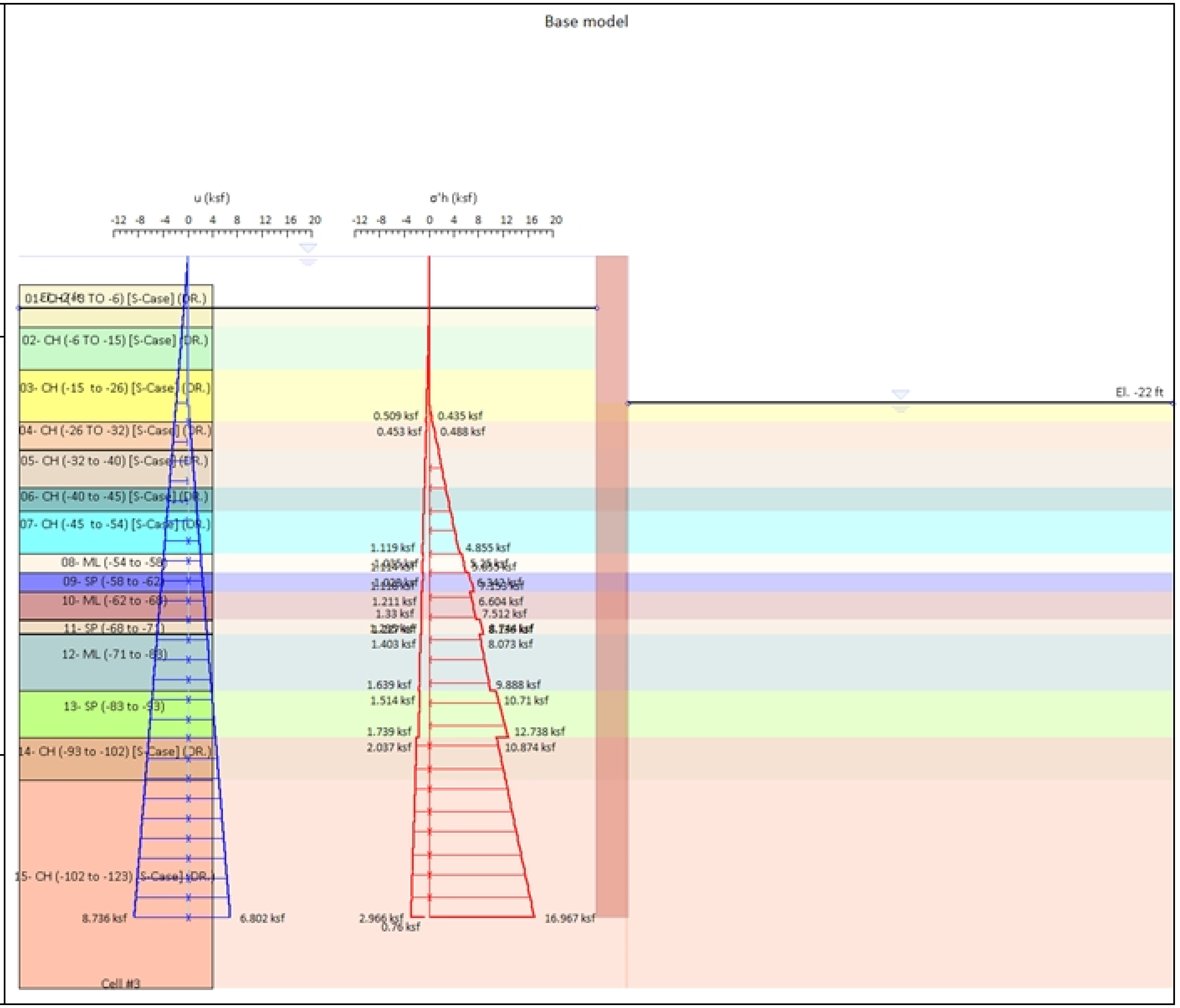
A sequence of figures for each excavation stage is reported


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us...\Cell 3 (Sta 5+75)18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP
DS: 0, C1 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
Deflection
(inch)
0
30
60
Shear (k/ft)
-200
-40
120
Moment
(k-ft/ft)
-2400
800
42.58 in
816.1 k-ft/ft
816.1 k-ft/ft
56.9 k/ft
-2289.4 k-ft/ft
-183.2 k/ft
El. -22 ft
02- CH (-6 TO -15) [S-Case] (DR.)
03- CH (-15 to -26) [S-Case] (DR.)
04- CH (-26 TO -32) [S-Case] (DR.)
05- CH (-32 to -40) [S-Case] (DR.)
06- CH (-40 to -45) [S-Case] (DR.)
07- CH (-45 to -54) [S-Case] (DR.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) [S-Case] (DR.)
15- CH (-102 to -123) [S-Case] (DR.)
Cell #3

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP

DS: 0, C1 FS = 1.0

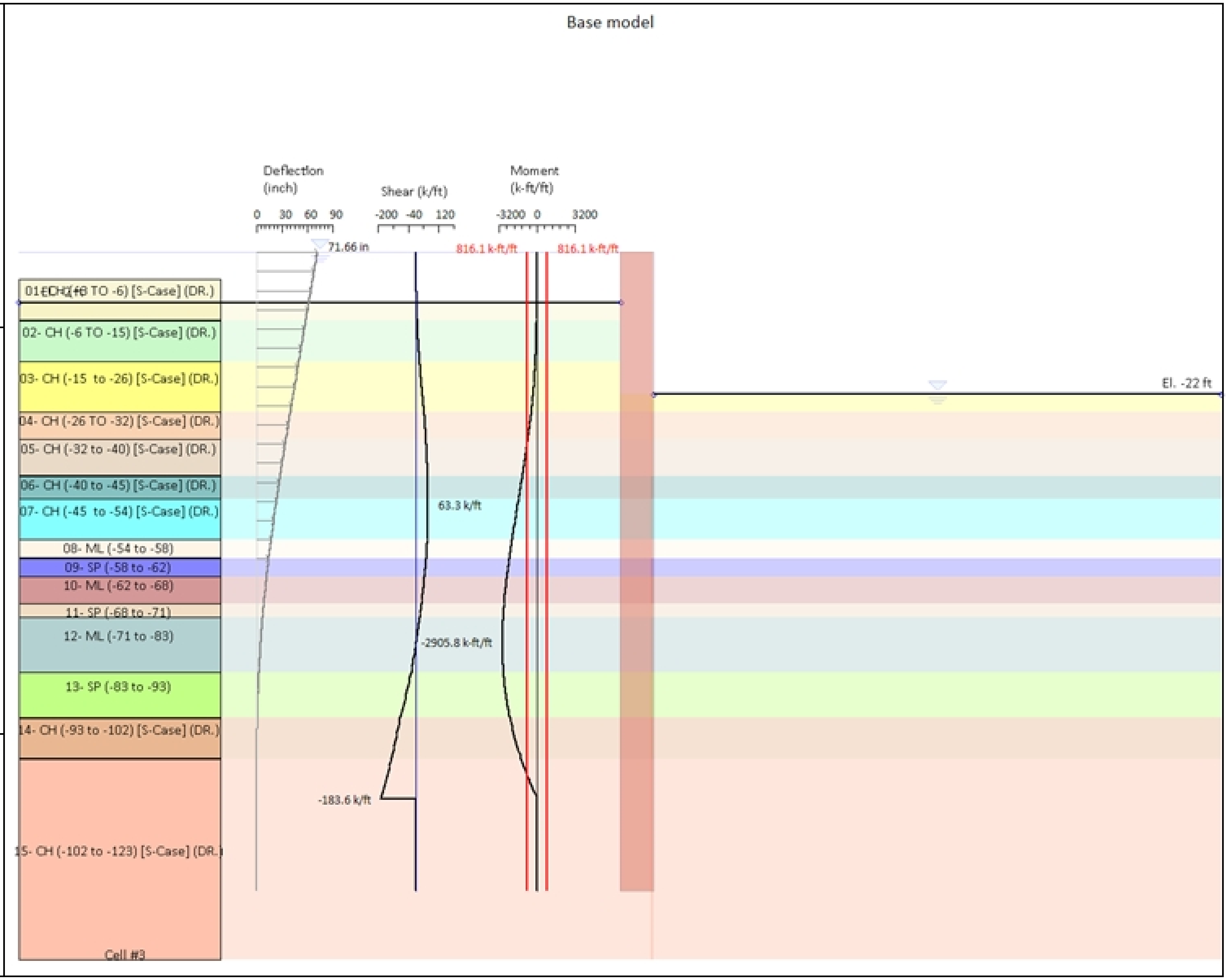
Deep Excavation LCC
DeepEX 2019
4/28/2020

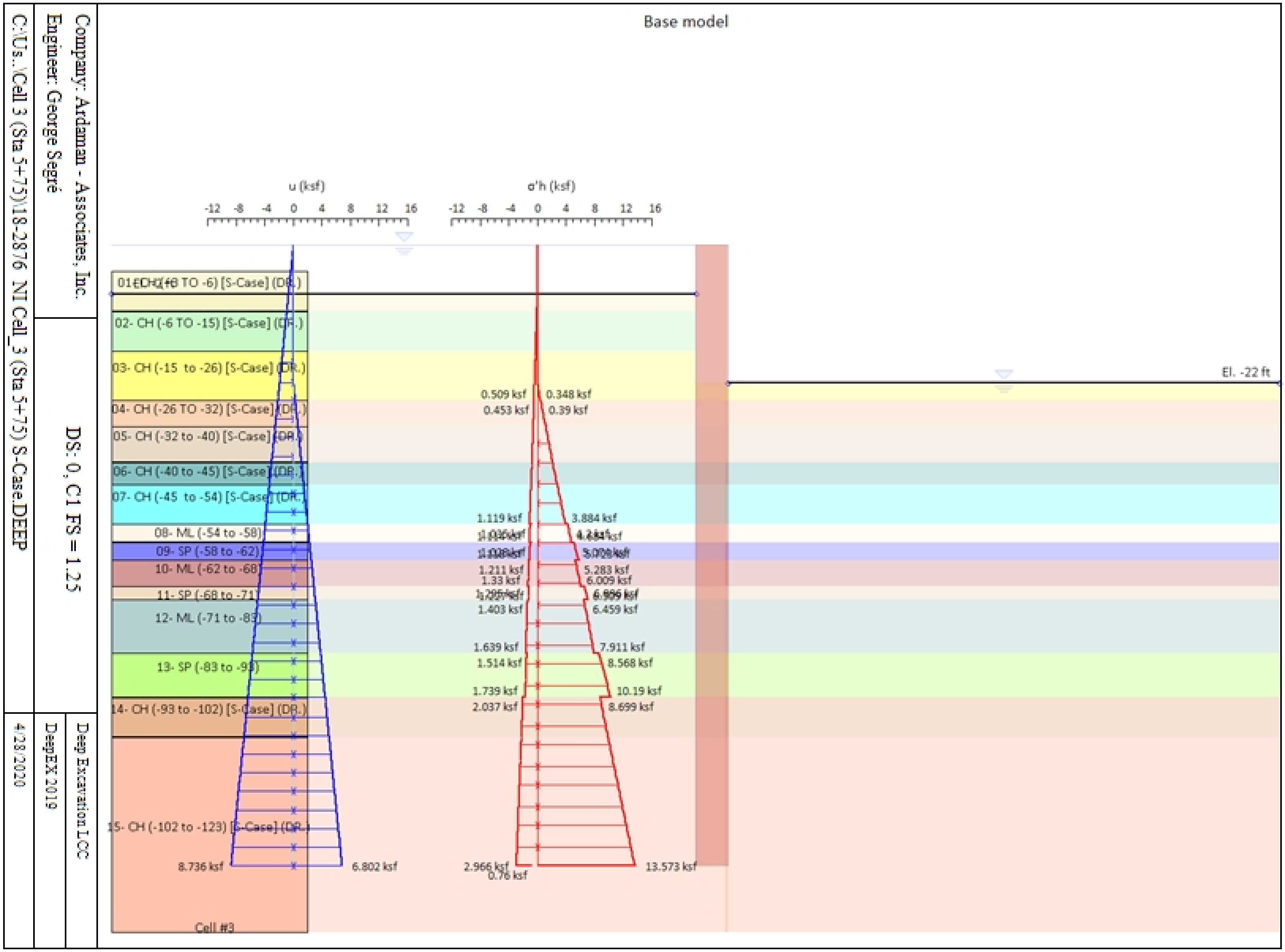


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP

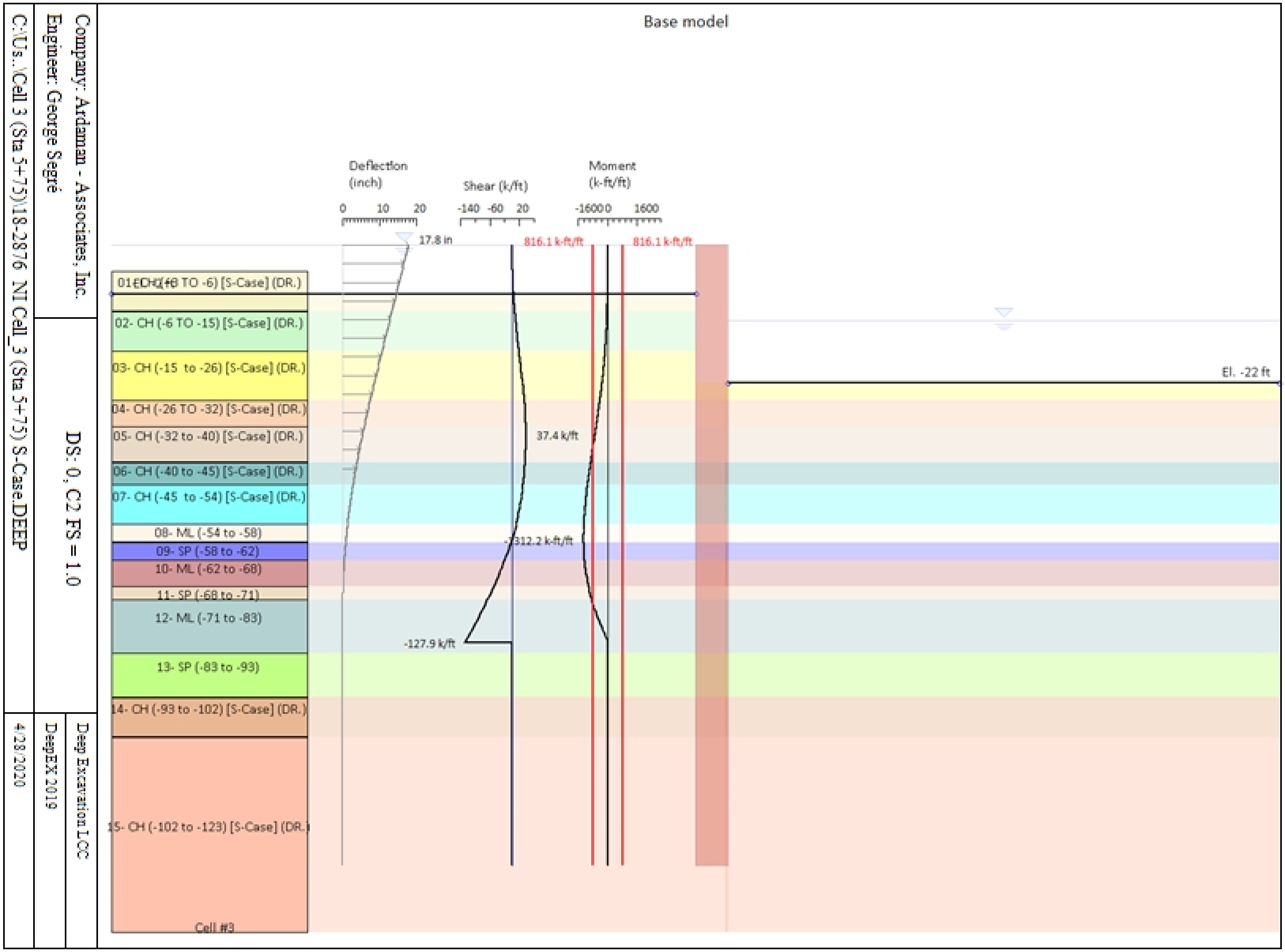
DS: 0, C1 FS = 1.25

Deep Excavation LCC
DeepEX 2019
4/28/2020





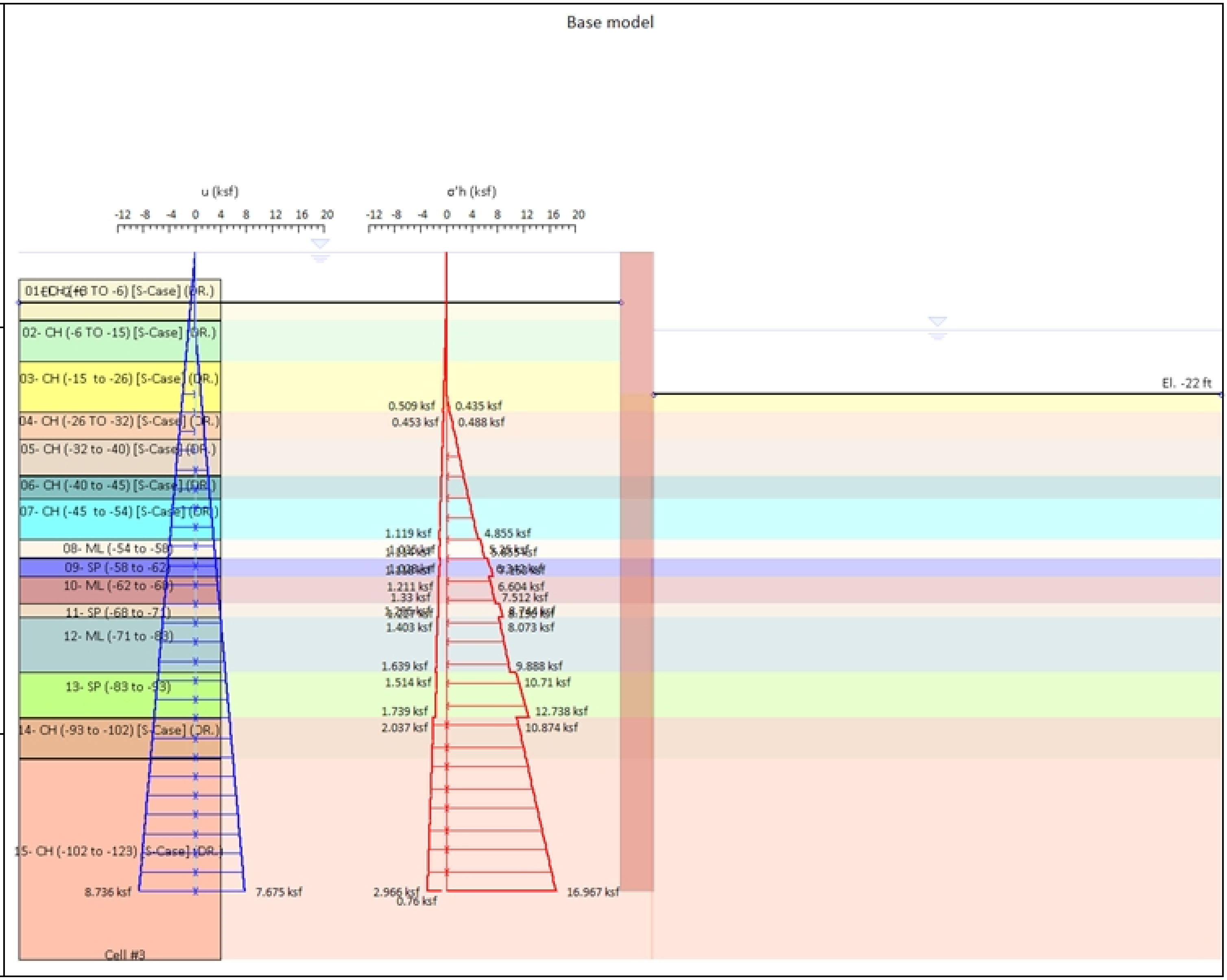
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP
DS: 0, C1 FS = 1.25
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
u (ksf)
σ'h (ksf)
-12 -8 -4 0 4 8 12 16
02- CH (-6 TO -15) [S-Case] (DR.)
03- CH (-15 to -26) [S-Case] (DR.)
04- CH (-26 TO -32) [S-Case] (DR.)
05- CH (-32 to -40) [S-Case] (DR.)
06- CH (-40 to -45) [S-Case] (DR.)
07- CH (-45 to -54) [S-Case] (DR.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) [S-Case] (DR.)
15- CH (-102 to -123) [S-Case] (DR.)
Cell #3
El. -22 ft
0.509 ksf
0.348 ksf
0.453 ksf
0.39 ksf
1.119 ksf
3.884 ksf
1.211 ksf
5.283 ksf
1.33 ksf
6.009 ksf
1.403 ksf
6.459 ksf
1.639 ksf
7.911 ksf
1.514 ksf
8.568 ksf
1.739 ksf
10.19 ksf
2.037 ksf
8.699 ksf
8.736 ksf
6.802 ksf
2.966 ksf
0.76 ksf
13.573 ksf

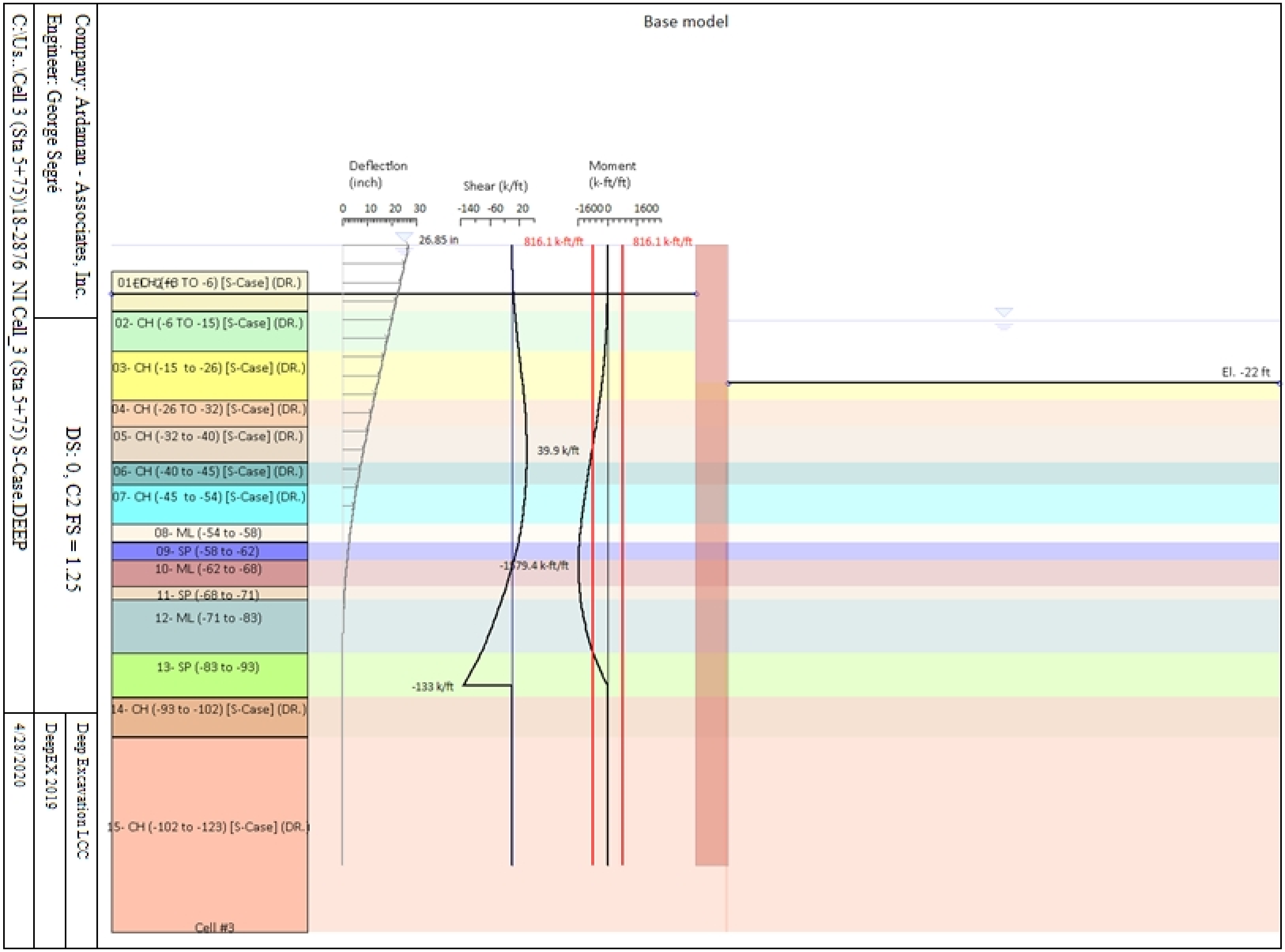

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP
DS: 0, C2 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
Deflection
(inch)
0 10 20
Shear (k/ft)
-140 -60 20
Moment
(k-ft/ft)
-1600 0 1600
17.8 in
816.1 k-ft/ft
816.1 k-ft/ft
37.4 k/ft
-1312.2 k-ft/ft
-127.9 k/ft
El. -22 ft
01- CH (+8 TO -6) [S-Case] (DR.)
02- CH (-6 TO -15) [S-Case] (DR.)
03- CH (-15 to -26) [S-Case] (DR.)
04- CH (-26 TO -32) [S-Case] (DR.)
05- CH (-32 to -40) [S-Case] (DR.)
06- CH (-40 to -45) [S-Case] (DR.)
07- CH (-45 to -54) [S-Case] (DR.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) [S-Case] (DR.)
15- CH (-102 to -123) [S-Case] (DR.)
Cell #3

Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP

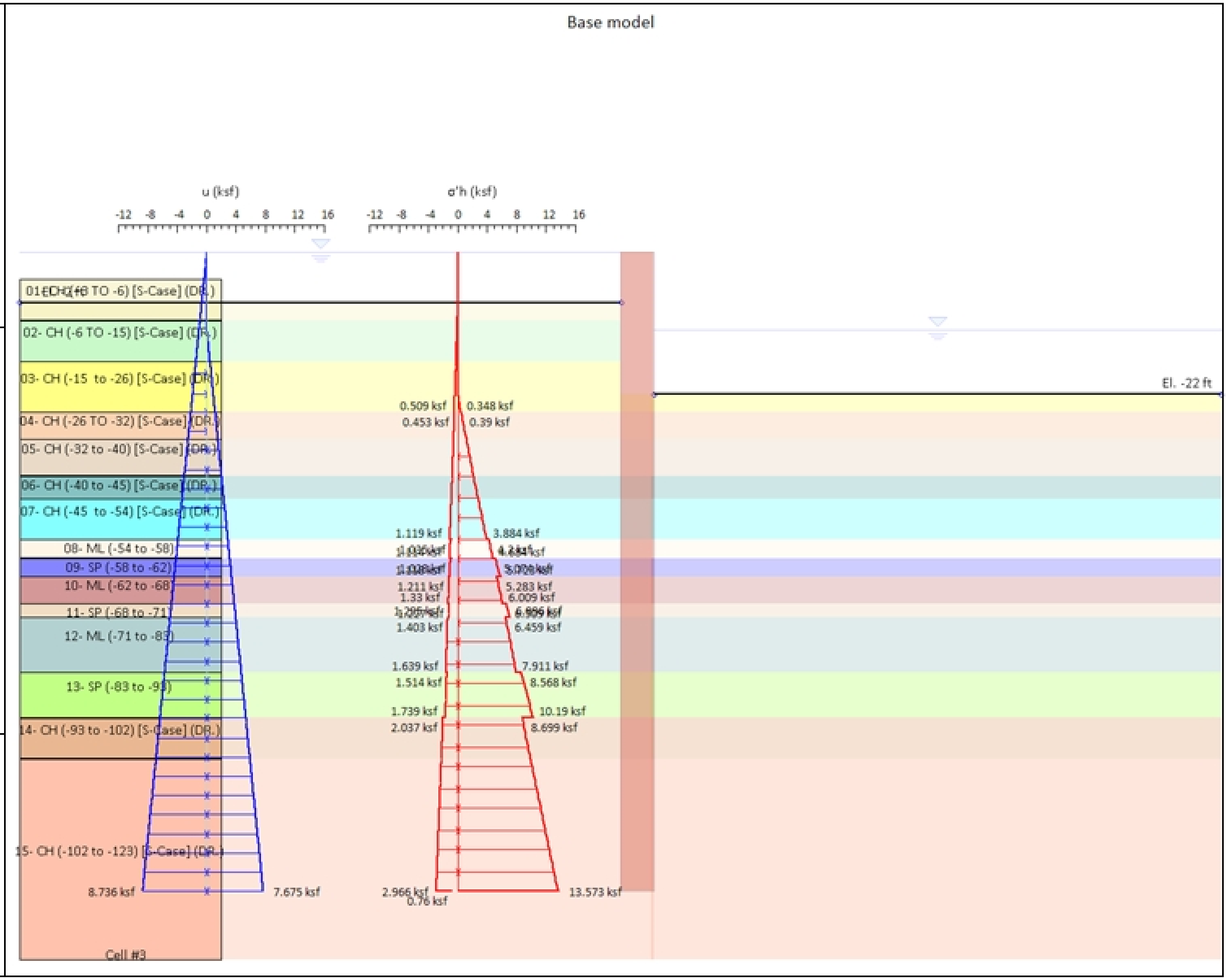
DS: 0, C2 FS = 1.0

Deep Excavation LLC
DeepEX 2019
4/28/2020




Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP
DS: 0, C2 FS = 1.25
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
Deflection (inch)
0 10 20 30
Shear (k/ft)
-140 -60 20
Moment (k-ft/ft)
-1600 0 1600
26.85 in
816.1 k-ft/ft
816.1 k-ft/ft
39.9 k/ft
-1379.4 k-ft/ft
-133 k/ft
El. -22 ft
02- CH (-6 TO -15) [S-Case] (DR.)
03- CH (-15 to -26) [S-Case] (DR.)
04- CH (-26 TO -32) [S-Case] (DR.)
05- CH (-32 to -40) [S-Case] (DR.)
06- CH (-40 to -45) [S-Case] (DR.)
07- CH (-45 to -54) [S-Case] (DR.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) [S-Case] (DR.)
15- CH (-102 to -123) [S-Case] (DR.)
Cell #3

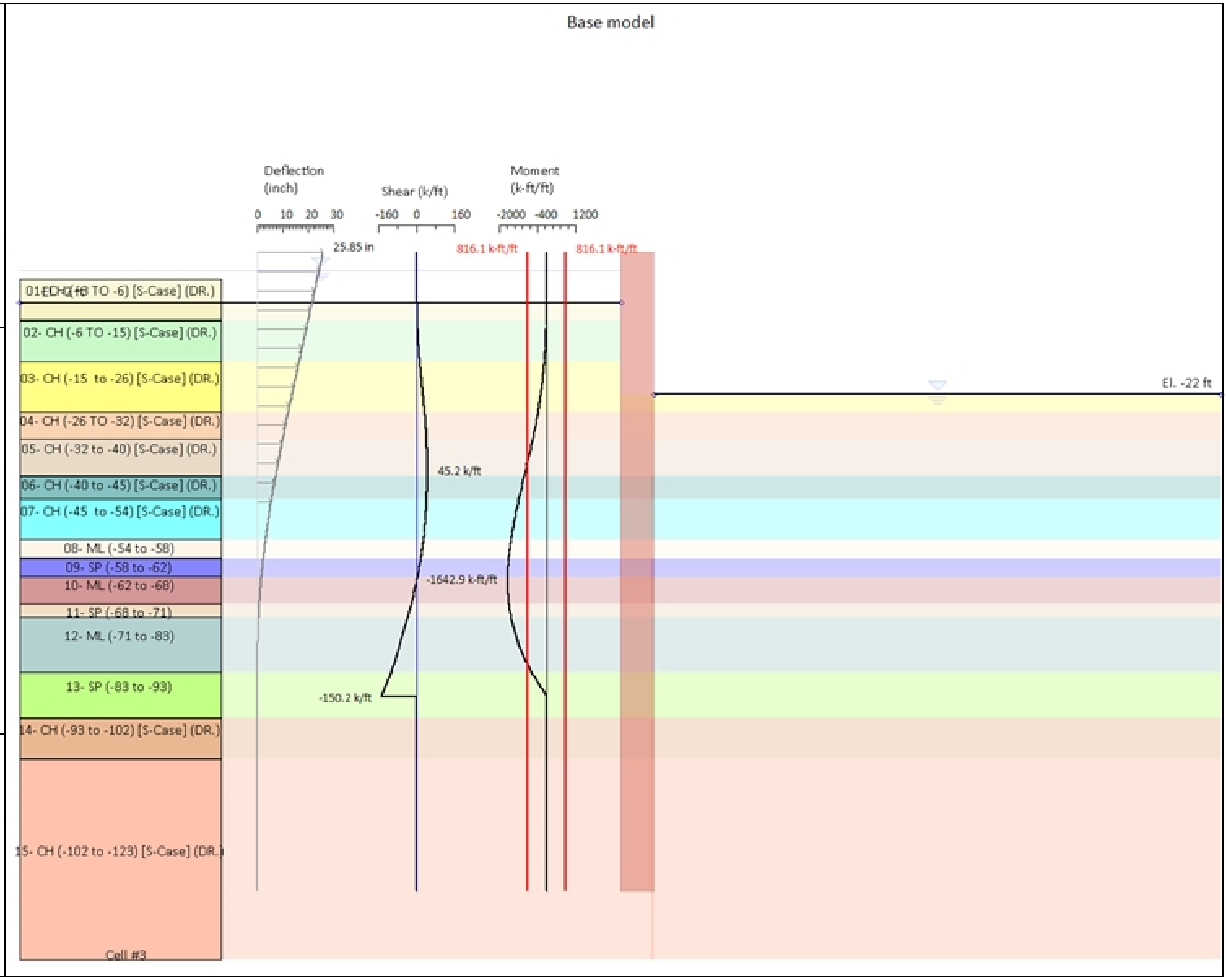
Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP
DS: 0, C2 FS = 1.25
Deep Excavation LCC
DeepEX 2019
4/28/2020

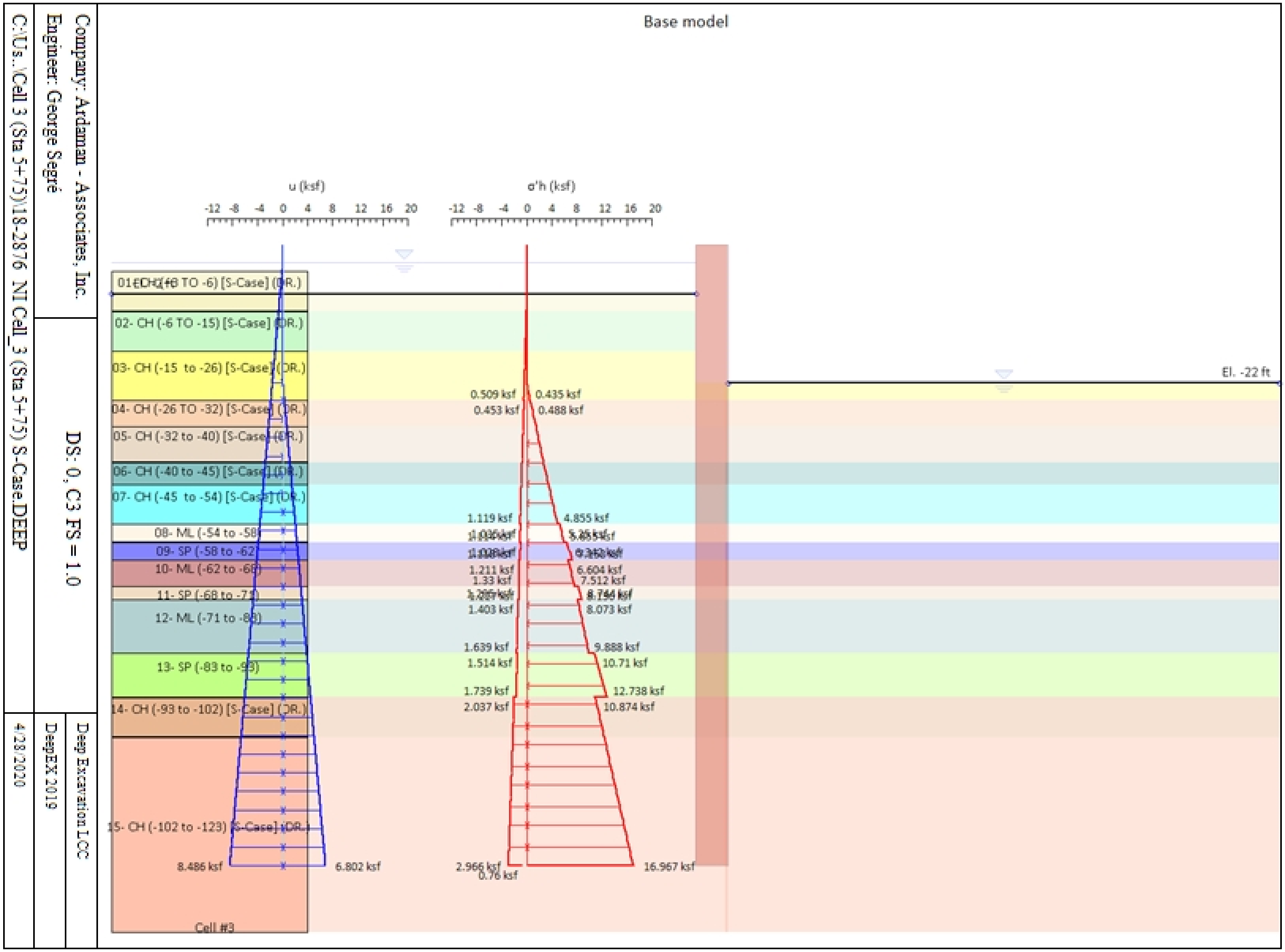


Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP

DS: 0, C3 FS = 1.0

Deep Excavation LCC
DeepEX 2019
4/28/2020





Company: Ardaman - Associates, Inc.
Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP
DS: 0, C3 FS = 1.0
Deep Excavation LCC
DeepEX 2019
4/28/2020
Base model
u (ksf)
σ'h (ksf)
-12 -8 -4 0 4 8 12 16 20
El. -22 ft
02- CH (-6 TO -15) [S-Case] (DR.)
03- CH (-15 to -26) [S-Case] (DR.)
04- CH (-26 TO -32) [S-Case] (DR.)
05- CH (-32 to -40) [S-Case] (DR.)
06- CH (-40 to -45) [S-Case] (DR.)
07- CH (-45 to -54) [S-Case] (DR.)
08- ML (-54 to -58)
09- SP (-58 to -62)
10- ML (-62 to -68)
11- SP (-68 to -71)
12- ML (-71 to -83)
13- SP (-83 to -93)
14- CH (-93 to -102) [S-Case] (DR.)
15- CH (-102 to -123) [S-Case] (DR.)
Cell #3
0.509 ksf
0.435 ksf
0.453 ksf
0.488 ksf
1.119 ksf
4.855 ksf
1.211 ksf
6.604 ksf
1.33 ksf
7.512 ksf
1.403 ksf
8.073 ksf
1.639 ksf
9.888 ksf
1.514 ksf
10.71 ksf
1.739 ksf
12.738 ksf
2.037 ksf
10.874 ksf
8.486 ksf
6.802 ksf
2.966 ksf
0.76 ksf
16.967 ksf

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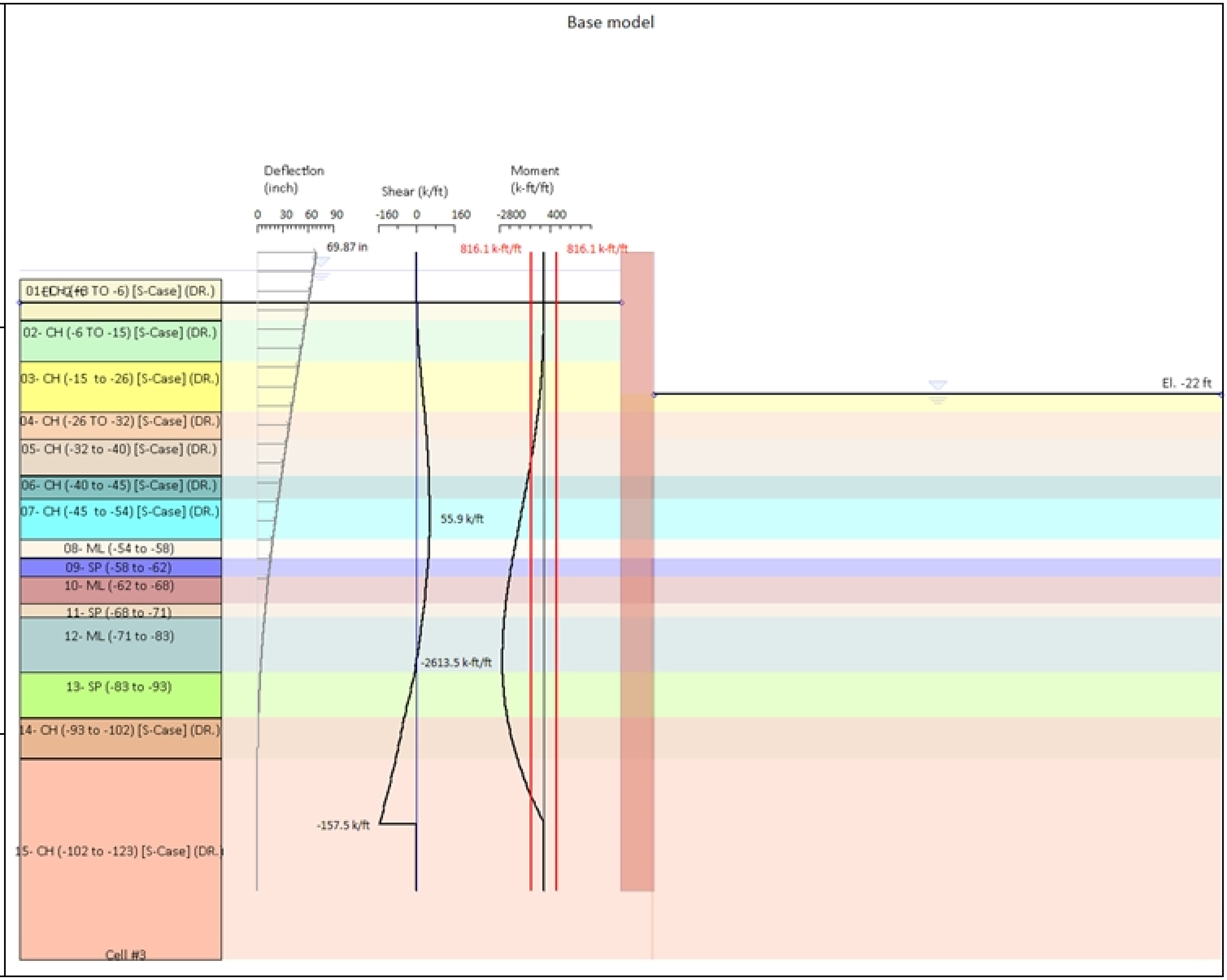
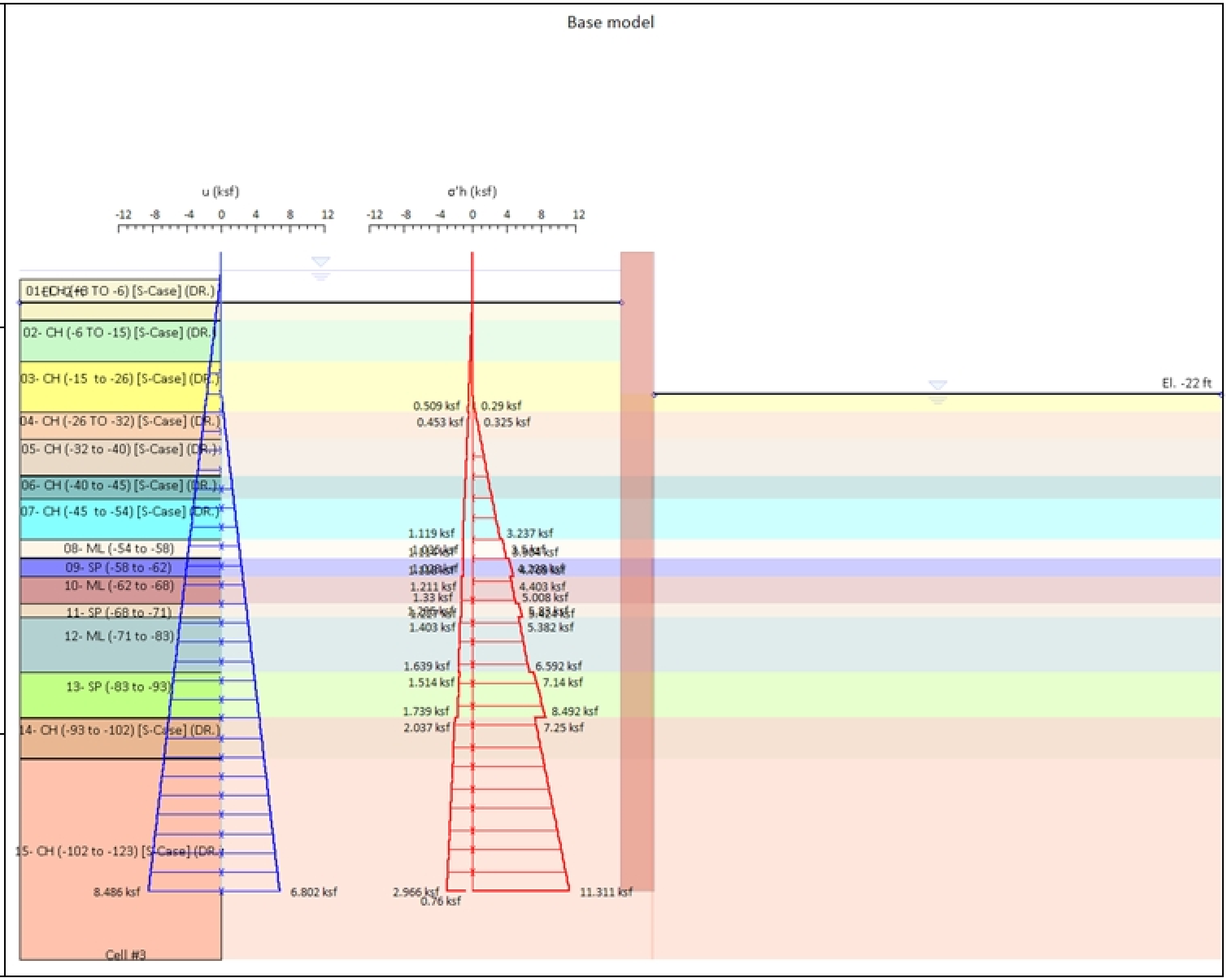
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP

DS: 0, C3 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/28/2020





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DS: 0, C3 FS = 1.5

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Deep Excavation LCC
DeepEX 2019
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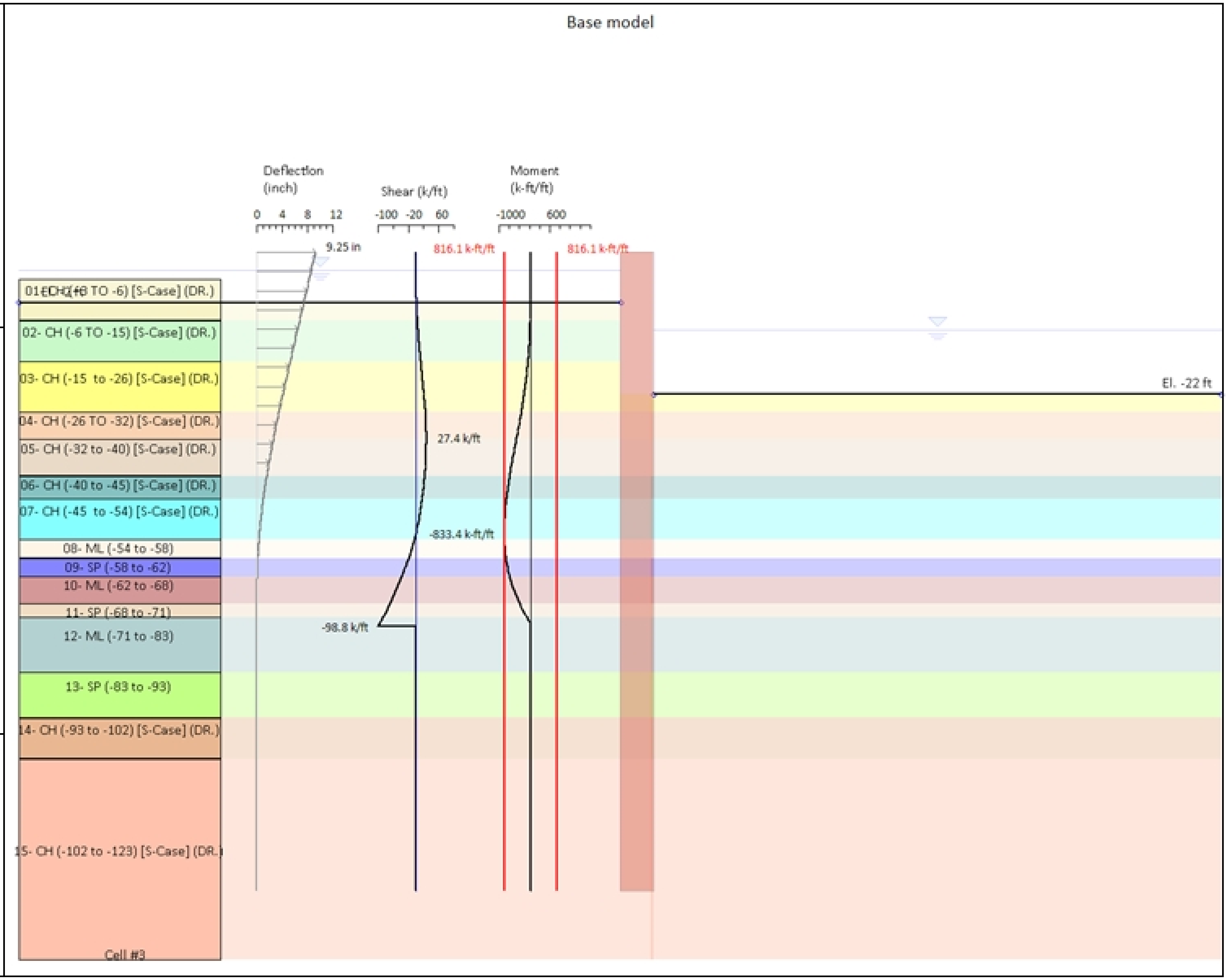
DS: 0, C4 FS = 1.0

Deep Excavation LLC
DeepEX 2019
4/28/2020



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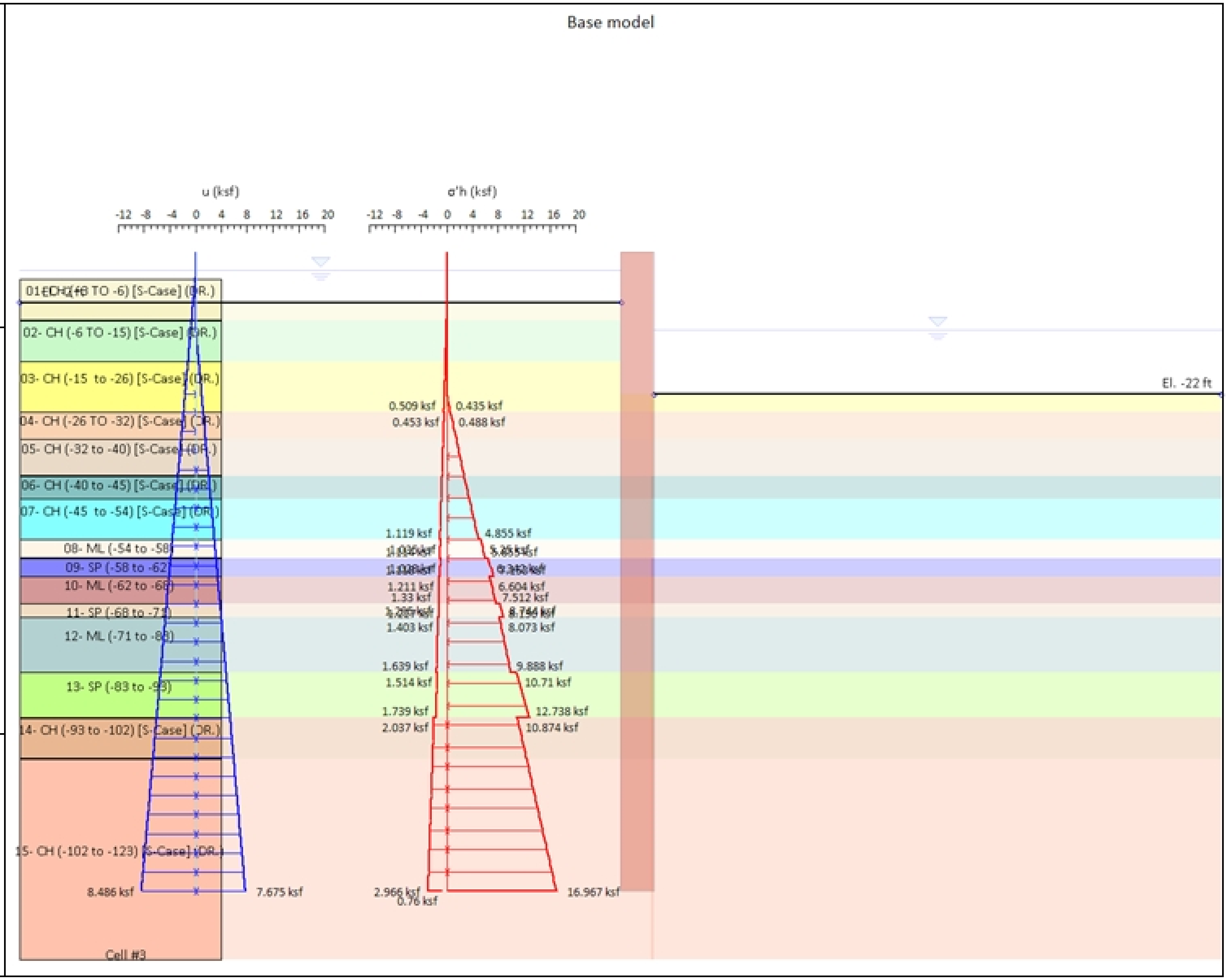
DS: 0, C4 FS = 1.0

Deep Excavation LCC

DeepEX 2019

4/28/2020



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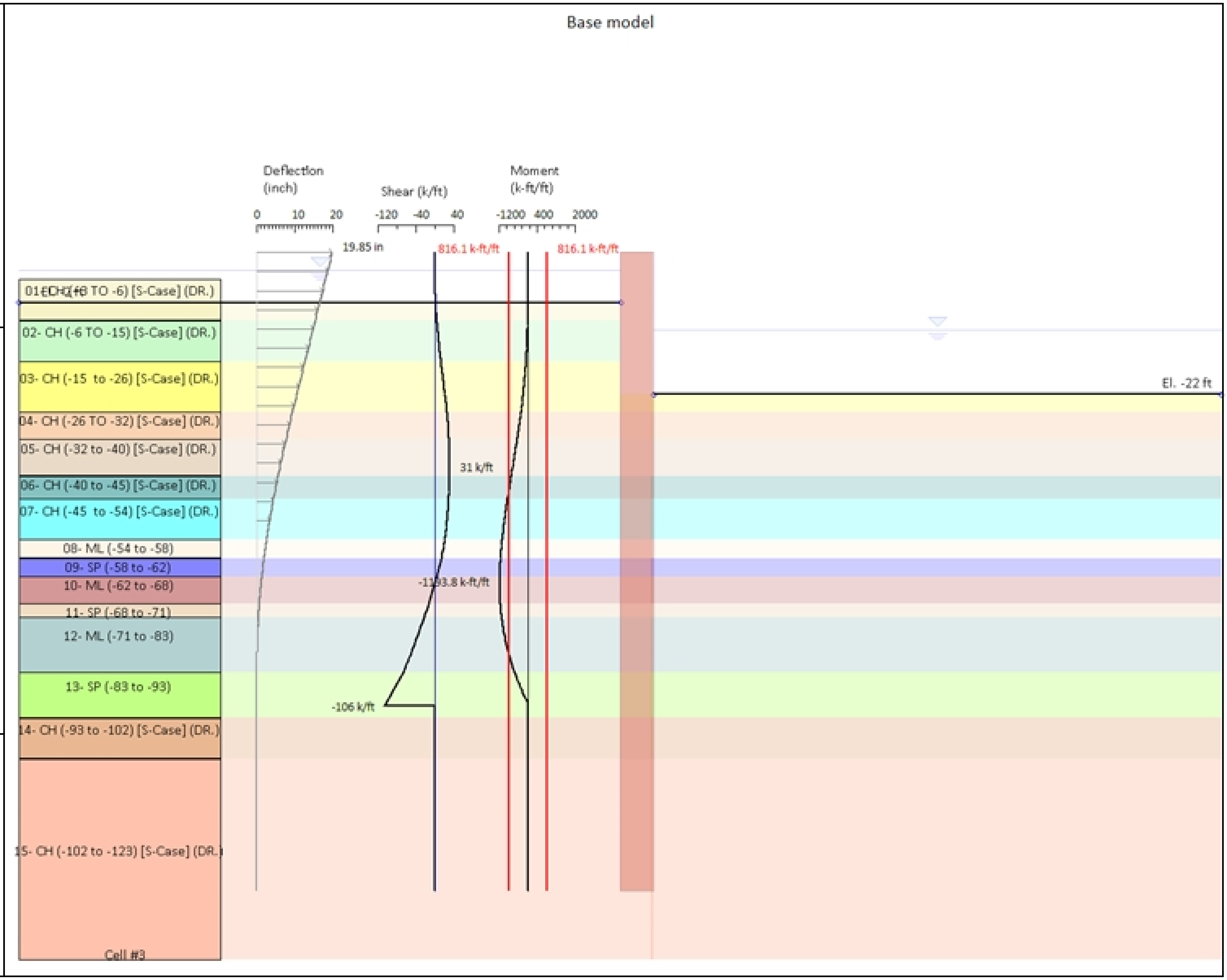
DS: 0, C4 FS = 1.5

Deep Excavation LCC
DeepEX 2019
4/28/2020



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Engineer: George Segré
C:\Us..\Cell 3 (Sta 5+75)\18-2876 NI Cell_3 (Sta 5+75) S-Case.DEEP

DS: 0, C4 FS = 1.5

Deep Excavation LLC
DeepEX 2019
4/28/2020