

### Cantilever Soldier Pile Design

|  |                    |           |                 |  |   |
|--|--------------------|-----------|-----------------|--|---|
| Pile Size  |                    | 1.33      | ft              |  |   |
| Pile Spacing   |                    | 7.00      | ft              |  |   |
| Exposed Height of Excavation   | H                  | 11.20     | ft              |  |   |
| Pile Embedment Below Grade   | D                  | 18.20     | ft              |  |   |
| Embedment Safety Factor  | D = 1.3*D          | 23.66     | ft              | Load Factor  |   |
| Active Pressure Coefficient  | K <sub>a</sub>     | 0.54      |                 | 0.40   | 1.35  |
| Passive Pressure Coefficient   | K <sub>p</sub>     | 4.52      |                 | 3.01   | 1.50  |
| Soil Weight  | γ                  | 172.50    | pcf             | 115.00   | 1.50  |
| Soil Internal Friction Angle   | φ                  | 30.00     |                 |  |   |
| Surcharge  |                    | 337.50    | psf             | 250.00   | 1.35  |
| Arching Adjustment Factor  |                    | 0.08      |                 |  |   |
| Arching Adjustment Factor for Design   | f <sub>arch</sub>  | 2.400     |                 | MIN(3, 0.08*φ)   |   |
| Soldier Pile Spacing Factor  | f                  | 0.457     |                 | MIN(1, f <sub>arch</sub> *Pile size/Pile spacing)  |   |
| Active Soil Pressure on Lagging  | P <sub>a1</sub>    | 1043.28   | psf             | H*K <sub>a</sub> *γ  |   |
| Active Soil Pressure on Pile at Bottom of Grade  | P <sub>a'1</sub>   | 476.93    | psf             | f*γ*H*K <sub>a</sub>   |   |
| Active Soil Pressure on Pile at Bottom of Pile   | P <sub>a2</sub>    | 1251.94   | psf             | f*γ*D*K <sub>a</sub> +P <sub>a'1</sub>   |   |
| Net Soil Pressure at bottom of Pile due to Passive Pressure below bottom of grade  | P <sub>e</sub>     | 5227.99   | psf             | f*γ*D*(K <sub>p</sub> -K <sub>a</sub> )-P <sub>a'1</sub>   |   |
| Net Soil Pressure at bottom of Pile due to Passive Pressure below top of grade   | P <sub>j</sub>     | 9692.57   | psf             | f*γ*D*(K <sub>p</sub> -K <sub>a</sub> )+f*γ*H*K <sub>p</sub>   |   |
| Active Surcharge Pressure  | P <sub>q</sub>     | 182.25    | psf             | K <sub>a</sub> *Surcharge  |   |
| Distance from bottom of pile to point where passive pressure below bottom grade turns to active pressure (inflection point in soil pressure diagram);                      | Z                  | 4.88      | ft              | ((P <sub>e</sub> -P <sub>a'1</sub> )*D-H*P <sub>a1</sub> -H*P <sub>q</sub> )/(P <sub>e</sub> +P <sub>j</sub> )   |   |
| Sum of the horizontal forces   | F                  | 1020.60   | plf             | H*P <sub>a1</sub> /2+P <sub>q</sub> *H+(P <sub>a'1</sub> +P <sub>a2</sub> )*D/2+(P <sub>e</sub> +P <sub>j</sub> )*Z/2-(P <sub>e</sub> +P <sub>a2</sub> )*D/2 |   |
| Sum of Moments about bottom of pile should be equal to Zero. "Increase embedment, D, by 20-40 percent unless a FS=1.5 or 1.75 has been used on passive pressure". Use 30%. | Moment             | -128.97   | lbs             | moment.  | Adjust "D" to achieve "0"   |
|  |                    |           |                 |  | 2+C5)+C17*C5*C5/2+(C18-C17)*(C5/2)*(C5/3)+(((C19+C20)*C23)/2)*(C23/3)-(((C19+C18)*C5)/2)*(C5/3) |
| Locate Point of zero shear; Distance from bottom grade to point where net pressure turns from active to passive pressure (inflection point A in pressure diagram)          | Y                  | 1.52      | ft              | P <sub>a'1</sub> /(f*γ*(K <sub>p</sub> -K <sub>a</sub> ))  | 4.12  |
| Surcharge pressure at A  | P <sub>q'</sub>    | 83.31     | psf             | f*P <sub>q</sub>   |   |
| Shear due to surcharge at A due to surcharge pressure above point A  | F <sub>qa</sub>    | 2167.96   | plf             | H*P <sub>q</sub> +Y*P <sub>q'</sub>  |   |
| Total Shear at A   | V <sub>total</sub> | 8373.16   | plf             | H*P <sub>a1</sub> /2+P <sub>a'1</sub> *Y/2+F <sub>qa</sub>   |   |
| Soil pressure on pile  | a1                 | 156.73    | pcf             | f*γ*(K <sub>p</sub> -K <sub>a</sub> )/2  |   |
| Surcharge pressure on pile   | b1                 | -83.31    | pcf             | -1*P <sub>q'</sub>   |   |
| Total shear must equal c1  | c1                 | -8373.16  | pcf             | -1*V <sub>total</sub>  |   |
| Determinate  | dt                 | 5256192.8 |                 | b1^2-4*a1*c1   |   |
| Add determinate  | xp                 | 7.58      |                 | (-1*b1+dt^0.5)/(2*a1)  |   |
| Subtract determinate   | xn                 | -7.05     |                 | (-1*b1-dt^0.5)/(2*a1)  |   |
| Distance to equivalent amount of shear   | X                  | 7.58      |                 | MAX(xp,xn)   |   |
| Check  | V <sub>check</sub> | 9636.17   |                 | a1*X^2-b1*X  |   |
| This should equal Vtotal (+/-)   | V <sub>total</sub> | 8373.16   |                 | V <sub>total</sub>   |   |
| Moment due to soil pressure above A  | M <sub>soila</sub> | 78103.09  | ft*lbs          | (H*P <sub>a1</sub> /2*(H/3+X+Y)+P <sub>a'1</sub> *Y/2*(2/3*Y+X))*I   |   |
| Moment due to soil pressure between A and B  | M <sub>soilb</sub> | 22751.29  | ft*lbs          | (f*γ*(K <sub>p</sub> -K <sub>a</sub> )*X*(X/2)*(X/3))*I  |   |
| Moment due to surcharge above excavation   | M <sub>qh</sub>    | 30008.38  | ft*lbs          | (P <sub>q</sub> *H*(H/2+Y+X))*I  |   |
| Moment due to surcharge below excavation   | M <sub>qd</sub>    | 7548.29   | ft*lbs          | (P <sub>q</sub> *X*(X+Y)*(X+Y)/2)*I  |   |
| Total Moment   | M <sub>totb</sub>  | 650359.3  | ft*lbs          | H*(M <sub>soila</sub> -M <sub>soilb</sub> +M <sub>qh</sub> +M <sub>qd</sub> )  |   |
| Pile Section Modulus Required (F <sub>b</sub> = 0.9*F <sub>y</sub> )   | S <sub>x</sub>     | 173.43    | in <sup>3</sup> | M <sub>totb</sub> *12/(50*1000*0.9)  |   |