Soldier Pile Design – 1 Anchor

Soil / Wall / Live Load

Spacing of Piles;	S=6ft;
Width of Piles;	b=2ft;
Live Load;	qLL=100psf
From Table 6 page 71 of FHAW Crcl 4;	
Diameter of Anchor;	D_{anc}=16in
Bond Capacity in square feet;	B_c=600psf
Anchor tranfer load;	A_{tl}=pi*D_{anc}*B_c
	A_{tl}=**2513.2741**plf
Anchor angle;	φ=15deg;
Height of Excavation;	H=12ft
Height of Anchor from Top of wall down;	H_1=4ft
Height Below H_1; H_2=H-H_1;	H_2=**8.0000**ft
Pile Steel Matieral F_b;	F_b=50ksi

Reese-Wang Equations

Soil weight;	γ=120pcf
Frictional angle;	ϕ=28deg;
β=45+ϕ/2;	β=**59.0000**deg
Typicaly between 1/3 and 2/3; α=0.416*ϕ;	α=**11.6480**deg
bf=β-ϕ;	bf=**31.0000**deg
tf=tan(ϕ);	tf=**0.5317**
tb=tan(β);	tb=**1.6643**
ta=tan(α);	ta=**0.2061**
tbf=tan(bf);	tbf=**0.6009**
Ka=tan(45-ϕ/2)^2;	Ka=**0.3610**
Kp= tan(45+ϕ/2)^2;	Kp=**2.7698**
Ko=1-sin(ϕ);	Ko=**0.5305**
Clear space; Sc=S-b;	Sc=**4.0000**

FHWA Anchor Design

Equivlant Soil Pressure

Pe=0.65*γ*Ka*H^2/(2/3*H);	Pe=**506.8910**psf
Surcharge Pressure	
Ps=Ka*qLL;	Ps=**36.1033**psf

Horizontal Loads and Moments T.A. Method

Trib Area 1; T_1=H_1+H_2*.5;	T_1=**8.0000**ft
Force on Anchor 1; T_{h1}=T_1*Pe+T_1*Ps;	T_{h1}=**4343.9549**plf

Moment @ point 1; M_1=13/54*H_1^2*Pe;	M_1=**1952.4691**lb
T_{1m}=((23*H^2-10*H*H_1)/(54*(H-H_1)))*(Pe+Ps);	T_{1m}=**3559.6297**
Reaction at Base; R=2/3*H*(Pe+Ps)-T_{1m};	R=**784.3252**lb/ft
Point of zero shear	
$X_{noshear}$=1/9*((26*H^2-52*H*H_1))^(1/2);	$X_{noshear}$=**3.9252**
Moment between 1 and bottom of exc;	
M_{12}=R*$X_{noshear}$-((Pe+Ps)*$X_{noshear}$^3)/(4*(H-H_1));	M_{12}=**2052.4363**
Design Moment	
M_d=S*max(M_1,M_{12});	M_d=**12314.6177**lb_ft
S_{xreqd}=M_d/(0.55*F_b);	S_{xreqd}=**5.3737**in^3
Minimum Dia required	
Flange Width ;	fw=10.5in
Space between channeles;	b_{os}=0in
Depth of beam;	d=16in
Dia=((fw+b_{os})^2+d^2)^(1/2);	Dia=**19.1377**in

Requireded Embedment

R_{load}=R*S+0.5*D*Ka*γ*(2*H+D)*b;	R_{load}=**30050.5017**
Embedment;	D=15ft

Rankine Continous; Eq-B6

Prc=Kp*γ*D*(Sc+b); Prc=**29914.1229**

Depth of adjacent wedges Eq B-3, should be positive so do not intersect;

di=D-Sc/(2*ta*tb); di=**9.1705**

Eb21=γ*D*((Ko*D*tf*sin(β)/(tbf*cos(α)))+tb/tbf*(b+D*tb*ta)+Ko*D*tb*(tf*sin(β)-ta));

Eb21=**52673.2993**

Eb22= γ*di*((Ko*di*tf*sin(β)/(tbf*cos(α)))+tb/tbf*(b+di*tb*ta)+Ko*di*tb*(tf*sin(β)-ta));

Eb22=**22056.7021**

hi=D-di; hi=**5.8295**

Eb23= γ*hi*((Ko*hi*tf*sin(β)/(tbf*cos(0)))+tb/tbf*(b+hi*tb*tan(0))+Ko*hi*tb*(tf*sin(β)-tan(0)));

Eb23=**7157.3406**

Pwr=if(di<0ft,Eb21,Eb21+Eb22-Eb23); Pwr=**67572.6608**

EqB-5 Flow Resistance;

Pfr=Ka*b*γ*D*tb^8+Ko*γ*D*tf*tb^4*1ft; Pfr=**80395.2333**

Minimum Passive Resistance;

Ppr=min(Pfr,Prc,Pwr); Ppr=**29914.1229**plf

Total Passive Force

Fpr=Ppr*D/2-R*1ft; Fpr=**223571.5966**

Active Pressure at Exc “(D=0)”

Papo=Ka*γ*(H); Papo=**519.8882**

Active Pressure At Depth D

Pap=Ka*γ*(H+D); Pap=**1169.7485**

Active Force

Fap=(Papo+Pap)/2*D*b; Fap=**25344.5505**

Check Rload and Rtot should be same

R_{load}=**30050.5017**

R_{tot}=Fap+R*S; R_{tot}=**30050.5017**

Factor of Saftey

FS=Fpr/R_{tot}; FS=**7.4399**

Anchor Design

Load on Anchor 1;

$DL_1=T_{h1}*S/\cos(\varphi)$; DL_1=**26983.1581**lbs

Bond Length with “FS=2.0 must add unbonded length equal to min of 4.5m(14.76’) or 2m(6.562’) beyond critical failure surface”;

$L_{bond}=DL_1/A_{tl}$; Lbond=**8.1778**ft

Failure Plane from vertical; $\psi=45-\phi/2$;

ψ=**31.0000**deg

Angle between failure plane and Anchor; $\Delta=180-(90-\varphi)-\psi$;

Δ=**74.0000**deg;

Unbonded Length; $L_{ub}=H_2*\sin(\psi)/\sin(\Delta)$;

L_{ub}=**4.2864**

$L_{tot}=L_{ub}+L_{bond}$; L_{tot}=**15.0226**

Axial Load

Wieght of soldier beam plf; Wsbplf=

Wieght of precast psf; Wpc=?

Wtanchor=Th1*sin(p); Wtanchor=?

Wtsbeam=(H+D)*Wsbplf; Wsbeam=?

Wtconc=150pcf*pi*b^2/4*D; Wconc=?

Wtprecast=Wpc*H*S; Wtprecast=?

Wtot=Wtanchor+Wtsbeam+Wtconc+Wtprecast; Wtot=?