Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

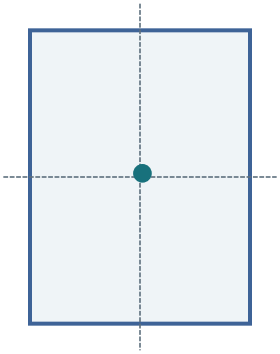
DESIGN OVERVIEW

Footing demand, resistance and engineering checks.

EFFECTIVE PRESSURE	FINAL ALLOWABLE	TOTAL SETTLEMENT	SLIDING SAFETY
2.622 ksf	**4.254** ksf	**0.588** in	**11.191**

FOOTING PLAN

Resultant

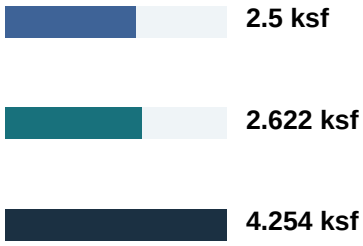


B = 6 ft

L = 8 ft

PRESSURE COMPARISON

Pressure (ksf)



DESIGN CHECKS

Check	Result	Criterion
Bearing capacity	FAIL	Meyerhof
Sliding	PASS	Required factor: 1.5
Eccentricity	PASS	Resultant / Contact Check
Controlling limit	Settlement	

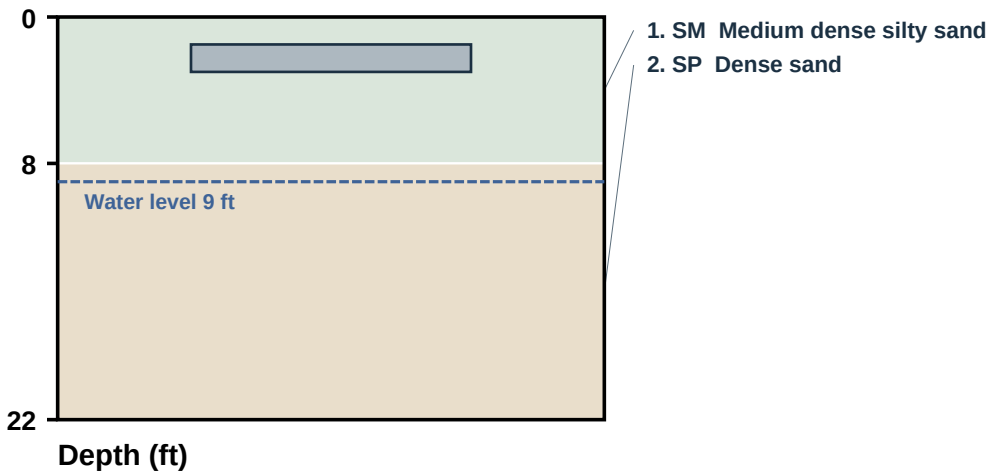
Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

GROUND MODEL

Soil stratigraphy and engineering properties used by the foundation analysis.

SOIL PROFILE / FOUNDATION SECTION



SOIL LAYERS & STRENGTH

Layer / USCS	Depth Interval	Unit Weight	Cohesion	Friction Angle
1 / SM	0 ft to 8 ft	0.12 kcf	0 ksf	32 deg
2 / SP	8 ft to 22 ft	0.125 kcf	0 ksf	35 deg

SOIL STIFFNESS & COMPRESSIBILITY

Layer	Young Modulus	Constrained Modulus	Poisson Ratio
1	250 ksf	336.538 ksf	0.3
2	400 ksf	511.364 ksf	0.28

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

SETTLEMENT RESPONSE

Method Comparisons | Selected Method: Steinbrenner

PREDICTED SETTLEMENT BY METHOD

Settlement (in)

METHOD COMPARISON

Method	Settlement (in)	Selection
Steinbrenner Layered Elastic	0.588	Selected
Janbu/Bjerrum/Kjaernsli Layered Elastic	0.392	Comparison
Poulos-Davis Elastic	0.618	Comparison

Selected Total Settlement	0.588 in
Tolerable Settlement	1 in

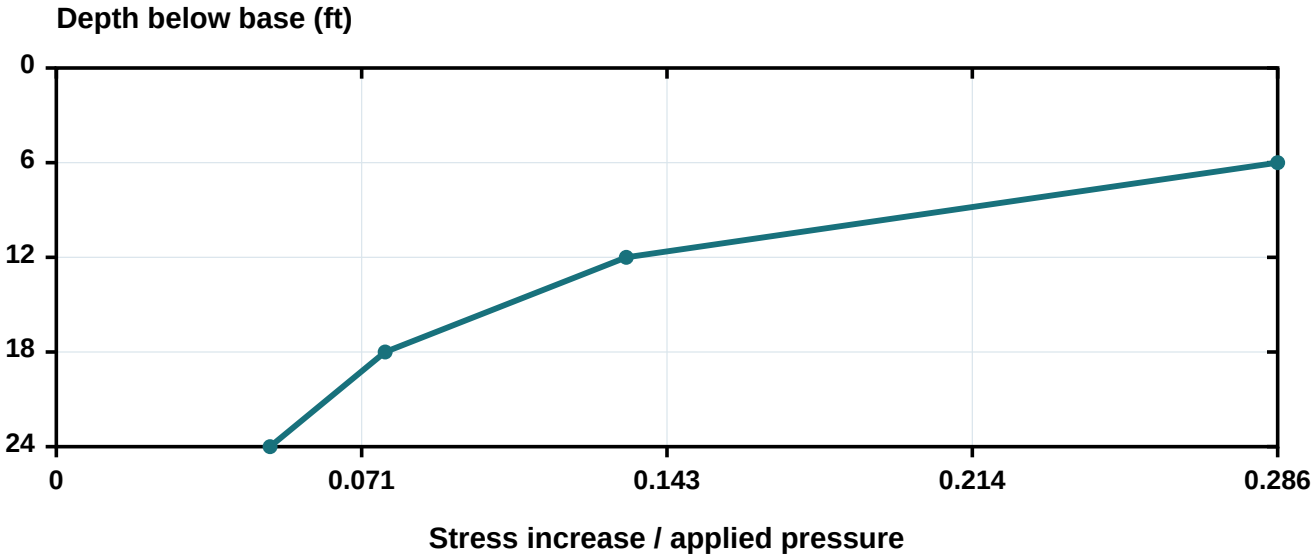
Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

RESPONSE & INFLUENCE

Stress attenuation below the footing and the evaluated bearing-capacity modes.

2:1 STRESS ATTENUATION



BEARING MODES - ULTIMATE CAPACITY

Pressure (ksf)

Surface Bearing		**19.777 ksf**

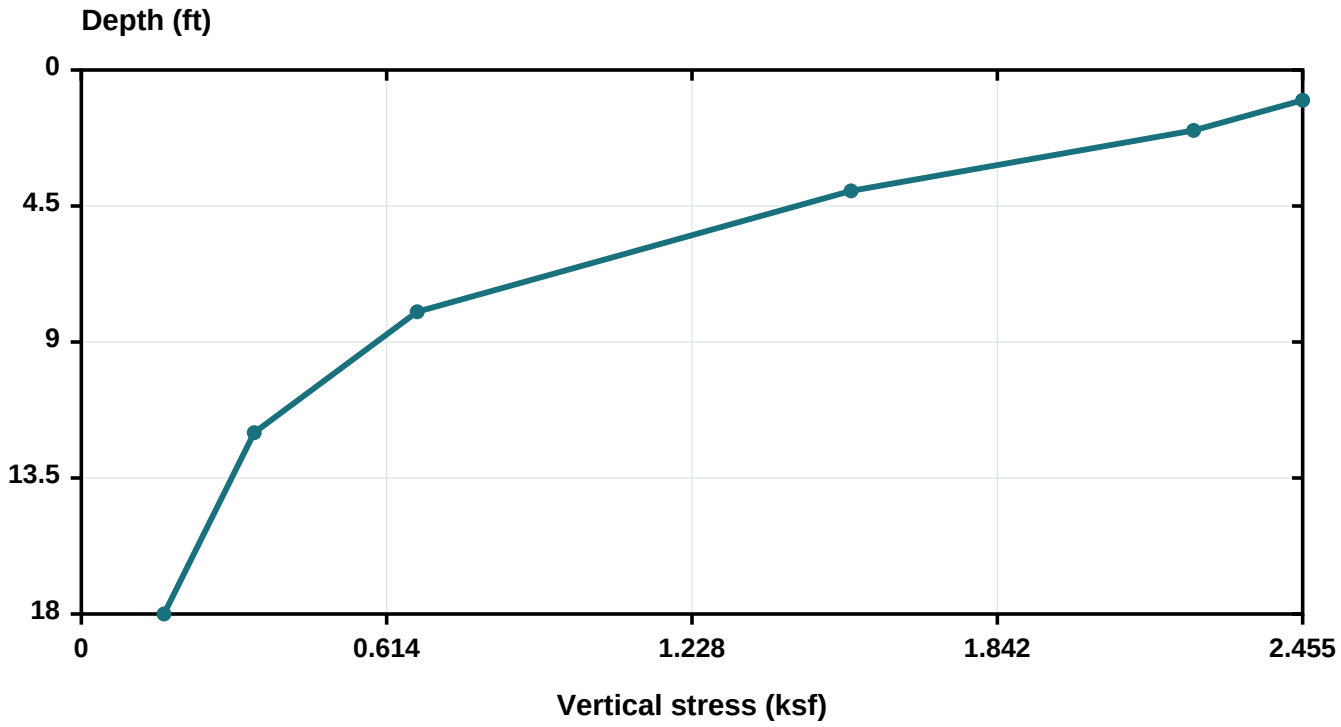
Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

VERIFIED STRESS PROFILE

Boussinesq | Samples at x = 0, y = 0 ft

VERTICAL STRESS WITH DEPTH



Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

CALCULATION DETAILS

Geometry, loading and method-specific engineering results

ANALYSIS SUMMARY

Applied / Effective Pressure	2500 / 2622.3776 psf
Final Allowable Pressure	4254.0677 psf
Controlling Limit State	Settlement
Bearing Check	FAIL
Sliding Check	PASS

FOOTING GEOMETRY / LOADS

Structure Type	Example building foundation
Footing Type	Rectangular Footing
Selected Boring	B-01
Footing Width	6 ft
Footing Length	8 ft
Footing Thickness	1.5 ft
Embedment Depth	3 ft
Groundwater Depth	9 ft
Area	48 ft^2
Effective Width	5.8667 ft
Effective Length	7.8 ft
Effective Area	45.76 ft^2
Eccentricity B	0.0667 ft
Eccentricity L	0.1 ft
Eccentricity Limit B	1 ft
Eccentricity Limit L	1.3333 ft
Eccentricity Within Limit	Yes
Contact Tension	No
Moment Axis Convention	ENGINE-XY

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Vertical Loads

Input Mode	Total Force
Service	120 kip
Service Pressure	2.5 ksf

Horizontal Loads

X	5 kip
Y	0 kip

Moments

Mx	12 kip-ft
My	8 kip-ft
Mz	0 kip-ft

SELECTED SOIL PROFILE

Layer	Top	Bottom	USCS	Description
1	0 ft	8 ft	SM	Medium dense silty sand
2	8 ft	22 ft	SP	Dense sand

BEARING CAPACITY

Method	Meyerhof
Design Method	Meyerhof
Bearing Factors Method	Meyerhof
Bearing Layer	1
Factor Of Safety	3
Ultimate Bearing Capacity	19.7773 ksf
Controlling Ultimate Bearing Capacity	19.7773 ksf
Controlling Mode	Surface Bearing
Allowable Bearing Capacity	6.5924 ksf
Equivalent Bearing Pressure	2622.3776 psf
Actual Factor Of Safety	0.0075

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Check Result	FAIL
Factors	
Nc	35.4903
Nq	23.1768
Ngamma	22.0225
Flow Number	3.2546
Corrections	
Shape C	1.4896
Shape Q	1.2448
Shape Gamma	1.2448
Depth C	1.1845
Depth Q	1.0923
Depth Gamma	1.0923
Term Corrections	
Base C	1
Base Q	1
Base Gamma	1
Ground C	1
Ground Q	1
Ground Gamma	1
Load C	0.9477
Load Q	0.9477
Load Gamma	0.8564
Slope Method	Hansen
Load Method	Meyerhof

Mode	Ultimate Bearing (ksf)
Surface Bearing	19.7773

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

SETTLEMENT / FINAL ALLOWABLE

Settlement

Method	Elastic Layered-System Settlement
Selected Method	Steinbrenner
Total Settlement	0.049 ft
Total Settlement Inches	0.5877 in
Applied Pressure KSF	2.5 ksf
Influence Depth Below Base	24 ft

Equivalent Layer Properties

Layer Count	2
Compressible Thickness	19 ft
Equivalent Young Modulus	345.4545 ksf
Average Poisson Ratio	0.2853

ELASTIC LAYER ROWS

Row	Layer	Top Z Below Base	Bottom Z Below Base	Mid Z Below Base	Thickness
1	1	0 ft	5 ft	2.5 ft	5 ft
2	2	5 ft	19 ft	12 ft	14 ft

Row	Young Modulus	Poisson Ratio, ν	Stress Influence Factor	Stress Increase, Δσ	Elastic Strain Settlement
1	250 ksf	0.3	0.8298	2.0745 ksf	0.0378 ft
2	400 ksf	0.28	0.1391	0.3477 ksf	0.0112 ft

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Method Results

Steinbrenner

Correlation	Steinbrenner Layered Elastic
Total Settlement	0.049 ft
Total Settlement Inches	0.5877 in

Factors

Correction Factor	1

Janbu / Bjerrum / Kjaernsli

Correlation	Janbu/Bjerrum/Kjaernsli Layered Elastic
Total Settlement	0.0327 ft
Total Settlement Inches	0.3924 in

Factors

μ_o	1
μ_1	0.7531
Rigidity Factor	1
Correction Factor	1

Poulos-Davis

Correlation	Poulos-Davis Elastic
Total Settlement	0.0515 ft
Total Settlement Inches	0.6176 in

Factors

Shape Factor	1.2903
Rigidity Factor	1
Finite Layer Factor	1
Depth Factor	1
Correction Factor	1

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Final Allowable	
Allowable Bearing Pressure	6.5924 ksf
Shear-Controlled Allowable Pressure	6592.4336 psf
Settlement-Controlled Allowable Pressure	4254.0677 psf
Final Allowable Pressure	4254.0677 psf
Controlling Limit State	Settlement
Settlement Control Method	Linear Settlement Scaling
Settlement Allowable Bearing Table Match	Not Available

Settlement Scaling	
Applied Pressure	2500 psf
Calculated Settlement	0.049 ft
Tolerable Settlement	0.0833 ft
Method Allowable Bearing Pressure	Not Available

SLIDING CHECK

Mode	Frictional

$$F_R = (W + W_{add}) \tan(\delta) + P_p$$

Inputs	
Vertical Load	120000 lbf
Additional Vertical Load	0 lbf
Normal Load	120000 lbf
Passive Resistance	0 lbf
Horizontal Load	5000 lbf
Interface Friction Angle	25 deg
Interface Adhesion	0 ksf

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Footing Width	6 ft
Footing Length	8 ft
Required Factor Of Safety	1.5
Sliding Resistance	55956.919 lbf
Sliding Factor Of Safety	11.1914
Required Factor Of Safety	1.5
Sliding Check	PASS

VERIFIED STRESS ANALYSIS

Analysis Method	Boussinesq
Foundation Behavior	Flexible
Boundary Condition	Elastic Half Space

Point	x (ft)	y (ft)	z (ft)	Vertical Stress
Centerline	0	0	1	2.4554 ksf
Centerline	0	0	2	2.2361 ksf
Centerline	0	0	4	1.5474 ksf
Centerline	0	0	8	0.6753 ksf
Centerline	0	0	12	0.3476 ksf
Centerline	0	0	18	0.1662 ksf

SETTLEMENT RESULT

Method	Immediate Settlement
Settlement Formulation	Vertical Stress

$$\varepsilon_z = \frac{\Delta\sigma_{zz}}{M}$$

Settlement	0.0458 ft
Evaluation Point XY	0 ft, 0 ft

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Sublayers Per Layer	20
Sublayer Count	40

SUBLAYER RESULTS

Row	Layer	Sublayer	Top Depth	Bottom Depth	Mid Depth
1	1	1	0 ft	0.4 ft	0.2 ft
2	1	2	0.4 ft	0.8 ft	0.6 ft
3	1	3	0.8 ft	1.2 ft	1 ft
4	1	4	1.2 ft	1.6 ft	1.4 ft
5	1	5	1.6 ft	2 ft	1.8 ft
6	1	6	2 ft	2.4 ft	2.2 ft
7	1	7	2.4 ft	2.8 ft	2.6 ft
8	1	8	2.8 ft	3.2 ft	3 ft
9	1	9	3.2 ft	3.6 ft	3.4 ft
10	1	10	3.6 ft	4 ft	3.8 ft
11	1	11	4 ft	4.4 ft	4.2 ft
12	1	12	4.4 ft	4.8 ft	4.6 ft
13	1	13	4.8 ft	5.2 ft	5 ft
14	1	14	5.2 ft	5.6 ft	5.4 ft
15	1	15	5.6 ft	6 ft	5.8 ft
16	1	16	6 ft	6.4 ft	6.2 ft
17	1	17	6.4 ft	6.8 ft	6.6 ft
18	1	18	6.8 ft	7.2 ft	7 ft
19	1	19	7.2 ft	7.6 ft	7.4 ft
20	1	20	7.6 ft	8 ft	7.8 ft
21	2	1	8 ft	8.7 ft	8.35 ft
22	2	2	8.7 ft	9.4 ft	9.05 ft

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Row	Layer	Sublayer	Top Depth	Bottom Depth	Mid Depth
23	2	3	9.4 ft	10.1 ft	9.75 ft
24	2	4	10.1 ft	10.8 ft	10.45 ft
25	2	5	10.8 ft	11.5 ft	11.15 ft
26	2	6	11.5 ft	12.2 ft	11.85 ft
27	2	7	12.2 ft	12.9 ft	12.55 ft
28	2	8	12.9 ft	13.6 ft	13.25 ft
29	2	9	13.6 ft	14.3 ft	13.95 ft
30	2	10	14.3 ft	15 ft	14.65 ft
31	2	11	15 ft	15.7 ft	15.35 ft
32	2	12	15.7 ft	16.4 ft	16.05 ft
33	2	13	16.4 ft	17.1 ft	16.75 ft
34	2	14	17.1 ft	17.8 ft	17.45 ft
35	2	15	17.8 ft	18.5 ft	18.15 ft
36	2	16	18.5 ft	19.2 ft	18.85 ft
37	2	17	19.2 ft	19.9 ft	19.55 ft
38	2	18	19.9 ft	20.6 ft	20.25 ft
39	2	19	20.6 ft	21.3 ft	20.95 ft
40	2	20	21.3 ft	22 ft	21.65 ft

Row	Thickness	Vertical Stress, $\Delta\sigma_{zz}$	Selected Modulus	Poisson Ratio, ν	Vertical Strain
1	0.4 ft	2.4996 ksf	336.5385 ksf	0.3	0.0074
2	0.4 ft	2.4896 ksf	336.5385 ksf	0.3	0.0074
3	0.4 ft	2.4554 ksf	336.5385 ksf	0.3	0.0073
4	0.4 ft	2.3897 ksf	336.5385 ksf	0.3	0.0071
5	0.4 ft	2.2937 ksf	336.5385 ksf	0.3	0.0068
6	0.4 ft	2.1737 ksf	336.5385 ksf	0.3	0.0065

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Row	Thickness	Vertical Stress, $\Delta\sigma_{zz}$	Selected Modulus	Poisson Ratio, ν	Vertical Strain
7	0.4 ft	2.0383 ksf	336.5385 ksf	0.3	0.0061
8	0.4 ft	1.8959 ksf	336.5385 ksf	0.3	0.0056
9	0.4 ft	1.7529 ksf	336.5385 ksf	0.3	0.0052
10	0.4 ft	1.6142 ksf	336.5385 ksf	0.3	0.0048
11	0.4 ft	1.4827 ksf	336.5385 ksf	0.3	0.0044
12	0.4 ft	1.3602 ksf	336.5385 ksf	0.3	0.004
13	0.4 ft	1.2474 ksf	336.5385 ksf	0.3	0.0037
14	0.4 ft	1.1443 ksf	336.5385 ksf	0.3	0.0034
15	0.4 ft	1.0506 ksf	336.5385 ksf	0.3	0.0031
16	0.4 ft	0.9659 ksf	336.5385 ksf	0.3	0.0029
17	0.4 ft	0.8893 ksf	336.5385 ksf	0.3	0.0026
18	0.4 ft	0.8201 ksf	336.5385 ksf	0.3	0.0024
19	0.4 ft	0.7577 ksf	336.5385 ksf	0.3	0.0023
20	0.4 ft	0.7014 ksf	336.5385 ksf	0.3	0.0021
21	0.7 ft	0.6326 ksf	511.3636 ksf	0.28	0.0012
22	0.7 ft	0.5576 ksf	511.3636 ksf	0.28	0.0011
23	0.7 ft	0.4943 ksf	511.3636 ksf	0.28	0.001
24	0.7 ft	0.4406 ksf	511.3636 ksf	0.28	0.0009
25	0.7 ft	0.3947 ksf	511.3636 ksf	0.28	0.0008
26	0.7 ft	0.3553 ksf	511.3636 ksf	0.28	0.0007
27	0.7 ft	0.3213 ksf	511.3636 ksf	0.28	0.0006
28	0.7 ft	0.2917 ksf	511.3636 ksf	0.28	0.0006
29	0.7 ft	0.266 ksf	511.3636 ksf	0.28	0.0005
30	0.7 ft	0.2433 ksf	511.3636 ksf	0.28	0.0005
31	0.7 ft	0.2234 ksf	511.3636 ksf	0.28	0.0004

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Row	Thickness	Vertical Stress, $\Delta\sigma_{zz}$	Selected Modulus	Poisson Ratio, ν	Vertical Strain
32	0.7 ft	0.2058 ksf	511.3636 ksf	0.28	0.0004
33	0.7 ft	0.1901 ksf	511.3636 ksf	0.28	0.0004
34	0.7 ft	0.1761 ksf	511.3636 ksf	0.28	0.0003
35	0.7 ft	0.1636 ksf	511.3636 ksf	0.28	0.0003
36	0.7 ft	0.1523 ksf	511.3636 ksf	0.28	0.0003
37	0.7 ft	0.1422 ksf	511.3636 ksf	0.28	0.0003
38	0.7 ft	0.133 ksf	511.3636 ksf	0.28	0.0003
39	0.7 ft	0.1246 ksf	511.3636 ksf	0.28	0.0002
40	0.7 ft	0.117 ksf	511.3636 ksf	0.28	0.0002

Row	Settlement
1	0.003 ft
2	0.003 ft
3	0.0029 ft
4	0.0028 ft
5	0.0027 ft
6	0.0026 ft
7	0.0024 ft
8	0.0023 ft
9	0.0021 ft
10	0.0019 ft
11	0.0018 ft
12	0.0016 ft
13	0.0015 ft
14	0.0014 ft
15	0.0012 ft

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

Row	Settlement
16	0.0011 ft
17	0.0011 ft
18	0.001 ft
19	0.0009 ft
20	0.0008 ft
21	0.0009 ft
22	0.0008 ft
23	0.0007 ft
24	0.0006 ft
25	0.0005 ft
26	0.0005 ft
27	0.0004 ft
28	0.0004 ft
29	0.0004 ft
30	0.0003 ft
31	0.0003 ft
32	0.0003 ft
33	0.0003 ft
34	0.0002 ft
35	0.0002 ft
36	0.0002 ft
37	0.0002 ft
38	0.0002 ft
39	0.0002 ft
40	0.0002 ft

Project: GEOKAL Demonstration — synthetic example

Foundation: F-01

2:1 STRESS PROFILE

Method	2:1

$$\Delta\sigma_v = \frac{q\ B\ L}{(B + z)(L + z)}$$

Zone Of Influence Below Base	14.9317 ft

Depth (ft)	Stress Increase (psf)	Stress / q
6	714.2857	0.2857
12	333.3333	0.1333
18	192.3077	0.0769
24	125	0.05