Savoy Engineering

Project: Rockingham Bridge **Date:** 1-5-15 **Sheet** 1 **of** 10
Prepared By: Phil Savoy P.E. **Project Details** sheet pile

1. Attached are sheet pile calcs for worst-case loads,
ie: 10' depth of 20' sheet, Surcharge up to 500 #/ft²

MAXIMUM DEFLECTIONS are all within specs.

9 sheets attached

STATE OF VERMONT
PHILIP J. SAVOY
No. 5671
REGISTERED
PROFESSIONAL ENGINEER

1-5-15

Sheeting structure verification

Input data

Project

Task : ROCKINGHAM BRIDGE
Descript. : SHEET PILE
Author : SAVOY ENGINEERING
Date : 1/5/2015

STATE OF VERMONT
PHILIP J. SAVOY
No. 5671
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Settings

USA - Safety factor

Materials and standards

Concrete structures : ACI 318-11

Excavations

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankin)
Earthquake analysis : Mononobe-Okabe
Consider reduction of the modulus of subsoil reaction for a braced sheeting
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor for internal stability of anchors :	SF_a =	1.50	[–]

Geometry of structure

Structure length = 20.00 ft

Type of structure: Bethlehem PZ 27
Coeff. of press. reduc. in front of wall = 1.00

Area of cross-section A = 2.52E-02 ft^2/ft
Moment of inertia I = 4.06E-03 ft^4/ft
Elastic modulus E = 30000.0 ksi
Shear modulus G = 12000.0 ksi

Modulus of subsoil reaction determined according to the Schmitt theory.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Poorly graded gravel (GP), dense		38.50	0.0	127.00	67.50	30.00

All soils are considered as cohesionless for at rest pressure analysis.

Parameters of soils to compute modulus of subsoil reaction (Schmitt)

No.	Name	Pattern	ν [–]	E_{oed} [psi]	E_{def} [psi]
1	Poorly graded gravel (GP), dense		0.20	34444.5	-

Soil parameters

Poorly graded gravel (GP), dense
Unit weight : γ = 127.0 pcf

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Stress-state :	effective	
Angle of internal friction :	φ_{ef} =	38.50 °
Cohesion of soil :	c_{ef} =	0.0 psf
Angle of friction struc.-soil :	δ =	30.00 °
Soil :	cohesionless	
Oedometric modulus :	E_{oed} =	34444.5 psi
Saturated unit weight :	γ_{sat} =	130.0 pcf

Geological profile and assigned soils

No.	Layer [ft]	Assigned soil	Pattern
1	-	Poorly graded gravel (GP), dense	

Excavation

Soil in front of wall is excavated to a depth of 10.00 ft.

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	YES		permanent	250.0				on terrain

No.	Name
1	ROAD

Global settings

Number of FEs to discretize wall = 20
Minimum dimensioning pressure is considered as $\sigma_{a,min} = 0.20\sigma_z$

Settings of the stage of construction

Design situation : permanent

Analysis results

Distribution of pressures acting on the structure (in front and behind the wall)

Depth [ft]	Ta,p [psf]	Tk,p [psf]	Tp,p [psf]	Ta,z [psf]	Tk,z [psf]	Tp,z [psf]
0.00	-0.00	-0.00	-0.00	46.34	94.37	1074.56
10.00	-0.00	-0.00	-0.00	281.73	573.78	6533.29
10.00	-0.00	-0.00	-0.05	281.74	573.78	6533.35
20.00	-235.40	-479.41	-5458.74	517.13	1053.18	11992.03

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Distributions of the modulus of subsoil reaction and internal forces on the structure

Depth [ft]	kh,p [pci]	kh,z [pci]	Displacement [in]	Pressure [psf]	Shear Force [lbf/ft]	Moment [lbfft/ft]
0.00	0.00	0.00	-0.55	46.34	0.00	0.00
1.00	0.00	0.00	-0.50	69.88	-58.11	27.09
2.00	0.00	0.00	-0.45	93.42	-139.75	124.06
3.00	0.00	0.00	-0.41	116.96	-244.94	314.45
4.00	0.00	0.00	-0.36	140.50	-373.67	621.79
5.00	0.00	0.00	-0.31	164.04	-525.93	1069.63
6.00	0.00	0.00	-0.27	187.58	-701.74	1681.51
7.00	0.00	0.00	-0.22	211.11	-901.08	2480.96
8.00	0.00	0.00	-0.18	234.65	-1123.97	3491.52
9.00	0.00	0.00	-0.14	258.19	-1370.39	4736.74
9.99	0.00	0.00	-0.11	281.55	-1638.10	6227.04
10.01	0.00	0.00	-0.11	277.56	-1642.60	6253.29
11.00	0.00	0.00	-0.07	-240.60	-1660.92	7934.33
12.00	0.00	0.00	-0.05	-762.93	-1159.16	9387.89
13.00	0.00	0.00	-0.02	-1285.27	-135.06	10078.53
14.00	1131.13	0.00	-0.01	-1575.09	1821.21	8956.73
15.00	1131.13	0.00	-0.00	-302.41	2686.96	6597.98
16.00	56.56	1131.13	0.00	478.37	2455.40	3927.41
17.00	56.56	1131.13	0.00	369.60	1688.08	1845.99
18.00	1131.13	1131.13	0.00	573.78	849.14	590.93
19.00	1131.13	1131.13	-0.00	430.05	230.43	81.71
20.00	1131.13	1131.13	-0.00	28.24	-0.00	-0.00

Maximum shear force = 2686.96 lbf/ft
Maximum moment = 10078.5 lbfft/ft
Maximum displacement = 0.55 in

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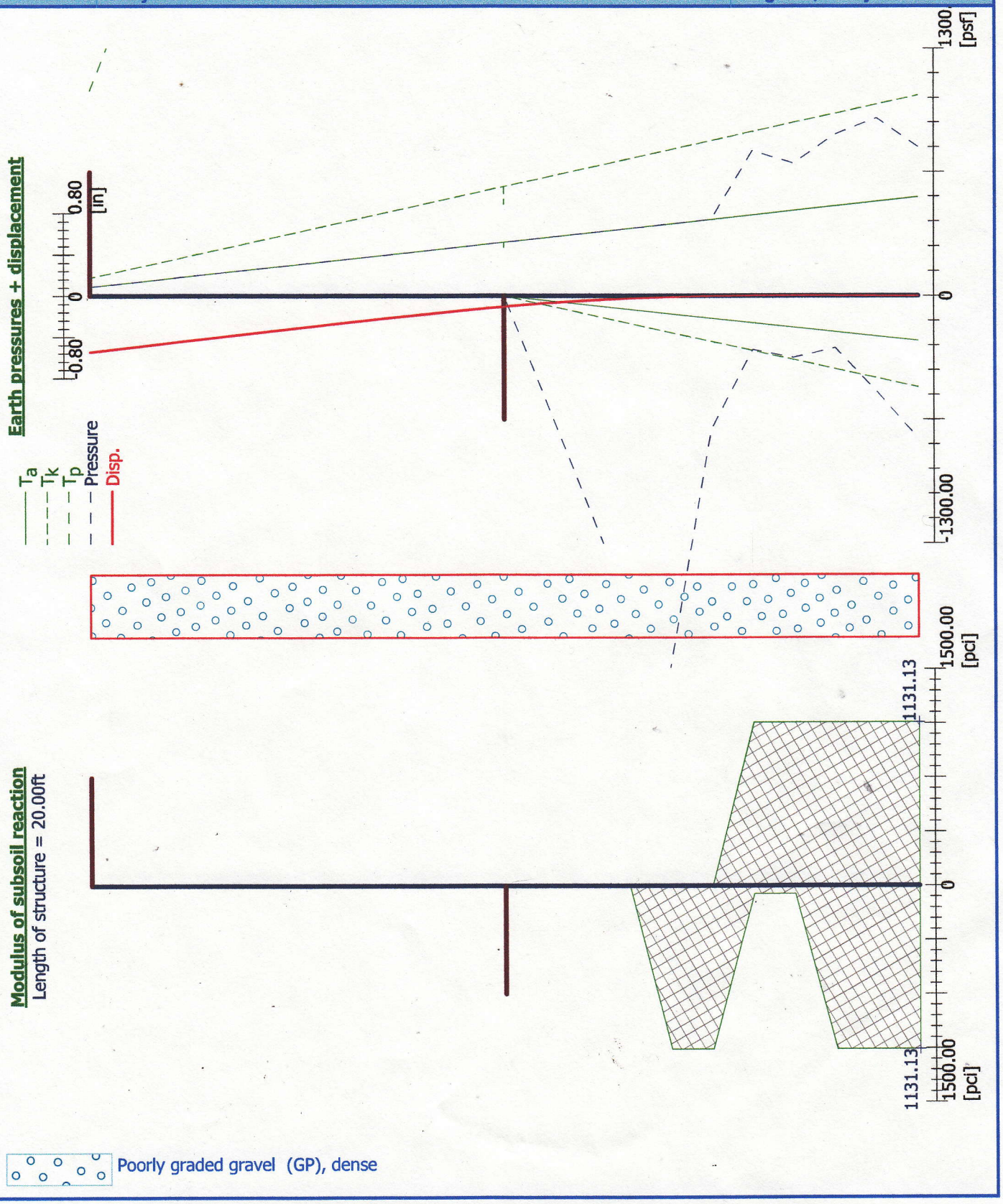
Name :	Analysis	Stage : 2; Analysis: 1



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Safety factor for internal stability of anchors :	SF_a =	1.50	[–]

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Shear modulus G = 12000.0 ksi

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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Poorly graded gravel (GP), dense		38.50	0.0	127.00	67.50	30.00

All soils are considered as cohesionless for at rest pressure analysis.

Parameters of soils to compute modulus of subsoil reaction (Schmitt)

No.	Name	Pattern	ν [–]	E_{oed} [psi]	E_{def} [psi]
1	Poorly graded gravel (GP), dense		0.20	34444.5	-

Soil parameters

Poorly graded gravel (GP), dense
Unit weight : γ = 127.0 pcf

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Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	38.50 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Angle of friction struc.-soil :	δ	=	30.00 °
Soil :	cohesionless		
Oedometric modulus :	E_{oed}	=	34444.5 psi
Saturated unit weight :	γ_{sat}	=	130.0 pcf

Geological profile and assigned soils

No.	Layer [ft]	Assigned soil	Pattern
1	-	Poorly graded gravel (GP), dense	

Excavation

Soil in front of wall is excavated to a depth of 10.00 ft.

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	YES		permanent	250.0				on terrain

No.	Name
1	ROAD

Global settings

Number of FEs to discretize wall = 20
Minimum dimensioning pressure is considered as $\sigma_{a,min} = 0.20\sigma_z$

Settings of the stage of construction

Design situation : permanent

Analysis results (Stage of construction 1)

Distribution of pressures acting on the structure (in front and behind the wall)

Depth [ft]	Ta,p [psf]	Tk,p [psf]	Tp,p [psf]	Ta,z [psf]	Tk,z [psf]	Tp,z [psf]
0.00	-0.00	-0.00	-0.00	46.34	94.37	1074.56
10.00	-0.00	-0.00	-0.00	281.73	573.78	6533.29
10.00	-0.00	-0.00	-0.05	281.74	573.78	6533.35
20.00	-235.40	-479.41	-5458.74	517.13	1053.18	11992.03

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Distributions of the modulus of subsoil reaction and internal forces on the structure

Depth [ft]	kh,p [pci]	kh,z [pci]	Displacement [in]	Pressure [psf]	Shear Force [lbf/ft]	Moment [lbfft/ft]
0.00	0.00	0.00	-0.55	46.34	0.00	0.00
1.00	0.00	0.00	-0.50	69.88	-58.11	27.09
2.00	0.00	0.00	-0.45	93.42	-139.75	124.06
3.00	0.00	0.00	-0.41	116.96	-244.94	314.45
4.00	0.00	0.00	-0.36	140.50	-373.67	621.79
5.00	0.00	0.00	-0.31	164.04	-525.93	1069.63
6.00	0.00	0.00	-0.27	187.58	-701.74	1681.51
7.00	0.00	0.00	-0.22	211.11	-901.08	2480.96
8.00	0.00	0.00	-0.18	234.65	-1123.97	3491.52
9.00	0.00	0.00	-0.14	258.19	-1370.39	4736.74
9.99	0.00	0.00	-0.11	281.55	-1638.10	6227.04
10.01	0.00	0.00	-0.11	277.56	-1642.60	6253.29
11.00	0.00	0.00	-0.07	-240.60	-1660.92	7934.33
12.00	0.00	0.00	-0.05	-762.93	-1159.16	9387.89
13.00	0.00	0.00	-0.02	-1285.27	-135.06	10078.53
14.00	1131.13	0.00	-0.01	-1575.09	1821.21	8956.73
15.00	1131.13	0.00	-0.00	-302.41	2686.96	6597.98
16.00	56.56	1131.13	0.00	478.37	2455.40	3927.41
17.00	56.56	1131.13	0.00	369.60	1688.08	1845.99
18.00	1131.13	1131.13	0.00	573.78	849.14	590.93
19.00	1131.13	1131.13	-0.00	430.05	230.43	81.71
20.00	1131.13	1131.13	-0.00	28.24	-0.00	-0.00

Maximum shear force = 2686.96 lbf/ft
Maximum moment = 10078.5 lbfft/ft
Maximum displacement = 0.55 in

Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Layer [ft]	Assigned soil	Pattern
1	-	Poorly graded gravel (GP), dense	

Excavation

Soil in front of wall is excavated to a depth of 10.00 ft.

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

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Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	YES		permanent	500.0				on terrain

No.	Name
1	VEHICLES

Settings of the stage of construction

Design situation : permanent

Analysis results (Stage of construction 2)

Distribution of pressures acting on the structure (in front and behind the wall)

Depth [ft]	Ta,p [psf]	Tk,p [psf]	Tp,p [psf]	Ta,z [psf]	Tk,z [psf]	Tp,z [psf]
0.00	-0.00	-0.00	-0.00	92.68	188.74	2149.11
10.00	-0.00	-0.00	-0.00	328.07	668.15	7607.85
10.00	-0.00	-0.00	-0.05	328.07	668.15	7607.90
20.00	-235.40	-479.41	-5458.74	563.47	1147.56	13066.58

Distributions of the modulus of subsoil reaction and internal forces on the structure

Depth [ft]	kh,p [pci]	kh,z [pci]	Displacement [in]	Pressure [psf]	Shear Force [lbf/ft]	Moment [lbfft/ft]
0.00	0.00	0.00	-1.77	92.68	0.00	0.00
1.00	0.00	0.00	-1.65	116.22	-104.45	50.26
2.00	0.00	0.00	-1.52	139.75	-232.43	216.74
3.00	0.00	0.00	-1.40	163.29	-383.95	522.97
4.00	0.00	0.00	-1.28	186.83	-559.02	992.49
5.00	0.00	0.00	-1.16	210.37	-757.62	1648.85
6.00	0.00	0.00	-1.03	233.91	-979.77	2515.59
7.00	0.00	0.00	-0.92	257.45	-1225.45	3616.23
8.00	0.00	0.00	-0.80	280.99	-1494.67	4974.33
9.00	0.00	0.00	-0.69	304.53	-1787.43	6613.42
9.99	0.00	0.00	-0.58	327.88	-2101.11	8540.23
10.01	0.00	0.00	-0.58	323.89	-2106.34	8573.89
11.00	0.00	0.00	-0.47	-194.26	-2170.64	10737.76
12.00	0.00	0.00	-0.38	-716.60	-1715.21	12724.22
13.00	0.00	0.00	-0.29	-1238.93	-737.45	13994.08
14.00	0.00	0.00	-0.21	-1761.27	762.65	14025.00
15.00	56.56	0.00	-0.15	-989.36	2273.10	12238.19
16.00	56.56	0.00	-0.09	-528.69	3027.03	9550.77
17.00	56.56	56.56	-0.03	111.53	3338.07	6253.45
18.00	56.56	56.56	0.01	905.25	2825.32	3105.66
19.00	0.00	56.56	0.06	1385.14	1584.08	826.18
20.00	0.00	56.56	0.11	1782.69	-0.00	0.00

Maximum shear force = 3338.07 lbf/ft
Maximum moment = 14025.0 lbfft/ft
Maximum displacement = 1.77 in

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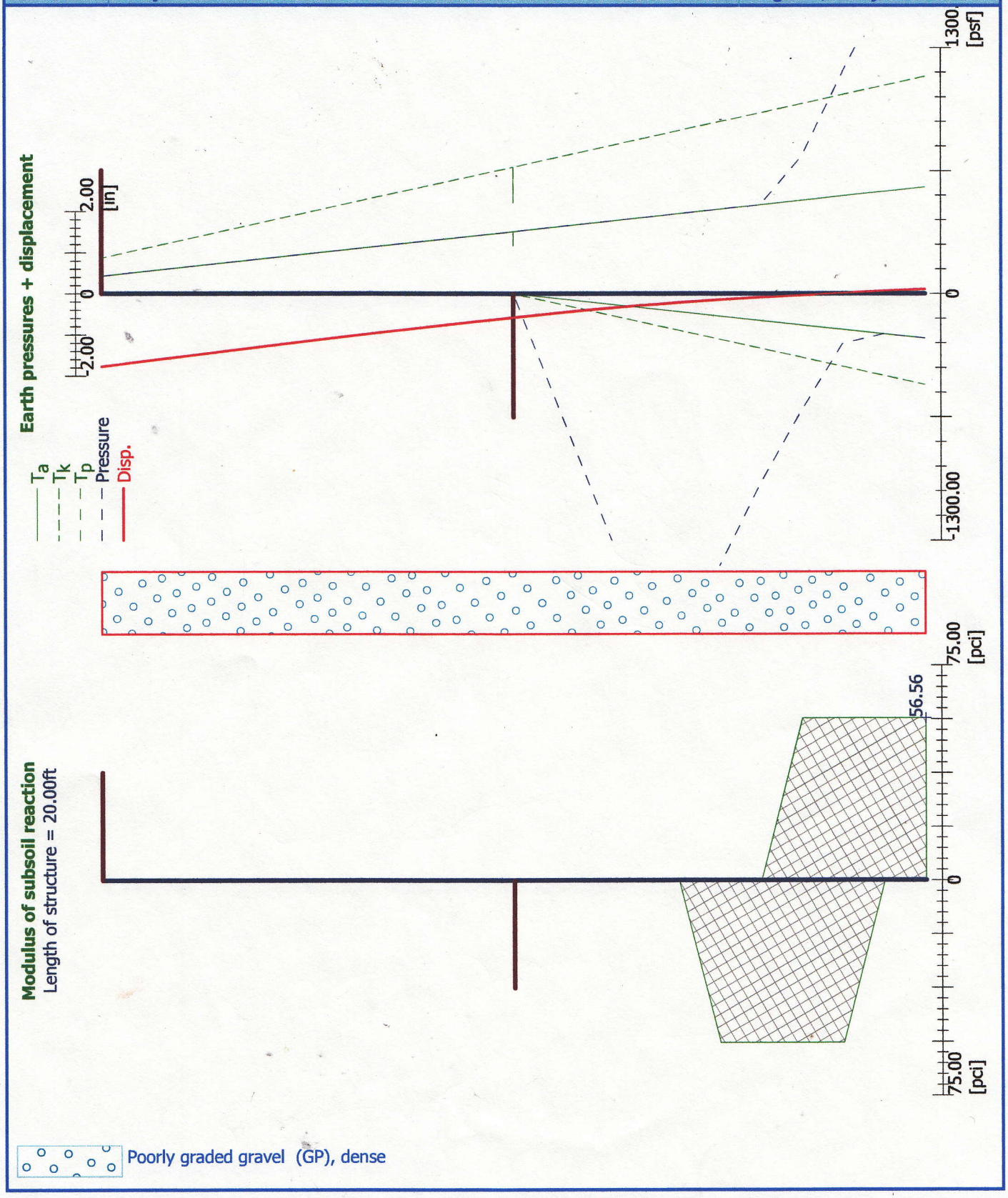
Name :	Analysis	Stage : 2; Analysis: 1



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