	Project				Job Ref.	
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ANCHORED SOLDIER PILE DESIGN

ANCHORED SOLDIER PILE RETAINING WALL;

Refer to California Trenching and Shoring Design Manual '90 (Nomenclature has been changed slightly in calculation);

Geometry and Soil Parameters;

Exposed Wall Height;	H=7.0ft;
Distance to anchor from top of wall;	a=1.5ft;
Angle of anchor from horizontal;	θ=15deg;
Spacing of Piles;	S=4ft;
Width of Piles;	b=3.5in;
Soil weight;	γ=120pcf
Frictional angle;	ϕi=28deg;
Interface friction angle (at back of wall);	δi=0deg;
Live Load;	qLL=320psf
Wall batter;	ω=0deg
Backslope;	β=0deg;
Distance to broken back;	db=8ft;
Toe slope (use negative);	β'=-12deg
Horizontal Distance to flat ground at toe;	db'=20ft;
Equivalent backslope;	βeq=if(db<2*H,atan(db*tan(β)/(2*H)),β); βeq=**0.000**deg;
Equivalent toe slope (approx);	βeq'=if(db'<2*H,atan(db'*tan(β')/(2*H)),β'); βeq'=**-12.000**deg;
Arching Adjustment Factor; f_{arch}=min(3,.08*ϕi);	f_{arch}=**2.240**
Soldier Pile Spacing Factor; f=Min(1, f_{arch} *b/S);	f=**0.163**;

Active pressure coefficient;;

Ka=cos(ϕi+ω)^2/[(cos(ω)^2)*cos(ω-δi)*[1+[(sin(ϕi+δi)*sin(ϕi-βeq))/(cos(ω-δi)*cos(ω+βeq))]^(0.5)]^2];

Ka=**0.361**

Kah=Ka*cos(δi-ω);	Kah=**0.361**
Kav= Ka*sin(δi-ω);	Kav=**0.000**;

Internal failure plane;

α_a=atan((-1*tan(ϕi-βeq)+(tan(ϕi-βeq)*(tan(ϕi-βeq)+cot(ϕi+ω))*(1+tan(δi-ω)*cot(ϕi-ω)))$^{0.5}$)/(1+tan(δi-ω)*(tan(ϕi-βeq)+cot(ϕi-ω))))+ϕi=**59.000**deg;

Passive pressure coefficient;

Kp=cos(ϕi-ω)^2/[(cos(ω)^2)*cos(ω+δi)*[1-[(sin(ϕi+δi)*sin(ϕi+βeq'))/(cos(ω+δi)*cos(ω+βeq'))]^(0.5)]^2];

Kp=**1.926**

Kph=Kp*cos(δi-ω);	Kph=**1.926**
Kpv= Kp*sin(δi-ω);	Kpv=**0.000**;

Internal failure plane;

α_p=atan((-1*tan(ϕi+βeq')-(tan(ϕi+βeq')*(tan(ϕi+βeq')+cot(ϕi+ω))*(1+tan(δi-ω)*cot(ϕi-ω)))$^{0.5}$)/(1+tan(δi-ω)*(tan(ϕi+βeq')+cot(ϕi-ω))))+ϕi=**-19.073**deg;

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Soil Pressures / Toe Embedment;

Depth of embeded toe; D=7.4ft;

Increase embeded toe depth by 30% or use FS on Pp; D'=1.3*D=**9.620**ft;

Active soil pressures;

Active soil pressure per foot of depth on lagging; Qs=Ka*γ=**43.324**pcf;

Active soil pressure at depth of excavation on lagging; Ps=Qs*H=**303.268**psf;

Active surcharge pressure on lagging; Pq=Ka*qLL=**115.531**psf;

Total Active pressure on lagging at depth of exc; Pa=Ps+Pq=**418.799**psf;

Active soil pressure on soldier pile at depth of exc.; P's=f*Qs*H=**49.534**psf;

Active surcharge pressure on soldier pile; P'q=f*Ka*qLL=**18.870**psf

Total Active pressure on soldier pile at depth of exc; P'a=P's+P'q=**68.404**psf;

Depth to zero net pressure; Y=P'a /(f*γ*(Kp-Ka)) =**2.231**?ft;

Force of soil pressure on lagging; Fs=Ps*H/2=**1061.438**plf;

Force of surcharge pressure on lagging; Fq=Pq*H=**808.715**plf;

Force of active soil pressure on soldier pile below exc; F's=P's*Y/2=**55.244**plf;

Force of active soil pressure on soldier pile below exc; F'q=P'q*Y=**42.091**plf;

Passive soil pressures;

Passive pressure per foot of depth on soldier pile; Qp=f*Kp*γ=**37.743**pcf;

Depth of net passive pressure; d=D-Y=**5.169**ft;

Passive pressure at toe of pile; Pp=Qp*d=**195.109**psf;

Force of passive pressure on pile; Fp=Pp*d/2=**504.301**plf;

Sum moments about anchor (equal to zero);

M=Fs*(2/3*H-a)+Fq*(H/2-a)+F's*(H-a+Y/3)+F'q*(H-a+Y/2)-Fp*(H-a+Y+2/3*d)=**-0.034**kip_ft/ft;

Anchor Forces;

Horizontal comp anchor tension; T=Fs+Fq+F's+F'q-Fp=**1463.187**plf;

Total Horiz comp anchor tension; Ttot=T*S=**5.853**kip;

Actual Tension; FT=Ttot/cos(θ)=**6.059**kip;

Vertical load on pile; FV=Pr=FT*sin(θ)=**1.568**kip;

Maximum moment on pile;

Locate point of zero shear (max moment); "Ps/(2*H)*x^2+Pq*x-T=0plf";

Quadratic; a1= Ps/(2*H)=**21.662**pcf; b1= Pq=**115.531**psf; c1=-1*T=**-1463.187**plf;

Determinate; dt=$b1^2$-4*a1*c1; dt=**140129.636**

Add determinate; xp=(-1*b1+$dt^{0.5}$)/(2*a1); xp=**5.974**

Subtract determinate; xn=(-1*b1-$dt^{(1/2)}$)/(2*a1); xn=**-11.307**

Distance to equivalent amount of shear; x=max(xp,xn)=**5.974**ft;

Check shear equals zero; Ps/(2*H)*x^2+Pq*x-T=**0.000**plf;

Max moment btwn exc and anchor; M1= -Ps/(2*H)*x^2*(x/3)-Pq*x*(x/2)+T*(x-a)=**2.945**kip_ft/ft;

Max moment above anchor; M2=Ps*a/H*a/2*a/3+Pq*a*a/2=**0.154**kip_ft/ft;

Max moment; Mmax=max(M1,M2)=**2.945**kip_ft/ft;

Design moment; Mr=Mmax*S=**11.781**kip_ft;

Lagging;

UDL per foot of height at bottom of excavation; Wlag=Pa+Pq=**534.330**plf/ft;

Moment on lagging; Mlag=(Wlag)*S^2/8=**1.069**kip_ft/ft;

Summary;

Embedment of toe; D'=**9.620**ft;

Tension on anchor; FT=**6.059**kip;

Shear on pile; Vr=Ttot=**5.853**kip;

Axial load on pile; Pr=**1.568**kip;

Moment on pile; Mr=**11.781**kip_ft;

Moment on lagging (per foot height of lagging); Mlag=**1.069**kip_ft/ft;