	Project				Job Ref.	
	Section				Sheet no./rev. 1	
	Calc. by RSF	Date 9/21/2012	Chk'd by	Date	App'd by	Date

SOLDIER PILE DESIGN – CANTILEVER WITH UNIFORM SURCHARGE;

Design Parameters;

Spacing of Piles;	S=8ft;	
Width of Piles;	b=14in;	
Soil weight;	γ=120pcf	
Frictional angle;	ϕ=28deg;	
Live Load;	qLL=30psf	

Soil Properties;

Acctive Pressure Coefficient;	Ka=0.35	
Passive Pressure Coefficient;	K'p=2.77	
Factor of Saftey on passive pressure;	KpFS=1.0;	Kp=K'p/KpFS; Kp=**2.770**
At-Rest Pressure Coefficient;	Ko=0.531	

Cantilever Design;

Height of Excavation;	H=8ft	
Embedment below bottom grade;	D =13.8 ft;	
"Increase 20-40 percent or use FOS=1.5 / 1.75";	D_{use}=1.30*D;	D_{use}=**17.940**ft
Arching Adjustment Factor; f_{arch}=min(3,.08*ϕ);	f_{arch}=**2.240**	
Soldier Pile Spacing Factor; f=Min(1, f_{arch} *b/S);	f=**0.327**;	
Active soil pressure on lagging;	P_{a1}=γ*H*Ka;	P_{a1}=**336.000**psf;
Active soil pressure on pile at bottom grade;	$P_{a'1}$=f*γ*H*Ka;	$P_{a'1}$=**109.760**psf;
Active soil pressure on pile at bottom of pile;	P_{a2}= f*γ*D*Ka+ $P_{a'1}$;	P_{a2}=**299.096**psf
Net Soil pressure at bottom of pile due to passive pressure below bottom grade;	P_e= f*γ*D*(Kp-Ka)- $P_{a'1}$;	P_e=**1199.363** psf;
Net Soil pressure at bottom of pile due to passive pressure below top grade;	P_j= f*γ*D*(Kp-Ka)+ f*γ*H*Kp;	P_j=**2177.795** psf;
Active surcharge pressure;	P_q=Ka*qLL;	P_q=**10.500**psf;
Distance from bottom of pile to point where passive pressure below below bottom grade turns to active pressure (inflection point in soil pressure diagram);	Z=((P_e-$P_{a'1}$)*D-H*P_{a1}-H*P_q)/(P_e+P_j);	Z=**3.632**ft;

Sum of Horizontal Forces;

F_H=H*P_{a1}/2+P_q*H+($P_{a'1}$+P_{a2})*D/2+(P_e+P_j)*Z/2-(P_e+P_{a2})*(D)/2; F_H=**42.000**plf;

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";

R= (H*P_{a1}/2)*(H/3+D)+P_q*H*(H/2+D)+ $P_{a'1}$*D*D/2+(P_{a2}-$P_{a'1}$)*(D/2)*(D/3)+(((P_e+P_j)*Z)/2)*(Z/3)-(((P_e+P_{a2})*D)/2)*(D/3);

R=**-50.494**lbs

	Project				Job Ref.	
	Section				Sheet no./rev. 2	
	Calc. by RSF	Date 9/21/2012	Chk'd by	Date	App'd by	Date

Moment;

Locate Plane of zero shear;

Distance from bottom grade to point where net pressure turns from active to passive pressure (inflection point A in pressure diagram); $Y=P_{a'1}/(f*\gamma*(Kp-Ka))$; Y=**1.157**ft

Surcharge pressure at A; $P_{q'}= f*P_q$; $P_{q'}$=**3.430**psf

Shear due to surchage at A due to surcharge pressure above point A; $F_{qa}=H*P_q+Y*P_{q'}$

F_{qa}=**87.969**plf

Total Shear at A; $V_{tota}=H*P_{a1}/2+P_{a'1}*Y/2+F_{qa}$; V_{tota}=**1495.466**plf

Point of zero shear (point B) will be loacated a propotional distance with the same amount of shear from point A;

Soil pressure on pile; $a1=f*\gamma*(Kp-Ka)/2$;

Surcharge pressure on pile; $b1=-1*P_{q'}$;

Total shear must equal c1; $c1=-1*V_{tota}$;

a1=**47.432**pcf; b1=**-3.430**; c1=**-1495.466**;

Determinate; $dt=b1^2-4*a1*c1$; dt=**283743.560**

Add determinate; $xp=(-1*b1+dt^{0.5})/(2*a1)$; xp=**5.651**

Subtract determinate; $xn=(-1*b1-dt^{(1/2)})/(2*a1)$; xn=**-5.579**

Distance to equivalent amount of shear; X=max(xp,xn); X=**5.651**

Check; $Vcheck=a1*X^2-b1*X$; Vcheck=**1534.234**

This should equal Vtota(+-); V_{tota}=**1495.466**

Moment at B

Moment due to soil pressure above A;

$M_{soila}=(H*P_{a1}/2*(H/3+X+Y)+P_{a'1}*Y/2*(2/3*Y+X))*1ft$; M_{soila}=**13142.225**lb_ft

Moment due to soil pressure between A and B;

$M_{soilab}=(f*\gamma*(Kp-Ka)*X*(X/2)*(X/3))*1ft$; M_{soilab}=**2853.629**lb_ft

Moment due to surcharge above excavation;

$M_{qh}=(P_q*H*(H/2+Y+X))*1ft$; M_{qh}=**907.900**lb_ft

Moment due to surcharge below excavation;

$M_{qd}=(P_q*(X+Y)*(X+Y)/2)*1ft$; M_{qd}=**243.355**lb_ft

$M_{totb}=S*(M_{soila}-M_{soilab}+M_{qh}+M_{qd})/1ft$; M_{totb}=**91518.809**lb_ft

$S_{xr'd}=M_{totb}/(22*1ksi)$; $S_{xr'd}$=**49.919**in^3

Lagging (multiply height of lagging by load);

Load per foot of height; $W_{lag}=(P_q+P_{a1})$; W_{lag}=**346.500**psf

Moment per foot of height; $M_{lag}=W_{lag}*S^2/8$; M_{lag}=**2772.000**lb