CON	SULTING	Enginoorin	a Calculatio	n Shoot		Job No		Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	II Sheet		iXX	x		1	
			J			J, () (.			-	
						Member/Lo	cation			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Dig. Mada by		Doto •		hd
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	ХХ	^{Date} 21	/11/2021	ina.
N										
Material I	roperties									
Charactori	tio otropoti			N/m^2			1	• •	NI /	OK
Viold strop	ath of longi	tudinal stop	.e, i _{cu} (≤ 60 √ f	mymm;⊓:	SC N/A)		4		N/mm	UK
Vield stren	ath of shee	r link stool	f				4	60 T	N/mm ²	
	ncrete and	density o	'yv		Normal	Weight		24	kN/m^3	
Concrete r		elasticity F		Cracked Long	Term (Creen)	reight	-	7000	N/mm^2	
					renn (creep)		•	7000		
Steel shee	l t nile steel (arade						\$270GP ▼		
Steel shee	t pile desiar	n strength.	n					270	N/mm ²	
Steel shee	t pile modu	lus of elasti	city, E _c					205000	N/mm ²	
								203000		
Factor of	Safety									
Factor of s	afety metho	bc			FC	DS on Ov	erall [Effect 💌		
	Factor of s	afetv (soil s	trenath), F	 OS₁ = {FOS	Sc', FOStand',	FOSsu	FOS	Stans'}		
		Factor of s	afety, FOS	= 1.2		30/		1.0		BS8002
		Factor of s	afety, FOS _t	and' = 1.2				1.0		BS8002
		Factor of s	afety, FOS	 = 1.5				1.0		BS8002
		Factor of s	afety, FOS _t	$\frac{1}{2} = 1.2$				1.0		BS8002
	Factor of s	afety (overa	all net (effe	ctive) beari	ng), FOS ₂ (2.5	2.5		
	Factor of s	afety (overa	all sliding re	esistance), l	FOS ₃ (usual		1.4	1.4		
	Factor of s	afety (overa	all uplift res	sistance), FO	OS₄ (usually		1.0	1.0		
	Factor of s	afety (overa	all overturn	ing resistan	ice for conc		1.4	1.4		
	Factor of s	afety (base	heave insta	ability), FOS	S_6 (usually		1.2	1.2	Koh	saka & Ishi:
Loading fa	ctor, K (bet	ween 1.20	and 1.40)					1.40		BS8110
Note loadi	ng factor K	multiplies S	LS loads fo	r ULS loads	for section	(reinfo	orcer	nent) desig	n; d	cl. 2.4.3.1.1
Soil Desc	ription									
Water unit	weight, γ_w	= 9.81kN/n	n ³					9.8	kN/m ³	
Soil name					User Defined			•		
Dry bulk u	nit weight, [,]	γdry						18.0	kN/m ³	
Saturated	bulk unit w	eight, γ _{sat}						20.0	kN/m ³	
Undrained	shear stren	ngth limit to	adopt ?			Le	ower	Limit 🔻		
	Undrained	shear stren	igth (lower	limit) (facto	ored), S _{u,II} /	FOS_{Su}		50.0	kPa	
	Undrained	shear stren	gth (upper	limit) (facto	ored), S _{u,ul}	/ FOS _{SL}		50.0	kPa	
Undrained	shear stren	igth limit ac	lopted (fact	ored), S _u /	$FOS_{Su} = \{S_{Su} \in S_{Su}\}$	S _{u,II} /FOS	5 _{Su} , (50.0	kPa	
Note that .	S _u can be c	btained fro	m SPT (Str	oud) values	;					Tomlinson
Ignore effe	ective cohes	sion (factore	ed), c' / FOS	S _{c'} ?	E	Exclude	▼	0.0	kPa	
Effective a	ngle of shea	ar resistanc	e (factored)), tan¹ (tan	ιφ' / FOS _{tanφ}	·)		30.0	degrees	
Note that	ϕ' can be of	btained fror	n SPT (Pecl	k) or CPT (L	Durgunoglu	and Mi	tche	ll) values;		Tomlinson
Effective a	ngle of frict	ion on 0.66ø'	(Insitu Concre	te Active Zone	- Soil Interfac	e)	•	19.8	degrees	
Effective a	ngle of frict	ion on 0.50ø'	(Insitu Concre	te Passive Zon	e - Soll Interfa	ice)	 ▼ − 	15.0	degrees	
	ngle of frict	ion on 1.000'	(Last in Place	Concrete - Sol		dina		30.0	degrees	pored:
Note that i	or coulomb		alikille) the	orice st	uces K _a an	n net	ases	κ _p , conse	valively igi	ioreu;
wole that i	or Doth COL	and F	kalikine the	ories, d'CC	nisiderea ol	n active	: wai	n, passive v	vali and bas	ж;
lladua :	d Drainad) Pearing	Canad	4 -1 -			
onaraine	u, prained		.ai Overall	LITECTIVE) bearing	Capac	LY			
Gross (off	 	ing canacity	(acoral					250	k Pa	
Note that	the arose (c	offective) be	paring cana	rity above i	sunfactoro	d.		250	κr α	
			anny capat			<i>u</i> ,				
	1	1	1	1	l .	1		I	1	

CON			<u> </u>			Job No.	Sheet No.		Rev.
	SULTING	Engineerin	g Calculatio	n Sheet		2000		2	
ENGI	NEEKS	Consulting	cilgineers			JXXX		2	
						Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.	1		
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by XX	Date 21	/11/2021	hd.
Analysis I	1ethod								
Undrained	or drained	analysis ?				Drained Analy	vsis 🔻		
	For clays,	perform und	drained and	drained an	alyses;			_	
	For sands ,	/ gravels, p	erform drai	ned analysi	s;				
	For rocks,	perform dra	ained analys	sis;	,				
Rankine or	Coulomb t	, heory for K,	and K _n (fo	r drained a	nalysis only	Coulomb The	orv 🔻		
At Rest or	Active K _a (f	or drained a	analysis onl	y)?	, ,		Active	_	
			,					_	
Evaluate o	verall uplift	resistance	?				Yes 🔻	1	
Note that o	overall uplif	t resistance	e (mid third) is conserv	ative to ove	erturnina. t	hus mav ir	certain	
instances l	be deemed	to be overc	onservative	and subse	auently ian	ored:			
						,			
Retaining	Wall Dime	ensions							
Retaining	vall type		Concrete Cant	tilever Retainin	a Wall	1		1	
Depth of re	etained soil	(active ear	th pressure), d ₋			3 900	m	L
Depth of re	esistina soil		arth nressur	-р) d			1 200	m	
Note that (d should h		in anticinat	ion of possi	ihle unnlanı	ned excavat	tion to the	minimum	858002
of the larg	er of 0 5m	and 0 10d							D30002
Dry or cat	urated coil k		/ viaht 2			Saturated Soil			
Depth of w	vator tablo f	rom surface	of retaine	d soil d			2 400		OK
Depth of w	ater table i	from curface					2.400		
Note that	d and d		rad to be pr	y son, u _{pw}	warde: Un	dorwator ro	taining wa	ll not catore	d for:
	anu u _{pi}	w die iequii			iwaius, one	uerwaler re			0101,
Angle of sc			n, p (< – 90	·)			0.0	uegrees	UK
Potoining	Wall Bain	forcomont							
Retaining			•						
Cover to a	 (wall into	nal face) re	inforcemer	nt cover (i	icually MAX	(25 J)	21	mm	
Cover to a	ll (wall ovto	rnal face) r	oinforcomo	r_{1} cover ($(23, \psi)$	50	mm	
Cover to a		tom and sid	la) roinforce	mont cover		$\frac{1}{75}$			
Cover to a			pont covor	(ucually M		ntornal: 10			
				t (usually M	ΑΛ(23, ψ) Π		J		
Dotoining		Looding							
Recaining	Wall SLS	Loading							
Curchange	at aurface	(an active e	ida) n (n	ainina. 10			10		00000
Surcharge		(on active s	nue), p _{s,a} (n		крај		10	кра	BS8002
Surcharge	at surface	(on passive	side), p _{s,p}				(кра	CI. 3.3.4.1
I									

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	NEEDS	Consulting	g Calculatio Engineers	n Sneet		ivvv	,		2	
ENGI	NEEKS	Consulting	Lingineers]~~~	•		5	
						Member/Loc	ation			
Job Title	Structure,	Member De	esign - Geot	echnics Ret	aining Wall	Drg.				
Structure,	Member De	esign - Geot	echnics Ret	aining Walls	5	Made by	хх	Date 21	/11/2021	hd.
Executive	Summary	1								
	_									
Overall net	(effective)	bearing ca	pacity			15%)	ОК		
Overall slic	ling resista	nce capacity	/			97%)	ОК		
Overall upl	ift resistan	ce capacity				96%)	ОК		
Overall over	erturning re	esistance ca	pacity			80%)	ОК		
	Concrete	Gravity Re	taining Wa	all						
	Note conci	rete gravity	retaining w	all reinforce	ement desig	gn not re	equ	ired since t	here is	
	no axial, s	hear or ben	ding effects	7						
	Concrete	Cantilever	Retaining	Wall						
	Bending m	oment in st	em			56%)	ОК		
	% Min long	gitudinal rei	nforcement	in stem		25%)	ОК		
	Ultimate s	hear stress	in stem			7%		ОК		
	Shear desi	gn capacity	in stem			49%	•	ОК		
	Bending m	oment in he	eel			0%		ОК		
	% Min long	aitudinal rei	nforcement	in heel		58%)	ОК		
	Ultimate s	hear stress	in heel			0%		ОК		
	Shear desi	an capacity	in heel			0%		ОК		
	Bendina m	oment in to	e			81%		ОК		
	% Min Ion	aitudinal rei	nforcement	in toe		58%	5	ОК		
	Ultimate s	hear stress	in toe			2%		ОК		
	Shear desi	an capacity	in toe			26%		OK		
	Deflection	requiremen	ts in stem			1339	6	NOT OK		
	Detailing r	equirement	s				Ō	K		
	Decaming									
	Concrete	or Steel Ca	antilever E	mbedded I	Retaining	Wall				
	Iteration fo	or moment	equilibrium	calculation			N	/Α		
	Bendina m	oment in w	all			N/A		N/A		
	% Min long	nitudinal rei	nforcement	in wall		N/A		N/A		
	Ultimate s	hear stress	in wall	in wan		N/A		N/A		
	Shear desi	an canacity	in wall			Ν/Δ		N/A		
	Deflection	requiremen	ts in wall (f	irst principle	25)	Ν/Δ		N/A		
	Deflection	requiremen	ts in wall (F	358110 met	hod)	Ν/Δ		N/A		
	Detailing r	equirement		50110 met	nou)		N	/Δ		
	Detailing I									
	Concrete	Pronned (Basement'	Retaining	Wall					
	Bending m	oment in st	em	,		N/A		N/A		
	% Min Ion	nitudinal rei	nforcement	in stem		N/A		N/A		
	Ultimate c	hear stress	in stem			N/A		N/A		
	Shear deci	an canacity	in stem			N/A		N/A		
	Deflection	requiremen	ts in stom			N/A		N/A	l	
	Detailing r	equirement	s				N	/Δ		
	Decanny I		-							
	Concrete	or Steel P	ronned (Ra	sement) F	mbedded	Retain	ina	Wall		
	Iteration f	or moment	equilibrium		meducu	Actain		/A		
	Bonding m		all	calculation						
	% Min long		uii nforcemont	in wall		N/A		N/A		
		hear stross	in wall	ni wall		N/A				
	Shoar dae	an canacity	in wall					N/A		
				irct principle				N/A		
	Deflection	requiremen	ts in wall (T		bod)			N/A		
	Detailing	aquirement	rts ill wall (E	osorin met	100)	N/A	N	N/A		
	Detailing r	equirement	5				-N,			

						Job No.	Sheet No.		Rev.
CON	SULTING	Engineerin	g Calculatio	n Sheet					
ENGI	NEERS	Consulting	Engineers			jXXX	4	1	
						Member/Location			
Job Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure.	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
0 0. 00001 07				annig tran	•				
Overall util	isation sum	mary					133%		
	Sacion Sam						200 /0		
% Sagging	reinforcem	ent in stem	1				0 52	0/0	
% Sagging	reinforcem	ont in hool					0.32	70 0/2	
% Sagging	reinforcem	ent in too					0.22	70 0/2	
% Vortical	reinforcem	ont in nile /	wall				N/A	70 0/2	
Estimated		rcement au	antity				38	ka/m^3	
	steel reinio	ity in ka/m	$\frac{3}{3}$ can be al	htainad frar	n 70 E v 0/	robarli	50	ку/п	
Matorial co	steer quant	.п.у III ку/III			$\frac{1170.5 \times \%}{1000}$	rebarj;	2500	unite/tonn/	
	si.	atorial cost				SLEEL, S	202	units/tonine	=
Reinforceu	concrete m	laterial cost	c = c + (est.)	rebar quan	.).\$		383	units/m ²	
Docian tat	l longth of	omboddod	rotainina						
Design tota	a length of	enneaged	retaining W	all, L _T			N/A	IU	
		,					,, · · ,		
Note that f	urther to th	ie above, tr	ne susceptit	oility of the	retaining w	all to the fo	ollowing sho	puld	
also be inv	estigated: ·	-							
(i)	base heave	e instability							
(ii)	piping insta	ability							
(iii)	slope insta	bility							
(iv)	water pres	sure on she	et piled exe	cavations in	clay				
								<u> </u>	
								1	
L		1				1		1	

CON	ISULTING	Engineerin	a Calculatio	n Chaot			Job No		Sheet No.		Rev.	
ENGI	NEERS	Consulting	Engineers	in Sheet			iXXX	ĸ		5		
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lab Titla	Structure	Mombor D		achaica D	lot	aining Wall	Dra.	cation				
JOD TILLE	Member De	Member De	esign - Geor				Made by	vv	Date 7	1/11/2021	3hd.	
Structure,		sign - Geol			an	5		~~	Ζ.	1/11/2021		
Factor of	Safety Me	thod for R	l etaining W	alls								
Two appro	aches to th	e applicatio	n of factor	of safety	are	e adopted i	n the ca	alcul	ations her	ein, i.e.		
	FOS on soi	l strength,	or									
	FOS on ove	erall effect;										
Note that	FOS on soil	strength in	lieu of FOS	on overa	<i> </i>	effect effec	tively r	esul	ts in a doι	ible counting	7	
of FOS / Ic	ad factor fo	or ULS men	ber design	since the	U	LS design i	s subjec	ct to	the loadii	ng factor, K.		
Although c	onservative	e, should ec	onomy be r	equired,	FC	S on overa	ll effect	shc	ould be em	ployed in lie	eu	
of FOS on	soil strengt	h for ULS n	nember des I	ign, altho	ug	h both app	roaches	s sho	ould be inv	estigated fo	or I	
the overall	stability er	rects;										
The forme	r method i i	e the FOS	nn soil strei	nath is de	isc	rihed as th	o strenc	nth f	actor met	hod F ·	Tomli	ncon
								,				
Meth	od 2 is referre	d to as the fa	ctor of safety	on shear	Ħ	Table 2.2 Pa	artial facto	ers on	material proj	perties for conve	ntional	
strength	(r _s) method	and is appli	ed to embedd	ed walls.	┦	design situatio	ons for ulti	mate	limit states			
Furocode	The strep 7 approach w	ngth factor r	nethod repres	ents the -		Material p	roperty			Partial factor	γ m	
the partia	al factors for	materials (y	m). The chara	acteristic		Tan φ				(1.2-1.25) (1.5-1.8)		
soil stren	gth could be t	aken as corre	sponding to the	e values						(1.0 1.0)		
the same	approach A v as the partia	l factors in E	Eurocode 7 (s	ee Table		5.25(2)) = 2	When th	e wa	Il is acting a	as a cantilever	(Fig.	
2.2).	-	1	1923 - C.			represent the	e passive	resis	stance mobil	lized at the rea	in due	
		For the can	tilever condit	tion (Fig.		to fixity at the	he toe (th	ie me	ethod is also	known as the	fixed	
5.25(<i>a</i>))	the depth d_0	must satisfy t	he equation	e -		book for the	t method design o	f she	given in the set pile walls	British Steel	hand-	
PP	$L_{\rm P} + P_{\rm WP}L_{\rm WI}$	$P = P_A L_A +$	$P_{WA}L_{WA}$.	(5.1)		ooon for me	acorgii o	1 0110	er prie main			
De	sign depth d =	= d _o		(5.2)								
Then d i	is increased fu	irther by 20 p	er cent to allo	w for the								
simpility	ing assumptio	on of the force	ск.	100 B (100 -								
The latter	method i.e.	the FOS of	n overall efi	fect is des	SCr	ibed as the	factor	on n	noments r	nethod, F _p ;	Tomli	nson
Matho	d 3 is applies	hla to amhad	dad and free	standina				_			<u>ل</u> م	
walls (Fi	ig. 5.26). It is	s known as t	he factor of s	afety on -	_	t.		Λ			-	
moments	(F_p) method	, and also as	the CP2 met	hod, the	_			/				
Code of	Practice: Ea	institution of rth-retaining	Structural En	figineers' This was	_		- /					
published	d in 1951, b	ut its revisio	on was long	delayed	_	Ĩ,	^	┥	b		-	
aspects o	of lack of agi f retaining wa	reement on the	he many cont	roversial	_		t /		W			
The de	pth of embed	ment or the p	roportions of	the wall		<u> </u>	L _A			-71		
stem and	base are calc	ulated, when	taking momer	nts about		_	•			$\frac{\Gamma_p}{T}L_p$		
the toe	to satisfy the	equation						(a)		T		
Fp	= Restoring	g moments					\triangleleft					
	Overturni	ng moments		(5.3)				Л				
Usually	only net wa	ter pressures	are included	for over-			/	$^{\prime}$				
	moments so i	Pala	ducu wans									
- Fp	$= \frac{1}{P_A L_A + 1}$	PWALWA -	PwLw	(5.4)	Н	P	NA .					
The des	ign embedme	ent $d = d_0$ is i	ncreased by 2	0 per cent			/ † `		w		-	
for cant	ilevered walls	s but not for p	propped walls		H	L	L _{WA}				-	
For f	ree-standing v	walls							Ŀ	P_{WP} L_{WP}		
Fp	$=\frac{1}{P \cdot I \cdot + I}$	$P_{PLP} + Wb$	Providence	(5.5)	H				(<i>b</i>)	Ť	1	
	$F_{A}L_{A} + I$	- WALWA	PWPLWP	(5.5)		Fig. 5.26 Ass	umed soil a	and wa	ater pressure di	stribution on free-		
						standing retain pressure (no se	ing walls. (/ epage).	a) Eff	ective soil press	sures. (b) Water		
											P	
L											1	



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1	ENGI	NEERS	Consultina	Engineers	II Sheet		iXX	х			7	
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							Member/Lo	ocation				
Job	Title	Structure,	Member De	esign - Geot	echnics Reta	ining Wall	Drg.					du
Str	ucture,	Member De	esign - Geot	echnics Re	aining Walls		Made by	XX	Date	21	/11/202	1 ^{Chd.}
Scl	neme D	Design										
	Dur			6 ·				. 11.				
	Prei	iminary	sizing	of retail	ning wall	S						
	Grav retair	ity retaini ed height.	ng walls -	Typically	have a base	width of	about	60-	80 pe	er cen	t of the	
	Prop	ped embe	dded reta	ining wa	IIs – There a	re 16 met	hods f	for t	he de	sian d	of these	
	walls	depending	on whethe	er they are	considered f	flexible (sł	neet pi	ling)	or ri	gid (c	oncrete	
	diaph	ragm). A r	easonable a	approach is	to use BS 8	002 Free I	Earth S	upp	ort N	letho	d which	
	takes	moments Any tonsi	about the	prop positi pight is lim	ited to the p	t by the E	Surland	181	Potts	Meth	od as a	
		. Any tensi		agricis irm	neu to the p	osition of	uie p	rop.				
	Emb	edded ret	aining wa	IIs – Must	be designed	for fixed	earth	supp	port v	vhere	passive	
\square	meth	od is to des	sign the wa	Il with free	earth suppo	rt by the	same n	neth	od as	the n	ropped	
\vdash	wall	but with m	ioments tak	ken at the	foot of the e	embedded	d wall,	bef	ore a	dding	20 per	
	cent	extra depth	as an estin	nate of the	extra depth	required	for the	e fixe	ed ear	th co	ndition.	1
									_			
	Retair	ning walls	ALINA NA		eeuoten to g	for retainin	الم المبيد م	acian				
	Rankine but Cou	s theory on la lomb's theory	teral earth pre is easier to ar	ssure is most oply for comp	commonly used lex loading con-	ditions. The	most di	fficult				
	part of	Rankine's the	ory is the ap	propriate sele	ection of the co	pefficient of	lateral	earth				
	moveme	, which dependent of a retaini	nds on wheth ing wall is likel	y and accepta	ble, 'active' and	'passive' pre	essures c	an be				
	assume	d, but where r	movement is u	unlikely or una	acceptable, the ized if the wall i	earth pressu moves 0.25-	res shou -1 per ce	ild be ent of				
	the wal	height, while	e passive pressure	sure will requ	ire movements	of 2-4 per	cent in	dense				_
	sand or	10–15 per ce will be mob	ent in loose s vilized, unless	and. As it is it is absolute	normally difficu ly necessary for	stability (e.	g, embe	edded	-			
	walls), t	he restraining	effects of pa	ssive pressure	s are often igno	ored in analy	sis. The	main	-			
	implicat	ions of Rankir to predict the	he's theory are forces which	will be applie	neer must pred d to the wall.	ict the defled	ted sha	pe, to				
	Rankine	's theory assu	mes that move	ement occurs,	that the wall ha	as a smooth	back, th	at the				
	retained	l ground surfa	ace is horizont	al and that th	ne soil is conhes	ionless, so th	nat: σ_h =	=k\sigma_v	-			
	For soil	at rest, $k = k_c$, for active p	pressure, $k = k$	and for passiv	e pressure,	$k = k_{p}$.		÷.			
		$k_{\rm o} \approx 1-s$	sinφ k _a	$=\frac{(1-\sin\phi)}{(1+\sin\phi)}$	$\frac{k_p}{k_a} = \frac{1}{k_a}$	$r = \frac{(1+\sin n)}{(1-\sin n)}$	φ) φ)					
	For co	hesive soil,	k _o should	be factor	ed by the	overconsoli	dation	ratio				
	OCR=	effective overbur	on pressure'									
\square	Typical	k _o values are dated clav and	0.35 for der	nse sand, 0.6 r overconsolie	tor loose sand dated clays such	as London	a for no	value	e			
	of k_0 c	lepends on t	he geological	history of t	he soil and sho	ould be obt	ained fi	rom	а			_
	geotecl	nnical enginee	er.		aile unbiek ener	chrink away	from th	0 10/2	11			-
	and rec	e s theory can luce active pre	essures at the	top of the wa	all as a tension '	crack' forms	. Theore	eticall	У			
	the soil	pressures ove	er the height o is likely to fill y	f the tension	crack can be om hydrate the clay	and remob	he desig ilize the	latera	al			
	pressur	e of the soil.	The height o	f crack is h_c =	$= 2c'/(\gamma\sqrt{k_a})$ for	or drained c	ondition	ns an	d			-
\vdash	$h_{\rm c} = 20$	u/γ for undra	ained conditio	ons.								
											1	
	Eart	n pressu	res greate	er than ac	tive							1
	It is no (with) K ₀ to	ot normal to factors of sat active is only	design the w fety). In gra about 10 ⁻³ n	vall for stabil nular soils, the radians (1mm	ity for earth pr he rotation nee h per metre hei ill prevent this	essures exc ded to red ght) and it unless the	ceeding uce eart would l wall is y	activ h pro be di well	e valu ssures fficult	es s from to ed.		
\square	make	. waariounu		anon mar w								1
\square	Some	walls may th	eretore be d p up due to	esigned on the vibratory loss	he basis of acti ads such as trai	ve pressure ffic and in t	es only. hese ca	Hou ses it	is sen	earth sible t	0	1
\square	use K	in the calcu	lation of ear	th pressures	for structural d	lesign. The	e Depar	tmen	t of	for		
	Transj ULS (ort require tesign. This	the wall sten seems rather	to be design over the to	p'.	a apply a fi	ariner la	oad j	actor	IOF		1
	10.0	cu :		hind share i	e : L the could store	atura must	ha daat		for			
	If the compa	action pressu	ompacted be ires, though	it is again lik	ely that rotatio	on or flexur	e of the	wall	will, i	in		
	reality wall, a calcul	, reduce thes and displacer ation, or a de	se to some en nent must be etailed displa	tent. If ver minimal, hi cement anal	y heavy compa gher earth pres ysis should be o	ction is to sures shoul carried out	be appli ld be us	ied cl ed in	ose to the st	the ability		

	CON	SULTING	Engineerin	a Calculatio	n Sheet		Job No.		Sheet No.			Rev.
	ENGI	NEERS	Consulting	Engineers	In Sheet		iXXX			8		
			_	-			Mombor/Locat	ion				
1.1	- T:+ -	Charlestown	Marahar Da	aian Coot	achaice Del	aining Wall	Dra					
101		Structure,	Member De	sign - Geol	echnics Rei	aining wai	Made by		Date 🤉	1 /	11/2021	hd.
Su	ucture,		esign - Geol		anning wan	5	······	X	Z.	1/	11/2021	
	RULES	OF THUM	В									
	Minimu	m thicknes	20									
	WIIIIII		55									
	Preferre	ed minimum	thickness o	of walls and	slabs: 300	mm	-					
	Where shrinka	thicker cons	sider surface cracking	e zones of 2	00mm each	face for rel	nforceme	nt	to control			
	Simila	goranonnar	ordonnig.									
	Reinfo	rcement										
	Typical	v for water	resistant wa	ills: T16 @	200 c/c in b	oth faces a	nd in both	ı di	irections			
		,		or T12 (@ 150 c/c ir	h both faces	and in b	oth	directions	ò		
\vdash	Standa	rd cover										
\vdash	Assume	ed concrete	grade 35 (T	his should b	be a minimu	im)						
\vdash	Put the	horizontal r	einforcemer	nt furthest fr	om earth fa	ce.						
\square												
	Face			(Cover (mm)							
	Earth fa	ace of walls wh	ere shuttered		50							
	Earth fa	ice of walls (ca	ast against		75							
	earth)											
	Externa	I exposed face	s of walls		40							
	Bottom	and sides to b	ase		75							
	Internal	faces		G	reater of 25							
				or	bar diameter							
	Waters	tops / wate	rbars									
	matore	topo / nato	- Dailo									
	 Rec Given 	quired by B%	S 8102 for g	rade 1 base	ements with	concrete de iso total rali	esign to B	S	8110 rkmanshin			
	 Not 	essential b	ut often des	irable	ints, otherw	ise total reli	ance on v	VOI	Kinanship			
	• Use	external w	aterstop for	basements	(preferred)							
	 Car car 	n use centre efully suppo	estop in verti arted/kept in	place.	ction if nece	essary (e.g.	swimming	g p	ool), must	be	•	
	2.2.2	a m		a						_		_
-	3.2.2	Cover (BS	s 8110, CI.3	.3 - Tables	3.2 and 3.3;	EC2, CI.4.	1)					
		Horizontal	bars are pla	aced further	from the ea	rth face. Co	over is me	eas	sured to the	e o	uter layer	
		of reinforc	ement.									
		Farth face		50mm)	See Model	Detail MRV	W1					
		External e	xposed face	: 40mm)	See Model	Detail Mix						
		Ne	ote:	There may	y be particu	lar requiren	nents for	coi	ncrete grad	le .	/ mix in	
				contamina	ated ground							
\mid		Internal fa	ce:	25mm or	har diamete	r. whicheve	er is oreat	er				
\vdash		N	ote:	This may	be modified	d by particu	lar intern	al o	environme	nt.		
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Endi		concurring	Linginicero]////	``		T	T	
						Member/Loc	cation				
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.					1
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date	21	/11/2021	hd.
Relevant	Retaining	Wall Parar	neters								
Relevant r	etaining wa	іі туре		Conc	rete Canti	lever R	eta	ning w	all		
								atoral	Ear	th Droccur	
									Lai		
								Angle (°)	, α	Aligie, γ (°)	
Concrete	Gravity Re	taining W	all					N/A		N/A	
Concrete	Cantilever	Retaining	Wall					90.0)	90.0	
Concrete	or Steel Ca	antilever E	mbedded	Retaining	Wall			N/A	<u> </u>	N/A	
Concrete	Propped (Basement) Retaining	a Wall				, N/A		, N/A	
Concrete	or Steel P	ropped (Ba	asement) I	- Embedded	Retaining	Wall		N/A		N/A	
			-					90.0)	90.0	
Gross work	king pressu	re, q _w							28	kPa	
			_		Overall	Sliding	j Re	sistan	ce C	apacity	
			B _{width} ,	Vertica	al Load	(kN/r	m)	Hori	zon	tal Load	(kN/m)
C b	0	t - :	base (M)	F	ı			F			
Concrete		Deteining Wa	N/A	F Concrete	,gravity,v	N/A	\	Γ _{co}	ncrete	e,gravity,h	N/A
Concrete	or Steel C	Relaining	2.700 N/A	concrete,can	tilever,v [−] VV4 /Δ	40 N/A		l con	crete,	cantilever,h /Δ	19 N/A
Concrete	Pronned (Basement	N/A	N	/A	N/A	\ \		N,	/A	N/A
Concrete	or Steel P	ropped (Ba	N/A	N	/A	N/A	`````		N/	/A	N/A
		F F (2.786	F	v	48	-		ļ	h	19
Note for co	oncrete can	tilever retai	ning wall, s	urcharge n	ot included	in calcu	ılatio	on of ve	ertica	al (downwa	rd)
Note for co load as it c	oncrete can cannot be g	tilever retai uaranteed;	ning wall, s	urcharge no	ot included	in calcu	ılatio	on of ve	ertica	al (downwa	rd)
Note for co load as it o Note negat	oncrete can cannot be g tive F _h is e	tilever retai uaranteed; ffectively th	ning wall, s e additiona	urcharge no I passive re	ot included sistance ca	in calcu pacity c	ilatio over	on of ve the act	ive i	al (downwa force;	rd)
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Note for co load as it o Note negat	oncrete can cannot be g tive F _h is e	tilever retai uaranteed; ffectively th	ning wall, s e additiona	urcharge no passive re	ot included sistance ca	in calcu	over	the act the act Re c e _{eff} (m)	ertica ive i eran esis	al (downwa force; i Upiiit tance acity e _{eff,limit} (m)	rd)
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Note for co load as it o Note negation Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete	Gravity Re Cantilever or Steel Ca Propped (or Steel Pr Gravity Re Cantilever or Steel Pr Cantilever or Steel Ca Propped (or Steel Pr	tilever retai uaranteed; ffectively th Retaining Wa Retaining antilever E Basement; ropped (Ba etaining Wa Retaining antilever E Basement; ropped (Ba	ning wall, s e additiona e additiona Wall mbedded) Retaining asement) B wall Wall mbedded) Retaining asement) B	Retaining Wall Embedded Retaining Wall Embedded	wall Retaining Wall Retaining	in calcu pacity c Wall	over	the act the act Re e _{eff} (m) N/A 0.65 N/A N/A 0.65 N/A N/A 0.65 N/A N/A 89 N/A 89 N/A 89 N/A 89	7 7 7 7 7 7 7 7 7	al (downwa force; i Upiint tance acity e _{eff,limit} (m) N/A 0.683 N/A N/A 0.683 N/A N/A 0.683 eraii urning tance t	rd)
Note for co load as it o Note negation Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete	Gravity Re Cantilever or Steel Ca Propped (or Steel Pr Gravity Re Cantilever or Steel Ca Propped (or Steel Ca Propped (or Steel Pr	tilever retai uaranteed; ffectively th etaining Wa Retaining antilever E Basement; ropped (Ba etaining Wa Retaining antilever E Basement; ropped (Ba	all wall wall mbedded) Retaining asement) f wall wall wall mbedded) Retaining asement) f	Retaining g Wall Embedded Retaining g Wall Embedded	wall Retaining Wall Retaining	in calcu ppacity c Wall	over	the act the act Re e _{eff} (m) N/A 0.65 N/A N/A 0.65 N/A N/A 0.65 N/A N/A 89 N/A 89 N/A 89	rticzenie sis	al (downwa force; i Upiint tance acity e _{eff,limit} (m) N/A 0.683 N/A N/A N/A N/A 0.683 erail urning tance m _{rt} (kNm/m N/A 1111 N/A N/A 1111	rd)
Note for co load as it o Note negation Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete	Gravity Re Cantilever or Steel Ca Propped (or Steel Pr Gravity Re Cantilever or Steel Pr Propped (or Steel Pr Propped (tilever retai uaranteed; ffectively th etaining Wa Retaining antilever E Basement; ropped (Ba etaining Wa Retaining antilever E Basement; ropped (Ba	ning wall, s e additiona all Wall mbedded) Retaining asement) B wall Wall mbedded) Retaining asement) B	Retaining Wall Embedded Retaining Wall Embedded	wall Retaining Wall Retaining	in calcu pacity c wall wall	over	the act the act Re e _{eff} (m) N/A 0.65 N/A N/A 0.65 N/A N/A 0.65 N/A N/A 89 N/A 89 N/A 89 N/A 89	rticz ive i erai esis cana 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	al (downwa force; i Upiint tance acity e _{eff,limit} (m) N/A 0.683 N/A N/A N/A N/A 0.683 erail urning tance t	rd)

CON	SULTING	Enginoorin	a Calculatio	n Shoot		Job No.		Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	II Sheet		iXXX		1	2	
LIGI			5			5,000		-		
	-					Member/Loca	tion			
Job Title	Structure,	Member De	esign - Geot	echnics Ret	aining Wall	Drg.		<u> </u>		4
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	X	Date 21	/11/2021	nd.
Undrained	l Lateral E	arth Press	sure							
Bulk unit w	leight, $\gamma = \gamma$	γ _{dry} or γ _{sat}						N/A	kN/m³	
Lateral (A	ctive) Pre	ssures of l	Retained S	oil		At		At		
						Surfac	e	Base	2	
Vertical tot	al stress, σ	$v_a = p_{s,a}$ to	$\sigma_{va} = p_{s,a} + $	γ.d _a		N/A		N/A	kN/m ²	
Active pres	sure, σ _{ha} =	MAX(0.0 to)	ο 4.8d _a , σ _{va}	– 2S _u)		N/A		N/A	kN/m²	BS5975
A 11 C									/	cl. 4.5.5.1
Active force	$e, F_a = 0.5$. (σ _{ha,surface} -	⊦σ _{ha,base}).d	a				N/A	kN/m	
Note earth	pressure a	cts normal	to retaining	face, angle	β ignored	1;			/	
Horizontal	component	$Of F_a, F_{ah} =$	F_a . SIN α					N/A	kN/m	
Vertical (do	ownward) c	component o	$Df F_a, F_{av} =$	F_a . COS α				N/A	kN/m	
Centroid of	$F_a, e_a = d_a$	a . (2σ _{ha,surfa}	_{ce} +σ _{ha,base})/	/ [3.(σ _{ha,surfa}	$(ce + \sigma_{ha, base})$	 		N/A	m	
Note the ce	entroid e _a l	is measured	a trom the b	base of the	retained so	11;				
Lateral (P	assive) Pr	essures of	f Resisting	Soil		At		At		
						Surfac	e	Base	2	
Vertical tot	al stress, σ	$v_{p} = p_{s,p}$ to	$\sigma_{vp} = p_{s,p} + $	γ.d _p		N/A		N/A	kN/m ²	
Passive pre	essure, σ_{hp}	$= \sigma_{vp} + 2S_u$				N/A		N/A	kN/m²	
Passive for	ce, $F_p = 0.5$	5.(σ _{hp,surface}	$_{e}$ + $\sigma_{hp,base}$).	d _p				N/A	kN/m	
Note earth	pressure a	cts normal	to resisting	face, angle	β ignored	;				
Horizontal	component	of F_p , F_{ph} =	= F _p . sinγ					N/A	kN/m	
Vertical (do	ownward) c	component o	of F_{p} , $F_{pv} =$	F_p . COS γ				N/A	kN/m	
Centroid of	$F_{p}, e_{p} = d_{p}$	_σ .(2σ _{hp,surfa}	_{ce} + $\sigma_{hp,base}$),	/ [3.(σ _{hp,surfa}	$\sigma_{hp,base}$]		N/A	m	
Note the ce	entroid e _p l	is measured	d from the b	pase of the	resisting so	oil;				
Calcula	ted process	we will only	ha mahilizar	l where eau	ivalant etrai	ne occur	and	d those will	ha dananda	at
upon th	ie elastic mo	odulus of the	e soil and of	the structur	al element	as intera	ctin	g members.	. Thus the	
restrain	ning effect of	f struts, grou	ind anchors	or tie-backs	may create	higher ac	tive	e pressures	than those fi	rom
the bas	ic active con	antion formu	nae, possibly	locany app	roacning the	ose from t	ne	passive cont	ntion iormu	lae.

CON	SULTING	Enginoorin	a Calculatio	n Shoot		Job No		Sheet No.		Rev.
	NEERS	Consulting	Engineers	II Sheet		iXX	x	1	3	
LIGI						,,,,,	· ·		5	
						Member/Lo	cation			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.				
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date 21	/11/2021	hd.
Drained L	ateral Ear	th Pressur	e							
Bulk unit w	$\gamma = \gamma$	γ_{dry} or γ_{sat}						20.0	kN/m³	
								_		
Lateral (A	ctive) Pre	ssures of I	Retained S	Soil	At	At		At		
					Surface	WT		Base	2	
Vertical tot	al stress, σ	$v_a = p_{s,a}$ to	$\sigma_{va} = p_{s,a} + p_{s,a}$	γ.d _a	10.0	58.0	0	88.0	kN/m ²	
Hydrostatio	c pressure,	$u_a = 0.0 \text{ to}$	$0.0 + \gamma_w.M$	AX(0.0, d _a -	0.0	0.0)	14.7	kN/m ²	
Vertical eff	ective stres	$\sigma_{va'} = \sigma_{va'}$	_a - U _a		10.0	58.0	0	73.3	kN/m²	
Active eart	n pressure	coefficient,	К _а		0.30	0.30	0	0.30		
	At Rest									
	$K_a = (1-sir)$	ιφ') 			0.50	0.50	0	0.50		
	Rankine T	heory								
	Note Ranki	ne theory a	assumes δ	$= 0^{\circ}, \beta = 0$	β^{α} and $\alpha =$	= 90°;	<u> </u>	0.00		
	$K_a = (1-sir)$	ιφ') / (1+sir 	ιφ') 		0.33	0.3	3	0.33		
	Coulomb	Theory								
	K _a				0.30	0.30	0	0.30		
	K _		$\sin^2(\alpha + \varphi')$)						
	Λ_a		[[sin(@'	$+\delta'$)sin(ω' -	$\left[\frac{\beta}{\beta}\right]^2$					
	$\sin^2 a$	$\alpha \sin(\alpha - \delta')$	$1 + \sqrt{\frac{\sin(\varphi)}{\sin(\alpha)}}$	$-\delta'$ sin(α +	$\frac{\beta}{\beta}$					
				e)5m(0/ 1						
			<u> </u>	4.4						
Active effe	ctive pressu	ure, σ _{ha} ' = κ	י'- 2c'י גייα. סעמ' - 2c'י	/K _a	3.0	17.3	3	21.8	kN/m²	
									/	
Active force	e, F _a '							54	kN/m	
Note If a _{aw}	$< a_a, F_a$	$= 0.5.(\sigma_{\rm p})$	ha, surface '+ σ	$h_{a,wt}$). a_{aw}	+ 0.5 . (σ	- ha,wt '+ d	$\sigma_{ha,b}$	_{ase} ').(0 _a -0	1 _{aw});	
Note If a _{aw}	$\geq a_a, F_a'$	$= 0.5.(\sigma_{t})$	σ_{I} σ_{I}	$(a,base') \cdot a_a$;					
Note earth	pressure a	cts normal	to retaining	face (Rank	ine theory), angle	β	gnored;	Ĺ	
Note earth	pressure a		normal to	retaining ta	ce (Coulom	ib theor	γ), č	angle β ign	orea;	
	component	OF Fa , Fah	$= F_a^2 \cdot COS(s)$	$90^{\circ} - \alpha + \delta'$	0 1 21)			50	KN/M	
	ownward) c	omponent d	$DFF_{a},F_{av} =$	F _a . Sin(90	$\beta^{\circ}-\alpha+\delta^{\circ}$			18	kN/m	
	r F _a ', e _a		·		[7]	1.		1.490		
Note If a _{aw}	$< a_a, e_a$	$= \{ [a_{aw} . ($	$2 \sigma_{ha,surface}$	$+ \sigma_{ha,wt}) / [$	$3.(\sigma_{ha,surfa})$	$\sigma_{ce} + \sigma_{ha}$	<u>, wt</u>)	$J + a_a - a_a$	w].[0.5.	$(\sigma_{ha,surface})$
$+ [(a_a - a_{av})]$	w). ($2\sigma_{ha,w}$	$+ \sigma_{ha,base}$)/[3.(σ _{ha,ι}	$_{wt}$ + $\sigma_{ha,base}$	<u>)]].[0.5.</u>	$(\sigma_{ha,wt})$	$+\sigma$	ha,base').(O	' _a -a _{aw})]} /	F _a ;
NOTE IT a aw	$e_a \ge a_a, e_a$	$= a_a \cdot (2\sigma)$	ha, surface $+ \sigma$	ha,base)/[3	.($\sigma_{ha,surface}$	$+ \sigma_{ha,ba}$	ise)	;		
Hydrostatio	c force, F _{ua}	$= 0.5 \cdot (u_{a,s})$	surface+U _{a,base}	e). (d _a -d _{aw})				11	kN/m	
Note nyard	static press	Sure acts no		aining face;					1-N1/	
	component	OI F _{ua} , F _{uah}	= F _{ua} . Sino	ι Γ				11	KN/M	
Vertical (u	Swnwaru) C		DI F _{ua} , F _{uav} =	= Γ_{ua} . $\cos \alpha$		11		0 500	KIN/ M	
	r _{ua} , e _{ua} =	(u _a -u _{aw}).(2	2u _{a,surface} +u _a	a,base)/[3.((J _{a,surface} +U _{a,}	,base)]		0.500	m	
	1	1	1			1			(1

CON	SULTINC	Enginegrin	a Calaulatia	n Chaot		Job No		Sheet No.		Rev.
	NEEDS	Consulting	g Calculatio Engineers	n Sneet		iVV	~	1	1	
ENGI	NEERS	consulting	Lingilieers]~~/	^	L	.4	
						Member/Lo	cation			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.				
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date 21	/11/2021	hd.
Lateral (D			Detained	Call	At	At		At		
Lateral (P	assive) Pr	essures of	Retained	5011	Surface	WT		Base		
Vertical tot	al stress, σ	$v_{p} = p_{s,p} \text{ to } q$	$\sigma_{vp} = p_{s,p} + $	γ.d _p	0.0	0.0)	24.0	kN/m ²	
Hydrostatio	c pressure,	$u_{p} = 0.0 \text{ to}$	$0.0 + \gamma_w.M$	AX(0.0, d _p -	0.0	0.0)	11.8	kN/m ²	
Vertical eff	ective stres	$\mathbf{ss, } \sigma_{vp}' = \sigma_{vp}$	_թ - u _թ		0.0	0.0)	12.2	kN/m ²	
Passive ear	th pressure	e coefficient	:, K _p		4.98	4.98	8	4.98	-	
	Rankine T	heory								
	Note Ranki	ine theory a	issumes δ	$= 0^\circ, \beta = 0$	0° and $\alpha =$	90°;				
	$K_p = (1+si)$	nø') / (1-sin	ıφ')		3.00	3.00	0	3.00		
	Coulomb [·]	Theory								
	K _p				4.98	4.98	8	4.98		
		I	$\sin^2(\alpha - \alpha)$)						
	$K_p =$		$\sin(\alpha - \varphi)$)	72					
	$\sin^2 \alpha$	$\alpha \sin(\alpha + \delta')$	$1 - \frac{\sin(\varphi)}{2}$	$(+\delta')\sin(\varphi'+$	(β)					
	-	· · ·	$\int \sqrt{\sin(\alpha)}$	$+\delta')\sin(\alpha +$	(β)					
	Note that H	K_P only acc	urate if δ' ·	<= ø'/3; Tł	nus conside	er adopt	ing i	zero δ' for	K , above;	
Passive eff	ective press	sure, $\sigma_{hn}' =$	$K_{\rm p}.\sigma_{\rm vp}' + 2c$:'√K _n	0.0	0.0)	60.9	kN/m ²	
		, 115	4 4	P						
Passive for	ce, F _n '							37	kN/m	
Note if d pu	< d _n , F _n '	= 0.5 . (σ	hn surface $'+\sigma$	hp.wt').d.pw	+ 0.5.(σ	bp wt '+	$\sigma_{hn h}$, (d -	d _{nw});	
Note if d pu	$\geq d_{p}, F_{p}'$	$= 0.5.(\sigma_{\rm F})$	σ_{1} surface $'+\sigma_{1}$	hp hase '). d n	:	πp,wc	- 110,0			
Note earth	nressure a	cts normal i	to resistina	face (Rank	, ine theorv)	. anale	ß ic	nored:		
Note earth	pressure a	$\frac{\delta}{\delta}$ to	normal to i	resisting fac	re (Coulom	h theor	v). a	nale ß ian	ored:	
Horizontal	component	of F _n ', F _{nh} '	$= F_{\rm m}' \cdot \cos(\theta)$	90°-ν-δ')			/// 4	35	kN/m	
Vertical (de	wnward) c	omponent o	$f_{\rm F} = 1000$	E.'. sin(90)°-ν-δ')			-9	kN/m	
Centroid of	F.' e.		, р / ру	1 p 1 3 (3 C	, , 0)			0 400	m	
Note if d		= {[d (2 5	$+\sigma$ $()/$	[] (σ	'+ σ.	. ')	0.+00	1 [0.5	(σ
$+ \int (d - d)$	(2σ)	$\frac{-1}{2} \left[\frac{1}{2} \sigma_{W} \right] $	$\frac{20 \text{ hp,surface}}{1 \text{ (} \sigma_{1})}$	$' + \sigma$	')11 [0 5	(σ)),wt / '+ σ	$\frac{1}{2}$	$\frac{1}{2} - \frac{1}{2} - \frac{1}$	(^O hp,surface
Note if d	> d	$-d$ (2 σ	$\gamma = 23.(0 hp)$	wt ^o hp,base)]].[0.5.	$' + \sigma_{i}$	<u>יי</u> רי	hp,base) · (C 1·		'p/
Hydrostatio	force F	$\frac{-u_p}{-0.5}$ (11	hp,surface 10	$\frac{hp, base}{(d - d)}$	hp,surface	ι Ο hp,b	ase 7	_/ 7	kN/m	
Note hydro	static press	ure acts no	ormal to rec	sisting face						
Horizontal	component		$= F \sin v$					7	kN/m	
Vertical (de	wnward) c	omponent o	$-\Gamma_{up} \cdot S \Pi_{r}$	= E cosv				0	kN/m	
	F e =	(d - d) (2)	Zu	·)/[3/	. +11	.)]		0.400	m	
	up, Cup —	(up upw) . (2	-up,surface u	p,base// LJ·(ap,surface ap	,base/J		0.400	111	
						1				

CON			<u></u>			Job No.	Sheet No.		Rev.
	NEEDS	Consulting	g Calculatio Engineers	on Sheet		ivvv	1	F	
ENGI	NEEKS	consulting	Lingineers			JXXX	L	5	
						Member/Location			
Job Title	Structure,	Member De	sign - Geot	technics Ret	aining Wall	Drg.			
Structure,	Member De	esign - Geot	echnics Ret	taining Wall	S	Made by XX	Date 21	/11/2021	hd.
Overall N	et (Effectiv	ve) Bearin	g Capacity	1					
Note this s	ection is ap	plicable onl	y for concr	ete gravity	and concret	te cantileve	r retaining	walls;	
(Effective)	surcharge	above found	ding level, p	o ₀ or p ₀ '			63	kPa	
	Case whe	n soil is dr	у У				Invalid		
		$p_0 = p_{s,p} + \gamma$	$d_{ry}.d_a \text{ or } p_0'$	$= p_{s,p} + \gamma_{dry}.$	d _a -γ _w .MAX(0.0, d _a -d _{aw})	N/A	kPa	
	Case whe	n soil is sa	turated				Valid		
		$p_0 = p_{s,p} + \gamma$	_{sat} .d _a or p ₀ '	$= p_{s,p} + \gamma_{sat}$	$d_a - \gamma_w$.MAX(().0, d _a -d _{aw})	63	kPa	
				(0)					
Net (effect	ive) bearing	g capacity, ($q_{fnet} = q_f - ($	(p ₀ =0) or q _f	$n_{et}' = q_f' - ($	p ₀ '=0)	250	kPa	
Nata 11	Gross (effe	ective) bear	ing capacity	y, q _f or q _f '			250	кРа	
Note that f	or retaining	y walls, the	(errective)	surcharge a	bove the fo	ounding lev	eı, p ₀ or p	0 [°] IS	
taken as 0 Салын	TOR DOTH th	e gross and	net (effect	tive) bearing	g capacity o	calculations	in view of t	tne L	
fact that it	is only on a	one side of	the retainin	ig wall that	the overbu	raen pressi	ire above ti	ne	
rounding le	evel exists;								
Not (offerst				(n, 0) = 0	a ! = !	$(r \downarrow 0)$			
ivet (effect	ve) workin	y pressure,	$q_{wnet} = q_w$	- (p ₀ =0) or	$q_{wnet} = q_w$	- (p ₀ '=0)	15	кга	
	Gross Work	king pressur	re, q _w				28	кРа	
	water pres	sure at fou	nding level	(active side	$(a), u_a = \gamma_w r$		15	кра	
	Water pres	sure at fou	nding level		$u_p = \gamma_w$.MAX(U.U, 0	12	кра	
	water pres	sure at iou	nuing ievei,	u = AVERA	$AGE(u_a, u_p)$		13	кра	
Note that f	Gross (ene	ective) work	(offootivo)	re, q_w or q_w	$= q_w - u$	ounding lou	15	кра	
Note that i	or retaining	y walls, the		surcharge a	bove the re	ounaing iev	$e_i, p_0 \text{ or } p_i$	0 15	
taken as U	for the net	(effective)	WORKING Pr	essure calcu	JIATION IN VI	ew of the f	act that the		
retaineu so	ni may be i	ormed by b	unung up i	Instead of D	y excavalio	<i>n;</i>			
Overall not	(offoctivo)	boaring ca	nacity (fact	arad) (a	or a. ') /	FOS	100	kDo.	
Overall net		bearing ca		(q_{fnet})	or a '	103_2	150/	кга	OK
In addition	to the abo	ve the sus	contibility o	of the retain	ing wall to	hase heave	instability	in the	OK
case of exc	avations n	ed to he ca	arried out		ing wan to i		mocability		
+ σ _{bp wt} '), (1 nw 1								
- 110,000	pw 1								

CONSULTING Engineering Calculation Shoot				Job No.	Sheet No.		Rev.		
CON	SULTING	Engineerin	g Calculatio	n Sheet					
ENGI	NEERS	Consulting	Engineers			јххх	1	16	
						Member/Locati	on		
Job Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure	Member De	esian - Geot	echnics Ret	aining Wall	s	Made by	X Date 21	/11/2021	hd.
				annig tran				//	
Overall Si	idina Resi	stance Car	pacity					-	
Note this s	ection is an	nlicable on	ly for concre	ete aravitv	and concret	te cantile	ver retaining	walls	
				ce gravity					
Dead load	component	of SLS ver	ical (downy	vard) load	Kala Pl		1.00		
Note that t	the dead loa	ad compone	nt is annlie	d to reduce	the SIS ve	ertical (do	wpward) loa	d to the	
dead vertic	ne ucau ioc	ard) load t	his required	l ac the live	load comp	onent car	not be quara	a to the	
Total retain	ning wall de	ad vertical	load kasa	. F '				kN/m	
Total retain	ning wall G	S horizonta	lload F.)[•• v			10	kN/m	
Total Tetal							19		
Overall clic	lina resistar	nce canacity	(factored)	F			20	kN/m	
	Undrained			, 's,cap					Tomlincon
	Drainad Ar	AllalySIS		th,base .Ju /	x' / FOC				Tomlineer
Overall all	ling register		s,cap — K _{SLS}		, 10 3 3		20	KIN/111	
	ing resistar		่นเมริสมับก	— г _h / Г _{s,сар}			97%	l	UK
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CON		Function	ngineering Calculation Sheet			Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1	7	
Endi		eeea.ey		1		JAAA	1	/	
	<u>a.</u>					Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Made by	Date 31	/11/2021	bd
Structure,	Member De	isign - Geol	echnics Rei	aning wai	S	XX	21	/11/2021	
Overall U	nlift Resist	ance Capa	city						
Note this s	ection is ap	plicable on	ly for concre	ete gravity	and concret	te cantileve	r retaining	walls;	
		,						,	
Overall up	ift resistand	ce capacity	utilisation =	= e _{eff} / e _{eff,lir}	nit		96%		ОК

CONSULTING Engineering Calculation Sheet			Job No.	Sheet No.		Rev.			
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1	8	
Endi				1		JAAA	1	0	
	<u>a.</u>					Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Dig. Made by	Date 31	/11/2021	bd
Structure,	Member De	isign - Geol	echnics Rei	aning wai	S	XX	21	/11/2021	
Overall O	verturnina	Resistanc	e Canacity	1					
Note this s	ection is ap	plicable on	ly for concre	, ete gravity	and concret	te cantileve	r retaining	walls;	
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Overall ove	erturning re	sistance ca	pacity utilis	ation = M_{ot}	/ M _{rt}		80%		ОК
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Concrete		toining W								
concrete	Gravity Re		ali SLS LUa	laing						
Retaining v	vall wall we	iaht (left tr	iangular poi	rtion). W₁ =	= 0.5.(d ₋ /ta	$n\alpha$).d	0	N/A	kN/m	
Retaining wall wall weight (rectangular portion), $W_2 = B_{width top, d_2}$								N/A	kN/m	
Retaining	vall wall we	ight (right)	triangular p	ortion), W ₃	$= 0.5.(d_a/t)$	$an\gamma$).d _a	.ρ.	N/A	kN/m	
Water pres	sure at fou	nding level	(active side	e), $u_a = \gamma_w$.	4AX(0.0, d _a	-d _{aw})	10	N/A	, kPa	
Water pres	sure at fou	nding level	(passive sid	de), $u_p = \gamma_w$.MAX(0.0, 0	$d_p - d_{pw}$)		N/A	kPa	
Water pres	sure at fou	nding level,	, u = AVERA	AGE(u _a , u _p)				N/A	kPa	
Water upli	ft force at fo	ounding lev	el, F _{water} = i	u.B _{width,base}				N/A	kN/m	
	Но	rizontal Lo	oad	E	ccentricity	y from	Bas	е		
	F _{ah} (F _{ah} ')	N/A	kN/m		ea	N//	4	m		
	F _{uah}	N/A	kN/m		e _{ua}	N//	4	m		
	$F_{ph} (F_{ph}')$	N/A	kN/m		ep	N//	4	m		
	F _{uph}	N/A	kN/m		e _{up}	N//	4	m		
	Vertical	(Downwa	rd) Load	Eccen	tricity from	m Base	e Cei -	ntroid		
	W ₁	N/A	kN/m	$d_a/tan\alpha)/3$ -	B _{width,base} /2	N//	4	m		
	W ₂	N/A	kN/m	-B _{width,top} /2-	$B_{width,base}/2$	N//	4	m		
		N/A	KN/M	idth,base/2-2.	$\frac{(u_a/tany)/3}{p}$		4	m		
	Fav (Fav)	N/A	KN/III kN/m	$-e_a/tana-$	B /2		4 A	m		
		N/A	kN/m	$= B \dots$	/2-e /tany		4 A	m		
	Fundation	N/A N/A	kN/m	= Buildth,bas	$\frac{e}{2} \frac{c_p}{\tan \gamma}$	N//	Δ	m		
	-F _{wator}	N/A	kN/m	Bwidth, base	$(u_{1}+u_{2})$	N//	Δ	m		
	water			wiutii,base/ i			-			
Total retai	ning wall SL	S vertical (downward)	load, F _{concre}	ete gravity v			N/A	kN/m	
Note F concr	ete.aravity.v =	$W_1 + W_2 + W_2$	$W_3 + F_{av}(F_a)$	$(F_{uav}) + 0(F_{uav})$	$+F_{pv}(F_{pv}')$)+0(F _{up}	<i>v);</i>		,	
Total retai	ning wall SL	S effective	vertical (do	wnward) lo	ad, F _{concrete}	,gravity,v		N/A	kN/m	
Note F concr	ete,gravity,v ' =	F concrete, grav	, ity, v - F water;							
Total retai	ning wall SL	.S horizonta	al load, F _{conc}	rete,gravity,h				N/A	kN/m	
Note F concr	ete,gravity,h =	F _{ah} (F _{ah} ')+	0(F _{uah})-F _{pt}	, (F _{ph} ')-0(F	_{uph});					
Note F concr	ete,gravity,h is	set to 0 if t	the sliding r	esistance c	apacity exc	eeds th	e sli	ding force;		
Total retai	ning wall SL	S moment	about base	centroid, M	l _{concrete,gravity}	,		N/A	kNm/m	
Note M conc	rete,gravity =	F _{ah} (F _{ah} ').e	$_{a} + 0(F_{uah}).$	e_{ua} - F_{ph} (F_{ph}	h').e _p -0(F _u	_{Iph}).e _{up}	+W	$_{1}.e_{w1}+W_{2}$	$.e_{w2} + W_3.e$	w3
		$+F_{av}(F_{av}')$).e _{av} +0(F _{ua}	$(v).e_{uav}+F_p$	ν (F _{pv} ').e _{pv}	$+0(F_{up})$	_v).e	$_{upv}$ - F_{water} . ϵ	water;	
Note M _{conc}	_{rete,gravity} is s	set to 0 if tl	he restoring	i moment c	apacity exc	eeds th	e ov	erturning n	noment;	
<u>Faulty alant</u>	o o o o o o tri city							51/0		
Equivalent	eccentricity	$v, e_{eff} = MA$	X(U, M _{concret}	e,gravity) / F _{co}	oncrete,gravity,v	1.6) / [N/A	m	
Linning et			li upilit (laci	lored), e _{eff,i}	imit = (Þ _{width}	_{,base} / O)/г	N/A	[[]	
Total retain	ning wall SI	Soverturni	ina moment	- M				N/A	kNm/m	
Note M		$= F \cdot (F \cdot ')$	$\rho \pm 0(F)$) e -F (F	avity,ot	/2-4	e)	N/A	KINITI/TT	
	rete,gravity,ot	-0(F)	(Buidth haas/	/2-e)+F.	av).(D width	, base / 2 .):		
Total retain	ning wall SI	S restoring	moment. N	uav / 1	valer · (— Wlath,	udser 2 C	- wate	N/A	kNm/m	
Note M conc	rete,gravity.rt =	[F _{ph} (F _{ph} ')).e _p +0(F _{up} +	$(1).e_{IID} + W_{1}$.(B width hase)	/2-e _{w1}))+W	2.(B width has	_e /2-e _{w2})	
conc	,	+W ₃ .(B	width,base/2-e	$(F_{w3}) + F_{nv}(F)$	pv').(B _{width}	_{.base} /2-6	e _{pv})	+0(F _{upv}).(E	B _{width.base} /2·	-e _{upv})] / FC
Note surch	arge not in	cluded in ca	alculation of	restoring r	noment as	it canno	ot be	e guarantee	ed;	<i>.</i>
Maximum	gross worki	ng pressure	$e, q_{w1} = F_{con}$	- Icrete,gravity,v/l	B _{width,base} +	6.M _{concr}	ete,qra	N/A	kPa	
Minimum g	ross workir	ig pressure	$, q_{w2} = F_{cond}$	crete, gravity, v/E	B _{width,base} – 6	.M _{concret}	e,grav	N/A	kPa	
Equivalent	width, B_{widt}	$_{h,base}' = B_{wid}$	$_{dth,base} - 2e_{et}$	ff				N/A	m	
Gross worl	king pressur	$re, q_w = F_{co}$	ncrete,gravity,v /	/ B _{width,base} '				N/A	kPa	

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						Member/Location			
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Structure,	Member De	sign - Geot	echnics Ret	aining Wall:	S	Made by XX	Date 21	/11/2021	ihd.
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loh Title	Structure.	 Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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Job Title Structure, Member Design - Geotechnics Retaining Walls Hats by XX Dain 21/11/2021 ^{ENL} Structure, Member Design - Geotechnics Retaining Walls Hats by XX Dain 21/11/2021 ^{ENL} Structure, Member Design - Geotechnics Retaining Walls Hats by XX Dain 21/11/2021 ^{ENL} Structure, Member Design - Geotechnics Retaining Walls Hats by XX Dain 21/11/2021 ^{ENL} Structure, Member Design - Geotechnics Retaining Walls Inc.	LIGI		J	5			Manchanilla antian		-	
Job Into Structure, Member Design - Geotechnics Retaining Walls Note: XX Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Note: XX Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Note: XX Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Note: Note: Note: Note: Structure, Member Design - Geotechnics Retaining Walls Note: Note: Note: Note: Note: Structure, Member Design - Geotechnics Retaining Walls Note: Note: Note: Note: Note: Structure, Member Design - Geotechnics Retaining Walls Note: Note: Note: Note: Note: Note: Structure, Member Design - Geotechnics Retaining Walls Note: Note: <td>2 1 2011</td> <td>Charles</td> <td>Manakan Da</td> <td></td> <td>a ale al a a Dat</td> <td>- 1</td> <td>Member/Location</td> <td></td> <td></td> <td></td>	2 1 2011	Charles	Manakan Da		a ale al a a Dat	- 1	Member/Location			
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						Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall:	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	S	Made by XX	Date 21	/11/2021	ihd.
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		J				Joor Manakara		5	
a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 71	/11/2021	hd.
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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	4	6	
21101		J				Manchanilla antian		0	
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Job Litle	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
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			-			Mombor/Location			
Job Title	Ctructure	Mombor Do	cian Coat	achaica Dat	aining Wall	Drg.			
Structure	Member De	sian - Geot	echnics Ret	aining Wall	anning wan s	Made by Y	Date 21	/11/2021	hd.
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ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	4	-8	
			-			Mombor/Location		-	
	Ctructure	Mombor D-	cian Cast	ochnice Det	aining Mal	Drg.			
Structure	Member De	sian - Geot	echnics Ret	aining Wall	anning wan s	Made by Y	Date 21	/11/2021	hd.
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a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	

undrained	l shear str	ength limi	t to adopt					1	
1	L								
Lower Limi	t :+								
	+								
ianore eff	ective coh	esion						2	
ignore en									
Include									
Exclude									
effective a	angle of fr	iction				1	7	5	
	_								
1.00ø' (Cas	st in Place (Concrete - S	Soil Interfac	e)				1.00	
0.90ø' (Pre	ecast Concre	ete - Soil In	terface)					0.90	
0.85ø' (Tim	nber - Soil I	Interface)						0.85	
0.80ø' (Roi	ugh Corrug	ated Steel -	Soil Interfa	ace)				0.80	
0.66ø' (Ins	itu Concret	e Active Zo	ne - Soil In	terface)				0.66	
0.60ø' (Sm	ooth Coate	d Steel - So	oil Interface	e)				0.60	
0.50ø' (Ins	itu Concret	e Passive Z	one - Soil I	nterface)				0.50	
0.40ø'								0.40	
0.30ø'								0.30	
0.20ø'								0.20	
0.10ø'								0.10	
0.00ø' (No	Friction Int	erface)						0.00	
method of	f analysis							2	
Undrained	Analysis								
Drained An	lalysis								
A ative ar		(fou duoin						2	
ACLIVE OF	AL RESL Na	(IOF Grain	eu analysi	s only)				Z	
At Post									
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Rankine o	r Coulomb) theory fo	r K. and K	" (for drai	ned analys	sis onlv)		2	
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Rankine Th	leorv								
Coulomb T	heory								
	,								
evaluate o	overall upl	ift resistaı	nce					1	
Yes									
No									
retaining	wall type							2	
Concrete G	Fravity Reta	ining Wall							
Concrete C	antilever R	etaining Wa							
Concrete o	r Steel Can	tilever Emb	edded Reta	ining Wall					
Concrete P	ropped (Ba	sement) Re	taining Wal		ning 14/-11				
Concrete 0	1 SLEEL Prop	ped (Baser	nent) Empe	euuea Ketai	ning wall				
cantilever	rotainina	wall posit	ion of ana	lication of	d				
canthever	retaining		ыны арр		Чp			2	
Above Four	ndina Level	(as Drawn))						
Below Four	ndina Level	(i.e. on Shi	ar Kev)						
dry or sat	urated soi	l bulk unit	weight ?					2	
Dry Soil									
Saturated	Soil								

CONSULTING		Engineering Calculation Sheet				Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	5	0	
			_			Member/Location			
loh Titlo	Structure	Member De	sian - Geot	ochnics Pot	aining Wall	Drg.			
Structure.	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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CONSULTING Engineering Calculation Shoot	Job No.	Sheet No.	Rev.
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	Member/Location		
Job Title Structure, Member Design - Geotechnics Retaining Wa	all ^{Drg.}		
Structure, Member Design - Geotechnics Retaining Walls	Made by XX	Date 21	/11/2021 ^{Chd.}
Concrete Cantilever Retaining Wall Dimensions			
200-300mm min.			
Minimum batter 50:1			
- B/3			
of seasonal volumo			
change and frost depth H/10			
B 0.4-0.7H			
Note that	t for the	concrete	cantilever
retaining	wall, the to	be may be	used to
in lieu of	f the heel,	however th	ne overall
	sistance sta	bility must	then be
B _{width,base,a} B _{width,base,b}	eaction force,	R _s ;	
	t for the	concrete	cantilever
	wall, the dep	th of retain	ed soil, d _a
B _{width,base} B _{width,base,c}	ired at the herein;	"virtual	back" as
	,		
Angle of retaining face from horizontal, $\alpha = 90^{\circ}$		90.0	degrees
Angle of exposed face from norizontal, γ (<= 90°) Thickness of base. Thus		90.0	degrees OK
Width of base, B _{width,base,a}		0.000	m
Width of base, B _{width,base,b}		3.800	m
Width of base, B _{width,base,c}		300	mm
Width of base, $B_{width,base} = B_{width,base,a} + B_{width,base,b} + B_{width,base,c}$	201	4.100	m OK
External sliding resistance passive reaction force, R _s		0	kN/m
Position of application of d _p Below Founding Le	evel (i.e. on Shea	r Key) 🔻	· · ·
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CONSULTING Engineering Coloulation Shoot				Job No.	Job No. Sheet No.		Rev.				
	NEEDS	Engineering	g Calculatio	n Sheet			,		F	n	
ENGI	NEEKS	Consulting	Ligineers]XX/	•		Э	Ζ	
						Member/Loo	ation				
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.					
Structure,	Member De	sign - Geot	echnics Ret	aining Walls	S	Made by	ХХ	Date	21	/11/2021	hd.
Concrete	Cantilever	Retaining	Wall Rein	forcement							
/	<u> </u>										
			. .	-							
		Stem rein	forcement								
		Heel reinf	orcement								
		Toe reinfo	rcement								
Longitudina	al steel rein	forcement	diameter in	stem, ϕ_{stem}				20	•	mm	
Longitudina	al steel rein	forcement i	oitch in ster	n, p _{stem}					200	mm	
Longitudina	al steel area	a provided i	n stem, A.,	$T_{\rm rov stem} = (\pi$.\phi_2/4)/p	stem		1	571	mm²/m	
Longitudina	al steel rein	forcement of	diameter in	heel, ϕ_{heel}				16	-	mm	
Longitudina	al steel rein	forcement i	pitch in hee	l, p _{heel}					200	mm	
Lonaitudina	al steel area	a provided i	n heel. A	$m_{\rm heel} = (\pi_{\rm e})$	² /4)/n⊾	ا ما		1	005	mm²/m	
Longitudina	al steel rein	forcement of	diameter in	toe, ϕ_{top}				16	-	mm	
Longitudina	al steel rein	forcement i	pitch in toe.	, nue					200	mm	
Lonaitudina	al steel area	a provided i	n toe. A	$\pi_{too} = (\pi_{\cdot}\phi_{\cdot})$	$n^{2}/4)/n_{10}$			1	005	mm²/m	
Longituani				v,toe (~~ 410							
Shear link	diameter in	stem, dunk	tom					None	-	mm	
Number of	links per m	etre in ster	n. n _{link stom}						5	/m	
Area provid	led by all li	nks ner met	re in stem	Δ.	= n	π. φ	² /4		0	mm ² /m	
Pitch of lin	ks in stem.	Satam	are in stern,	nsv,prov,stem	- Ink,stem	ν•Ψlink,ster	n / ¬		200	mm	
Shear link	diameter in	heel, durate to	1					None		mm	
Number of	links ner m	etre in hee	l number					itterie	5	/m	
Area provid	led by all li	nks ner met	re in heel	Δ –	- n	h	'Δ		0	mm^2/m	
Pitch of lin	ks in heel			rsv,prov,heel	- Ilink,heel	Ψlink,heel /	-		200	mm	
Shear link	diameter in	toe dury .						None		mm	
Number of	links ner m	etre in toe	n					None	5	/m	
		nks nor mot	Tlink,toe		n. .	2/1			0	mm^2/m	
Pitch of lin	ks in top S	пка рег птет		sv,prov,toe —	link,toe•개•Ψlin	k,toe / +			200	mm	
	11100, 3	toe							200	111111	
Effective d	onth to long	nitudinal ste	al in stam	d – B		vor - h			240	mm	
Effective d	epth to long			u _{stem} – D _{wid}		νer ₂ - φ	ink,st		240	mm	
Effective d	opth to long		ol in too d		$-cover_4 - cover_4 - cov$	link,heel	Ψhee		202	mm	
			er in toe, u	toe — Ibase -		nk,heel ⁻ Ψ	toe/ 4		392	11111	
Ectimated	stool rainfa	rcomont au	antity						20	la /m^3	
Estimated	steer relinio		anury ۸ ۱	/ (B	L R)/2 7.			<u>5</u> 8 ⊿1	kg/m	
	baca	[7.050 . (/	י s,prov,stem אין s,prov,stem	(U width,top -	T. 1.	:)/∠]î			41 25	κg/m ⁻	
No curt-il	uase	L 7.050 . (7	s,prov,heel +A	s,prov,toe //	I base Ji				35	κg/m⁻	
ivo curtailh	тепт; по тар	s; LITIKS IGI	iorea; Disti	IDULION STE	er ignored;						

CON	CONSULTING Engineering Calculation Sheet					Job No.		Sheet No.		Rev.
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LIGI						J/0/0	~		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
						Member/Lo	cation			
Job Title	Structure,	Member De	esign - Geot	echnics Ret	aining Wall	Drg.		1		
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date 21	/11/2021	ihd.
.	0	D								
Concrete	Cantilever	Retaining	wall SLS	Loading						
Bulk unit w	l veiaht v = v	/. Or v.						20.0	l/m^3	
Retaining v	vall base we	eight. W1 =	Buidth haas T	hana. On				44	kN/m	
Retaining v	vall wall we	ight (rectar	ngular porti	mase Pc		·B	t	25	kN/m	
Retaining v	vall wall we	ight (triand	ular portion	$(1), W_3 = 0.5$.(Bwidth base	-Bwidth	ton).	0	kN/m	
Retaining v	vall surchar	ae, W₁ = p	s a Bwidth base	- <i>//</i> ··· 5 · •··	··(= wiutii,base,	,c — width,	τομ7-	0	kN/m	
Retaining v	vall earth b	ackfill, W₅ =	$= B_{width hace a}$.(d _a -(B _{width})		2-Thace)	.γ	0	kN/m	
Note weiał	nt of earth i	n front of w	all over toe	ianored. c	onservative	e for ov	erall	slidina res	istance can	acitv:
Water pres	sure at fou	ndina level	(active side	$r_{\rm s}$), $u_{\rm s} = \gamma_{\rm w}$.	1AX(0.0, d _a	-d _{aw})	0	15	kPa	,
Water pres	sure at fou	ndina level	(passive sid	de), $u_n = \gamma_w$.MAX(0.0,	dd_w)		0	kPa	
Water pres	sure at fou	nding level	u = AVERA	$AGE(u_a, u_p)$	ζ,	p p,		7	kPa	
Water upli	t force at for	ounding lev	el, F _{water} =	u.B _{width,base}				30	kN/m	
•										
	Но	rizontal Lo	oad	E	ccentricity	y from	Bas	e		
	F _{ah} (F _{ah} ')	50	kN/m		ea	1.49	90	m		
	F _{uah}	11	kN/m		e _{ua}	0.50	00	m		
	F _{ph} (F _{ph} ')	35	kN/m		ep	-0.8	00	m		
	F _{uph}	7	kN/m		e _{up}	-0.8	00	m		
	Vertical	(Downwa	rd) Load	Eccen	tricity fro	m Base	e Ce	ntroid		
	W_1	44	kN/m	e	$_{w1} = 0.000$	0.00	00	m		
	W ₂	25	kN/m	B _{width,base} /2-	FB _{width,top} /2	-1.9	00	m		
	W ₃	0	kN/m	B _{width,top} +B _v	/idth,base,c)/3	-1.7	50	m		
	W ₄	0	kN/m	width,base,a/2-	$B_{width,base}/2$	-2.0	50	m		
	W ₅	0	kN/m	width,base,a/2-	$B_{width,base}/2$	-2.0	50	m		
	F _{av} (F _{av} ')	18	kN/m	B _{width,base,a} -	$B_{width,base}/2$	-2.0	50	m		
	F_{uav}	0	kN/m	B _{width,base,a} -	$B_{width,base}/2$	-2.0	50	m		
	F_{pv} (F_{pv} ')	-9	kN/m	e _{pv} =	$B_{width,base}/2$	2.05	50	m		
	F _{upv}	0	kN/m	e _{upv} =	$B_{width,base}/2$	2.05	50	m		
	-F _{water}	-30	kN/m	.B _{width,base} /[$3.(u_a+u_p)]$	-0.6	83	m		
	Note eccer	ntricity of ve	ertical load	from base o	entroid bas	sed upo	n th	e simplifica	tion that	
	the active	pressure ac	ts entirely	on the stem	(d _a -T _{base})) and th	hat t	he passive	pressure	
	acts entire	ly on the ba	ase T _{base} , w	here the sh	iear key (if	employ	/ed)	is assumed	d to also be	;
Total retain	ning wall SL	S vertical (downward)	load, F _{concre}	te,cantilever,v	L		78	kN/m	
Note F _{concr}	ete,cantilever,v	$= W_1 + W_2$	$+W_{3}+W_{4}+$	$W_5 + F_{av}(F)$	_{av} ')+0(F _{uav}	$_{v})+F_{pv}$	(F _{pv}	')+0(F _{upv})	;	
Total retain	ning wall SL	S effective	vertical (do	wnward) lo	ad, F _{concrete}	,cantilever,	v	48	kN/m	
Note F _{concre}	ete,cantilever,v	$= F_{concrete,concr$	antilever, v - F wa	teri					/	
Total retain	ning wall SL	S horizonta		rete,cantilever,h				19	kN/m	
Note F concre	ete,cantilever,h	$= F_{ah}(F_{ah}')$)+0(F _{uah})-F	_{ph} (F _{ph} ')-0(F _{uph})-R _s ;		+	alidia a faus		
Nole F concre	ete, cantilever, h	S Set to 0 I	about boos	resistance		xceeus	the s	silaing torc		
	ning wall SL	S moment	about base	centrola, №	concrete,cantile	ver		31		
NOLE M conci	rete,cantilever =	$- \Gamma_{ah}(\Gamma_{ah})$), e _{ua} -r _{ph} (r	ph $j.e_p - U(1)$	_{uph}).e	$\frac{up}{1}$	$\frac{100}{100}$	$v_2 \cdot e_{w2} + vv_3$.e _{w3}
Noto curch	area nat in	$+W_5.e_w$	<u>5 + r_{av} (r_{av})</u>	$J.e_{av} + O(r_u)$	av).e _{uav} +r	pv(r _{pv}	$).e_{p}$	$V + O(F_{upv})$	e _{upv} -r _{water} .	e _{water} ;
Note SUICH	arge not in ;,		the restori	rescoring r	canacity or	it canno	ul De	- yuarantee	u, momenti	
Conci	rete,cantilever IS			ig moment		ALCEUS		over curring		
Fauivalent	eccentricity	/ e – MA	X(0 M		F	. '_\^	1.)	0 457	m	
Note surch	arge not in	cluded in c	alculation of	e,cantilever) / \	ertical (do	lever,v - V	1) /~	Co.u das it can	not he quar	antood
l imiting er	centricity for	or no overa	Il unlift (fac	tored) e) / F	10 03 11 Call	m	anceu,
				eff,		i,pase / U	,,,	0.003	111	

CON		F		. Charach		Job No.		Sheet No.		Rev.
	NEEDS	Consulting	g Calculatio Engineers	n Sneet		iVVV		5	1	
ENGI	NEEKS	consulting	Lingineers]~~~		5	4	
						Member/Locat	ion			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.				
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	X	Date 21	/11/2021	hd.
Total retai	ning wall SL	S overturni	ng moment	, M _{concrete,car}	ntilever,ot			89	kNm/m	
Note M conc	rete,cantilever,ot	$= F_{ah}(F_{ah})$	').e _a +0(F _{ua}	_{ah}).e _{ua} -F _{av}	(F _{av} ').(B _{wid}	dth,base/2-	e _{av})		
		-0(F _{uav}).(B _{width,base}	/2-e _{uav})+F	$F_{water}.(B_{widt})$	th,base/2-e	wat	_{rer});		
Total retai	ning wall SL	S restoring	moment, N	1 concrete, cantile	ver,rt			111	kNm/m	
Note M conc	rete,cantilever,rt	$= [F_{ph}(F_{ph})]$	').e _p +0(F _u	_{ıph}).e _{up} +W	1.(B width,bas	_{se} /2-е _{w1}))+1	V ₂ .(B _{width,t}	$_{ase}/2-e_{w2})$	
		+W ₃ .(1	B width, base /2	-e _{w3})+W ₅ .	(B _{width,base} /	′2-e _{w5})				
		+F _{pv} (F	' _{pv} ').(B _{width,}	_{base} /2-e _{pv})	+0(F _{upv}).(E	3 _{width,base} /	/2-	e _{upv})] / FC)S ₅ ;	
Note surch	arge not in	cluded in ca	lculation of	restoring r	noment as	it cannot	be	guarantee	ed;	
					-					
Maximum	gross worki	ng pressure	$q_{w1} = F_{con}$	crete,cantilever,	/B _{width,base} -	+ 6.M _{concr}	ete,	30	kPa	
Minimum g	ross workir	ng pressure	$q_{w2} = F_{conc}$	crete,cantilever,v	/B _{width,base} –	6.M _{concret}	te,ca	8	kPa	
Equivalent	width, B _{widt}	$h,base' = B_{wid}$	ith,base – 2e _{el}	ff (D	,			2.786	m	
Gross worl	king pressur	$re, q_w = F_{cor}$	ncrete,cantilever,	v / B _{width,base}	-			28	кРа	
Concrete	Cantilever	Retaining	Wall ULS	Loading						
									11	
L/				NOTE IT IS A	ssumea tha	at the UL	5 10	oaas act at	the	
ĸ		/1	KN/M	same eccel	ntricities as	the SLS	102	ias;		
I/		15	kN/m							
ĸ		49	KN/M							
	к. г _{uph}	10	KIN/M							
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CONSULTING Factors for Cale lattice Chart	Job No.	Sheet No.		Rev.
ENCINEE BS Consulting Engineers	ivvv	F	F	
	JVVV	5	5	
	Member/Location			
Job Title Structure, Member Design - Geotechnics Retaining Wall	Drg.			
Structure, Member Design - Geotechnics Retaining Walls	Made by XX	Date 21	/11/2021	hd.
Concrete Cantilever Retaining Wall Reinforcement Design				
Shear force diagram				
Bending moment diagram				
Bending Moment Design in Stem				
Moment at stem base per metre, M		87	kNm/m	
Note $M = MAX [0, K.F_{ab}(K.F_{ab}').(e_a - T_{base} + B_{width, base, c}/2) + 0(K.F_{ua})$	h).(e _{ua} -T _{ba}	$B_{se} + B_{width,bas}$	_{se,c} /2)	
$-K.F_{ph}(K.F_{ph}').(e_p-T_{base}+B_{width,base,c}/2)-O(K.F_{uph}).(e_{up}-K.F_{width,base,c}/2)$	$-T_{base} + B_{widi}$	$_{th,base,c}/2)];$		
Concrete moment capacity per metre, $M_{\mu} = 0.156 f_{cu} \cdot 1000. d_{stem}^2$		359	kNm/m	
Bending stress, $[M/bd^2] = M / [(1000), d_{stem}^2]$		1.51	N/mm ²	
Bending stress ratio, $K = [M/bd^2] / f_{cl} <= 0.156$		0.038		ОК
Lever arm, $z = d_{ctom}$, $[0.5 + (0.25 - K/0.9)^{0.5}] <= 0.95d_{ctom}$		228	mm	
Area of tension steel required, $A_c = M / [(0.95f_v).z]$		873	mm ² /m	
Area of tensile steel reinforcement provided, Ac provided		1571	mm ² /m	
Bending moment in stem utilisation = A_a / A_a may stem		56%		ОК
Denang memere in ocenn achioacteri i rig y rig,prov,stem		0070		UN
Min longitudinal reinforcement in stem (>= 0.0024.1000 Buside to		0.52	0/_	
96 Min longitudinal reinforcement in stem utilication	ase,c CLOO	0.52	70	
		25%		OK
		25%		ОК
Shear Design in Stem		25%		ОК
Shear Design in Stem		25%		ОК
Shear Design in Stem Shear force at stem base per metre. Vult = MAX [0, K.Fab(K.Fab')+0)(K.F)-K.F	25%	kN/m	OK
Shear Design in Stem Shear force at stem base per metre, V _{ult} = MAX [0, K.F _{ah} (K.F _{ah} ')+0) Shear force at stem base per metre, V = MAX [0, K.F _{ah} (K.F _{ah} ')+0))(K.F _{uah})-K.F	25%	kN/m kN/m	OK
Shear Design in Stem Shear force at stem base per metre, V _{ult} = MAX [0, K.F _{ah} (K.F _{ah} ')+0 Shear force at stem base per metre, V = MAX [0, K.F _{ah} (K.F _{ah} ')+0(H)	I(K.F _{uah})-K.F K.F _{uah})-K.F _{pl}	25% 86 86	kN/m kN/m	OK
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $V = V_u / (1000 d_{v-1}) (< 0.8 f^{-0.5} g^{-0.5} g^{-0.5})$	(K.F _{uah})-K.F _{pl} (.F _{uah})-K.F _{pl}	25% 86 86	kN/m kN/m	OK
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem utilisation	(K.F _{uah})-K.F (K.F _{uah})-K.F _{pl} (SN/mm ²)	25% 86 86 0.36 7%	kN/m kN/m N/mm ²	OK
Shear Design in Stem Shear force at stem base per metre, V _{ult} = MAX [0, K.F _{ah} (K.F _{ah} ')+0 Shear force at stem base per metre, V = MAX [0, K.F _{ah} (K.F _{ah} ')+0(H Ultimate shear stress in stem, v _{ult} =V _{ult} /(1000.d _{stem}) (< 0.8f _{cu} ^{0.5} & 5 Ultimate shear stress in stem utilisation	(K.F _{uah})-K.F (K.F _{uah})-K.F _{pl} N/mm ²)	25% 86 86 0.36 7%	kN/m kN/m N/mm ²	OK
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem utilisation Design shear stress in stem, $v_{ult}=V/(1000.d_{stem})$	(K.F _{uah})-K.F _{pl} (.F _{uah})-K.F _{pl} (N/mm ²)	25% 86 86 0.36 7%	kN/m kN/m N/mm ²	ОК ОК
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ Design shear stress in stem, $v_d=V/(1000.d_{stem})$ (Conservatively, shear capacity enhancement by either calculation)	(K.F _{uah})-K.F _{pl} (K.F _{uah})-K.F _{pl} (SN/mm ²)	25% 86 86 0.36 7% 0.36	kN/m kN/m N/mm ² N/mm ²	ОК
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult} = V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5} \& 5$ Ultimate shear stress in stem, $v_{ult} = V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5} \& 5$ Ultimate shear stress in stem, $v_d = V/(1000.d_{stem})$ (Conservatively, shear capacity enhancement by either calculation comparing against unenhanced v_c as clause 3.4.5.10 BS8110 or	(K.F _{uah})-K.F _{pl} (K.F _{uah})-K.F _{pl} N/mm ²) g v _d at d fi calculating	25% 86 86 0.36 7% 0.36 rom support	kN/m kN/m N/mm ² N/mm ² t and port and	ОК ОК
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult} = V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{ult} = V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{d} = V/(1000.d_{stem})$ (Conservatively, shear capacity enhancement by either calculation (Conservatively, shear capacity enhancement by either calculation (Comparing against unenhanced v_c as clause 3.4.5.10 BS8110 or (Comparing against enhanced v_c within 2d of the support as clause	(K.Fuah)-K.Fpi $(K.Fuah)-K.Fpi(K.Fuah)-K.Fpi(K.Fuah)-K.Fpi(K.Fuah)-K.Fpi(K.Fuah)-K.Fpi$	25% 86 86 0.36 7% 0.36 rom support v _d at support 8110 ignore	kN/m kN/m N/mm ² N/mm ² t and ort and ed;)	ОК ОК
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{d}=V/(1000.d_{stem})$ Conservatively, shear capacity enhancement by either calculation Comparing against unenhanced v_c as clause 3.4.5.10 BS8110 or comparing against enhanced v_c within 2d of the support as clause Area of tensile steel reinforcement provided. As any stem	(K.F _{uah})-K.F _{pl} (K.F _{uah})-K.F _{pl} SN/mm ²) (calculating (3.4.5.8 BS)	25% 86 86 0.36 7% 0.36 rom support v _d at support 8110 ignore 1571	kN/m kN/m N/mm ² N/mm ² t and ort and ed;) mm ² /m	OK
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult} = V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{ult} = V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{d} = V/(1000.d_{stem})$ (Conservatively, shear capacity enhancement by either calculation comparing against unenhanced v_c as clause 3.4.5.10 BS8110 or comparing against enhanced v_c within 2d of the support as clause Area of tensile steel reinforcement provided, $A_{s,prov,stem}$ $p_{ut} = 100A_{total}$	(K.Fuah)-K.Fpl(K.Fuah)-K.Fpl(N/mm2)(N/mm2)(ng vd at d find(calculating)(3.4.5.8 BS)	25% 86 86 0.36 7% 0.36 rom support v _d at support 8110 ignore 1571 0.65	kN/m kN/m N/mm ² N/mm ² t and ort and ed;) mm ² /m %	ОК ОК
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{d}=V/(1000.d_{stem})$ (Conservatively, shear capacity enhancement by either calculating comparing against unenhanced v_c as clause 3.4.5.10 BS8110 or comparing against enhanced v_c within 2d of the support as clause Area of tensile steel reinforcement provided, $A_{s,prov,stem}$ $p_w = 100A_{s,prov,stem}/(1000.d_{stem})$	$(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$	25% 86 86 0.36 7% 0.36 rom support v _d at support 8110 ignore 1571 0.65 0.73	kN/m kN/m N/mm ² N/mm ² t and ort and ed;) mm ² /m %	OK
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem}) (< 0.8f_{cu}^{0.5} \& 5]$ Ultimate shear stress in stem, $v_{d}=V/(1000.d_{stem})$ <i>Conservatively, shear capacity enhancement by either calculating comparing against enhanced</i> v_c <i>as clause 3.4.5.10 BS8110 or comparing against enhanced</i> v_c <i>within 2d of the support as clause</i> Area of tensile steel reinforcement provided, $A_{s,prov,stem}$ $p_w = 100A_{s,prov,stem}/(1000.d_{stem})$ $v_c = (0.79/1.25)(p_wf_{cu}/25)^{1/3}(400/d_{stem})^{1/4}; p_w<3; f_{cu}<40; (400/d_{stem})$	(K.Fuah)-K.Fpl(K.Fuah)-K.Fpl(N/mm2)(N/mm2)(Calculating(3.4.5.8 BS)(Calculating)	25% 86 86 0.36 7% 0.36 rom support v _d at support 8110 ignore 1571 0.65 0.73	kN/m kN/m N/mm ² N/mm ² t and ort and ed;) mm ² /m % N/mm ²	OK OK
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (< $0.8f_{cu}^{0.5}$ & 5 Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem})$ (Conservatively, shear capacity enhancement by either calculating comparing against unenhanced v_c as clause 3.4.5.10 BS8110 or comparing against enhanced v_c within 2d of the support as clause Area of tensile steel reinforcement provided, $A_{s,prov,stem}$ $p_w = 100A_{s,prov,stem}/(1000.d_{stem})$ $v_c = (0.79/1.25)(p_wf_{cu}/25)^{1/3}(400/d_{stem})^{1/4}; p_w<3; f_{cu}<40; (400/d_{stem})$	$(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$ $(K.F_{uah})-K.F_{pl}$	25% 86 86 0.36 7% 0.36 7% 0.36 7% 0.36 7% 0.36 8110 ignore 1571 0.65 0.73	kN/m kN/m N/mm ² N/mm ² t and ort and ed;) mm ² /m % N/mm ²	OK OK
Shear Design in Stem Shear force at stem base per metre, $V_{ult} = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Shear force at stem base per metre, $V = MAX [0, K.F_{ah}(K.F_{ah}')+0]$ Ultimate shear stress in stem, $v_{ult}=V_{ult}/(1000.d_{stem}) (< 0.8f_{cu}^{0.5} \& 5]$ Ultimate shear stress in stem, $v_{d}=V/(1000.d_{stem})$ (Conservatively, shear capacity enhancement by either calculating comparing against unenhanced v_c as clause 3.4.5.10 BS8110 or comparing against enhanced v_c within 2d of the support as clause Area of tensile steel reinforcement provided, $A_{s,prov,stem}$ $\rho_w = 100A_{s,prov,stem}/(1000.d_{stem})$ $v_c = (0.79/1.25)(\rho_w f_{cu}/25)^{1/3}(400/d_{stem})^{1/4}; \rho_w < 3; f_{cu} < 40; (400/d_{stem})$	$(K.F_{uah})-K.F_{pi}$ $(K.F_{uah})-K.F_{pi}$ $(K.F_{uah})-K.F_{pi}$ $(K.F_{uah})-K.F_{pi}$ $(K.F_{uah})-K.F_{pi}$ $(K.F_{uah})-K.F_{pi}$ $(K.F_{uah})-K.F_{pi}$	25% 86 86 0.36 7% 0.36 rom support v _d at support 8110 ignore 8110 ignore 8110 ignore 0.73 0.65 0.73	kN/m kN/m N/mm ² N/mm ² t and ort and ed;) mm ² /m % N/mm ²	OK
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	S Consulti	ng Engineers	in Sheet		iXX	х	6	56	
			1		Momber"			-	
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Structure Member	e, Member	Design - Geol	taining Wall		Made by	vv	Date 21	/11/2021	hd.
Structure, Member			Lanning wan	5		~~	21	/11/2021	
Bending Moment	Design in	Heel							
Moment in heel (at	stem) per	metre, M					0	kNm/m	
Note $M = K.W_1.(B)$	width,base,a/B	width,base).(B wid	dth,base,a +B w	idth,base,c)/2	$+K.W_4$.(B "	<i>idth,base,a</i> +B	width,base,c)/2	2
+K.W ₅ .(I	3 _{width,base,a} +	$-B_{width,base,c})/2$		(2)/P	1/0		 P	(2)/2	
-ĸ.[2.y _{w2}	$+(q_{w1} - q_{w2})$ +B	(D width, base, a)	$+D_{width,base,c}$ $+a_{a})/[3]$	$(a_{a}+a_{a})$	ase].(D))7	width,i	base,a +D width	n,base,c/∠)/∠	
where a	$a_{2} = a_{2} + (a_{2} + (a_{2} + a_{3}))$	ase,c/2):(24 w2	$+ q_{W3} + B_1$	(9 W2 + 9 W3) width base $c/2$)/B width	hace	,		
	<u> </u>		lulli,Dase,a · —	width,Dase,C7 —7	// — wiatii,	Dase /			
Concrete moment o	apacity per	metre, M _u =	0.156f _{cu} .10	00.d _{heel} ²			959	kNm/m	
Bending stress, [M/	bd^2] = M /	[(1000).d _{heel} ²]				0.00	N/mm ²	
Bending stress ratio	o, K = [M/b	d^{2}] / $f_{cu} <= 0$.156				0.000		ОК
Lever arm, $z = d_{hee}$. [0.5 + (0	0.25-K/0.9) ^{0.5}] <= 0.95d	neel			372	mm	
Area of tension stee	el required,	$A_{s} = M / [(0.9)]$	95f _y).z]				-1	mm²/m	
Area of tancila stac	Iroinforcon	ant provided	<u></u>				1005	21	
Rending moment in	heel utilisa	ation = A / A	, As,prov,heel				1005	mm /m	OK
			,prov,heel				0 70		UK
% Min longitudinal	reinforceme	ent in heel (>:	= 0.0024.10	D00.T _{base} G2	_ 250; >:	= 0.0	0.22	%	
% Min longitudinal	reinforceme	ent in heel util	isation	bube			58%		ОК
Shear Design in H	leel								
Shear force in heel	(at stem) p	per metre, V _{ult}					0	kN/m	
Note V = and V = K	(at stem) p	ber metre, v	+ <i>K</i> W, + <i>k</i>	(W _ = K [2 /	$a \rightarrow (a)$	1 . =/	0 (, ,) B	KIN/M	
	(B	,base,a/D width,bas B	se + N. W 4 + M		Y w2 +(Y	w1 -	Υw2J·D width,	base,a	
,	width,base J	width,base,a/ =/							
Ultimate shear stre	ss in heel, v	$v_{ult} = V_{ult} / (1000)$.d _{heel}) (< 0	.8f _{cu} ^{0.5} & 5N	V/mm²)		0.00	N/mm ²	
Ultimate shear stre	ss in heel u	tilisation					0%	-	ОК
Design shear stress	in heel, v _d	=V/(1000.d _{hee}	el)				0.00	N/mm ²	
(Conservatively, sh	ear capacit	y enhancemer	nt by eithe	r calculatin	ng v _d a	tdf.	rom suppor	t and	
comparing against	unennanced	I V _c as clause	3.4.5.10 B	58110 or		ting o pc	V _d at supp	ort and	
Area of tensile stee	reinforcen	c within 20 0			5.4.5.0	5 03	1005	mm^2/m	
$\rho_{\rm w} = 100 A_{\rm s \ prov \ heel}/($	1000.dhaal)		· · ·s,prov,neel				0.26	%	
$v_c = (0.79/1.25)(\rho_v$	(f _{cu} /25) ^{1/3} (4	00/d _{heel}) ^{1/4} ; p		; (400/d _{hee}	$(1)^{1/4} > 0.$	67	0.47	N/mm ²	
Check $v_d < v_c$ for	no links						VALID		
Concret	e shear cap	acity v _c .(1000	.d _{heel})				185	kN/m	
CNECK $v_c < v_d < 0$	4 + V _c for		(5	(1000)//0	05f \	ic	N/A	ma ma 2 /	
Concrete		nal links choor	r_{sv} / $\sigma > 0.4$	$\frac{1}{4 + \sqrt{1}}$	000 Y		342	///m///mm/	11
				,,, , ,,,,,,,,		eel /	542		
Check v _d > 0.4 +	v _c for desi	gn links					N/A		
Provide	shear links	$A_{sv} / S > 100$	0.(v _d -v _c)/(0	.95f _{yv}) i.e.	A _{sv} / S	>	0.92	mm²/mm/	m
Concret	e and desig	n links shear o	capacity (A _s	v,prov,heel/She	_{eel}).(0.9	5f _{yv})	185	kN/m	
Area provided by a	l links per r	netre, A _{sv,prov,}	heel				0	mm²/m	
I ried A _{sv,prov,heel} / S _t	_{eel} value	1 #11' 1'					0.00	mm²/mm/	m
Design shear resist	ance in hee	utilisation					0%		ОК
			1		1			1	

CONSULTING	Engineorin	a Calculatio	n Sheet		Job No).	Sheet No.		Rev.
ENGINEERS	Consultina	e calculatio Engineers	in Sheet		iXX	x			
	g				Momber"	-			
	Marshan Da		a ale a la a Dat		Member/Lo	cation			
Job Title Structure,	Member De	esign - Geot		aining wai	Made by	VV	Date 31	/11/2021	thd
Structure, Member De	esign - Geot	echnics Ret	aining wall	S	Made by	ХХ	^{Date} 21	/11/2021	
Bending Moment De	sian in To	e							
Moment in toe (at ste	m) per met	re, M					133	kNm/m	
Note $M = K.[2.q_{w1}-(q_{w1})]$, . _{w1} -q _{w2}).(В	$\frac{1}{3}_{width,base,b}$ +	B _{width,base,c} /	2)/B _{width,bas}	e].(B _{wid}	dth,ba	se,b +B width,b	_{ase,c} /2)/2	
.(B width,base,b	+B width, base,	c/2).(2q _{w1} ·	+q _{w3})/[3.	$(q_{w1} + q_{w3})$]	,			
-K.W ₁ .(B _{wid}	ith,base,b /B wid	ith,base).(B wi	$d_{th,base,b} + B_{v}$	vidth,base,c)/2	2				
where q _{w3} =	$= q_{w2} + (q_{w2})$	1 -q _{w2}).(B _{wi}	$_{idth,base,a}$ +B ,	vidth,base,c/2))/B _{width,l}	base ;			
Note weight of earth i	in front of w	all over toe	e conservati	vely ignore	ed;				
Concrete moment cap	acity per m	etre, $M_u = 0$	0.156f _{cu} .100	$10.d_{toe}^2$			959	kNm/m	
Bending stress, [M/bd	$I^{2}] = M / [(1)$	1000).d _{toe} ²]					0.87	N/mm ²	
Bending stress ratio, I	$K = [M/bd^2]$	$ / f_{cu} <= 0.$	156				0.022		ОК
Lever arm, $z = d_{toe}$.	0.5 + (0.25)	p-K/0.9) ^{0.5}]	$<= 0.95d_{to}$	e			372	2 .	
Area of tension steel i	requirea, A _s I	= M / [(0.9	∃5Γ _γ).Ζ]				818	mm²/m	
Area of tancila staal r	inforcomor	torovidad	^				1005	21	
Bending moment in to		$\frac{1}{2} - \frac{1}{2} / \frac{1}{2}$	A _{s,prov,toe}				21005	mm-/m	OK
		$I - A_s / A_{s,p}$	rov,toe				81%		UK
% Min longitudinal rei	 nforcement	in toe (>=	0 0024 100		50·>=	0.0	0.22	0/0	
% Min longitudinal rei	nforcement	in toe utili	sation	Dase 02	50, 2	0.0	58%	70	ОК
Shear Design in Toe									
Shear force in toe (at	stem) per i	netre, V _{ult}					48	kN/m	
Shear force in toe (at	stem) per i	metre, V					48	kN/m	
Note V _{ult} and V = K.[2.q _{w1} -(q _{w1}	-q w2).B widt	h,base,b /B widt	h,base].B widt	h,base,b/2	2-K.	W ₁ .B _{width,b}	ase,b/B width,ba	ase i
Note weight of earth i	in front of w	all over toe	e conservati	vely ignore	ed;				
Ultimate shear stress	in toe, v _{ult} =	V _{ult} /(1000.	d _{toe}) (< 0.8	f _{cu} ^{0.5} & 5N/	mm²)		0.12	N/mm ²	
Ultimate shear stress	in toe utilis	ation					2%		ОК
Design shear stress in	toe, v _d =V/	$(1000.d_{toe})$					0.12	N/mm ²	
(Conservatively, snea	r capacity e	nnancemer	T DY eitne	r calculatin	$\frac{1}{2}$ v _d at		rom suppor	t and	
comparing against un		_c as clause	5.4.5.10 D	50110 UF		IIIY 2 BC	v _d at supp	ort anu	
Area of tensile steel re		nt provided		i as clause	5.4.5.0	כם נ	1005	mm^2/m	
$\rho_{\rm w} = 100 A_{\rm cmm}$, /(100)0.d)		'`s,prov,toe				0.02	%	
y = (0.79/1.25)(0.16)	$(25)^{1/3}(400)$	/d.) ^{1/4} . o	<3.f <40.	(400/d.)	^{1/4} >0.6	7	0.20	N/mm^2	
		/ StoeJ / Pw	······································	(100/ u _{toe})	20.0	,			
Check $v_d < v_c$ for no	links						VALID		
Concrete s	hear capaci	ty v _c .(1000	.d _{toe})				185	kN/m	
								• *	
Check $v_c < v_d < 0.4$	+ v _c for no	minal link	S				N/A		
Provide no	minal links	such that A	_{sv} / S > 0.4	.(1000)/(0	.95f _{yv}) i	i.e. /	0.92	mm²/mm/	m
Concrete a	nd nominal	links shear	capacity (C	$0.4 + v_{c}).(1$	000.d _{to}	e)	342	kN/m	
Check $v_d > 0.4 + v_c$	for design	links					N/A		
Provide sh	ear links A _s	,/S>1000	$0.(v_d - v_c)/(0)$.95f _{yv}) i.e.	A_{sv} / S	>	0.92	mm²/mm/	m
Concrete a	nd design li	inks shear o	capacity (A _s	v,prov,toe/Stoe).(0.95	f _{yv}).	185	kN/m	
Area provided by all li	nks per me	tre, A _{sv,prov,t}	oe				0	mm²/m	
I ried A _{sv,prov,toe} / S _{toe} V	value						0.00	mm²/mm/	m
Design shear resistan	ce in toe uti I	llisation					26%		OK

CON	SULTING	Engineering Calculation Sheet				Job No	o. Sheet No.			Rev.
	NEERS	Consulting	e Calculatio Engineers	II Sheet		iXX	х	5	8	
			5		1	Mombor// a				
	Charlestan	Marahar Da	aian Caat	achaice De	taining Ma		cation			
Job Title	Structure,	Member De	ochnics Pot	echnics Re	Laining wa	Made by	vv	Date 71	/11/2021	hd.
Structure,		sign - Geol	echnics Rei	annny wai	15		~~	21	/11/2021	
Detailing	Requireme	ents								
All detailing	g requireme	ents met ?						ОК		
Manulanath			and with the last of							
Max longitu	Idinal steel	reinforcem	ent pitch in	stem (<30 $hool$ (<30	l _{stem} , 50</td <td>mm)</td> <td></td> <td>200</td> <td>mm</td> <td>OK</td>	mm)		200	mm	OK
Max longitu		reinforcem			heel, <75011	n)		200	mm	OK
								200		<u>UK</u>
Max	imum spaci	ng: 0.5%	% Ast or less	- 300mm						
	1	Betw	ween 0.5% a	nd 1.0% - 2	25mm					
		1.0%	% Ast or grea	ater - 175m	m					
Max longitu	udinal steel	reinforcem	ent pitch in	stem				200	mm	ОК
Max longitu	udinal steel	reinforcem	ent pitch in	heel				200	mm	ОК
Max longitu	udinal steel	reinforcem	ent pitch in	toe				200	mm	ОК
Min longitu	dinal steel	reinforceme	ent pitch in	stem (>75	mm+\ophistem,	>100m	m+¢	200	mm	ОК
Min longitu	dinal steel	reinforceme	ent pitch in	heel (>75r	nm+ _{\$heel} , 2	>100mm	1+¢h	200	mm	ОК
Min longitu	dinal steel	reinforceme	ent pitch in	toe (>75m	$m + \phi_{toe}$, >1	100mm+	- \$toe	200	mm	OK
Note an all	owance has	s been mad	e for laps ir	n the min p	itch by inc	reasing	the o	criteria by t	he bar dian	neter.
0/ Max lon	aitudinal ra	inforcomon	t in stom (a	- 0 04 10	00 B			0.24	0/	
% Max lon		inforcement		= 0.04.10	$00.D_{width,bas}$	se,c)		0.34	% 0/2	OK
% Max lon	gitudinal re	inforcement	t in toe (<=	= 0.04.100	(T_{base})			0.22	%	OK
	gicaaniarre			010 11200	Jase/			0.22	70	ÖK
Longitudina	al steel rein	forcement of	diameter in	stem, ϕ_{sten}	 (>=12mr	n)		20	mm	ОК
Longitudina	al steel rein	forcement of	diameter in	heel, ϕ_{heel}	(>=12mm)		16	mm	ОК
Longitudina	al steel rein	forcement of	diameter in	toe, ϕ_{toe} (>	>=12mm)			16	mm	ОК
Deflection	Criteria i	n Stem								
Span, $I = c$	$I_a - T_{base} + B_{wid}$	dth,base,c/2	_					3.600	m	
Span, I / e	fective dep	oth, d _{stem} rat	tio					15.0		
De sie en en		dauth uatio	auitauia (7					7.0		
Basic span	/ effective	depth ratio	criteria (7	cantilever)				7.0		
Modificatio	n factor for	tension C	_{n 10m} noc ap	pilcable,						
	M/hd ²							1 51	N/mm ²	
	stem							1.01	• •/ •• •• •	
	$f_{s} = \frac{2f_{y}A_{s}}{34}$	$\frac{1}{\beta_1} \times \frac{1}{\beta_2}$	$(\beta_{b} = 1.0)$					171	N/mm ²	
	0115 1	arov Pb								
		0.55.4	(477-f_)	~ 20						
	Modificatio	n 12	$20(0.9 + \frac{M}{h - t})$	$\frac{1}{2} = 2.0$				1.61		
			, oa	7						
Modified sp	oan / effecti	ive depth ra	atio criteria					11.3		
Deflect		in a til a se						1284		NOTOK
Deflection	in stem util	isation						133%		NOT OK





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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	6	1	
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a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	6	2	
21101		J	5			Manchanilla antian		-	
a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
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21101		J				Joor Manakara		5	
a. 1. 1	Charles	Manakan Da		a ale al a a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

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						Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.	D (
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	S	Made by XX	Date 21,	/11/2021	ina.
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CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	6	5	
21101		J	5			Joor Manakara		5	
a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1	Member/Location			
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Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

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ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX 66			
			_			Member/Location			
loh Title	Structure	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure.	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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Local Jack Processing Calculation Single pxx 67 Job Title Structure, Member Design - Geotechnics Retaining Walls Maximum Accounts Maximum Accounts Job Title Structure, Member Design - Geotechnics Retaining Walls Maximum Accounts Maximum Accounts Job Title Structure, Member Design - Geotechnics Retaining Walls Maximum Accounts Maximum Accounts Job Title Structure, Member Design - Geotechnics Retaining Walls Maximum Accounts Maximum Accounts Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title Job Title	CON	SULTINC	Enginegrin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
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Job Title Structure, Member Design - Geotechnics Retaining Walls Weinty XX Constructure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Weinty XX Constructure, Member Design - Geotechnics Retaining Walls Value XX Constructure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Weinty XX Constructure, Member Design - Geotechnics Retaining Walls Value XX Constructure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Weinty XX Constructure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Weinty XX Constructure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Design - Geotechnics Retaining Walls Structure, Member Desige Retaining Walls	21101		J				Manchanilla antian			
		Christer	Montes		ochaice Det	oining M-1	Drg.			
	Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
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			-			Member/Location			
loh Title	Structure	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure.	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.

CON	SULTING	Enginoorin	a Calculatio	n Shoot		Job No. Sheet No.		Rev.	
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Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.	2-11 04		
Structure,	Member De	sign - Geot	echnics Ret	aining Wall:	S	Made by XX	Date 21	/11/2021 [.]	ha.
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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	7	1	
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a. 1. 1	Charles	Manakan Da		a ale al a se Dad	- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	
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a. 1. 1	Charles	Manakan Da		a ale al a se Dad	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

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LIGI		consulting	Linghiecito			JXXX	,	5	
						Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.	2-11 04		
Structure,	Member De	sign - Geot	echnics Ret	aining Wall:	S	Made by XX	Date 21	/11/2021 [.]	ha.
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8									
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ah an linte				4	4				
snear link	alameter			4	4	1	L	1	
						3	4	T	
None									
6									
8									
10									
12									
16									
20									
25									
type of en	nbedded r	etaining w	vall				2	2	
Concrete C	ontiguous /	' Interlockir	ig / Secant	Pile Wall					
Concrete D	viaphragm V	Vall							
Steel Shee	t Pile Wall								
contiguou	s / interlo	cking / se	cant pile s	shaft diam	eter		7	5	
300mm								300	
450mm								450	
600mm								600	
750mm								750	
900mm								900	
1050mm								1050	
1200mm								1200	
1350mm								1350	
1500mm								1500	
1650mm								1650	
1800mm								1800	
1950mm								1950	
2100mm								2100	
steel shee	t pile sect	ion descri	ption				48	121	
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shear case	e		3	3	3	1	1	1	
bendina n	noment an	d shear de	esign in en	nbedded ro	etaining w	alls			
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relevant he	eight of exp	osed face.	Hp					N/A	
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Point	Depth. v	Fahr	e _{2 v}	F	e , ,,	м	V		
1	N/A	- an,y N/A	−a,y N/A	- μπ,γ Ν/Δ	<u>-ρ,γ</u> Ν/Δ	N/A	N/A		
2	N/A	N/A	N/A	Ν/Δ	N/A	N/A	Ν/Δ		
2	N/A	N/A	N/A	N/A		N/A	N/A		
<u>л</u>									
5									
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Link Cells					
link 1				0 200	
				 8.300	
				N/A	
link 3				6.500	
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link 5				30.000	
link 6				30.000	



CONSULTING Engineering Calculation Sheet	J	lob No.	Sheet No.	Rev.
E N G I N E E R S Consulting Engineers		jXXX	75	
	M	Member/Location		
Job Title Structure, Member Design - Geotechnics Ret	aining Wall ^D	Drg.		
Structure, Member Design - Geotechnics Retaining Walls	5 ^M	Made by XX	Date 21/11	/2021 ^{Chd.}
Pile				
spacing	_			
	- Co			
- () () () () () () () ()	_ (لر			
Figure A3.5 Contiguous pile wall (see Table A3.1)				
Table A3.1 Contiguous pile wall – typical diameters and spacing		_		
Diameter Spacing Diameter Spacing D	ameter Spac	cing		
<u> </u>	m mm			
300 400 900 1000 18	00 1900	2		
450 550 1050 1150 21 600 700 1200 1300 24	00 2200	,)		
750 850 1500 1600	2.00			
Pile spacing				
	à			
$-1(\ell \rightarrow)(\ell \rightarrow)(\ell \rightarrow)(\ell \rightarrow)(\ell \rightarrow)(\ell \rightarrow)(\ell \rightarrow)(\ell \rightarrow)$)			
Figure A3.7 Hard/soft secant pile wall (see Table A3.2)				
Table 43.2 Harr/soft secont nile wall - twiced diameters and spacing				
		-		
Male Female mm Male Fema	Spacing ((1)		
450 450 600 900 600	1100			
600 600 800 1200 600 750 750 1000 1200 750	1400	-		
750 750 1000 1200 750	1450	—— F		
 The gap between the male piles should not exceed 40 per cent of the d 	iameter of the so	oft piles.		
Bile sparing				
	<i>)</i>			
	/			
Figure A2.9 Hard/See second allo well (see Table A2.9)				
rigure AS.a maronim secant pire wan (see Table AS.3)	┓			
Table AS.5 Frankning secant pile wall – typical diameters and spacing				
male and female mm				
600 900				
750 1150				
Dila			Specing	
Pile	Disc	meter mm		
- spacing	Dian Male	neter mm e and femal	e mm	
	Dian Male 750	meter mm e and femal	e mm 650	
	Dian Mak 750 880 1180	meter mm e and femal)	e mm 650 760 1025	
	Dian Mak 750 880 1180	meter mm ie and femal	e mm 650 760 1025	

CON	SULTING	LTING Engineering Calculation Sheet						Sheet No.		Rev.	
FNGI	NEERS	Consulting	y Calculatio Fngineers	II Sheet		iXX	x		76	с.	
ENGI		consulting	Linghiedro			JAA	~		7	0	
						Member/Lo	cation				
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.					
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date 2	21/	11/2021	hd.
Angle of re	taining face	e from horiz	ontal, $\alpha = 9$	90°				90	.0	degrees	
Angle of ex	posed face	from horizo	ontal, $\gamma = 9$	0°				90	.0	degrees	
Height of e	exposed face	e, H _R (usua	ly <= 5.00	0)				8.30	00	m	
Note that I	H_R should b	pe specified	in anticipat	tion of poss	ible unplan	ned exc	cava	tion to th	e n	ninimum	
of the larg	er of 0.5m a	and 0.10 of	the origina	l retained h	eight, this	increas	ing i	the value	of	Ή _R ;	
Note that I	H_R should a	ilso be spec	ified accour	nting for the	e fact that	the pro	p loc	cation ma	y n	not be at	
the very to	op of the wa	nll, but inste	ad stepped	down, this	decreasing	g the va	alue	of H _R by	the	e step dow	n;
Type of en	bedded ret	aining wall	Concre	te Diaphragm	Wall				•		
	Concrete	Contiguou	s / Interlo	cking / Se	ecant Pile	Wall					
		Note that p	oile below re	efers to the	hard reinfo	orced p	ile;				
		Pile shaft d	iameter, D		90	0mm	▼	N,	/A	mm	
		Pile clearar	ice spacing	, s (usually	50 to 75)			1(00	mm	
		Pile pitch, J	o = D+s					N,	/A	mm	
		Pile shaft s	econd mom	ent of area	$I = [\pi D^4 / D^4]$	64]/p		N,	/A	cm ⁴ /m	
		Pile shaft c	ross sectior	nal area, A _p	$_{\rm s} = \pi D^2/4$			N,	/A	mm²/pile	
		Longitudina	al steel rein	forcement of	diameter in	pile, ϕ_p	oile	32	•	mm	
		Longitudina	al steel rein	forcement i	number in J	pile, n _{pil}	le		18	/pile	
		Longitudina	al steel area	a provided i	n pile, A _{s,pro}	ov,pile =	n _{pile} .	N/	Ά	mm²/pile	
		Shear link	diameter in	pile, $\phi_{link,pile}$	e			10	•	mm	
		Number of	links in a c	ross sectior	n in pile, i.e	. numb	er o	1	2	/pile	
		Area provid	led by all li	nks in a cro	ss-section	in pile,	A _{sv,p}	N/	Ά	mm²/pile	
		Pitch of lin	ks in pile, S	pile				1!	50	mm	
		Ratio h _s /D	= (D - 2.M/	$AX(cover_1, or all a cover_1)$	$cover_2) - 2.$	∮link,pile	- ¢ _{pil}	N,	/A		
		Estimated	steel reinfo	rcement qu	antity			N/	Ά	kg/m ³	
		[7850.A	s,prov,pile / (1	τ.D ² /4)]; [No laps; Lir	nks igno	pred	;			
	Concrete	Diaphragn	n Wall								
		Wall thickn	ess, t (usua	ally 600 to 2	1500)			90	00	mm	
		Wall secon	d moment o	of area, I =	100.t ³ /12			N,	/A	cm⁴/m	
		Longitudina	al steel rein	forcement of	diameter in	wall, φ	wall	32	•	mm	
		Longitudina	al steel rein	forcement	pitch in wal	l, p _{wall}		1	50	mm	
		Longitudina	al steel area	a provided i	n wall, A _{s,pr}	ov,wall =	(π.¢	N/	Ά	mm²/m	
		Shear link	diameter in	wall, $\phi_{link,wa}$	all			10	•	mm	
		Number of	links per m	etre in wall	, n _{link,wall}				7	/m	
		Area provid	led by all li	nks per met	tre in wall,	A _{sv,prov,v}	wall =	N/	Ά	mm²/m	
		Pitch of linl	ks in wall, S	wall				20	00	mm	
		Effective de	epth to long	jitudinal ste	el in wall, o	d _{wall} = t	: - co	N,	/A	mm	
		Estimated	steel reinfo	rcement qu	antity			N/	Ά	kg/m ³	
		[7.850 . (/	4 _{s,prov,wall}) /	[t];							
		No curtailn	nent; No lar	os; Links ig	nored; Dist	ributior	ı ste	el ignore	d;		
	Steel She	et Pile Wal	11								
		Section des	scription	High Mod Z-T	ype Frodingha	am 4N (70	62x26	57x173)	•		
		Section ma	iss, m					N,	/A	kg/m	
		Section ma	iss, m					N,	/A	kg/m²	
		Section de	oth, h					N,	/A	mm	
		Section sec	cond mome	nt of area,	I			N,	/A	cm ⁴ /m	
		Section ela	stic modulu	is, Z				N,	/A	cm ³ /m	
		Section she	ear area, h.	t/b				N,	/A	cm²/m	
ing											

CON	CONSULTING Engineering Calculation Sheet					Job No.	Sheet No.		Rev.
	NEERS	Consultina	y Calculatio Fngineers	ii Sheet		iXXX	7	7	
ENGI		concurring	Linghieero			JVVV	,	/	
						Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall:	S	Made by XX	Date 21	/11/2021 ^c	hd.
Concrete	or Steel Ca	antilever E	mbedded	Retaining	Wall SLS L	oading			
	Но	rizontal Lo	ad	E	ccentricity	y from Bas	e		
	F _{ah} (F _{ah} ')	N/A	kN/m		ea	N/A	m		
	F _{uah}	N/A	kN/m		e _{ua}	N/A	m		
	F_{ph} (F_{ph} ')	N/A	kN/m		ep	N/A	m		
	F _{uph}	N/A	kN/m		e _{up}	N/A	m		
Total retain	ning wall SL	S horizonta	l load, F _{cant}	ilever,h			N/A	kN/m	
Note F cantil	$ever,h = F_{ah}$	(F _{ah} ')+0(F _u	$(F_{ph})-F_{ph}(F_{ph})$	h')/FOS ₅ -0	(F _{uph});				
Note nega	tive F _{cantileve}	_{r,h} is effecti	vely the ad	ditional pas	sive resista	ance capaci	ty over the	active force	2;
Go	oal seek Mca	ntilever to	0.0 by chan	ging da and	dp (fixed e	earth metho	od)		
	(click mu	Iltiple times	until conve	rgence to th	ne practical	solution)			BS8002
Total retain	ning wall SL	S moment	about point	of rotation	, M _{cantilever}		N/A	kNm/m	N/A
Note M _{canti}	$_{lever} = F_{ah}(I)$	F _{ah} ').e _a +0	(F _{uah}).e _{ua} -	F _{ph} (F _{ph} ')/F	OS ₅ .e _p -0(F _{uph}).e _{up} ;			
Anticipated	l maximum	value of d_a	for comme	ncement of	iteration		30.000	m	
Employ fac	tor on emb	edment ?				Yes, Factor 1.	2 🗸		
Note that t	he factor o	n embedme	ent should b	e employed	l if the othe	er FOS met	hods are no	t employed	;
Design em	bedment of	embedded	retaining w	vall, $L_0 = (1$.2 or 1.0).c	1 _p	N/A	m	Tomlinson
Design tota	al length of	embedded	retaining w	all, $L_T = L_0$	⊦H _R		N/A	m	
Concrete	or Steel Ca	antilever E	mbedded	Retaining	Wall ULS L	oading			
	ULS I	lorizontal	Load	Note it is a	ssumed tha	at the ULS	loads act at	the	
K	F_{ah} (K. F_{ah} ')	N/A	kN/m	same eccel	ntricities as	the SLS lo	ads;		
	$K.F_{uah}$	N/A	kN/m						
K.	F _{ph} (K.F _{ph} ')	N/A	kN/m						
	K.F _{uph}	N/A	kN/m						

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ENGI	NEERS	Consulting	Engineers	II Sheet			iXXX	ĸ		7	8	
LIGI							J/00	`			0	
							Member/Lo	cation				
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining	ı Wall	Drg.					
Structure,	Member De	esign - Geot	echnics Ret	aining Walls	5		Made by	XX	Date	21/	/11/2021	ihd.
Concrete	or Steel Ca	antilever E	mbedded	Retaining	Wall	Section	on Des	ign				
					•							
		5	near force (liagram								
	$\mathbf{\Lambda}$	Ben	ding mome	nt diagram	J							
											• -	
Bending I	Noment De	esign in Wa	all, Shear I	Design in V	vall a	nd D	etailin	g Re	equirem	ent	ts	
	Point	Depth, y	Bending N	loment in	Sh	ear F	orce in	า				
	Point	(m)	Wall, M (kNm/m)	Wa	ll, V	(kN/m)				
	1	NI/A	N	/Λ		N	/^					
	2	N/A	N N	/Α /Δ		N	/A /A					
	2		N	/Δ		N	/Δ					
	4	N/A N/A	N	/Δ		N.	/Δ					
	5	N/A	N	/Δ		N	/Δ					
	6	N/A	N	/Α		N	/A					
	7	N/A	N	/A		N	/A					
	8	N/A	N	/A		N	/A					
	9	N/A	N	/A		N	/A					
	10	N/A	N	/A		N	/A					
	11	/A		N	/A							
	11 N/A N/A 12 N/A N/A			/A		, N	/A					
	13	N/A	N	/A	N/A							
	14	, N/A	N	/A		N,	/A					
	15	N/A	N	/A		N	/A					
	16	N/A	N	/A		N,	/A					
	17	N/A	N	/A		N,	/A					
	18	N/A	N,	/A		N,	/A					
		Σ	N	/A		N,	/A					
	Note M = I	K.F _{ah,y} (K.F _a	_{а,y} ').е _{а,y} -К	.F _{ph,y} (K.F _{ph}	, _y ')/F	OS 5.6	e _{p,y} +0(K.F	_{uah,y}).e _{ua}	_{a,y} -(0(K.F _{uph,y}).	е _{ир,у} ;
	Note V = k	K.F _{ah,y} (K.F _a	_{h,y} ')-K.F _{ph,y}	(K.F _{ph,y} ')/F	- OS 5 -	-0(K.I	F _{uah,y})-	0(K.	F _{uph,y});			
	where for	undrained a	nalysis				and for	- dra	ined ana	alys	is	
	$\sigma_{va,surface} =$	= р _{s,a}					$\sigma_{\it va, surfa}$	ce ' =	= p _{s,a} -0.	0		
	$\sigma_{va,y} = p_{s,y}$	a + γ .γ					$\sigma_{va,y}$ ' =	= p _{s,}	.a + γ .y- γ	v _w .1	MAX(0.0, y	-d _{aw})
	$\sigma_{ha,surface}$ =	= ΜΑΧ(0, σ _{να}	a,surface –2S u)			$\sigma_{\it ha, surfa}$	ce ' =	= K _a . σ _{va}	a,surf	_{face} ′−2c′√ł	<a>a
	$\sigma_{ha,y} = MA$	X(4.8y, σ_{va}	$_{y}-2S_{u})$				$\sigma_{ha,y}$ ' =	= K _a	. $\sigma_{\it va,y}$ ' –	-2c'	√K _a	
	$F_{ah,y} = 0.5$	5.($\sigma_{ha,surface}$	+ $\sigma_{ha,y}$).y.s	in α			F _{ah,y} ' =	= 0.3	5.($\sigma_{ha,sur}$	face	'+ $\sigma_{ha,y}$ ').y	.cos(90°- α
	$e_{a,y} = y.(2$	$2 \sigma_{ha,surface} +$	σ _{ha,y})/[3.($\sigma_{ha,surface} + c$, _{ha,y})]		$e_{a,y} =$	y.(2	$\sigma_{ha,surfac}$	e '+	$\sigma_{ha,y}$ ')/[3.	$\sigma_{ha,surface}$ '+
	$\sigma_{vp,surface} =$	= p _{s,p}					U _{a,surfac}	e =	0.0			
	$\sigma_{vp,y} = p_{s,y}$	$_{p} + \gamma . (y - H_{R})$)				$u_{a,y} =$	0.0	+ γ _w .ΜΑ	X(0	.0, y-d _{aw})	
	$\sigma_{hp,surface} =$	$\sigma_{vp,surface}$ +	2S _u				F _{uah,y} =	= 0.	5.(u _{a,surf}	ace -	+u _{a,y}).MAX	(0.0, y-d _{aw}
	$\sigma_{hp,y} = \sigma_{v}$	_{p,y} +2S _u					$e_{ua,y} =$: (y-	d _{aw}).(21	l _{a,st}	$urface + u_{a,y})$	/[3.(u _{a,surfac}
	$F_{ph,y} = 0.5$	5.($\sigma_{hp,surface}$	+ $\sigma_{hp,y}$).MA	X(0.0, у-Н ₊	_R).sin	γ	$\sigma_{vp,surfa}$	ce ' =	= p _{s,p} -0.	0		
	$e_{p,y} = (y-h)$	H_R).(2 $\sigma_{hp,sl}$	$_{urface} + \sigma_{hp,y}$)/[3.($\sigma_{hp,sur}$	face +	σ _{hp,y})	$\sigma_{vp,y}' =$	= p _s	. _p + γ.ΜΑ	X(0).0, y-H _R)-	γ _w .MAX(0.
							$\sigma_{hp,surfa}$.	ce ' =	= Κ _p . σ _{vµ}	o,surf	_{face} ' +2C' √I	۲ _p
							$\sigma_{hp,y}' =$	$= K_{p}$. σ _{vp,y} '+	-2c'	VK_p	
							r _{ph,y} ' =	= 0.1	5.($\sigma_{hp,sur}$	face	$+ \sigma_{hp,y}').N$	IAX(U.U, Y-I
							$e_{p,y} =$	MΑλ	<u>(U.U, y-</u>	H _R).(2 $\sigma_{hp,surfa}$	_{'ce} '+ σ _{hp,y} '),
							U _{p,surfac}	$e = \frac{1}{2}$	0.0	<u></u>	0	
							$u_{p,y} =$	0.0	+ γ _w .ΜΑ. Ε (x(U	.u, y-H _R -d	pw)
							Г _{ирh,y}	- U.	ינע _{p,surf} ער		ти _{р,у} Ј.МАХ	$(U.U, Y-H_R)$
							e _{up,y} =	· (<i>Y</i> -	דו _R - U _{pw}).(2 	.u _{p,surface} +L	_{p,y})/[3.(U _p
		1										l .

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ENGI	$\mathbf{GINEERS}$ Consulting Engineers						x	7	'9	
			5			Mombor/	ocation		-	
loh Titlo	Structure	Member De	sian - Geot	ochnics Pot	aining Wall	Drg.	location			
Structure.	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by	xx	Date 21	/11/2021	hd.
Scructure,		olgin debe		annig wan	5				/ 11/ 2021	
	Bending	Moment a	nd Shear F	orce Diagra	ams					
	-					-				
-	В	Shear Force	nt, M (KNM/M) e, V (kN/m)			ŀ				
	15	1	10	5	0	-				
	- 		 -8-8-8-		0.000 •••• ••	ŀ				
					0 100					
					. 0.100					
					0.200					
\vdash					0.300	ŀ				
H						ŀ				
H F					0.400	Ē				
\square					0.500	h, K				
					0.000	Dept				
					0.600					
\vdash					0.700	-				
						ŀ				
					0.000	ŀ				
\vdash					0.900					
					1.000					
	- Bending Mom	ent in Wall, M (k	:Nm/m) —	- Shear Force	in Wall, V (kN/r	n)				
Momont in	wall por m	otro M						N / A	kNm/m	
Shear force	e in wall per	r metre, V	₊ or V					N/A	kN/m	
	Concrete	Contiguou	s / Interlo	cking / Se	ecant Pile	Wall				
	Ratio h _s /D		3					N/A	2	
	Bending st	ress, M.p/D action chart	ς 100Δ /Δ					N/A	N/mm²	
	Area of ter	isile steel re	eauired, A	s = (100A₅/A	ns)/100.Ans			2.0 N/A	mm ² /nile	
			1 / 5					,//		
	Area of ter	sile steel re	einforcemer	nt provided,	$A_{s,prov,pile}$			N/A	mm²/pile	
+δ)	Bending m	oment in w	all utilisatio	$n = A_s / A_{s,}$	prov,pile			N/A		N/A
· σ _{ha,y} ')]	Nata 11		anter to t				-1-			
	Note that p	olle shear de	esign to be	performed	as per colu	mn de	sıgn;			
).sin α	All detailing	n requireme	ents met ?					N/A		
$\frac{1}{16} + \frac{1}{16} \frac{1}{16}$										
	Min longitu	dinal steel i	reinforceme	ent number,	, n _{pile} (>=6	circula	ar)	N/A		N/A
0, у-Н _R -d _p	Min longitu	dinal steel ı	reinforceme	ent diamete	r, ϕ_{pile} (>=1	L2mm))	N/A	mm	N/A
	Percentage	of reinforc	ement A _{s,pro}	$_{\rm pv,pile}/A_{\rm ps} \ge 1$.00% (>0.4	% and	d <6.	N/A	%	N/A
	Longitudina	al steel rein	forcement	pitch (>= 75	5mm but >	=100m	$\frac{1}{1}$	N/A	mm	N/A
$[1_R].cos(90)$	$\frac{\gamma - \gamma - \delta}{Min link dir$	urcular pile		= π(υ-2.ΜΑ 5・ヽー&>	$\frac{1}{2}$	over ₂)-	- _{\$pile}),	N/A	mm mm	N/A
L J. (^U hp,surf	Max link ni	tch, S_{nile} (<	$=12\phi_{nilos} <=$	=300mm. <	=D for circ	ular)		N/A	mm	N/A
	Require an	overall end	closing link.	· · · · · · · · · · · · · · · · · · ·)				
$-d_{pw}$).sin γ										
,surface +U p,y)]									

CON	CONSULTING Engineering Calculation Sheet).	Sheet No.		Rev.
	NEERS	Consulting	g Calculatio Fngineers	in Sneet		iXXX		ş	20	
ENGI		concurring				JAA	~			
						Member/Lo	cation			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.				
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date 21	/11/2021	hd.
	Concrete	Diaphragn	n Wall							
	Concrete n	noment cap	acity per m	etre, $M_u = 0$	0.156f _{cu} .10	00.d _{wall}	2	N/A	kNm/m	
	Bending st	ress, [M/bd	$^{2}] = M / [(1)$	1000).d _{wall} 2				N/A	N/mm ²	
	Bending st	ress ratio, k	$x = [M/bd^2]$	/ f _{cu}				N/A		N/A
	Lever arm	$z = d_{wall}$	[0.5 + (0.2	5-K/0.9) ^{0.5}]	<= 0.95d	vall		N/A	mm	
	Area of ter	nsion steel r	equired, A _s	= M / [(0.9	95f _y).z]			N/A	mm²/m	
									2	
	Area of ter	nsile steel re	einforcemer	nt provided,	$A_{s,prov,wall}$			N/A	mm²/m	
	Bending m	oment in w	all utilisatio	$n = A_s / A_{s_s}$	prov,wall			N/A		N/A
	% Min long	gitudinal rei	nforcement	in wall (>=	= 0.0024.10	000.t G	250;	N/A	%	
	% Min long	gitudinal rei	nforcement	in wall utili	sation			N/A		N/A
	Ultimate s	hear stress	in wall, v _{ult}	=V _{ult} /(1000	d_{wall}) (< 0.	8f _{cu} ^{0.5} 8	& 5N	N/A	N/mm ²	
	Ultimate sl	hear stress	ın wall utilis	sation				N/A		N/A
	<u> </u>			(1000 L						
	Design she		wall, $v_d = V_d$	/(1000.d _{wall})	,		N/A	N/mm²	
	(Conservat	tively, sheai	r capacity e	nhancemer ,	it by eithe	r calcu	latin	$g v_d$ at d f	rom suppor	t and
	comparing	against une	enhanced v	c as clause	3.4.5.10 B	58110	or		v_d at suppo	ort and
	comparing	against enl		within 2d of	the suppor	rt as cla	ause	3.4.5.8 BS	8110 ignore	ed;)
	Area of ter	nslie steel re		it provided,	A _{s,prov,wall}			N/A	mm²/m	
	$\rho_w = 100A_g$	s,prov,wall/(100	$\frac{1}{(0.0 \text{ wall})}$			(100)		N/A	%	
	$v_{c} = (0.79)$	/1.25)(p _w t _{cu} /	/25)*/*(400	/d _{wall})*''; p _v	,<3; f _{cu} <40	; (400/	d _{wall}	N/A	N/mm²	
	Charless	<u> </u>	linka					NI / A		
	Check v _d	Concrete el		+	d)			N/A	L(NL/m	
		Concrete s	near capaci	ly v _c .(1000	.u _{wall})			N/A	KIN/M	
	Charles		L v for po	minal link						
	Check v _c	$< v_d < 0.4$	+ v _c IOF IIC		.s / C > 0 /	(1000	<u>)//0</u>	N/A	21	
		Concrete a		links shoor	$_{\rm sv}$ / 5 > 0.4		${}{}$		mm ⁻ /mm/	m
						J.4 + v.	c).(1	N/A	KIN/ITI	
	Chock y	$> 0.4 \pm v$	for decian	linke				NI / A		
		\mathbf{P}	oar links A	/ 5 > 100		05f)	io			
		Concrete a	nd design li	$\frac{1}{3}$ $\frac{3}{1000}$	$\frac{1}{2} \frac{1}{2} \frac{1}$.951 _{yv})	e. /	N/A	mm /mm/	m
					apacity (A _s	v,prov,wal	_l / J _{wa}	N7 A		
	Area provi	l ded by all liv	nks ner mo	tre A				NI / A	mm^2/m	
	Tried A		value	sv,prov,v	vall				mm^2/mm^4	m
	Design she	ov,wail / Swall	re in wall ut	tilisation						N/A
	Design Sile							N/A		N/A
	All detailin	a requireme	ents mot ?					N/A		
								N/A		
	Max longit	udinal steel	reinforcem	ent nitch in	wall (224	_ " ∠ 75	0mr	NI/A	mm	N/A
	Max longit	udinal stool	reinforcom		wall	_{all} , 5</td <td></td> <td>N/A</td> <td>mm</td> <td>N/A</td>		N/A	mm	N/A
	max ionyit				wall		_	N/A		N/A
	May	kimum spacij	ng: 0.5%	6 Ast or less	- 300mm		┣──			
	.vict		Bet	ween 0.5% a	nd 1.0% - 2	25mm				
			1.0%	% Ast or grea	ater - 175mr	n				
	Min Ionaitu	Idinal steel	reinforceme	ent nitch in	wall (>75m	յm+հ		NI/A	mm	N/A
	Note an al	lowance had	s heen mad	e for lane in	the min n	itch hv	incr	easing the	criteria hv t	he har dian
	% Max lon	aitudinal re	inforcement	t in wall (~	= 0 04 100	0 +)		N/A	0/0	
	Lonaitudin	al steel rein	forcement a	diameter in	wall. h(>=12m	յայ		mm	N/A
	_ongraam				····ν Ψwall ()	N/A		- N/A
		1		I					1	

CON	SULTINC	Enginegrin	- Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consulting	Engineers	n Sneet		iXXX	8	1	
		J	5			Joo o C		-	
a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by vv	Date ว1	/11/2021	hd.
Structure,		sign - Geol	echnics Rei	anning wan	5	~~~~	21	/11/2021	
	Steel She	et Pile Wal	11						
	Section (el	astic) mom	ent capacity	y per metre	, $M_c = p_y.Z$		N/A	kNm/m	
	Bending m	oment in w	all utilisatio	$n = M / M_c$			N/A		N/A
	Cashiana ah							1.817	
	Section she	ear capacity	o in wall ut	$V_{c} = 0.6$ n.	t.p _y		N/A	kN/m	
	Design sile				• / • _c		N/A		N/A
ieter.									

CONSULTING Engineering Calculation Sheet						Job No).	Sheet	No.		Rev.
	NEERS	Consulting	Fngineers	n Sheet		iXX	x		8	2	
Endi		oonouning				JXX	~		0	2	
						Member/Lo	ocation				
Job Title	Structure,	Member De	sign - Geot	echnics Re	etaining W	all ^{Drg.}		I			
Structure,	Member De	esign - Geot	echnics Ret	aining Wa	lls	Made by	XX	Date	21	/11/2021	hd.
Deflection	n Criteria i	n Wall									
Span, $I = c$	lepth, y to	zero shear f	orce, V						N/A	m LNL (
SLS mome	nt in wall p	er metre, ™	_{SLS} = M/K						N/A	KNM/M	
	21		_	RA							
- %	101		-		\sim	_		-			
		C, ,	<i>B</i> ,		RA 1	- W					
	a	⊅· ∠			~						
Η '		-	'	_							
⊢⊢			_	- M	-curved_	st/10	ight	H			
	-x	·	-					113			
		Wx 3	-				<u> </u>	174			
H	Mx	Ja ²	F		¢c =	Wa V					
	M, -	Wa	-		ī	Wa3/,	50				
	~	3		Ŭ	max. 15	EI	là/				
Equivalent	back-calcu	lated triang	ular distribu	ited loadir	ng, W = 3N	M _{SLS} /I			N/A	kN/m	
	Concrete	Contiguou	s / Interlo	cking / S	Secant Pil	e Wall					
	Maximum	deflection in	wall, δ_{max}	= W.l ³ /(15	5E _c .I)			ſ	N/A	mm	
	Deflection	in wall (first	principles)	utilisatior	$n = \delta_{max}/(l)$	/250)		ſ	N/A		N/A
	Span, I / p	ile shaft dia	meter, D ra	tio				ſ	N/A		
	Basic span	/ effective	depth ratio	criteria (7	' cantileve	r)			N/A		
	Note multi	plier C _{1,span}	more or less thai	_{10m} not a	pplicable;						
	Modificatio	n factor for	tension C_2								
		M.p/D ³							N/A	N/mm²	
		$f_s = \frac{2f_y A_{s reg}}{2A}$	$\times \frac{1}{6}$	Note A s,pr	_{rov,pile} /2 as	circular s	sectio	on;			
		OA's prov	μ _b	$(\beta_b = 1.0)$)				N/A	N/mm²	
		Maral Charles	0.55 + (4)	$\frac{M-T_{s}}{0.9 + M} \leq 1$	2.0				NI / A		
	Madified ar			bd ²⁾					N/A		
	Defloction		ve ueptil ra	d) utilicat	ion						N/A
	Denection		110 metrio	u) utilisat					N/A		N/A
	Concrete	Dianhrage	ı Wall								
	Maximum	deflection in	wall 8	= W ³ /(1	5ET)			R		mm	
	Deflection	in wall (first	principles)	utilisation	$\frac{1}{1} = \frac{\delta_{max}}{(1)}$	/250)					N/A
					~iiidx/ (1						
	Span, I / e	ffective dep	th, d _{wall} rati	0					N/A		
	Basic span	/ effective	depth ratio	criteria (7	' cantileve	r)			N/A		
	Note multi	plier C _{1,span}	more or less that	not a	pplicable;	-					
	Modificatio	n factor for	tension C_2								
		M/bd_{wall}^{2}							N/A	N/mm ²	
		$f = \frac{2f_y A_s}{1}$	× 1								
		⁷⁵ 3A _{5 prov}	β _b	$(\beta_b = \overline{1.0})$)				N/A	N/mm ²	
			0.55 +	$\frac{77-f_s}{M} \leq \frac{M}{M}$	2.0						
		Modification	ר ^{120 (}	$(0.9 + \frac{m}{b d^2})$					N/A		
	Modified sp	oan / effecti	ve depth ra	tio criteria	a			ľ	N/A		
	Deflection	in wall (BS8	110 metho	d) utilisat	ion			ſ	N/A		N/A
			_								
	Steel She	et Pile Wal									
	Maximum	deflection in	wall, δ_{max}	= W.I ³ /(15	σE _s .I)	(250)		Γ	A/N	mm	
	Deflection	ın wall (first	: principles)	utilisation	$n = \delta_{max}/(l)$	/250)		ſ	A/A		N/A

CON	SULTING	IG Engineering Calculation Sheet		Job No.	Sheet No.		Rev.		
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	8	3	
			-			Member/Location		-	
loh Title	Structure	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
l									

CONSULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.				
FNGI	NFFRS	Consulting	g Calculatio Engineers	n Sheet		iXXX	8	1	
LIGI		consulting	Linginicero			JXXX	0	т	
						Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.	Data a a		11
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	S	Made by XX	Date 21	/11/2021	na.
-									

CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	8	5	
21101		J				Joor Manakara		5	
a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	
	1	1				1		1	

CON	SULTING	${f G}$ Engineering Calculation Sheet		Job No.	Sheet No.		Rev.		
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	8	6	
						Member/Location			
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
···· ·				5	-			/,	
			1						

CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	8	7	
21101		J	5			Manchanilla antian			
a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics Rei	anning wan	5	· •	21	/ 11/ 2021	

CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	8	8	
21101		J				Joor Manakara		0	
a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	g Calculatio Engineers	n Sneet		iXXX	8	<u>م</u>	
		J	5			Mombor/Looption		5	
	Charlestan	Marahar Da	aian Caat	achaice Dat	aining Wall	Drg			
JOD LILIE Structure	Structure, Member De	member De	echnics Ret	aining Wall		Made by	Date 21	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	
							-		

CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	q	0	
21101		J	5			Manchanilla antian		0	
a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	
	1	1				1	1		

CON	SULTING	${f G}$ Engineering Calculation Sheet		Job No.	Sheet No.		Rev.		
ENGI	N E E R S	Consulting	Engineers	II Sheet		jXXX	9	1	
						Member/Location			
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
	<u> </u>		 						

CONSULTING Engineering Calculation Sheet			Job No.	Sheet No.		Rev.			
FNGI	NFFRS	Consulting	g Calculatio	n Sheet		iXXX	9	b	
ENGI		consulting				јллл		2	
	ļ					Member/Location			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.	2.11		. "
Structure,	Member De	sign - Geot	echnics Ret	aining Walls	S	Made by XX	Date 21	/11/2021	.ha.
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CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	q	3	
		J				Joor Manakara		5	
a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	
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CON	SULTING	Enginoorin	a Calculatio	n Shoot		Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	9	4	
				,		- Member/Location			<u> </u>
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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CON	SULTINC	Enginegrin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
FNGI	NEERS	Consulting	g Calculatio Fngineers	n Sheel		iXXX	9	5	
LIIGI		y				J////		5	
1.1. 7.1.	Churchtung	Marahan Da	sian Cast	a ala a i a a D a t		Member/Location			
JOD LITIE	Structure, Mombor Do	Member De	sign - Geot		aining wali	Made by	Date 71	/11/20210	hd.
Structure,		sign - Geol	echnics Rei	anning wan	5	~~~~	21	/11/2021	

CON	SULTINC	Enginegrin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
FNGI	NEERS	Consulting	g Calculatio Fngineers	n Sheel		iXXX	9	6	
LIIGI		y				Joon	5	ő	
1.6.7.64	Churchtung	Marahan Da	sian Cast	a ala a i a a D a t		Member/Location			
JOD LITIE	Structure, Mombor Do	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 31	/11/20210	hd.
Structure,		sign - Geol	echnics Rei	anning wan:	5	~~~~	21	/11/2021	

9	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
11	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
12	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
15	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
16	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
17	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
18	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Point	Depth, y	σ _{ha,surface} '	σ _{ha,WT} '	σ _{ha,base}	F _{a,y} '	F _{ah,y} '	e _{a,y}	F _{uah,y}	e _{ua,y}
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	IN/A	IN/A	IN/A		IN/A	N/A	N/A	IN/A
10	N/A	IN/A	IN/A	N/A		IN/A	N/A	N/A	N/A
10		IN/A	N/A	N/A		N/A			N/A
10	N/A	IN/A	N/A	IN/A	N/A	IN/A	N/A	N/A	N/A
		<u> </u>	6	<u>.</u> '	F '	F. '	۵	F.	<u>م</u>
		Onp,surface	Onp,WI N/Δ	Onp,base N/Δ	• p,y N/Δ	pn,y	Cp,y N/Δ	upn,y	Cup,y N/Δ
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		, N/A	, N/A	, N/A	, N/A	, N/A	, N/A	, N/A	, N/A
		, N/A	, N/A	, N/A	, N/A	, N/A	, N/A	N/A	, N/A
		, N/A	, N/A	, N/A	, N/A	, N/A	, N/A	, N/A	, N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	•			•					
deflection	i în cântile	ver embed	Ided retail	ning wall					
v		Denth y							
ν N/Δ		N/A	<u></u>						
N/A	N/A	N/A							
Ν/Δ	Ν/Δ	Ν/Δ							
N/A	N/A	N/A							
N/A	N/A	N/A						<u> </u>	
N/A	N/A	N/A						+	
N/A	N/A	N/A							
N/A	N/A	N/A							
, N/A	N/A	, N/A							
								·	

м	v				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
N/A	N/A				
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N/A	N/A				
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CONSULTING	CONSULTING Engineering Colculation Sheet					Sheet No.		Rev.
ENGINEERS	Consulting	Engineers	II Sheet		iXXX	9	7	
		5			Momber/Leastion		-	
Joh Titla Structura	Mombor Do	cian Coot	ochnice R	otaining Wall	Drg.			
Structure Member De	sian - Geot	echnics Ret	aining W	alls	Made by	Date 21	/11/2021	hd.
	Sign Geot			uns			/ 11/ 2021	
Concrete Propped (Basement) Retaining	g Wall Di	mensions				
Note should the retain	ning wall als	so be subjec	ct to axia	compressive	forces fror	n the super	structure	
above as well as bend	ling momen	ts and shea	ars calcula	ated herein, a	a column de	esign check	should	
be undertaken over a	metre strip	o or the reta	ning wai	accounting i	ror both axi m ²) this h	al and bend	ing effects.	
retaining walls suppor	tina its self	weight and	ai suesse La suspei	nded deck, th	ne axial com	nressive fo	rce only	
serves to reduce the s	teel area re	equirement.	Howeve	r for retaining	g walls subj	iect to high	axial	
stresses, this being th	e case for r	retaining wa	alls suppo	rting column	loads from	superstruct	ture	
above or in the case o	of core walls	s, the axial	compress	ive force will	increase th	ne steel area	Э	
requirement. This phe	nomenon is	s apparent i	when the	column inter	action char	t is studied.		
The base of the retain	ing wall sho	ould also be	e designe	d as for a stri	p or a pile i	foundation t	to resist	
this vertical load;								
	_							
		T _{prop}						
⊢	_11							
ی ص ^ہ B _{widtl}	n							
		There						
Angle of retaining fac	from horiz	iontal (00.0	dograac	
	from horiz	$\alpha = 1$	90 ⁻			90.0	degrees	Ν/Δ
Thickness of prop, T_{pro}						250	mm	N/ A
Thickness of base, T_{ba}	se					250	mm	
Note that the physical	thickness of	of the prop	and base	has not beer	n considere	d in effectiv	ely	
reducing the effective	span of the	e simply sup	oported re	etaining wall,	instead the	e full define	d	
depth dimension, d _a i	s adopted a	as the effec	tive span	;				
Width, B _{width}						350	mm	N/A
	D = = = = = = = = = = = = = = = = = = =							
Concrete Propped (Basement) Retaining	j wali ke	einforcemen	t			
	Champ uninfo	reement	1					
	Stem reinit	breement						
Longitudinal steel rein	forcement	diameter in	stem, ϕ_{st}	em		20 🔻	mm	
Longitudinal steel rein	forcement	pitch in ster	n, p _{stem}	2		200	mm	
Longitudinal steel area	a provided i	n stem, A _{s,r}	prov,stem =	$(\pi.\phi_{stem}^2/4)/p$	stem	N/A	mm²/m	
Shoar link diamotor in	stom +					Nono		
Number of links per m	etre in ster	n, numero and				110He = 5	/m	
Area provided by all li	nks per mei	tre in stem	Asy provert	m = Nlink store	$\pi.\phi_{\text{link stam}}^2/2$	N/A	mm²/m	
Pitch of links in stem,	S _{stem}		sv,prov,ste	2		200	mm	
Effective depth to long	jitudinal ste	el in stem,	$d_{stem} = B$	width - cover ₁	-	N/A	mm	
Estimated steel reinfo	rcement qu	antity				N/A	kg/m ³	
stem	[7.850 . (/	A _{s,prov,stem}),	/ B _{width}]	;		N/A	kg/m ³	
No curtailment; No la	os; Links ig	nored; Disti	ribution s	teel ignored;				

CON			<u> </u>			Job No.	Sheet No.		Rev.
	SULTING	Engineerin	g Calculatio	n Sheet		2000	0	0	
ENGI	NEEKS	Consulting	Ligineers			JXXX	9	8	
						Member/Location			-
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by XX	Date 21	/11/2021	hd.
Concrete	Propped (Basement)	Retaining	y Wall SLS	Loading				
		Но	rizontal Lo	pad		Eccent	tricity fron	n Base	
			F _{ah} (F _{ah} ')	N/A	kN/m	ea	N/A	m	
$\sigma_{ha,su}$	r_{face} .sin α (σ_{f}	ha,surface'.COS	(90°-α+δ))	N/A	kN/m ²				
σ	ha,base.sin α ($\sigma_{ha,base}$ '.COS	(90°-α+δ))	N/A	kN/m ²				
			F _{uah}	N/A	kN/m	e _{ua}	N/A	m	
		u	$a,surface.sin\alpha$	N/A	kN/m ²				
			$u_{a,base}.sin\alpha$	N/A	kN/m²				
	Note that e	expressions	above are	simplified ii	n that the c	hange of sl	ope on the	vertical	
	and horizo	ntal effectiv	e stress dia	agrams due	to the wat	er table are	unaccount	ed for;	
Dron	المعام براجع		marceler					LeNI /	
Prop unitor	iniy distribu			Dau, F _{concret}	te,propped,h		N/A	KIN/M	
NOLE F concre	ete,propped,h =	- (「 _{ah} (「 _{ah})	.e _a +0(r _{uah}).e _{ua})/u _a ;					
Concrete	Dropped (Bacoment	Dotainin	ı Wall III o	Loadina				
concrete	Propped (Dasement	Retaining		Loaunig				
			lorizontal	Load		Note it is a	ssumed the	at tha 111 S 1	oads act at
		K.	F-+ (K.F-+')		kN/m	same ecce	ntricities as	the SIS In	ads [.]
K.σha aurfa	L sinα (Κ.σ.		$(90^{\circ}-\alpha+\delta))$	N/A	kN/m^2				<i>uus,</i>
K.σ _{ha}	$\sin \alpha$ (K.		$(90^{\circ}-\alpha+\delta))$	N/A	kN/m^2				
		lid, base 1000	K.F.	N/A	kN/m				
		K.u	a surface.sinα	N/A	kN/m ²				
		K	$u_{a \text{ base}}.sin\alpha$	N/A	kN/m ²				
	Note that e	expressions	above are	simplified in	n that the c	hange of sl	ope on the	vertical	
	and horizo	ntal effectiv	e stress dia	agrams due	to the wat	er table are	unaccount	ed for;	
				-					
Prop unifor	mly distribu	uted ULS co	mpression	load, K.F _{con}	crete,propped,h		N/A	kN/m	
							<u> </u>	<u> </u>	

CONSULTING Engineering Coloulation Shoot	Job No.	Sheet No.	Rev.
FNCINEERS Consulting Engineers	iXXX	٩	٩
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	Member/Location		
Job Title Structure, Member Design - Geotechnics Retaining Wall	Drg.	1	1
Structure, Member Design - Geotechnics Retaining Walls	Made by XX	Date 21	/11/2021 ^{Chd.}
	_		
Concrete Propped (Basement) Retaining Wall Reinforcemen	t Design		
Shear force diagram			
Rending memort diagram			
Bending Moment Design in Stem			
Moment in stem (near midspan) per metre, M		N/A	kNm/m
Note $M = [K. \sigma_{ha,surface} .sin \alpha (K. \sigma_{ha,surface} '.cos(90^{\circ} - \alpha + \delta))].0.125.d$	2 a		
+0.5.[K. $\sigma_{ha,base}$.sin α (K. $\sigma_{ha,base}$ '.cos(90°- α + δ))-K. $\sigma_{ha,s}$	$_{urface}$.sin α (K. $\sigma_{ha,surface}$ '	$.cos(90^{\circ}-\alpha+\delta))].0.12$
+[0(K.u _{a,surface} .sin α)].0.125.d _a ² +0.5.[0(K.u _{a,base} .sin α)	-0(K.u _{a,surfa}	α .sin α)].0	.128.d _a ² ;
Note for simplicity, the maximum bending moments from both the	uniform an	d the triang	gular
load distributions are added although they occur at slightly differer	nt locations,	;	
Concrete moment capacity per metre, $M_u = 0.156 f_{cu} \cdot 1000 \cdot d_{stem}^2$		N/A	kNm/m
Bending stress, $[M/bd^2] = M / [(1000).d_{stem^2}]$		N/A	N/mm ²
Bending stress ratio, $K = [M/bd^2] / f_{cu} <= 0.156$		N/A	N/A
Lever arm, $z = d_{stem} \cdot \left[0.5 + (0.25 - K/0.9)^{0.5}\right] <= 0.95d_{stem}$		N/A	mm
Area of tension steel required, $A_s = M / [(0.95I_y).2]$		N/A	mm²/m
Area of tensile steel reinforcement provided A		N/A	mm^2/m
Bending moment in stem utilisation $-\Delta$ / Δ		N/A	mm /m N/A
		N/A	
Min longitudinal reinforcement in stem (>= 0.0024.1000.Bwidth C		N/A	%
% Min longitudinal reinforcement in stem utilisation	,	N/A	N/A

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	NEEDS	Consulting	g Calculatio Engineers	n Sneet		ivv	v	1	20	
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						Member/Lo	cation			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.				
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date 21	/11/2021	hd.
Shear Des	sign in Ste	m								
Shear force	e at stem b	ase per met	tre, V _{ult}					N/A	kN/m	
Shear force	e at stem b	ase per met	tre, V					N/A	kN/m	
Note V _{ult} a	nd V = [K.	$\sigma_{ha,surface}$.Si	n α(Κ. σ _{ha,su}	urface '.cos(90	$(\alpha + \delta))].$.d _a /2				
	+0.	5.[K. $\sigma_{ha,bas}$	_e .sin α(K. σ	ha,base '.COS (90°- $\alpha + \delta$))-K. σ_{ha}	,surfa	c_{e} .sin $\alpha(K. \alpha)$	Tha,surface '.CC	s(90°-α+a
	+[0	(K.u _{a,surface}	.sin α)].d $_a$ /	/2+0.5.[0(k	.u _{a,base} .sin	α)-0(K	.u _{a,s}	$surface$.sin α)].2.d _a /3;	
Ultimate sł	near stress	in stem, v _{ul}	t=V _{ult} /(1000).d _{stem}) (< ().8f _{cu} ^{0.5} & 5	N/mm ²)	N/A	N/mm ²	
Ultimate sh	near stress	in stem util	isation					N/A		N/A
8.d _a ²										
Design she	ar stress in	stem, v _d =	V/(1000.d _{ste}	em)				N/A	N/mm ²	
(Conservat	ively, shea	r capacity e	nhancemer	nt by eithe	r calculatin	g v _d a	t d fi	rom suppor	t and	
comparing	against un	enhanced v	_c as clause	3.4.5.10 B	S8110 or (calculat	ing	v _d at supp	ort and	
comparing	against en	hanced v _c v	within 2d of	the suppor	t as clause	3.4.5.8	B BS	8110 ignor	ed;)	
Area of ter	sile steel re	einforcemer	nt provided,	A _{s,prov,stem}				N/A	mm²/m	
$\rho_w = 100A_s$	_{s,prov,stem} /(10	000.d _{stem})						N/A	%	
$v_{c} = (0.79)$	/1.25)(ρ _w f _{cu}	/25) ^{1/3} (400	/d _{stem}) ^{1/4} ; ρ	_w <3; f _{cu} <40); (400/d _{ste}	m) ^{1/4} >0	.67	N/A	N/mm ²	
Check v _d	< v _c for no	links						N/A		
	Concrete s	hear capaci	ty v _c .(1000	.d _{stem})				N/A	kN/m	
									-	
Check v _c •	< v _d < 0.4	+ v _c for no	ominal link	S				N/A		
	Provide no	minal links	such that A	_{sv} / S > 0.4	.(1000)/(0.	.95f _{vv}) i	.e. /	N/A	mm ² /mm/	n
	Concrete a	nd nominal	links shear	capacity (C	$0.4 + v_c).(1$	000.d _{st}	_{em})	N/A	kN/m	
Check v _d :	> 0.4 + v _c	for design	links					N/A		
-	Provide she	ear links A _{sv}	/ S > 1000	0.(v _d -v _c)/(0	.95f _{vv}) i.e	A _{sv} / S	>	N/A	mm ² /mm/	n
	Concrete a	nd design li	inks shear o	capacity (A _s	, prov.stem/S _{st}		95f _{v\}	N/A	kN/m	
		_			·//···/		/ -			
Area provid	ded by all li	nks per met	tre, A _{sv.prov.s}	stem				N/A	mm²/m	
Tried A _{sy.pro}	w _{stem} / S _{ster}	, value						N/A	mm ² /mm/	n
Design she	ar resistan	 ce in stem ι	utilisation					N/A	,,	N/A
L			<u> </u>	<u> </u>				<u> </u>	<u> </u>	

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	NEERS	Consulting	g Calculatio Fngineers	n Sneet		iXXX	1	01	
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	-					Member/Locat	ion		
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wa	Mada by	Data ad	111 10001	hd
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S			/11/2021	na.
Detailing	Requireme	ents							
Jetainig									
All detailin	g requireme	ents met ?					N/A		
Max longitu	udinal steel	reinforcem	ent pitch in	stem (<3d	_{stem} , <750)mm)	N/A	mm	N/A
5))].2. <u>d /</u> 3									
Max	timum spaci	ng: 0.5%	6 Ast or less	- 300mm					
		1.0%	6 Ast or gree	nd 1.0% - 2. ater - 175mn	25mm				
			51151 51 8.0						
Maxilarati		roinformer	opt pitch in	store			NI / A	mm	
max iongiti	luinai steel	reinforcem	ent pitch in	stem			N/A		N/A
Min Ionaitu	dinal steel	reinforceme	nt nitch in	stem (>75r	nm+հ	>100mm	+d N/A	mm	N/A
Note an all	owance has	s heen mad	e for lans in	the min ni	tch hv inc	reasing th	e criteria hv f	he bar dian	neter.
% Max lon	gitudinal re	inforcement	t in stem (<	<= 0.04.100	00.B _{width})		N/A	%	N/A
Longitudina	al steel rein	forcement of	diameter in	stem, ϕ_{stem}	(>=12mr	n)	N/A	mm	N/A
Deflection	n Criteria i	n Stem							
Span, $I = c$	l _a						N/A	m	
Span, I / e	ffective dep	oth, d _{stem} rat	tio				N/A		
Decie enen	/ offerstive	danth ratio	aritaria (20		nortod)		N/A		
Note multi	/ effective		criteria (20	o simpiy sup	ported)		IN/A		
Modificatio	n factor for	tension C	10m 110c ap						
	M/bd_{ctom}^2						N/A	N/mm ²	
							,.		
	$f_{5} = \frac{2I_{y}A_{5}}{34}$	$\frac{1}{\beta_1} \times \frac{1}{\beta_2}$	$(\beta_{b} = 1.0)$				N/A	N/mm ²	
	0115 1	arov Pb							
		0.55.4	(477-f_)	~ 20					
	Modificatio	n 12	$20\left(0.9 + \frac{M}{hd}\right)$	2 2.0			N/A		
			00	~					
Modified sp	oan / effecti	ive depth ra	itio criteria				N/A		
Doflaction	in ctom ·····	ication							N / A
Denection		เรลเเบเไ					N/A		N/A






CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1(75	
21101		J				Joor Manakara			
a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

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						Member/Location			
loh Title	Structure	Memher De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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CONSULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.				
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	10	07	
						Member/Location			
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	1	08	
						Member/Locatio	n		
Job Title	Structure,	l Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by X	C Date 21	/11/2021	hd.
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						Member/Location			
loh Title	Structure	Memher De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall:	Drg.	2.11		. "
Structure,	Member De	sign - Geot	echnics Ret	aining Walls	S	Made by XX	Date 21	/11/2021	.ha.
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21101		J	5			Manchanthan			
a. 1. 1	Charles	Manakan Da		a ale al a a Dat		Drg			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1.	13	
21101		J	5			Manchanilla antian			
a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	
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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1.	14	
21101		J	5			Manchanthan			
a. 1. 1	Charles	Manakan Da		a ale al a a Dat		Drg			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1.	15	
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2 1 7 11	Charles	Manakan Da		a ale al a se Dad		Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	

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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1.	16	
		J	5			Manchanilla antian	±.		
a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	
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CONSULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.				
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1.	17	
21101		J	5			Manchanilla antian		_ ,	
a. 1 7 . 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	
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	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1-	18	
		J	5			Joor Manakara			
2 1 7 11	Charles	Manakan Da		a ale al a a Dat	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	

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Structure	Structure, Member De	sign - Geot	echnics Ret	aining Wall		Made by	Date 21	/11/2021	hd.
Structure,		Sign Geot	cennes ree	annig wan.	5		21,	/ 11/ 2021	
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N/A	N/A	N/A						
N/A	N/A	N/A						
N/A	N/A	N/A						
N/A	N/A	N/A						
N/A	N/A	N/A						
N/A	N/A	N/A						
N/A	N/A	N/A						
N/A	IN/A	IN/A						
N/A	N/A	N/A						
(V)) from	N/A							
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етріоу та	ctor on er	nbeament	1			L	L	
Yes, Factor	1.2						1.2	
No Factor	10						1.0	
	1.0						1.0	
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ENGI		concurring	Linginicero			JVV	~		14	<u> </u>	
						Member/Lo	cation				
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.					
Structure,	Member De	sign - Geot	echnics Ret	aining Walls	S	Made by	XX	Date	21	/11/2021	hd.
Angle of re	taining face	e from horiz	ontal, $\alpha = 9$	90°					90.0	degrees	
Angle of ex	posed face	from horizo	ontal, $\gamma = 9$	0°					90.0	degrees	
Height of e	xposed face	e, H _R						6	.500	m	
Note that I	H _R should b	e specified	in anticipat	tion of poss	ible unplan	ned exc	cava	tion to	the	minimum	
of the large	er of 0.5m a	and 0.10 of	the origina	l retained h	eight, this	increas	ing t	the val	lue oi	fH _R ;	
Note that I	H_R should a	lso be spec	ified accour	nting for the	e fact that t	the prop	o loc	cation I	may	not be at	
the very to	p of the wa	ll, but inste	ad stepped	down, this	decreasing	the va	lue	of H _R	by th	e step dow	n;
Type of em	bedded ret	aining wall	Concre	ete Diaphragm	Wall			1	▼		
	Concrete	Contiguou	s / Interlo	cking / Se	ecant Pile	Wall					
		Note that p	oile below r	efers to the	hard reinfo	orced pi	ile;				
		Pile shaft d	iameter, D		12	00mm	▼		N/A	mm	
		Pile clearar	ice spacing	, s (usually	50 to 75)				50	mm	
		Pile pitch, p	o = D+s						N/A	mm	
		Pile shaft s	econd mor	nent of area	$, I = [\pi D^4/(2\pi D^4))$	64]/p			N/A	cm⁴/m	
		Pile shaft c	ross sectior	nal area, A _p	$_{\rm s}=\pi {\rm D}^2/4$				N/A	mm²/pile	
		Longitudina	al steel rein	forcement of	diameter in	pile, ϕ_p	oile	25	▼	mm	
		Longitudina	al steel rein	forcement r	number in p	oile, n _{pil}	e		21	/pile	
		Longitudina	al steel area	a provided i	n pile, A _{s,pro}	ov,pile =	n _{pile} .		N/A	mm²/pile	
		Shear link	diameter in	pile, $\phi_{link,pile}$	2			10	▼	mm	
		Number of	links in a c	ross section	in pile, i.e	. numb	er of		2	/pile	
		Area provio	led by all li	nks in a cro	ss-section i	in pile, i	A _{sv,p}		N/A	mm²/pile	
		Pitch of lin	ks in pile, S	pile					200	mm	
		Ratio h _s /D	= (D - 2.M/	$AX(cover_1, or all a cover_1)$	$cover_2) - 2.$	∮link,pile ·	- ¢ _{pile}	-	N/A		
		Estimated s	steel reinfo	rcement qu	antity				N/A	kg/m ³	
		[7850.A _s	s,prov,pile / (1	τ.D ² /4)]; I	No laps; Lir	nks igno	ored,	;			
	Concrete	Diaphragn	n Wall								
		Wall thickn	ess, t (usua	ally 600 to 1	L500)				1000	mm	
		Wall secon	d moment o	of area, I =	100.t ³ /12				N/A	cm⁴/m	
		Longitudina	al steel rein	forcement of	diameter in	wall, 🖣	wall	20	◄	mm	
		Longitudina	al steel rein	forcement p	oitch in wal	I, p _{wall}			200	mm	
		Longitudina	al steel area	a provided i	n wall, A _{s,pr}	ov,wall =	(π.¢		N/A	mm²/m	
		Shear link	diameter in	wall, $\phi_{link,wa}$	all			8	◄	mm	
		Number of	links per m	etre in wall	, n _{link,wall}				5	/m	
		Area provid	led by all li	nks per met	re in wall,	A _{sv,prov,v}	vall =		N/A	mm²/m	
		Pitch of linl	ks in wall, S	wall					200	mm	
		Effective de	epth to long	jitudinal ste	el in wall, o	$d_{wall} = t$	- cc		N/A	mm	
		Estimated :	steel reinfo	rcement qu	antity				N/A	kg/m ³	
		[7.850 . (/	A _{s,prov,wall}) /	't];							
		No curtailn	nent; No la _l	os; Links igi	nored; Dist	ribution	ste	el igno	ored;		
	Steel She	et Pile Wal	1						-		
		Section des	scription	Standard U-Ty	pe PU28+1	1		1	▼		
		Section ma	ss, m						N/A	kg/m	
		Section ma	ss, m						N/A	kg/m ²	
		Section dep	oth, h						N/A	mm	
		Section sec	ond mome	nt of area,	I				N/A	cm⁴/m	
		Section ela	stic modulu	is, Z					N/A	cm³/m	
		Section she	ear area, h.	t/b					N/A	cm²/m	

CON	SULTING	Engineerin	a Calculatio	n Shoot		Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	IT SHEEL		iXXX	1	22	
LIGI		J	J		1	5000			
	_					Member/Location			
Job Title	Structure,	Member De	esign - Geot	echnics Ret	aining Wall	Drg.	Data		b
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by XX	Date 21	/11/2021	nd.
_									
Concrete	or Steel Pr	ropped (Ba	asement) I	Embedded	Retaining	Wall SLS	Loading		
		•							
	FIO	rizontal Lo			ccentricity	y from Bas	se		
	F _{ah} (F _{ah} ')	N/A	kN/m		ea	N/A	m		
		N/A	kN/m		e _{ua}	N/A	m		
	F _{ph} (F _{ph})		KIN/ M		ep	N/A	m		
	Г _{uph}	N/A	KN/M		e _{up}	N/A	m		
Total rotai	ning wall SI	C horizonta					NI / A	kNI/m	
			$(1)_{-E}$	ped,h	E),		N/A	KIN/111	
Noto positi	$e_{d,h} = r_{ah}(I)$	ah J+U(F ua	hJ ⁻ r _{ph} (r _{ph}	$_{\rm J}$ = 0.05 $_{\rm 5}$ = 0(1	uph);	SIC come	accion land		
Note positi	vег _{propped,h}				aisti ibutea	SLS COMP		, 	
(change	Goal seek Mi initial da a	propped to nd click mu	0.0 by chan tiple times	ging da and until conver	dp (free ea gence to th	e practical	1) solution)		BCQUUD
Total rotai	ning wall CI	S momont	about prop	M	<u>, en ce-co-di</u>			kNm/m	D30002
		(d - a)) + 0(F)	/ ''propped (<i>d _</i>)_F	(F . ')/F($S_{-}(d_{-e})$	-0(F)	$d - \rho$	N/A
note M prop	_{bed} — Г _{аһ} (Г	_{ah} j.(u _a -e _a)+U(F _{uah}).	(u _a -e _{ua})-r	ph(' ph)/ FC	5.(u _a -e _p	יין ד _{עף} א אין אין אין אין אין אין אין אין אין אי	u _a -e _{up});	
Anticipator	l maximum	value of d	for commo	ncomont of	itoration		20.000	-	
Employ for	tor on omb	odmont 2			ILEI ALIOIT	Voc. Eactor 1	2 20.000	111	
Employ lac	tor on end	n ombodme	nt chould k		d if the oth	res, ractor 1.	koda ara na		
Design em	hedment of		retaining w	vall I – (1	$\frac{1}{2}$ or 10	4 <u>FUS IIIEL</u>		m	, Tomlincon
Design tot	al length of	embedded	retaining w	van, <u>c</u> o — (1 all 1 - — 1 -		а _р	N / A	m	101111115011
Design tota		embedded		an, L _T – L ₀ -			N/A	111	
Concroto	or Staal Dr	onnod (Br	comont)	Emboddod	Potoining	Wall III S	Loading		
concrete				Liiibeuueu	Retaining		Loaunig		
	UI S I	Horizontal	Load	Note it is a	ssumed the	at the III S	loads act at	the	
ĸ	E-+ (K.E-+')	N/A	kN/m	same ecce	ntricities as	the SIS In	ads		
	K.E	N/A	kN/m						
K	Ent (K.E.t')	N/A	kN/m						
	K.F	N/A	kN/m						
	···· upn								
Total retai	ning wall UL	S horizonta	al load, K.F.	propped b			N/A	kN/m	
Note positi	ve K.F proppe	d h is effect	ivelv the pr	op uniform	lv distribute	ed ULS com	pression loa	ad;	
	- рюрре		- / -		,				

00	NSULTING	Enginoorin	a Calculation	Shoot			Job No		Sheet No).	Rev.
ENG		Consultina	Engineers	Sheet			iXX	x		123	
End		g					JAA	~		125	
							Member/Lo	cation			
Job Title	Structure,	Member De	sign - Geoteo	chnics Ret	aining	ı Wall	Drg.		1		1
Structure	e, Member De	esign - Geot	echnics Retai	ning Walls	5		Made by	XX	Date 2	1/11/2021	Ghd.
Concrete	e or Steel P	ropped (Ba	sement) En	nbedded	Reta	ining	Wall S	Sect	ion Desig	jn	
			l I								
		ک ا	la a a u Cauca a dia		•						
				ayrann							
		Ben	ding moment	diagram	1						
	-										
	Manada								•		
вепаіпд	Moment De	esign in wa	all, Shear De	esign in v	vall a	na D	etaiiin	g K	equireme	ents	
	Point	Depth, y	Bending Mo	oment in	Sh	ear F	orce i	n			
	Point	(m)	Wall, M (k	Nm/m)	Wa	ill, V	(kN/m	ı)			
	1	N/A	NI/A			N	/Δ				
	2	N/A				N.	/Δ				
	2					N.	/Δ				
	4	N/A	N/A			N	/Δ				
	5	N/A	N/A			N	/Δ				
	6	N/A	N/A			N	/Δ				
	7	N/A	N/A			N	/Δ				
	8	N/A	N/A			N	/Α				
	9	N/A	N/A			N	/A				
	10	N/A	N/A			N	/A				
	11	N/A	N/A			N	/A				
	12	N/A	, N/A			, N	/A				
	13	N/A	N/A			N/	/A				
	14	, N/A	N/A			, N	/A				
	15	N/A	N/A			N	/A				
	16	N/A	N/A			N,	/A				
	17	N/A	N/A			N,	/A				
	18	N/A	N/A			N,	/A				
		Σ	N/A			N,	/A				
	Note $M = 1$	K.F _{ah,y} (K.F _a	_{аh,y} ').е _{а,y} -К.Г	_{ph,y} (K.F _{ph}	. _y ')/F	OS 5.6	e _{p,y} +0(ʹK.F	_{uah,y}).e _{ua,}	y-0(K.F _{uph,y})	.e _{up,y} -K.F _{pr}
	Note V = H	K.F _{ah,y} (K.F _a	_{h,y} ')-K.F _{ph,y} (H	K.F _{ph,y} ')/F	'OS 5 +	-0(K.I	F _{uah,y})-	0(K.	F _{uph,y})-K	F propped,h ;	
	where for	undrained a	nalysis				and fo	r dra	nined ana	lysis	
	$\sigma_{va,surface}$ =	= p _{s,a}					$\sigma_{\it va,surfa}$	ace ' =	= p _{s,a} -0.0)	
	$\sigma_{va,y} = p_{s,y}$.a + γ .γ					$\sigma_{\it va,y}$ ' =	= p _s	,a + γ .γ- γ	".MAX(0.0, y	′-d _{aw})
	$\sigma_{ha,surface}$ =	= MAX(0, σ _v	a, surface $-2S_u$)				$\sigma_{\it ha, surfa}$		= Κ _a . σ _{va,}	_{surface} ′−2c′√	K _a
	$\sigma_{ha,y} = MA$	$X(4.8y, \sigma_{va,})$	$y - 2S_u$)				σ _{ha,y} '=	= K _ē	. σ _{va,y} '-2	$2c'\sqrt{K_a}$	
	$F_{ah,y} = 0.5$	5.($\sigma_{ha,surface}$	$+ \sigma_{ha,y}$).y.sin	α	-		F _{ah,y} '	= 0	5.($\sigma_{ha,surf}$	$\sigma_{ce}' + \sigma_{ha,y}').y$.cos(90°- α
	$e_{a,y} = y.(2$	$2 \sigma_{ha,surface} +$	$\sigma_{ha,y})/[3.(\sigma_h$	$_{na,surface} + \sigma$	- _{ha,y})]		$e_{a,y} =$	y.(2	$\sigma_{ha,surface}$	'+ σ _{ha,y} ')/[3.	($\sigma_{ha,surface}$ '+
	$\sigma_{vp,surface} =$	= p _{s,p}					U _{a,surfac}	e =	0.0		
	$\sigma_{vp,y} = p_{s,y}$	$p + \gamma \cdot (\gamma - H_R)$	20				$u_{a,y} =$	0.0	+ γ _w .ΜΑΧ	$(U.U, y-d_{aw})$	
	$\sigma_{hp,surface}$ =	= $\sigma_{vp,surface}$ +	25 _u				F _{uah,y}	= 0.	$5.(U_{a,surfact})$	$_{ce} + u_{a,y}$).MAX	((U.U, y-d _{aw}
	$\sigma_{hp,y} = \sigma_{v}$	_{/p,y} +23 _u Ε (-		(0,0,y,y)) 01-		e _{ua,y} =	- (Y-	u _{aw}).(20	$a, surface + U_{a, y}$	ין נ ס. (U _{a,surfac}
	$F_{ph,y} = 0.3$	$\sigma_{hp,surface}$	+ $\sigma_{hp,y}$).MAX	(U.U, у-п _к).SIN	γ 	$\sigma_{vp,surfa}$	ice =	$= p_{s,p} - 0.0$		ΜΑΥ(Ο
	$e_{p,y} = (y - 1)$	\sqcap_R).(2 $\sigma_{hp,s}$	$_{\mu rface} + \sigma_{hp,y}) / [$	[3.($\sigma_{hp,surf}$	face + d	[,] hp,y)	σ _{vp,y} ·	- p _s	, _p + γ.ΜΑλ - Κ –	$(U.U, y-H_R)$	·γ _w .ΜΑΧ(U. κ
							$\sigma_{hp,surfa}$	ace =	$-\kappa_p \cdot \sigma_{vp}$	$\frac{1}{2} \frac{1}{2} \frac{1}$	м _р
							F '	- ^ / - 0	$5.0_{VP,Y} + 1$	$\frac{1}{4} \propto \frac{1}{4}$	
							' ph,y	_ U.	() hp,surf	$f_{ace} = O_{hp,y} J.T$	'+ - '
							с _{р,у} =		<u>(0.0, y-r</u> 0.0	$R J \cdot (\leq O hp, surf$	ace то _{hp,y})/
							∽ p,surfac		- γ ΜΔΥ	(0.0 V-H	()
							Funk	= 0	5.(11	(3,2), (1,1)	(0.0. v-H ~
							e	= (v-	H _P -d)	(2U n curface +1	(,)/[3.(II
							ap,y	.,	κ · μw /		p,y , , L (= p

CON	SULTING	Enginoarin	a Calculatio	n Chaot		Job N	0.	Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	n Sheet		iXX	x	1	24	
			-			J Member/l	ocation			
loh Titlo	Structure	Member De	sian - Geot	ochnics Pot	aining Wall	Drg.	ocation			
Structure.	Member De	sian - Geot	echnics Ret	aining Wall	.anning wan s	Made by	xx	Date 21	/11/2021	hd.
				annig rran			7474		//	
	Bending	Moment a	nd Shear F	orce Diagr	ams					
	Ве	ending Mome	nt, M (kNm/m))						
		Shear Force	e, V (kN/m)							
20	15		10 	5	0 0.000					
					0.100					
					0.100					
\vdash					• 0.200					
\vdash					0.300					
$\Box \sqcup$					0.400					
						m) X				
\vdash					0.500	spth,				
					0.600	ă				
					. 0.800					
					. 0.000					
					0.900					
┝┤┕					1.000					
	- Bending Mom	ent in Wall, M (k	:Nm/m) —	- Shear Force	in Wall, V (kN/n	n)				
			,			·				
Moment in	wall per me	etre, M						N/A	kNm/m	
Shear force	e in wall pei	r metre, V _{ul}	_t or V					N/A	kN/m	
	Concrete	Contiquou	s / Interlo	ocking / Se	ecant Pile	Wall				
opped,h•Y;			-							
-	Ratio h _s /D							N/A		
	Bending st	ress, M.p/D	3					N/A	N/mm ²	
	Area of ten	action chart Isile steel re	s, 100A _s /A _c	= (100A_/A)/100 A			0.5 N/A	% mm²/nile	
				(_00/15/7	ps// = 0 0 11 vps					
	Area of ten	isile steel re	einforcemer	nt provided,	A _{s,prov,pile}			N/A	mm²/pile	
$+\delta$)	Bending m	oment in w	all utilisatio	$n = A_s / A_{s,}$	prov,pile			N/A		N/A
- σ _{ha,y} ')]	Note that r	nile chear d	esian to bo	nerformed	as ner colu	mn da	sian			
	NULE LIIAL L	ne snedi U		periorned	as per colu	inn ue	siyii;			
).sin α	All detailing	g requireme	ents met ?					N/A		
$(e^{+u_{a,y}})]$										
	Min longitu	dinal steel	reinforceme	ent number	$n_{\text{pile}} (>=6$	circula	ar)	N/A		N/A
, у-п _к -d _р	Percentage	of reinforc	ement A		(>=)	∟∠mm) I‰ ang	1 < 6		mm %	N/A
	Longitudina	al steel rein	forcement i	pitch (>=75	50 / 0 (2 0. 4	=100m	nm fo	N/A	mm	N/A
H _R).cos(90	°-γ-δ)	Circular pile	e bar pitch	= π(D-2.MA	X(cover ₁ , co	over ₂)-	- \pile)	N/A	mm	
([3.($\sigma_{hp,surfa}$	Min link dia	ameter, _{ølink}	, _{pile} (>=0.2	5 _{\$pile} ; >=8r	nm)			N/A	mm	N/A
	Max link pi	tch, S _{pile} (<	$=12\phi_{\text{pile}}, <=$	=300mm, <	=D for circ	ular)		N/A	mm	N/A
d) sin v	кеquire an	overail end	link.							
s_{pw} $J_{surface}$ $+ U_{pv}$)]					1				

CON	CONSULTING Engineering Calculation Sheet					Job No).	Sheet No.		Rev.
	NEERS	Consulting	g Calculatio Fngineers	in Sneet		iXX	x	1	25	
LIGI		consulting	Engineers]~~.	^	I	25	
						Member/Lo	cation			
Job Title	Structure,	Member De	sign - Geot	echnics Ret	aining Wall	Drg.				
Structure,	Member De	esign - Geot	echnics Ret	aining Wall	S	Made by	XX	Date 21	/11/2021	hd.
	Concrete	Diaphragn	n Wall							
	Concrete n	noment cap	acity per m	etre, M _u =	0.156f _{cu} .10	00.d _{wall}	2	N/A	kNm/m	
	Bending st	ress, [M/bd	$^{2}] = M / [(1)]$	1000).d _{wall} ²				N/A	N/mm ²	
	Bending st	ress ratio, k	$\zeta = [M/bd^2]$	/ f _{cu}				N/A		N/A
	Lever arm	$z = d_{wall}$	[0.5 + (0.2	5-K/0.9) ^{0.5}]	<= 0.95d	vall		N/A	mm	
	Area of ter	nsion steel r	equired, A _s	= M / [(0.9	95f _v).z]			N/A	mm²/m	
			-		/					
	Area of ter	nsile steel re	einforcemer	nt provided,	A _{s.prov.wall}			N/A	mm²/m	
	Bending m	oment in w	all utilisatio	$n = A_s / A_s$	prov wall			N/A	,	N/A
	5			<u> </u>						
	% Min long	aitudinal rei	nforcement	in wall (>=	= 0,0024.10)00.t G	250.	N/A	%	
	% Min Ion	gitudinal rei	nforcement	in wall utili	sation		-201	N/A	· · -	N/A
	I litimate d	hear stress	in wall y		d) (< 0	8f ^{0.5} ø	5 N	N / A	N/mm ²	
	Illtimate d	hear strees	in wall utilie	sation	$a_{wall} (< 0.$	cu c		N/A	11/11111	N/A
	Sicillate S									- N/ A
	Decian cha	ar stross in	wall vV	/(1000 d)			Ν / Δ	N/mm^2	
	(Concerva	tively chear	$r_{canacity} = v_{d}$	nhancemer) ht hy eithe	r calcu	latin	av. at d t	nymm from suppor	t and
	comparing	against un	anhanced v		2 / 5 10 B	C 2110	or	g v _d at u i		ort and
	comparing		hancod y	c as clause	5.4.5.10 D				v_d at suppo	ont anu
				willin 20 01		L as cia	luse	3.4.3.0 D3	2,	eu;)
				it provided,	A _{s,prov,wall}			N/A	mm ⁻ /m	
	$\rho_w = 100A_g$	s,prov,wall/(100	$\frac{1}{(2\pi)^{1/3}}$	(1) 1/4	12.6.10	(100/	(_l	N/A	% N/ 2	
	$V_{c} = (0.79)$	/1.25)(p _w r _{cu} /	/25) ^{-/-2} (400	/ɑ _{wall})-''; ρ _v	,<3; f _{cu} <40	; (400/	a _{wall}	N/A	N/mm ⁻	
	Charless	<u> </u>	linka					NI / A		
	Cneck V _d	< V _c for no		h (1000	۲ L			N/A	L.N.I./	
		Concrete s	near capaci	ty v _c .(1000	.d _{wall})			N/A	kN/m	
	<u></u>									
	Check v _c	< v _d < 0.4	$+ v_c$ for no		S	(1000)		N/A	2	
		Provide no	minal links	such that A	_{sv} / S > 0.4	.(1000)/(0.	N/A	mm²/mm/	m
		Concrete a	nd nominal	links shear	capacity ($0.4 + v_0$	c).(1	N/A	kN/m	
	Check v _d	$> 0.4 + v_c$	for design	links				N/A		
		Provide she	ear links A _s	,/S>1000	0.(v _d -v _c)/(0	.95f _{yv})	i.e.	N/A	mm²/mm/	m
		Concrete a	nd design li	inks shear o	capacity (A _s	v,prov,wal	/S _{wa}	N/A	kN/m	
	Area provi	ded by all li	nks per me	tre, A _{sv,prov,v}	vall			N/A	mm²/m	
	Tried A _{sv,pr}	$_{\rm ov,wall}$ / S _{wall}	value					N/A	mm²/mm/	m
	Design she	ear resistanc	ce in wall ut	tilisation				N/A		N/A
	All detailin	g requireme	ents met ?					N/A		
	Max longit	udinal steel	reinforcem	ent pitch in	wall ($<$ 3d _w	_{/all} , <75	0mr	N/A	mm	N/A
	Max longit	udinal steel	reinforcem	ent pitch in	wall			N/A	mm	N/A
							1			
	Max	kimum spacin	ng: 0.5%	% Ast or less	- 300mm					
			Betw	ween 0.5% a	nd 1.0% - 2	25mm				
			1.0%	% Ast or grea	ater - 175mr	n				
	Min longitu	Idinal steel	reinforceme	ent pitch in	wall (>75m	m+ ϕ_{wal}	", >:	N/A	mm	N/A
	Note an al	lowance has	s been mad	e for laps ir	the min p	itch by	incre	easing the	criteria by t	he bar dian
	% Max Ion	gitudinal re	inforcement	t in wall (<	= 0.04.100	, 0.t)		N/A	%	N/A
	Longitudin	al steel rein	forcement	diameter in	wall, own (, >=12m	nm)	N/A	mm	N/A
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L		1		1		1		I	1	

CON	SULTING	Enginoprin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	n Sheet		jXXX	12	26	
			-			Member/Location		-	
loh Title	Structure	Memher De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
,		5		5					
			-						
	Steel She	et Pile Wal	1						
	Section (el	astic) mom	ent capacity	v per metre	$M_c = p_v Z$		N/A	kNm/m	
	Bending m	oment in w	all utilisatio	$n = M / M_c$, c iy		N/A	,	N/A
	Section she	ear capacity	per metre	$V_{c} = 0.6h.$	t.p _y		N/A	kN/m	
	Design sne	ar resistand	ce in wall ut	llisation =	V / V _c		N/A		N/A
l	<u> </u>								
eter									

CONSULT	INC Engineering Calculati	Job No.	Sheet No.		Rev.	
FNGINER	B S Consulting Engineers	on Sheet	iXXX	1	27	
ENGINEI		T	JVVV	1.	27	
			Member/Location			
Job Title Struc	ure, Member Design - Geo	technics Retaining Wall	Drg.			
Structure, Memb	er Design - Geotechnics Re	etaining Walls	Made by XX	Date 21	/11/2021	Shd.
Deflection Crite	eria in Wall					
Span, $I = d_a$				N/A	m	
SLS moment in v	vall per metre, $M_{SLS} = M/K$			N/A	kNm/m	
	W 12W	RA				
		→×/+	≤ 1	R _		
	- <i>L</i>	$R_A = W/3$				
P _A	Rġ	$B_{\rm p} = 2W/3$				
	\frown	~ <u>B</u> = 2.11/5				
			dmax.			
M	<i>뽁ギ(/- 중</i> /		~~~ ⁵			
	= 0·/28W/	d _{max.} = 0.003				
	= 0.5774/		07/			
	y= 0.3//42	when $\chi = 0.50$				
Equivalent back-	calculated triangular distrib	uted loading W - M	/(0.128.1)		kN/m	
			(0.120.I)	N/A	KIN/III	
Cana	rata Cantinuaua / Intari	le ching / Secont Dile	14/~//			
Conc	rete Contiguous / Interi		wali			
Maxin	hum deflection in Wall, δ_{max}	$c = 0.01304W.F/(E_c.I)$		N/A	mm	
Deflec	tion in wall (first principles	s) utilisation = $\delta_{max}/(1/2)$	50)	N/A		N/A
Span,	I / pile shaft diameter, D r	ratio		N/A		
Basic	span / effective depth ratio	o criteria (20 simply sup	oported)	N/A		
Note	multiplier C _{1,span} more or less th	_{an 10m} not applicable;				
Modif	cation factor for tension C ₂	2				
	M.p/D ³			N/A	N/mm ²	
	$f_{z} = \frac{2f_{y}A_{z \text{ reg}}}{1} \times \frac{1}{z}$	Note A _{s,prov,pile} /2 as ci	rcular section	on;		
	$3A_{s prov} \beta_b$	$(\beta_{b}=1.0)$		N/A	N/mm ²	
	0.55 +	$\frac{(477 - f_s)}{(s - s - M)} \le 2.0$				
	Modification ¹²⁰	$\left(0.9 + \frac{m}{bd^2}\right)$		N/A		
Modif	ed span / effective depth r	ratio criteria		N/A		
Deflee	tion in wall (BS8110 meth	od) utilisation		N/A		N/A
Conc	rete Diaphragm Wall					
Maxin	num deflection in wall, δ_{max}	$_{c} = 0.01304 \text{W.} \overline{I^{3}/(\text{E}_{c}.\text{I})}$		N/A	mm	
Deflee	tion in wall (first principles	s) utilisation = $\delta_{max}/(1/2)$	50)	N/A		N/A
Span,	l / effective depth, d _{wall} ra	tio		N/A		
Basic	span / effective depth ratio	o criteria (20 simply su	oported)	N/A		
Note	multiplier C 1,span more or less th	an 10m not applicable;				
Modif	cation factor for tension C2	2				
	M/bd _{wall} ²			N/A	N/mm ²	
	$= \frac{2f_yA_z}{1}$					
	$I_5 = \frac{1}{3A_{\rm s prov}} \times \overline{\beta_{\rm b}}$	$(\beta_b = 1.0)$		N/A	N/mm ²	
	0.55.4	$(477 - f_{s}) < 2.0$				
	Modification 120	$\left(0.9 + \frac{M}{b d^2}\right) = 2.0$		N/A		
Modif	ed span / effective depth r	atio criteria		N/A		
Defler	tion in wall (BS8110 meth	od) utilisation		N/A		N/A
Steel	Sheet Dile Wall					
Massim					mm	
	tion in well (first principles	$\frac{1}{2} - \frac{1}{2} - \frac{1}$	50)			NI / A
Deneo		$o_{\text{max}}/(1/2)$	50)	N/A		N/A

CONSULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.				
ENGI	NEERS	Consulting	Engineers	II Sheet		iXXX	12	28	
2			5			Mombor/Location			
	Charlestan	Marahar Da	aian Caat	achaica Dat	aining Wall	Drg			
JOD LILIE Structure	Structure, Member De	member De	echnics Ret	aining Wall		Made by	Date 21	/11/2021	hd.
Structure,				anning wan	5		21	, 11, 2021	
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CONSULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.				
ENGI	NEERS	Consulting	Engineers	n Sheer		iXXX	12	29	
2						Mombor/Location			
loh Titlo	Structuro	Mombor Do	cian - Coot	ochnics Pot	aining Wall	Drg.			
Structure	Member De	sian - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
Structure,		Sign Geot		anning wan	5		<u> </u>	, 11, 2021	
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CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	1'	30	
21101		J	5			Manchanilla antian			
a. 1. 1	Charles	Manakan Da		a ale al a a Dat	- 1 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

CONSULTING Engineering Calc		a Calculatio	alculation Sheet	Job No. Sheet No.			Rev.		
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	13	31	
21101		J				Joor Manakara			
a. 1. 1	Charles	Manakan Da		a ale al a se Dad	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	

CONSULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.				
ENGI	NEERS	Consulting	g Calculatio Engineers	n Sheet		iXXX	13	32	
		J	5			Mombor/Looption			
	Charlestan	Marahar Da	aian Coot	achaice Dat	aining Wall	Member/Location			
JOD LILIE	Structure, Member De	sian - Geot	echnics Ret	aining Wall		Made by	Date 21	/11/2021	hd.
Structure,		sign - Geol	echinics Rei	anning wan	5	· •	21	/ 11/ 2021	

CONSULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.				
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	13	33	
		J	5			Manchanilla antian			
	Christer	Montes		ochaice Det	oining M-	Drg.			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wall	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol	echnics Rei	anning wan	5	······································	21	/11/2021	
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CON	SULTINC	Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	n Sneet		iXXX	13	34	
21101		J	5			Joor Manakara		51	
2 1 7 11	Charles	Manakan Da		a ale al a a Dat	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	

CON	SULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.			
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	13	35	
						Member/Location			
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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CON	SULTING	ULTING Engineering Calculation Sheet		Job No.	Sheet No.		Rev.		
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	13	36	
						Member/Location			
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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CONSULTING E N G I N E E R S		Engineering Calculation Sheet				Job No.	Sheet No.	heet No.	
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		Consulting	Engineers	II Sheet		iXXX	13	37	
			5			Mombor/Location			
	Charlestan	Marahar Da	aian Coot	achaice Dat	aining Wall	Drg			
JOD LILIE Structure	Structure, Member De	member De	echnics Ret	aining Wall		Made by	Date 21	/11/2021	hd.
Structure,				anning wan	5		21	, 11, 2021	

CONSULTING		Enginogrin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	g Calculatio Engineers	n Sneet		iXXX	13	28	
		j				Mombor/Loootion			
	Chrusture	Mambar Da	aian Coot	a chaice Dat	aining Mall	Member/Location			
JOD LILIE	Member De	sign - Geot	echnics Ret	echnics Ret		Made by	Date 71	/11/2021	hd.
Structure,		Sign Geot	cennes ree	annig wan.	5		21,	/ 11/ 2021	
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CONSULTING E N G I N E E R S		Engineerin	a Calculatio	n Sheet		Job No.	Sheet No.		Rev.
		Consulting	Engineers	II Sheet		jXXX	13	39	
						Member/Location			
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
l									

CONSULTING		Engineering Calculation Sheet				Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	II Sheet		jXXX	14	40	
						Member/Location			
lob Title	Structure.	Member De	sian - Geot	echnics Ret	aining Wall	Drg.			
Structure,	Member De	sign - Geot	echnics Ret	aining Wall	s	Made by XX	Date 21	/11/2021	hd.
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CONSULTING E N G I N E E R S		Facinosvin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
		Consultina	g Calculatio Engineers	n Sneet		iXXX	14	41	
21101		J				Manchanilla antian	-		
a. 1. 1	Characteria	Manakan Da		a ale a la a Dat	- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by	Date 71	/11/2021	hd.
Structure,		sign - Geol		anning wan	5	· •	21	/ 11/ 2021	
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CONSULTING E N G I N E E R S		Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
		Consultina	g Calculatio Engineers	n Sneet		iXXX	14	42	
21101		J	5			Joor Manakara			
2 1 7 11	Charles	Manakan Da		a ale al a a Dat	- 1- 1	Member/Location			
Job Litle Structure	Structure,	Member De	sign - Geot	echnics Ret	aining wali	Made by VV	Date 71	/11/2021	hd.
Structure,		sign - Geol	echinics rei	anning wan	5	· •	21	/ 11/ 2021	
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