Project Title:
Project Number: D14306

Designer: Robert Johnson
Station Number: 433

Description: Case XX
Design height = 38.6'

$$\text{ORIGIN} = 0$$

Input Data

Wall Geometry:

Total Wall Height: $H_d := 38.6\ ft$ Input Field

Reinforcement length at base: $L := 15\ ft$

External Loads:

Traffic Surcharge: $q := 260\ psf$

Soil Properties:

Moist Unit Weight: $\gamma := 130\ psf$

Effective Friction Angle: $\phi := 34\ deg$

Active Wedge Inclination: $\psi := 45\ deg + \frac{\phi}{2} = 62\ deg$

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Active Earth Pessure Coeff.: $K_a := \tan\left(45\ deg - \frac{\phi}{2}\right)^2 = 0.28271\ rad$

Reinforcement Properties:

$Type_1$	T_{ult} $\left(\frac{lb}{ft}\right)$	RF_{cr}	RF_{id}	RF_d	C_i	Rc
1400	4800	2.56	1.25	1.10	0.8	90
1500	7810	2.56	1.25	1.10	0.8	90
1600	9870	2.56	1.25	1.10	0.8	90
1700	11990	2.56	1.25	1.10	0.8	90

$$T_{al1} := \frac{\overrightarrow{\left(\left(\frac{T_{ult}}{RF_{cr}}\right)\right)}}{RF_{id}}}{RF_d} = \begin{bmatrix} 1363.64 \\ 2218.75 \\ 2803.98 \\ 3406.25 \end{bmatrix} \frac{lb}{ft}$$

$Table\_result_1 := \text{stack}\left(\left[\text{“Type” “T\_ult” “RF\_cr” “RF\_id” “RF\_d” “T\_al” “C\_i” “Rc”}\right], \left[\text{“” “lb/ft” “” “” “” “lb/ft” “” “%”}\right], \text{augment}\left(Type_1, T_{\text{i}}\right.\right.$

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$$Table\_result_1 = \begin{bmatrix} \text{“Type”} & \text{“T\_ult”} & \text{“RF\_cr”} & \text{“RF\_id”} & \text{“RF\_d”} & \text{“T\_al”} & \text{“C\_i”} & \text{“Rc”} \\ \text{“”} & \text{“lb/ft”} & \text{“”} & \text{“”} & \text{“”} & \text{“lb/ft”} & \text{“”} & \text{“%”} \\ 1400 & 4800 & 2.56 & 1.25 & 1.1 & 1363.64 & 0.8 & 90 \\ 1500 & 7810 & 2.56 & 1.25 & 1.1 & 2218.75 & 0.8 & 90 \\ 1600 & 9870 & 2.56 & 1.25 & 1.1 & 2803.98 & 0.8 & 90 \\ 1700 & 11990 & 2.56 & 1.25 & 1.1 & 3406.25 & 0.8 & 90 \end{bmatrix}$$

Evaluation of Reinforcement Rupture:

$Layer\#$	$Elevation$ (ft)	$Type_2$
1	0.58	1700
2	1.25	1700
3	2.5	1700
4	4.33	1600
5	5.00	1600
6	6.83	1500
7	7.00	1500
8	7.50	1500
9	8.00	1500
11	9.33	1500
12	10.75	1500
13	10.00	1500

$$z := \left\| \begin{array}{l} \text{for } i \in \text{ORIGIN} .. (\text{rows}(Elevation) - 2) \\ \quad z_i \leftarrow H_d - Elevation_i \\ z \end{array} \right.$$

$$z^{\mathrm{T}} = [38.02 \;\; 37.35 \;\; 36.1 \;\; 34.27 \;\; 33.6 \;\; 31.77 \;\; 31.6 \;\; 31.1 \;\; 30.6 \;\; 29.27 \;\; 27.85 \;\; \ldots] \; ft$$

$$A_t := \left\| \begin{array}{l} a_{\text{ORIGIN}} \leftarrow \dfrac{Elevation_{\text{ORIGIN}+1} - Elevation_{\text{ORIGIN}}}{2} + Elevation_{\text{ORIGIN}} \\ \text{for } i \in (\text{ORIGIN}+1) .. (\text{rows}(Elevation) - 2) \\ \quad a_i \leftarrow \dfrac{Elevation_{i+1} - Elevation_i}{2} + \dfrac{Elevation_i - Elevation_{i-1}}{2} \\ a \end{array} \right.$$

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15	12.05	1600
16	15.0	1700
17	17.50	1700
18	20.00	1600
19	22.50	1600
20	25.00	1500
21	27.50	1500
22	30.00	1500
23	32.50	1400
24	35.00	1400
"_"	38.60	"_"

$$A_t^{\mathrm{T}} = [0.92 \;\; 0.96 \;\; 1.54 \;\; 1.25 \;\; 1.25 \;\; 1 \;\; 0.34 \;\; 0.5 \;\; 0.92 \;\; 1.38 \;\; 0.34 \;\; 0.54 \;\; \ldots] \;\; ft$$

$$K_r := \left\| \begin{array}{l} \text{for } i \in \text{ORIGIN} .. (\text{rows}(Elevation) - 2) \\ \quad k_{r_i} \leftarrow K_a \\ k_r \end{array} \right.$$

$$K_r^{\mathrm{T}} = [0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; 0.283 \;\; \ldots]$$

$$\sigma_v := \left\| \begin{array}{l} z \leftarrow \dfrac{z}{ft} \\ \text{for } i \in \text{ORIGIN} .. (\text{rows}(Elevation) - 2) \\ \quad \sigma_{v_i} \leftarrow \gamma \cdot z_i + q \\ \sigma_v \end{array} \right.$$

$$\sigma_v^{\mathrm{T}} = [5202.6 \;\; 5115.5 \;\; 4953 \;\; 4715.1 \;\; 4628 \;\; 4390.1 \;\; 4368 \;\; 4303 \;\; 4238 \;\; \ldots] \;\; psf$$

$$\sigma_h := \overrightarrow{\sigma_v \cdot K_r}$$

$$\sigma_h^{\mathrm{T}} = [1470.85 \;\; 1446.23 \;\; 1400.29 \;\; 1333.03 \;\; 1308.4 \;\; 1241.15 \;\; 1234.9 \;\; \ldots] \;\; psf$$

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$$T_i := \overrightarrow{\frac{\sigma_h \cdot A_t}{\left(\frac{Rc_0}{100}\right)}}$$

$$T_i^{\mathrm{T}} = [1495.37 \;\; 1542.64 \;\; 2396.05 \;\; 1851.43 \;\; 1817.23 \;\; 1379.05 \;\; 459.66 \;\; \ldots] \;\; ft \cdot psf$$

$$T_{al2} := \left\| \begin{array}{l} \text{for } i \in \text{ORIGIN} .. (\text{rows}(Elevation) - 2) \\ \quad T_{al2_i} \leftarrow \text{lookup}\left(Type_{2_i}, Type_1, T_{al1}\right)_0 \\ T_{al2} \end{array} \right.$$

$$T_{al2}^{\mathrm{T}} = [3406.25 \;\; 3406.25 \;\; 3406.25 \;\; 2803.98 \;\; 2803.98 \;\; 2218.75 \;\; 2218.75 \;\; \ldots] \;\; \frac{lb}{ft}$$

$$FS_r := \overrightarrow{\frac{\left(\frac{T_{al2}}{lb}\right)}{\left(\frac{T_i}{psf}\right)}} \cdot ft^2$$

$$FS_r^{\mathrm{T}} = [2.28 \;\; 2.21 \;\; 1.42 \;\; 1.51 \;\; 1.54 \;\; 1.61 \;\; 4.83 \;\; 3.28 \;\; 1.82 \;\; 1.26 \;\; 5.43 \;\; 3.29 \;\; \ldots]$$

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$$Criteria_{FS\_r} := \text{for } i \in \text{ORIGIN} .. (\text{rows}(Elevation) - 2)$$
$$\quad \text{if } FS_{r_i} > 1.5$$
$$\quad\quad Criteria_i \leftarrow \text{“Yes”}$$
$$\quad \text{else}$$
$$\quad\quad Criteria_i \leftarrow \text{“No”}$$
$$Criteria$$

$$Criteria_{FS\_r}^{\mathrm{T}} = [\text{“Yes”} \ \text{“Yes”} \ \text{“No”} \ \text{“Yes”} \ \text{“Yes”} \ \text{“Yes”} \ \text{“Yes”} \ \text{“Yes”} \ \ldots]$$

$$Table\_result_2 := \text{augment}\left(\text{stack}\left(\left[\text{“Layer \#”} \ \text{“Elevation”} \ \text{“Type”}\right], \text{augment}\left(Layer\#, Elevation, Type_2\right)\right), \text{stack}\left(\text{stack}\left(\left[\text{“z (ft)”} \ \text{“A\_t(ft)”} \ \text{“K\_r”} \ \text{“S}\right.\right.\right.$$

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$Table\_result_2 =$

"Layer #"	"Elevation"	"Type"	"z (ft)"	"A_t(ft)"	"K_r"	"Sigma_v (psi)"	"Sigma_h (psi)"	"T_i"	"T_al"	"FS_r"
1	0.58 ft	1700	38.02 ft	0.92 ft	0.28	36.13 psi	10.21 psi	48112.01 $\frac{lb}{s^2}$	3406.25 $\frac{lb}{ft}$	2.28
2	1.25 ft	1700	37.35 ft	0.96 ft	0.28	35.52 psi	10.04 psi	49633.08 $\frac{lb}{s^2}$	3406.25 $\frac{lb}{ft}$	2.21
3	2.5 ft	1700	36.1 ft	1.54 ft	0.28	34.4 psi	9.72 psi	77090.52 $\frac{lb}{s^2}$	3406.25 $\frac{lb}{ft}$	1.42
4	4.33 ft	1600	34.27 ft	1.25 ft	0.28	32.74 psi	9.26 psi	59567.98 $\frac{lb}{s^2}$	2803.98 $\frac{lb}{ft}$	1.51
5	5 ft	1600	33.6 ft	1.25 ft	0.28	32.14 psi	9.09 psi	58467.6 $\frac{lb}{s^2}$	2803.98 $\frac{lb}{ft}$	1.54
6	6.83 ft	1500	31.77 ft	1 ft	0.28	30.49 psi	8.62 psi	44369.68 $\frac{lb}{s^2}$	2218.75 $\frac{lb}{ft}$	1.61
7	7 ft	1500	31.6 ft	0.34 ft	0.28	30.33 psi	8.58 psi	14789.02 $\frac{lb}{s^2}$	2218.75 $\frac{lb}{ft}$	4.83
8	7.5 ft	1500	31.1 ft	0.5 ft	0.28	29.88 psi	8.45 psi	21744.69 $\frac{lb}{s^2}$	2218.75 $\frac{lb}{ft}$	3.28
9	8 ft	1500	30.6 ft	0.92 ft	0.28	29.43 psi	8.32 psi	39191.69 $\frac{lb}{s^2}$	2218.75 $\frac{lb}{ft}$	1.82
11	9.33 ft	1500	29.27 ft	1.38 ft	0.28	28.23 psi	7.98 psi	56491.86 $\frac{lb}{s^2}$	2218.75 $\frac{lb}{ft}$	1.26
12	10.75 ft	1500	27.85 ft	0.34 ft	0.28	26.95 psi	7.62 psi	13138.46 $\frac{lb}{s^2}$	2218.75 $\frac{lb}{ft}$	5.43

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$$Outpt\_Data := \text{WRITEEXCEL}\left(\text{“C:\Output.xls”}, Table\_result_2\right)$$