

Building Code Clause(s).....

PRODUCER STATEMENT – PS1 – DESIGN

(Guidance on use of Producer Statements (formerly page 2) is available at www.engineeringnz.org)

ISSUED BY:
(Design Firm)
TO:(Owner/Developer)
TO BE SUPPLIED TO:
(Building Consent Authority)
IN RESPECT OF: (Description of Building Work)
AT:
(Address)
Town/City: DP SO
We have been engaged by the owner/developer referred to above to provide:
(Extent of Engagement)
services in respect of the requirements of Clause(s)of the Building Code for:
All or Part only (as specified in the attachment to this statement), of the proposed building work.
The design carried out by us has been prepared in accordance with:
Compliance Documents issued by the Ministry of Business, Innovation & Employmentor (verification method/acceptable solution)
Alternative solution as per the attached schedule
The proposed building work covered by this producer statement is described on the drawings titled:
together with the specification, and other documents set out in the schedule attached to this statement.
On behalf of the Design Firm, and subject to: (i) Site verification of the following design assumptions (ii) All proprietary products meeting their performance specification requirements;
I believe on reasonable grounds that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the following level of construction monitoring/observation:
CM1 CM2 CM3 CM4 CM5 (Engineering Categories) or as per agreement with owner/developer (Architectural)
I, am: CPEng # Reg Arch #
I am a member of: Engineering New Zealand NZIA and hold the following qualifications: The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than \$200,000*. The Design Firm is a member of ACENZ:
SIGNED BY(Signature)(Name of Design Professional)
ON BEHALF OFDateDate
Nate. This statement shall only be relied upon by the Duilding Concert Authority nemed above. Lickility under this statement a statement to the

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of \$200,000*.

This form is to accompany Form 2 of the Building (Forms) Regulations 2004 for the application of a Building Consent. THIS FORM AND ITS CONDITIONS ARE COPYRIGHT TO ACENZ, ENGINEERING NEW ZEALAND AND NZIA Form 2A

Memorandum from licensed building practitioner: Certificate of design work Section 45 and Section 30C, Building Act 2004

Please fill in the form as fully and correctly as possible.

If there is insufficient room on the form for requested details, please continue on another sheet and attach the additional sheet(s) to this form.

THE BUILDING

Street address: 33 Great West Road

Suburb:	
Town/City: Rotorua	Postcode: 3015

THE OWNER

Name(s): Spencer and Lisa Adlam	
Mailing address: As noted above	

Suburb:	PO Box/Private Bag:
Town/City:	Postcode:
Phone number:	Email address:

BASIS FOR PROVIDING THIS MEMORANDUM

I am pro	widing this memorandum in my role as the: Please tick the option that applies ($$)
()	sole designer of all of the RBW design outlined in this memorandum – I carried out all of the RBW design myself – no other person will be providing any additional memoranda for the project
()	lead designer who carried out some of the RBW design myself but also supervised other designers – this memorandum covers their RBW design work as well as mine, and no other person will be providing any additional memoranda for the project
()	lead designer for all but specific elements of RBW – this memorandum only covers the RBW design work that I carried out or supervised and the other designers will provide their own memoranda relating to their specific RBW design
(√)	specialist designer who carried out specific elements of RBW design work as outlined in this memorandum – other designers will be providing a memorandum covering the remaining RBW design work

IDENTIFICATION OF DESIGN WORK THAT IS RESTRICTED BUILDING WORK (RBW)

I <u>Stephen Bos</u> carried out / **supervised** the following design work that is restricted building work

PRIMARY STRUCTURE: B1

Design work that is	Description	Carried out/	Reference to plans
restricted building work		supervised	and specifications
Tick($$)if included Cross (X) if excluded	[If appropriate, provide details of the restricted building work]	[Specify whether you carried out this design work or supervised someone else carrying out this	[If appropriate, specify references]

design work]	

All RBW Design	()		() Carried out	
work relating to B1			() Supervised	
Foundations and	(√)	Foundation and	() Carried out	Refer to Stratum PS1
subfloor framing		Footings	() Supervised	(235655) and drawings 235655-STR-D001
Walls	(√)	Retaining Wall	() Carried out	Refer to Stratum PS1
			() Supervised	(235655) and drawings 235655-STR-D001
Roof	()		() Carried out	
			() Supervised	
Columns and	(√)	Beams and Posts	() Carried out	Refer to Stratum PS1
beams			() Supervised	(235655) and drawings 235655-STR-D001
Bracing	(√)	Post footing	() Carried out	Refer to Stratum PS1
			($$) Supervised	(235655) and drawings 235655-STR-D001
Other	(√)	Retaining Wall	() Carried out	Refer to Stratum PS1
			() Supervised	(235655) and drawings 235655-STR-D001

Primary structure

EXTERNAL MOISTURE MANAGEMENT SYSTEMS: E2

All RBW design work relating to E2	()	() Carried out
		() Supervised
Damp proofing	()	() Carried out
		() Supervised
Roof cladding or	()	() Carried out
roof cladding system		() Supervised
Ventilation system	()	() Carried out
(for example, subfloor or cavity)		() Supervised
Wall cladding or	()	() Carried out
wall cladding system		() Supervised
Waterproofing	()	() Carried out
		() Supervised
Other	()	() Carried out
		() Supervised

FIRE SAFETY SYSTEMS: C1 – C6

Emergency ()	() Carried out	
warning systems, evacuation and fire	() Supervised	
systems,		

suppression or		
control systems, or		
other		

Note: The design of fire safety systems is only restricted building work when it involves small-to-medium apartment buildings as defined by the Building (Definition of Restricted Building Work) Order 2011.

Note: continue on another page if necessary.

WAIVERS AND MODIFICATIONS

Waivers or modifications of the building code are required () Yes $(\sqrt{)}$ No

If Yes, provide details of the waivers or modifications below:

Clause	Waiver/modification required
[List relevant clause numbers of building code]	[Specify nature of waiver or modification of building code]

Note: continue on another page if necessary.

ISSUED BY

Name: Stephen Bos	LBP or Registration number: 154367			
The practitioner is a: () Design LBP ()	Registered $(\sqrt{)}$ Chartered professional architect engineer			
Design Entity or Company (optional): Stratum Co	nsultants Ltd			
Mailing address (if different from below):				
Street address / Registered office: Level 1, Rydal House, 29 Grey Street,				
Suburb:	Town/City: Tauranga			
PO Box/Private Bag: 13651	Postcode: 3141			
Phone number: (07) 571 4500	Mobile:			
After Hours:	Fax: (07) 571 3500			
Email address: Stephen.bos@stratumnz.co.nz	Website:			

DECLARATION

I Stephen Bos

[name of practitioner], CMEngNZ,

state that I have applied the skill and care reasonably required of a competent design professional in carrying out or supervising the Restricted Building Work (RBW) described in this form, and that based on this, I also state that the RBW:

- Complies with the building code; or
- Complies with the building code subject to any waiver or modification of the building code recorded on this form.

Signature: Date: 16/02/2022



INSPECTION SCHEDULE

Project No: 235655
Site: 33 Great West Road, Rotorua
Date: 16/02/22
Client: Spencer and Lisa Adlam
By: Daniel Archbold
Subject: Post footing inspections / observation

The following inspections / observations are recommended for completion of the proposed works to CM3.

Engineering inspections:

- 1. Foundation and Footing inspection.
- 2. Retaining Wall Block Inspection.
- 3. Beam and Post Inspection.

Any further inspections required are to be undertaken by council.

Yours faithfully, Stratum Consultants Ltd

Daniel Archbold

Structural Engineer BE (Hons), MEngNZ

235655-STR-C001-Inspection Schedule

Page 1 of 1

GENERAL NOTES

- 1. THESE STRUCTURAL DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL DRAWINGS AND SPECIFICATIONS. THE ENGINEER IS TO BE INFORMED OF ANY DISCREPANCIES.
- 2. SET OUT OF STRUCTURAL MEMBERS AS PER ARCHITECTURAL DRAWINGS UNLESS NOTED OTHERWISE.
- 3. DURING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE STRUCTURE IN A STABLE CONDITION AND ENSURING NO PART IS OVERSTRESSED UNDER CONSTRUCTION ACTIVITIES. THE CONTRACTOR SHALL DESIGN AND PROVIDE PROPPING TO SUPPORT ALL CAST-INSITU AND PRECAST CONCRETE WORK UNTIL SUCH CONCRETE HAS REACHED THE REQUIRED STRENGTH TO BE SELF SUPPORTING. (TYPICALLY FOR A MINIMUM OF 14 DAYS AFTER POURING).
- 4. WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE RELEVANT NEW ZEALAND STANDARDS AND LOCAL AUTHORITY REGULATIONS, EXCEPT WHERE VARIED BY THE CONTRACT DOCUMENTS.

STEELWORK

- 1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH NZS 3404.
- 2. ALL WELDING SHALL COMPLY WITH AS/NZS 1554 ALL WELDS TO BE 6mm CATEGORY SP CONTINUOUS FILLET WELDS UNLESS NOTED OTHERWISE. FOR THE WELDING OF STRUCTURAL STEEL WELDING PERSONNEL SHALL BE QUALIFIED IN ACCORDANCE WITH CLAUSE 4.11 OF AS/NZS 1554.1 OR AS/NZS 1554.5 AS APPROPRIATE.
- 3. WHERE STEEL BEAM ENDPLATES FACE FIX TO CONCRETE, PACKING (BETWEEN THE WALL AND THE ENDPLATE) MAY BE A MAXIMUM OF 5mm THICK. IF THE REQUIRED PACKER THICKNESS EXCEEDS 5mm INFORM ENGINEER AND REQUEST A FIXUP DETAIL.
- 4. ALL STEEL TO BE OF THE FOLLOWING GRADE U.N.O.

<u>GRADE 250</u> CHS, TFC, TFB, PL, EA -< 100 x 100, UA -<125 x 75 GRAD<u>E 300</u>

UB, PFC, UC, EA >= 125 x 125, UA >= 150 x 90 GRADE 350

RHS, SHS BOLTS GRADE 4.6 SNUG TIGHT U.N.O.

PLATE AND RODS PLATE GRADE 250, ROD GRADE 300, UNLESS NOTED OTHERWISE.

- 5. ALL BOLTS SHALL BE GRADE 4.6 SNUG TIGHT (4.6/S) U.N.O. ALL EXTERIOR BOLTS IN STEEL WORK OR BOLTS CAST OR DRILLED INTO CONCRETE SHALL BE HOT DIPPED GALVANISED U.N.O.
- 6. UNLESS OTHERWISE SPECIFIED ALL STEELWORKS SHALL BE PAINTED WITH ONE COAT OF AN APPROVED INORGANIC ZINC PRIMER IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS. ALL EXPOSED STEELWORK TO BE PAINTED AS FOLLOWS TO ACHIEVE 20 YEARS TIME TO FIRST MAINTENANCE AS SPECIFIED BY AS/NZS 2312:1994. ALL SURFACES SHALL BE FREE OF OIL, GREASE, AND SALT CONTAMINATION. ABRASIVE BLAST CLEAN IN ACCORDANCE WITH AS1627.9 CLASS 2.5 PRIME COAT WITH INORGANIC ZINC SILICATE WITH DRY FILM THICKNESS OF 75 MICRONS. TOP COAT TO BE HIGH BUILT/HIGH SOLIDS EPOXY WITH DRY FILM THICKNESS OF 175 MICRONS. PAINTING SHALL BE IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS. ANY ALTERNATIVE COATING SYSTEMS PROPOSED BY CONTRACTOR TO BE APPROVED BY ENGINEER. TENSION BOLTED CONNECTION SURFACES TO BE PAINTED WITH PRIMER IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS AS APPROVED BY ENGINEER.

CONCRETE

- 1. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH NZS 3109.
- 2. MINIMUM COVER TO REINFORCEMENT TO CAST INSITU CONCRETE SHALL BE AS FOLLOWS:

MEMBER	CAST AGAINST EARTH	EXPOSED TO WEATHER	NOT EXPOSED TO WEATHER
FOOTINGS	75mm	-	-
PILES	75mm	-	-
SLAB	50mm	35	25
PANELS	40mm	35	25

MINIMUM COVER TO REINFORCEMENT TO PRECAST CONCRETE AS PER NZS 3101.

3. NO HOLES, CHASES OR EMBEDMENT OF PIPES OTHER THAN THOSE SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE MADE IN CONCRETE WITHOUT THE APPROVAL OF THE ENGINEER.

FOUNDATIONS	25 MPa
SLAB ON GRADE	25 MPa
FLOOR TOPPING	40 MPa
WALLS PRECAST	50 MPa
COLUMNS	40 MPa
INSITU BEAMS	40 MPa
	FOUNDATIONS SLAB ON GRADE FLOOR TOPPING WALLS PRECAST COLUMNS INSITU BEAMS

				NOTES/KEY:	DRAWN BY:	DA		
					CHECKED BY:	SB	SPENCER AND LISA ADLAM	GENERAL NOTES
-				 CONFIRM ALL DIMENSIONS PRIOR TO CONSTRUCTION. 	DESIGNED BY:	DΔ		
+					DEGIGINED DT.	57	JJ GREAT WEST ROAD	
					APPROVED BY:	SB		
С	-	-	-		OFFICE:	TAURANGA	KUTUKUA	
В	-	-	-		CONTACT	07 571 4500		
A	16/02/22	DA	FOR BUILDING CONSENT		001111011	0.000		
No.	Date	By	Issue/Revision					
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REINFORCEMENT

1. REINFORCEMENT BARS SHALL CONFORM WITH NZS 3402 AND WELDED WIRE FABRIC SHALL CONFORM WITH NZS 3421 & NZS 3422. REINFORCING WHICH IS NOT MANUFACTURED BY PACIFIC STEEL IN NEW ZEALAND IS REQUIRED TO BE APPROVED BY THE ENGINEER.

2. ALL REINFORCING BARS HAVE BEEN DESIGNATED AS FOLLOWS:

GRADE 500E HD GRADE 300 D

ORIGINAL DWG. SIZE A3				
SCALE:	N.T.S			
DRAWING No.				
235655-S	TR-D001			
SHEET No.		ISSUE		
S00		Α		



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ORIGINAL DWG. SIZE A3				
SCALE:	1:10@A3			
DRAWING No.				
235655-STR-D001				
SHEET No.		ISSUE		
S03		A		



ners I Engineers I Surveyor



ORIGINAL DWG. SIZE A3				
SCALE:	1:10@A3			
DRAWING No.				
235655-ST	FR-D001			
SHEET No.		ISS		
S04		1		

RETAINING HEIGHT	VERTICAL REI	NFORCING	HORIZONTAL	FOOTING LENGTH	
(Maximum)	SIZE	SPACING	REINFORCING		
1000	HD12	400		1250	
1500	HD16	400	HD12 BARS AT	1850	
2000	HD16	400	600mm CENTRES	2250	
2800	HD20	200		2450	

NOTE: - DO NOT BACKFILL WALL UNTIL GROUT HAS CURED FOR 5 DAYS - HD DENOTES DEFORMED GRADE 500E REINFORCING - ALL CONCRETE 25 MPa UNLESS NOTED OTHERWISE



				NOTES/KEY	DRAWN BY:	DA		
					CHECKED BV-	CB	SPENCER AND LISA ADLAM	RETAINING WALL DETAILS
				1. CONFIRM ALL DIMENSIONS PRIOR TO CONSTRUCTION.	CHECKED DT.	30		
					DESIGNED BY:	DA	33 GREAT WEST ROAD	
					APPROVED BY:	SB		
					-	-	ROTORUA	
С	-	-	-		OFFICE:	TAURANGA		
В	-	-	-		CONTACT	07 571 4500		
А	16/02/22	DA	FOR BUILDING CONSENT		CONTACT.	07 371 4300		
No.	Date	By	Issue/Revision					
202								

ORIGINAL DWG. SIZE A3				
SCALE:	N.T.S			
DRAWING No.				
235655-STR-D001				
SHEET No.		ISSUE		
S05		Α		



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Date By

ORIGINAL DWG. SIZE A3		
SCALE: 1:10@A3		
DRAWING No.		
235655-STR-D001		CONSULTANTS
SHEET No.	ISSUE	Experience. Knowledge. Better Outcomes.
S06	А	Planners I Engineers I Surveyors



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Date Bv

ORIGINAL DWG. SIZE A3		
SCALE: 1:10@A3		
DRAWING No. 235655-STR-D001		Stratum
SHEET No. S07	ISSUE A	Experience. Knowledge. Better Outcome Planners I Engineers I Su



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Site Address 33 Great West Road	No of Pages	
City Rotorua	Date Feb 22	
Job No. 235655		
	Experience. Knowledge. Be	tter Outcomes.
LOADING SUMMARY		
Importance Level = 2. Normal Structures and	structures not falling into other levels	
Design Life = 50 Years		
1. CALCULATION OF WIND ACTIONS		
1.1 SITE WIND SPEED		
$V_{sit,\beta} = V_R M_d (M_{z,cat} M_s M_t)$	Eqn 2.2	
Regional Wind Speed $V_R = -3$	37.0 m/s Region A7, R=25 (Design Life=50, A	EP=1/25)
Regional Wind Speed $V_R =$	45.0 m/s Region A7, R=500 (Design Life=50,	AEP=1/500)
Wind Direction Multiplier M _d =	1.0 East Wind Direction	
Shielding Multiplier $M_{z,cat} =$		
	H = 50.0 m x = 70.0) m
Topographic Multiplier M _t =	1.2 Lu = 117.0 m z = 8.0	m
Ult V _{sit 6} = 41.51 m/s 149.452 Km	n/hr Ser V _{sit ß} = 34.13 m/s	
Wind Zone: High E	Equvalent to NZS3604:2011	
1.2 DESIGN WIND PRESSURE		
$p = (0.5 \rho_{air}) \left[V_{des,\theta} \right]^2 C_{fig} C_{dyn}$	Eqn 2.4(1)	
Density of air $\rho_{air} =$	1.2 kg/m ³	
Site Wind Speed $V_{des,\theta} = V_{des,\theta}$	41.5 m/s From 2.2	
$C_{fig} = C_{pn}$, k _p for external pressures	
$\kappa_{a,} \kappa_{c,} \kappa_{l,} \kappa_{p} = C_{dvo} =$	1 1.0	
- ayı		
Walls - windward	d = <u>19.5</u> m	$\theta = 90$
$C_{p,e} = 0.7$ Table 5.2(A)	b = 14.5 m d/	b = 1.34
$C_{p,i} = -0.3$ Table 5.2(B)	$\alpha = \frac{300}{100}$	d = 0.40 d = 0.74
Walls - leeward		u – 0.7 1
$C_{p,e} = -0.5$ Table 5.2(A)		
$C_{p,i} = 0.0$ Table 5.2(B) s_{\neg}	d = <u>14.5</u> m	θ = 0
C _{fig combined} = -0.5	$b = \frac{19.5}{70}$ m d/	b = 0.74
Boof(R) = 90 deg	$h = \frac{7.8}{30.0}$ m h/	d = 0.54 d = 1.34
$C_{p,e} = -0.6$		u = 1.04
Poof (II) 0 dog	Y	
$C_{p,e} = -0.3$		
$\frac{Roof(D) - 0 \text{ deg}}{C_{p,e}} = -0.6$		
p walls $w = 1.03$ kPa 0.70 kPa		
$p \text{ walls}_{L} = -0.52 \text{ kPa} -0.35 \text{ kPa}$		
p roof $_{R}$ = -0.62 kPa -0.42 kPa		
$p \operatorname{roof}_{U} = -0.31 \text{ kPa} -0.21 \text{ kPa}$		
p 1001 _D = -0.62 KPa -0.42 KPa		

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<i>City</i> Rotorua	ouu		Date	Feb 22	
Job No 235655			Bv	П۵	Stratum
300 NO. 233033			Ву		CONSULTANTS
2. CALCULATION OF EARTHQU	JAKE AC	TIONS			Experience. Knowledge. Better Outcomes
2.1 ELASTIC SITE SPECTRA					
$C = C_{h}(1) \ge R N(1,D)$	T 4	0.4	Eqn 3.1(1)		
Estimite of Building Period	11 = 0	0.4	Seconds		1 accords (cooursed)
Spectral Shape Factor	$C_h(T) =$	3.0	Class D - Deep S	$1_1 = 0.$	4 seconds (assumed)
Razaro Factor	Z = R -	0.24	Rolorua	oturn pariod	(Table 2.5)
Return Period	P _	0.25			(Table 3.3)
Near Fault Factor	N(T D) =	0.25	Use 0.25 althoug	n no AEP sp	ecilied for Serviceability
Near Fault Factor	N(1,D) -	1.00			
$C_u = 0.72$ $C_s =$	0.18				
2.2 HORIZONTAL DESIGN ACTIO	ON COEFF	ICIENTS			
$C_{d}(T_{1}) = C(T_{1}) S_{p} / k_{\mu}$			Eqn 5.2(1)		
Ordinate of Elastic Site Spectrum	$C_u(T_1) =$	0.72	From Eqn 3.1(1)		
	$C_s(T_1) =$	0.18			
Structural Perfomance Factor	Sp =	1.3-0.3µ	4.4.2 Sp = 0.	7 except who	ere 1 <u<2.0< td=""></u<2.0<>
Structural Ductility Factor	μ=	1	Ultimate Catego	ry 3 (Section	n 12 NZS 3404)
	μ =	1	Serviceability		
	Sp =	07	Onimate		
Inelastic Spectrum Scaling Factor	· k=	(μ-1) T₁+1	where T < 0.7s		
,	μ_	0.7			
	k., =	1.00	Ultimate		
	$k_{\mu}^{\mu} =$	1.00	Serviceability		
$C_{1}(T_{1}) = -0.72$	l Iltimate				
$C_{d}(T_{1}) = 0.12$ $C_{d}(T_{1}) = 0.13$	Serviceat	oilit∨			
2.3 EQUIVALENT STATIC METH	OD - Horiz	ontal Seis	<u>mic Shear, V</u>		
$V = C_d(T_1) W_t$			Eqn 6.2	2(1)	
Seismic Weght	$W_t =$	$G + \psi_E Q$	G = Pe	rmanent Act	ion / Dead Load
			Q = Im	posed Actior	n / Live Load
Combination factor	$\Psi_{E} =$	0.3	Clause	4.2	
Design Action Coefficient	$C_{d}(T_{1}) =$	0.72	Non St	orage Applic	ations
	$C_{d}(T_{1}) =$	0.13			

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City Rotorua		Date	Feb 22	C C C C C C C C C C C C C C C C C C C
Job No. 235655		Ву	DA	
				E U N S U L I A N I S

Proposed Strip Footing Foundation Loading - per metre

<u>GENERAL</u>	UNIFORM	<u>Y DISTRIBUTED LOADS</u>	Load (kN/m	1 ²)
	Roof	Corrugated Metal	0.35	kN/m ²
	External Walls	Weatherboard	0.45	kN/m ²
	First Floor	Timber	0.5	kN/m ²
	Ground Floor	Concrete Floor	2.4	kN/m ²
	Foundation beams	0.3 x 0.3 x24 kN/m ³	2.16	kN/m ²

LOADS							
UDL(kN/m)		G	Q	WIDTH	WG	WQ]
	ROOF	0.350	0.250	4.000	1.40	1.00	1
	WALL	0.450		4.800	2.16	0.00	
	FIRST FLOOR	0.500	1.500	1.800	0.90	2.70	
	GROUND FLOOR	2.400	1.500	1.000	2.40	1.50	
	FOUNDATION	2.160		1.000	2.16	0.00	
	TOTAL				9.02	5.20	
							_
LOAD COMBINATIONS		ULTIMATE		wu = 1.2G ·	+ 1.5Q =	18.62	kN/m
		SERVICEA	BILITY	ws = G + 0.	7 Q =	12.66	kN/m

BEARING

FACTORED ULTIMATE BEARING CAPACITY (kPa) = 105 (ALLOWABLE = 70)

FOOTING LENGTH (I) =	<mark>1.00</mark> m	
$B,REQ = (R^*/(\phi UBC \times I) =$	197.08 mm => USE	300mm WIDE FOOTING OK

	Job Tit	le Spencer a	and Lisa Ac	llam		Page				
Site Address 33 Great West Road			^	No of Pages						
	Ci	ty Rotorua				Date	Feb 22			
	Job N	o. 235655				By	DA	St	atu	\mathbf{m}
Flo	or Beam 1					TGA RE\	/ 2 9/07/2010	CONS Experience. Kr	5 ULTAN	JTS utcomes.
(a) <u>GEN</u>	IERAL	BEAM SP	AN =	7.100	m					
(h) I OA	ne				-					
	<u>kN/m</u>)		G	0	WIDTH	WG	Wo	1		
02=(ROOF	Ū	~		0.00	0.00		Win	d
		WALL	0.500	4 500	0.000	0.00	0.00	V	V (kPa)	
	F F	-LOOR DECK	0.500	1.500	2.900	1.45	4.35 0.00	().9G+w kPa	0
		SELF	0.200		1.000	0.20	0.00		kN/m	0
		TOTAL				1.65	4.35] –		
LOA	D COMBINATI	ONS	ULTIMATE SERVICEA	BILITY	wu = 1.2G ws = G + (+ 1.5Q =).7 Q =	8.51 4.70	kN/m g kN/m	joverns	
(c) <u>FLE</u>	$\frac{\text{XURE}}{\text{M}^*} = \frac{\text{(ULTIM}}{\text{W}_{\text{H}}} ^2 / 8$	ATE) = 53.59	kNm							
	TRY: 250 UB 3	7 🔻		φ Ms =	135	kNm				
	$Le = k_t k_l k_r$ Le = 10.9	L WHERE		$k_t =$	1.1	k ₁ =	1.4	k _r =	1.0	
		FROM TA	BLES			GRADE	300]		
			φ Mb =	28.1	kNm			1		
			αm =	1.13		h Mh (am) –	31.7	kNm	TOO 9	SMALL
	BUT JOISTS \	WILL PROVID	E LATERAL	RESTRAI	۹ = NT => Le am	1.0 1.13	φ I	Mb (αm) =	149.2 × M	kNm * OK
(d) <u>DEF</u>	<u>LECTION</u> (SE	RVICEABILIT	Y)							
	DEFLECTION	$I = 5 w_s L^4$	-			E =	200000	MPa		
		384 E I = 14.0	mm	<	15mm OK	=	55.6	x 10° mm *		
		= span	<u>.</u>							
				:	> L/350 OK	40	mm			
		NESS DEFLEC	CTION (1 kN	AT MIDSF	PAN) =	4.9 0.67	mm	<= 1.5mm	ок	
	OTION			00.40				But OK		
(e) <u>REA</u>	T		VUL =	30.19	KIN					
(I) <u>FUS</u>							105			
(g) <u>FOO</u>		Breg = (R	*/oUBC) ^{1/2} :	536	mm =>	USE	600X600X	300mm DE	EP RC PA	٩D
(h) <u>UPL</u>	<u>IFT</u>	R* = 0.5 \	Nind* L =	0.00	kN	Wall Weigh	nt			kN
						Floor Weig	ht			kN
		Uplift =		0.00		Footing We	eight	_	0.00	kN kN
		Additional	Weight Req	uired =	0	m ³		_		
						=> USE Calculate	Specific D	esign Reqo	t	
SUN	IMARY	Floor Be	am 1							
		<u>SIZE</u>	250 UB 37		CAMBER	NIL	<u>SPAN</u>	7.100 r	n	
		DOST	BOLT TOP	PLATE TO	D BEAM WI	TH 2/M12 @	900mm c/	/c		
		FOOTING	600X600X30	00mm DEEP	RC PAD					
			WITH D12	@ 150mm	c/c BOTH	WAYS WITH	H 75mm CC	OVER		
			OR STAN	DARD 300	WIDE STR	IP FOOTING	G			



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	Job No. 235655				By	DA	ST	atum
Floor Be	am <u>3</u>				TGA RE\	/ 2 9/07/2010	CONS Experience. Kn	ULTANTS owledge. Better Outcomes.
(a) <u>GENERAL</u>	BEAM SF	PAN =	5.000	m				
(b) LOADS								
UDL(kN/m)		G	Q	WIDTH	WG	WQ]	
	ROOF	0.400	0.250	4.100	1.64	1.03	14	Wind
	FLOOR	0.500	1.500	2.450 3.500	1.75	0.00 5.25	0	.9G+w
	DECK				0.00	0.00		kPa 0.36
	SELF TOTAL	0.200		1.000	0.20	0.00		kN/m 1.476
LOAD CON	IBINATIONS	ULTIMATE SERVICEA	BILITY	wu = 1.2G ws = G + 0	+ 1.5Q =).7 Q =	14.75 8.84	kN/m g kN/m	overns
(c) <u>FLEXURE</u> M* =	(ULTIMATE) $w l^2 / 8 = 46.09$	kNm						
TRY:	250 UB 31		φMs =	110	kNm			
Le = Le =	k _t k _l k _r L WHERE 7.7 m		k _t =	1.1	k _l =	1.4	k _r =	1.0
	FROM TA	BLES			GRADE	300]	
		φ Mb =	28.2	kNm				
		um –	1.10	_ ¢	o Mb (αm) =	31.9	kNm	TOO SMALL
BUT J	OISTS WILL PROVID	E LATERAL	RESTRAI	NT => Le = αm =	1.0 1.13	φľ	Vlb (αm) =	121.2 kNm > M* OK
(d) <u>DEFLECTIO</u> DEFL	<mark>ON (SERVICEABILIT</mark> ECTION = 5 w₅ L ⁴	Ύ)			E =	200000	MPa	
	384 E I	-			l =	44.4	x 10 ⁶ mm ⁴	
	= 8.1 = span	mm	<	: 15mm OK				
	617	-	:	> L/350 OK				
	LIVELINESS DEFLEC	CTION = CTION (1 kN	AT MIDS	PAN) =	4.1 0.29	mm mm	<= 1.5mm But OK	ок
(e) <u>REACTION</u>	R* = 0.5	wuL=	36.87	kN				
(f) <u>POST</u>	USE	75X75X5.0	SHS					
(g) <u>FOOTING</u>	FACTORE Breq = (R	D ULTIMAT */¢UBC) ^{1/2} :	E BEARIN 593	G CAPACI mm =>	ΓΥ (kPa) = USE	105 600X600X	(ALLOWAE 300mm DEE	BLE = 70) E P RC PAD
(h) <u>UPLIFT</u>	R* = 0.5	Wind* L =	3.69	kN	Wall Weigl Floor Weig	nt Iht		kN kN
	Liplift =		3 69	1	Footing We	eight		kN
	Additional	Weight Req	uired =	N/A	m ³		_	0.00 111
					=> USE	600X600X	300mm DEI	EP RC PAD
SUMMARY	Floor Be	eam 3						
	SIZE	250 UB 31		CAMBER	NIL	<u>SPAN</u>	5.000 m	n
	POST	BOLT TOP	PLATE TO) BEAM WI	IH 2/M12 @	v 900mm c∕	C (C	
	FOOTING	600X600X30	00mm DEEF	RC PAD				
		WITH D12	@ 150mm סמצ חאר		WAYS WITH	H 75mm CC G	OVER	
		<u></u> 01/11				-		

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					TGA RE	V 2 9/07/2010	C O	NSULT	ANTS	
<u>GARAGE I</u>	<u>_INTEL</u>			_			Experie	ence. Knowledge. Be	tter Outcomes.	
(a) <u>GENERAL</u>	BEAM SP	AN =	5.800	m						
UDL(kN/m)		G	Q	WIDTH	WG	WQ				
- (- ,	ROOF	0.400	0.250	3.600	1.44	0.90				
	WALL	0.450	4 500	3.600	1.62	0.00				
	SELF	0.500	1.500	1.000	0.25	0.75				
Ì	TOTAL				3.61	1.65				
		G	0	WIDTH	LENGTH	We	Wo			
	ROOF	0	Q	WIDTH	LENGTH	0.00	0.00			
	WALL	0.450	4 = 0.0	3.600	3.600	5.83	0.00			
	FLOOR SELF	0.500	1.500	3.500	3.600	6.30 0.00	18.90			
	TOTAL					12.13	18.90			
ULTIMATE	wu = 1.2G + 1.5Q = Pu = 1.2G + 1.5Q =	6.81 42.91	kN/m kN	SERVICEA	BILITY	ws = G + 0. Ps = G + 0.	.7 Q = .7 Q =	4.77 25.36	kN/m kN	
LET:	a=DISTANCE TO POIN					T LOAD.		a=	2.00	0
		II LOAD FRO		TFURINE	NEST FRO		JAD.	D=	3.00	0
(c) <u>FLEXORE</u> ((M* =	$w_u l^2 / 8 + Pu a / 2 =$	71.53	kNm							
M* _{POINT} =	$P_U a b/L+wu a(L-a)/2=$	82.09	kNm	CRITICAL						
TRY:	$360 \text{ UB } 57 \qquad \checkmark$ $\text{Le} = k_t \frac{k_l \ k_r \ L \ W}{k_l \ k_r \ L \ W}$	HERE	φ Ms = k _t =	273 1.1	kNm k _l =	1.4	k _r =	1.0		
	Le = 8.9	m BLES			GRADE	300				
		φ Mb =	73.7	kNm	ORADE	500				
		αm =	1.13	ф	Mb (αm) =	83.3	kNm		> M*	ОК
		VIDE LATERA	AL RESTRAI	NT => Le = αm =	1.0 1.00	φ N	/lb (αm) =	271.1	kNm > M *	ок
(d) <u>DEFLECTIO</u>	N (SERVICEABILITY) Point of max deflection	for point load	d = a.(1/3+2b	o/3/a)^0.5 =	2.530	(m)	E =	200000 161	MPa F 6 mm	م ⁴
DEFLECTION	N AT MIDSPAN FROM	UDL =	$5 w_s L^4$	_ =	2.18	mm			_ • · · · ·	
MAX d FROM	I POINT LOAD =	<u>Ps L² .b.x/l</u> 6EI	384 E T L(1-(b/L)^2-()	x/L)^2) =	2.80 4.99	_mm mm	<15mm 0	ĸ		
LIVELINESS	DEFLECTION (1 kN AT	MIDSPAN) :	.1	Span / d = mm	1163.5	-	> L/350 C <= 1.5mm	OK I OK		
(e) <u>REACTION</u>	R* LEFT : R* RIGHT	= 0.5 w _u L + P = 0.5 w _u L +	u b / L = Pu a / L =	47.85 34.54	kN kN	CRITICAL				
(f) <u>POST</u>	USE	75X75X5.0) SHS							
(g) <u>FOOTING</u>	FACTORE Breq = (R	D ULTIMATE */¢UBC) ^{1/2} =	BEARING (675	CAPACITY(mm =>	kPa) = USE	105 750X750X3	300mm DI	(ALLOWA EEP RC P	ABLE = [·] AD	70)
SUMMARY	GARAG	E LINTEL								
	SIZE	360 UR 57		CAMRER	NII	SPAN	5 800	m		
		BOLT TOP	PLATE TO	BEAM WIT	H 2/M12 @	900mm c/c	0.000			
	<u>POST</u> <u>FOOTING</u>	75X75X5.0 750X750X3 WITH D12) SHS 300mm DEE @ 150mm c	P RC PAD c/c BOTH W	AYS WITH	75mm COV	ER			

		A SHIELDER
Job Title : Spencer and Lisa Adlam	Page :	
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		CONSULIANIS

Height of wall

Retaining Wall Design Cantilever Wall Parameters Allow atotal wall height, with varying retaining heights. Extension of wall to act as a fence/barrier

H _w =	2.70 m
H _{ret} =	2.30 m
L _{stem} =	0.24 m
L _{toe} =	2.00 m
L _{base} =	0.30 m
L _{heel} =	0.00 m
L _{key} =	0.00 m
$\gamma_{soll} =$	17.0 kN/m3
$\gamma_{conc} =$	21.0 kN/m3
ω _g =	6.00 kPa
ω _{gs} =	4.50 kPa
ω _{eq} =	5.00 kPa

Height of retained ground Thickness of wall Length of toe Thickness of base Length of heel Depth of shear key Soil unit weight Masonry unit weight

Seismic Coefficients for the Ove	rturning	of Wall Itself
$C_{d}(T_{1}) =$	0.58	Ultimate
$C_{d}(T_{1}) =$	0.13	Serviceability

Factored Surcharge, gravity case, destabilising (1.2G+1.5Q) Factored Surcharge, gravity case, stabilising (0.9G)

Factored Surcharge, EQ, destabilising (G+Eu+0.3Q)



L	·Stern ≺→ 1
1	
Hw	H _T .
Lbase x	
k	k x Lbaie Haat

Reinforcement Summary Wall Reinforcement

	inene
A _{wv} =	HD20 Bars @200crs (1571mm2/m)

A _{wallv} =	HD20 Bars @200crs (1571mm2/m)
A _{wh} =	HD12 Bars @400crs (283mm2/m)
Footing Reinford	ement

ooting A_{ft} = HD20 Bars @200crs (1571mm2/m)

A_{fl} = 8 x HD12 Bars

LRFD parameters

$\Phi_{\rm bc}$ =	0.5
Φ_{sl} =	0.8
Φ _p =	0.5
$\alpha_{G_{stab}}=$	0.9
$\alpha_{G_{destab}}=$	1.2
$\alpha_{\text{FP static}}=$	1.5

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							Experience Knowledge Better Outcomes.
Computed Para	meters	_			Width of foot	ina	
L _{foot} -	Ltoe T Lstem T Lheel	=	2.21	n		ing LL ·····	
H _T =	H _W + L _{base} + L _{key}	=	2.61	n	lotal retained	i neight	
VV _{foot} =	Lfoot · Lbase · Yconc	=	14.1 KP	а	weight of foo	ting	
vv _{key} =	Lkey · Lbase · Yconc	=	0.0 KP	а	weight of key	(same tnickne	ss as base)
VV _{stem} =	H _w .L _{stem} .γ _{conc}	=	13.6 kP	a -	Weight of wa	li stem	
vv _{soil} –	Lheel · Tw · 7soll	=	0.0 KP	d	weight of sol	above neer	
Check 'middle th	hird rule'						
P _a =	0.5 $k_a \cdot \gamma_{soil} \cdot H_T^2$	=	18.3 kN/r	n	Active thrust,	soil weight cor	mponent
P _{av} =	$P_a.sin(\delta_a) =$	=	8.6 kN/r	n	Vertical comp	onents	
P _{ah} =	$P_a.cos(\delta_a) =$	=	16.2 kN/r	n	Horizontal co	mponents	
P _{a\u03c0} =	$\omega_g . K_a . H_T$	=	5.0 kN/r	n	Active thrust,	surcharge com	nponent
P _{avo} =	$P_{a\omega}$.sin (δ_a) =	=	2.3 kN/r	n	Vertical comp	onents	
P _{ahw} =	$P_{a\omega}.cos(\delta_a) =$	=	4.4 kN/r	n	Horizontal co	mponents	
P ₆₀ =	ω _{gs} . L _{heel}	=	0.0 kN/r	n	Surcharge ab	ove heel	
M _{ab} =	$(P_{ab}.(H_T/3-L_{kev}) + P_{abco}.(H_T/2-L_{kev}))\alpha_{FP, ctatic}$	=	29.6 kN/r	n	Moment from	horizontal act	ive pressure (+ve)
May =	$(P_{av} + P_{avo})$. Least	=	24.5 kN/r	n	Moment from	vertical active	pressure (-ve)
M=	$P_{\rm ev}(1_{\rm fort} - 1_{\rm hout}/2)$	=	0.0 kN/r	n	Moment from	surcharae aho	nve heel (-ve)
	· w. · · root · nee/ · /		0.0 KN/1		Restoring mo	ment from self	weight of wall and soil above bee
α _{c cob} Mc=	see working below	=	40.2 kN/r	n	ve)	inche jroni seij	neight of num and son above nee
	working sciew	-	40.2 KN/I				
	Weight, W	x	Dist from toe		=	M*	
Footing	g 14.1 kľ	v/m	L _{foot} /2	= 1.1 m	ı =	15.8 kNm/	m
Sterr	n 13.6 kt	N/m	L _{top} + L _{ctom} /2	= 2.1 m	ı =	28.8 kNm/	m
Key	v 0.0ki	V/m	Lfoot - 1 km/2	= 2.2 m		0.0 kNm/	m
Soi	il 0.0 kr	1/m	Lfoot - Lheel/2	= 2.2 m	. =	0.0 kNm/	m
W .=		4/m	iour neer		M. =	44.7 kNm/	
vv total -	- 27.7 KI	N/III			IVIG -	44.7 KINIII/	
M .=	M M - M - M	-	-35.1 kNm/r	n	Net moment i	must he < 0 for	stability
P =	W_{α} , α_{α} , $+P$, $+P$, $+P$	_	25.9 kNm/r	n n	factored verti	cal load on foo	ting
vert -	v total. CG_stab ' av ' avo ' o	-	33.3 (((()))	-	Juctored verti		farra (diatara a farra ta a)
Lnet -	-Winet/ Pvert	=	1.01	n	Line of action	oj net vertical	Jorce (distance from toe)
Check bearing ca	apacity						
L _{third} =	1/3 .L _{foot} =		0.7 m << L _{net} =	1.0 m	<< 2.L _{third} =	1.5	m =>> OK
B _{eff} =	2. L _{net}	=	1.96 r	n	Effective foot	ing width	Check B _{eff} < <l<sub>foot</l<sub>
							=>> OK
If footing is ecce	entric						
k =	1+6.Lnet/Lfoot	=	3.	6	eccentric load	l factor	
$V_{u,eccentricity} =$	k P _{vert} / L _{foot}	=	58.0 kN/r	n	factored verti	cal loading for	eccentricty
V _u =	Pvert	=	35.9 kN/r	n	Ultimate vert	ical load on foc	oting
H _u =	$(P_{ah} + P_{ah\omega}).\alpha_{EP_static}$	=	30.9 kN/r	n	Ultimate hori.	zontal load on	footing
Drained bearing	capacity shallow footing - Vesic						
L =	capacity shallow rooting - vesic	=	6.00 r	n	Lenath of wal	1	
					min horizonto	11 distance fron	n edge of underside of footing to f
D. =		=	4.00 r	n	of adiacent de	ownward slope	
β=		=	0.0 de	ø	Ground slone	in front of foot	ting
c =		=	0 kP	a	Soil effective	cohesion	
s., =			80 kP	a	undrained sh	ear strenath	
a =	Vesil here	=	5.1 kP	- a	Surcharae		
ч	1 2011 - Daze		5.1 M		surenurge		
N _q =	$= e^{\pi \tan(\phi)} \tan(\phi/2+45)^2$		$N_c = (N_q - 1)1/tan(\phi)$		Ν _γ =	$(\phi > 0) = 2.(N_q)$	+ 1)tan(φ)
=	= 14.720		= 25.80		=	16.72	
Shape factors							
λ _{qs} =	= 1+ (B _{eff} /L).tan(\$)		$\lambda_{cs} = 1 + (B_{eff} \cdot N_q) / (L \cdot N_c)$		$\lambda_{\gamma s} =$	1-0.4(B _{eff} /L)	
=	= 1.1/3		= 1.186		=	0.870	
Depth factors							
	= $(L_{bace}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^2(L_{bace}/B_{eff}))$		$\lambda_{cd} = (\phi > 0) = \lambda_{cd} (1 - \lambda_{cd}) / (N_o.tan)$	φ))	λ _{vd} =	1	
40	= 1.042		= 1.048		14		
Load Inclination	factors - (loading parallel to B _{eff})						
n _B =	$= (2+B_{eff}/L)/(1+B_{eff}/L)$						
=	= 1.754						-A.A
λ _{qi} =	= $(\phi > 0) = (1 - (L.H_u/(L.V_u+B_{eff}.L.c.1/tan(\phi))))^{ns}$		$\lambda_{ci} = (\phi > 0) = \lambda_{qi} - (1 - \lambda_{qi})/(N_c.tan(\phi$))	$\lambda_{\lambda i} =$	(φ > 0) = (1- (H	$_{u}/(V_{u}+B_{eff}.L.c.1/tan(\phi))))^{nB+1}$
=	= 0.032		= -0.039			0.004	
Ground Inclinati	ion factors						
λ _{ae} =	= $(D_e > 2.L_{foot}) = \lambda_{cg} = \lambda_{qg} = \lambda_{gg} = 1$		λ_{cg} = (D _e > 2.L _{foot}) = λ_{cg} = λ_{qg} = λ_{gg}	= 1	$\lambda_{\gamma g} =$	$(D_e > 2.L_{foot}) =$	$\lambda_{cg} = \lambda_{qg} = \lambda_{gg} = 1$
-16	= 1.00	=	1.00		=	1.00	
a. =	= $q_{\lambda_{\alpha\beta}}\lambda_{\alpha\beta}\lambda_{\alpha\beta}\lambda_{\alpha\beta}$.Na		que= c.λes.λes.λes.λes.Nc		α=	0.5 γ.Βλ	unt·λui·λum·Nu
Yuq"	= 2.9 kPa		= 0.0 kPa		Ψuλ= =	1.1 kPa	ru 11 18 1
-			0.0 M U		-		
q., =	$= q_{uq} + q_{uc} + q_{u\lambda}$		= 4.0 kPa				
10			= 300 kPa				
q _u =	= 210.0 kPa			check against	ultimate bearin	g pressure	
V _{unter} =	Boff, Q., . Φ_{bc}	-	205 A LNI /	n			Check V>V.
usudi	Cii 10 UC	-	200.4 KN/1				ustar -u

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Wall Sliding (Gr	ravity Case)				Experience: Knowledge: Better Oukcomes.
W _{slide} =	(L _{foot} - L _{base}). L _{key} .γ _{soil}	=	0.0 kN/m	Weight of soil t	trapped under footing
P _p =	$0.5 . K_p . \gamma_{soil} . (L_{base} + L_{key})^2$	=	3.1 kN/m	Passive resista	nce
P _{ph} =	$P_p .cos(\delta_p)$	=	2.9 kN/m	Horizontal com	nponent
P _{pv} =	$P_p .sin(\delta_p)$	=	0.9 kN/m	Vertical compo	onent
H _s =	$(V_u + W_{slide} \cdot \alpha_{G_{stab}} - P_{pv}) \cdot tan(\phi)$	=	18.6 kN/m	Friction under	footing
H _{star} =	$P_{ph}.\phi_p + H_s.\phi_{sl}$	=	16.3 kN/m	Factored ultim	ate resistance Check H _{star} >H _u
				BUT OK AS RES	STRAINED BY SLAB
alculate maxin	num bending moment in wall stem				
ssume waterp	roof membrane with padding, i.e negligible interface	friction	0		
		o _s =	0 22		
P =	05 K v H ²	-	14.8 kN/m	Active thrust	
P=	$P_{-1} \cos(\delta_{-})$	-	14.8 kN/m	Horizontal com	nonent
P =	ωK	-	4.6 kN/m	Active thrust s	urcharae component
Paber =	Poor cos(δ.)	=	4.6 kN/m	Horizontal com	nonent
M _{uG} =	$(P_{abs} \cdot H_w/3 + P_{abcos} \cdot H_w/2) \cdot \alpha_{FP \text{ static}}$	=	24.9 KNm/m	Ultimate bendi	ing moment in stem
			- ,		
oundation bea	aring (Earthquake case)				
K _h =	see previous working	=	0.308	horizontal acce	eleration
K _{aE} =	see previous working	=	0.661		
heck 'middle t	hird rule'				
P _{aE} =	$0.5 \cdot k_{aE} \cdot \gamma_{soil} \cdot H_T^2$	=	38.0 kN/m	Active thrust, s	oil weight component
P _{aEv} =	P_{aE} .sin (δ_a) =	=	17.8 kN/m	Vertical compo	onents
P _{aEh} =	P_{aE} .cos (δ_a) =	=	33.5 kN/m	Horizontal com	nponents
P _{aFm} =	ω_{FO} . K_{aF} . $(H_{ret} + L_{haco} + L_{vov})$	=	8.6 kN/m	Active thrust	surcharge component
PaEven =	P_{aFm} .sin (δ_a) =	=	4.0 kN/m	Vertical compo	pnents
Pasho =	$P_{2500}\cos(\delta_2) =$	=	7.6 kN/m	Horizontal com	nonents
P _{E00} =	Qar, Lhad	=	0.0 kN/m	Surcharae abo	ve heel
Mark =	$(P_{ret} (H_r/3 - I_{loc})) + P_{ret} (H_r/2 - I_{loc}))$	-	38.9 kN/m	Moment from	horizontal active pressure (+ve)
M . =	$(P_{a} + P_{a})$ I_{c}	_	49.0 kN/m	Moment from	vertical active pressure (-ve)
Mr=	$P_{r}(I_{fort} - I_{hort}/2)$	=	0.0 kN/m	Moment from	surcharae above heel (-ve)
M.=	(M/ C (T))(H (2+1)+(M/ K) (H (2+1)+)M	-	13.7 kN/m	Moment from i	inertia forces (+ve)
	<pre>(W stem.Cd(1))(hw/2+Lbase)+(W soil.Nh).(hw/2+Lbase)+W t.Kh.Lhace/2 - Wkev.Kh.Lkev/2</pre>	foo	2577 114711	momentyrom	
				Restoring more	nent from self weight of wall and soil above heel (
M _{EG} =	as above	=	44.7 kN/m	ve)	
M =	M - + M - M M M	_	-41.0 kN/m	Net moment m	nuct he < 0 for stability
P =	$W_{aEh} + P_{-} + P_{-} + P_{-}$	-	-41.0 KN/m	factored vertic	al load on footing
vert =	-March / Puret	-	45.0 KN/m	Line of action of	of net vertical force (distance from toe)
Het	···net/ · vert		0.0 1.1	Line of action e	
heck bearing c	capacity				
L _{third} =	1/3 .L _{foot} =	0.7 m	<< L _{net} =	0.8 m << 2.L _{third} =	1.5 m =>> OK
B _{eff} =	2. L _{net}	=	1.7 m	Effective footin	ng width Check B _{eff} < <l<sub>foot</l<sub>
· · · · · · · · · · · · · · · · · · ·					=>> OK
k =	1+6.1 net/l foot	=	3.21	eccentric load	factor
V _{u.eccentricity} =	k P _{vert} / L _{foot}	=	71.1 kN/m	factored vertic	al loading for eccentricty
V _{uEq} =	Pvert	=	35.9 kN/m	Ultimate vertic	cal load on footing
H _{uEq} =	$P_{aeh} + P_{aeho} + W_{stem}.k_{h} + W_{soil}.K_{h} + W_{foot}.K_{h} + W_{key}.k_{h}$	=	49.6 kN/m	Ultimate horizo	ontal load on footing
	the second shall be fronted wheth				
Indrained bear	ring capacity shallow footing - Vesic	-	6.00 m	Length of wall	
			0.00 m	min horizontal	distance from edge of underside of footing to fac
D _e =		=	4.00 m	of adiacent do	wnward slope
β=		=	0.0 de#	Ground slone in	n front of footing
s _u =		=	80.0 kPa	undrained shee	ar strength
c =	Su	=	80.0 kPa	Soil effective of	ohesion
a =	- Yenil-Lhace	=	5 1 kP>	Surcharae	
φ =	, oon ooge	=	0.0 deg	undrained frict	tion angle
	= top(Å)				
N _q :	$= e^{\kappa \cdot \cos(\psi)} \cdot \tan(\phi/2 + 45)^2$	$N_c = (\phi =$	= 0) = 5.14	$N_{\gamma} = ($	$\phi = 0) = 5.14$
:	= 1.000	= 5.1	4	= (0.00
hape factors					
λης:	= 1+ (B _{eff} /L).tan(ϕ)	$\lambda_{cs} = 1 +$	(B _{eff} .N _q)/(L.N _c)	$\lambda_{vs} = 1$	1- 0.4(B _{eff} /L)
	= 1.000	= 1.0	54	,- = C	0.890
onth fact					
Depth factors	$= (1, /B_{\alpha} < 1) = 1 + 2 \tan(\phi) (1 - \sin(\phi))^2 (1, /B_{\alpha}))$	λ.= (φ.	> 0) = λ(1-λ .)/(N tan(φ))	λ.= 1	
^-qd ∶	= 1.050		-, ~ _{qa} (+ , _{~qd})) ((* _q , can(ψ)) 44	N _{yd} = 1	.
oad Inclination	factors				
n _B	$= (2+B_{eff}/L)/(1+B_{eff}/L)$				
	= 1.784				
	-(b-0) - 1				
λ_{qi}	$= (\phi = 0) = 1$	λ _{ci} = 1-(n _B .H _{uEq} .L)/(c.N _c .B.L)	$\lambda_{\gamma i} = \lambda$	h _{qi}

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Site Addre	Struct Determo				No of Pa	ges :	Eab 22		
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								CONSULTAN Depetence Knowledge Better Cub	T S
Ground Incl	ination factors								
	λ_{qg} = (D _e > 2.L _{foot}) = λ_{cg} = λ_{qg} = λ_{gg} = 1	λ	$c_{cg} = (D_e > 2.L_{fc})$	$\lambda_{\rm ot}$) = $\lambda_{\rm cg}$ = $\lambda_{\rm qg}$ = $\lambda_{\rm gg}$ = 1	1	$\lambda_{\gamma g} = ($	$(D_e > 2.L_{foot}) = 2$	$\lambda_{cg} = \lambda_{qg} = \lambda_{gg} = 1$	
	= 1.000		= 1.000			= 1	1.000		
	$q_{uq} = q.\lambda_{qs}.\lambda_{qd}.\lambda_{qi}.\lambda_{qg}.Nq$	q	$l_{uc} = c.\lambda_{cs}.\lambda_{cd}.\lambda_{cd}$	$l_{cl} \cdot \lambda_{cg} \cdot Nc$		q _{uλ} = 0	D.5γ.B _{eff} .λ _{γs} .λ _{γd}	$.\lambda_{\gamma i}.\lambda_{\gamma g}.N_{\gamma}$	
	= 5.4 kPa		= 431.0 kPa	1		= (0.0 kPa		
	$q_u = q_{uq} + q_{uc} + q_{u\lambda}$		= 436.3 kPa	1					
		= 300 kPa							
	q _u = 210.0 kPa		check ago	ainst ultimate bearing	pressure				
V _{ustar} =	$B_{eff} . q_u . \Phi_{bc}$	=		173.5 kN/m				Check V _{ustar} >V _u	=>> OK
Wall Sliding	; (Earthquake Case)								
Passive p	ressure neglected due to possible desiccation and	disturbance		k _p =	$1 as \phi =$	0			
				S _u =	70 kPa Undra	ined she	ar strength (as	stated in getotechnic	al report)
				C _a =	70 kPa (where	$C_a = Su$	1)		
P _p =	$0.5 .K_p .\gamma_{soil} .(L_{base}+L_{key})^2 + 2.S_u .L_{key}$	=		0.8 kN/m	Passive	e resista	nce		
H _{star} =	$P_p + C_a.B_{eff}$	=		116.4 kN/m	Factor	ed ultim	ate resistance	Check H _{star} >H _u	=>> OK
Calculate m	aximum bending moment in wall stem								
Assume v	waterproof membrane with padding, i.e negligible	interface friction δ =	0						
		K - =	0 702						
P . =	$0.5 K = 7 = H^{2}$	aEs -	0.752	25.6 kN/m	Active	thruct			
P =	$P = \cos(\delta)$	-		35.6 kN/m	Horizo	ntal con	nnonent		
P = =	$\omega_{re} K_{re} (H + 1, +1, -)$	-		8.6 kN/m	Active	thrust s	urcharae com	nonent	
Parkus =	$P_{-rus} cos(\delta_{-})$	_		8.6 kN/m	Horizo	ntal con	nnonent	bonent	
MuEO =	$P_{aEws} = 100 (-5)$ $P_{aEws} = H_w/3 + P_{aEws} = H_w/2 + W_{stam} \cdot C_d \cdot T_1 H_w/2$	=		47.9 KNm/m	Ultima	te bendi	ina moment in	stem	
ulq.									
Design of W	/all - Flexural Capacity								
M _{max} =	$Max(M_{uG}, M_{UEQ})$	=		47.9 KNm/m					
	Try Vertical Rein	nforcing HD20 B	ars @200crs	(1571mm2/m)		φ =	0.8	5	
¢	o Mi= o As fv (d-0.59 As.fv / f'm b)	=		54.3 KNm/m	с	over = d =	120 mr 120 mr	n n	
т	, , , , , , , , , , ,	M _{max} >> ∳Mi	=>> OK			fc =	25 MP	а	
						fy =	500 MP	а	
						f'm =	12 MP	а	
						b =	1000 mr	n	
						As =	15/1 mm2/r	n	

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		CONSULTANTS

Height of wall

Retaining Wall Design Cantilever Wall Parameters Allow atotal wall height, with varying retaining heights. Extension of wall to act as a fence/barrier

H _w =	2.70 m
H _{ret} =	1.50 m
L _{stem} =	0.24 m
L _{toe} =	1.60 m
L _{base} =	0.30 m
L _{heel} =	0.00 m
L _{key} =	0.00 m
$\gamma_{soll} =$	17.0 kN/m3
$\gamma_{conc} =$	21.0 kN/m3
ω _g =	6.00 kPa
w _{gs} =	4.50 kPa
ω _{eq} =	5.00 kPa

Height of retained ground Thickness of wall Length of toe Thickness of base Length of heel Depth of shear key Soil unit weight Masonry unit weight Factored Surcharge, gravity case, destabilising (1.2G+1.5Q) Factored Surcharge, gravity case, stabilising (0.9G)

Factored Surcharge, EQ, destabilising (G+Eu+0.3Q)

Seismic Coefficients for the Overturning of Wall Itself $C_d(T_1) = 0.58$ Ultimate $C_d(T_1) = 0.13$ Serviceability

Anterior

w ŝ 2.5m ₩ ↓ 1

- Vs

	·Stem K-X
<u> </u>	
Hw	нт
Ltoe.	Lheel
Lbase x	K S
k	L baie

Reinforcement Summary

waii	Keinforcement	

A _{wv} =	HD16 Bars @400crs (503mm2/m)
A _{wallv} =	HD16 Bars @400crs (503mm2/m)
A _{wh} =	HD12 Bars @400crs (283mm2/m)

Pp

Footing Reinforcement

HD16 Bars @400crs (503mm2/m) A_{ft} =

A_{fl} = 7 x HD12 Bars

LRFD parameters

$\Phi_{\rm bc}$ =	0.5
$\Phi_{sl} =$	0.8
Φ _p =	0.5
α _{G_stab} =	0.9
$\alpha_{G_{destab}}=$	1.2
$\alpha_{EP \text{ static}} =$	1.5

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omnuted Parar	meters							Experience Knowledge Better Outcomes.
L _{foot} =	Ltna + Lctam + Lhaal	=		1.8 m	V	Vidth of footi	na	
H ₊ =		-		1.8 m	7	otal retained	neiaht	
W _{foot} =	Lfoot Lboro Vconc	=		11.6 kPa	N	Veiaht of foor	ina	
W _{key} =		=		0.0 kPa	- V	Veiaht of kev	 (same thicki	ness as base)
Watara =	Hundlater Veren	-		13.6 kPa	-	Veiaht of wal	l stem	,
W _{soil} =	L _{heel} .H _w .γ _{soll}	=		0.0 kPa	- V	Veight of soil	above heel	
3011	icci w ison							
eck 'middle th	ird rule'							
P _a =	0.5 $.k_a . \gamma_{soil} . H_T^2$	=		8.8 kN/m	A	ctive thrust,	oil weight c	omponent
P _{av} =	$P_a.sin(\delta_a) =$	=		4.1 kN/m	ι	ertical compo	onents	
P _{ah} =	$P_a.cos(\delta_a) =$	=		7.8 kN/m	ŀ	lorizontal cor	nponents	
P _{aco} =	ω_{g} .Ka. H _T	=		3.4 kN/m	A	ctive thrust,	surcharge co	mponent
P _{avo} =	$P_{a\omega}$.sin (δ_a) =	=		1.6 kN/m	ι	ertical compo	onents	
P _{ahw} =	P _{aω} .cos (δ _a) =	=		3.0 kN/m	ŀ	lorizontal cor	nponents	
P _ω =	ω _{gs} . L _{heel}	=		0.0 kN/m	S	urcharge abo	ve heel	
M _{ah} =	$(P_{ah}.(H_T/3-L_{key}) + P_{ah\omega}.(H_T/2-L_{key}))\alpha_{EP}$	static =	1	11.1 kN/m	٨	∧oment from	horizontal a	ctive pressure (+ve)
M _{av} =	(Pay + Paye).Lfoot	=	1	10.6 kN/m	٨	Лотепt from	vertical acti	ve pressure (-ve)
M _w =	P _m .(L _{foot} -L _{heel} /2)	=		0.0 kN/m	٨	Aoment from	surcharge a	bove heel (-ve)
					F	estoring mor	nent from se	If weight of wall and soil above he
α _{G stab} .M _G =	see working below	=	3	30.7 kN/m	v	e)	-	
	Weight, W	x	Dist from toe			=	M*	
Footing	l .	11.6 kN/m		$L_{foot}/2 =$	0.9 m	=	10.7 kNn	ı/m
Stem	I Contraction of the second	13.6 kN/m	L _{toe} ·	+ L _{stem} /2 =	1.7 m	=	23.4 kNn	ı/m
Key	,	0.0 kN/m	L _{foo}	$_{\rm ot}$ - $L_{\rm key}/2$ =	1.8 m	=	0.0 kNn	ı/m
Soil	l	0.0 kN/m	L _{foot}	$_{t}$ - L _{heel} /2 =	1.8 m	=	0.0 kNn	ı/m
W _{total} =		25.2 kN/m				M _G =	34.1 kNn	ı/m
						-		
M _{net} =	M _{ah} - M _{av} - M _G - M _ω	=	-30.	.1 kNm/m	Λ	let moment n	nust be < 0 fo	or stability
P _{vert} =	$W_{total} \alpha_{G_{stab}} + P_{av} + P_{av\omega} + P_{\omega}$	=	28.	.4 kNm/m	f	actored vertic	al load on fo	poting
net =	-M _{net} / P _{vert}	=		1.1 m	L	ine of action	of net vertice	al force (distance from toe)
eck bearing ca	apacity							
L _{third} =	1/3 .L _{foot} =		0.6 m << L _{net} =		1.1 m <	< 2.L _{third} =	1.	2 m =>> OK
B _{eff} =	2. L _{net}	=		2.12 m	E	ffective footi	ng width	Check B _{eff} < <l<sub>foot</l<sub>
								=>> Allow for eccentricity
ooting is eccei	1+6 I pet/I foot	-		4.5		ccentric load	factor	
к= V	I+6.LNet/LIOOL	-	<i>.</i>	4.5	e f	actorod vorti	jucior al loadina fr	ar accontricty
vu,eccentricity -	K Pvert / Lfoot	=	c	58.9 KN/III	J	actorea vertit	ai ioaaing jo	or eccentricty
V =	Vu eccentricity	-	f	58.9 kN/m	1	Iltimate verti	ral load on fi	notina
ч. Н =	$(\mathbf{P}_{1} + \mathbf{P}_{2}) q_{12} \dots$	-	1	16.2 kN/m	1	Iltimate horiz	ontal load o	n footing
	(an · · ano) EP_static			LU.2 KN/111		numate nonz	ontai loud o	njooting
ained bearing	capacity shallow footing - Vesic							
L =		=		6.00 m	L	ength of wall		
					n	nin horizonta	distance fro	om edge of underside of footing to
D _e =		=		4.00 m	C	of adjacent do	wnward sloj	De la
β=		=		0.0 deg	6	Ground slope	in front of fo	oting
c =		=		0 kPa	S	oil effective c	ohesion	
s _u =				80 kPa	u	ndrained she	ar strength	
q =	$\gamma_{soil}.L_{base}$	=		5.1 kPa	S	urcharge		
	π tan(à)							
N _q =	e		$N_c = (N_q - 1)1/tan(\phi)$			Ν _γ =	(φ > 0) = 2.(N	l _q + 1)tan(φ)
=	14.720		= 25.80			=	16.72	
ape factors								
-με .actors λ _{er} =	1+ (B _{eff} /L).tan(\$)		$\lambda_{cs} = 1 + (B_{off} \cdot N_{a})/(L \cdot N_{a})$			λ =	1- 0.4(B _{~#} /I)	
-45	1.188		= 1.202			- 13	0.859	
pth factors								
$\lambda_{qd} =$	$(L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^{2}(1-sin(\phi))^{2}$	- _{base} /B _{eff}))	$\lambda_{cd} = (\phi > 0) = \lambda_{qd} - (1 - \lambda_{qd}),$	/(N _q .tan(ϕ))		$\lambda_{\gamma d} =$	1	
=	1.039		= 1.044					
ad Inclination	factors - (loading parallel to B)							
n. =	(2+B _{eff} /L)/(1+B _{eff} /L)							
	1.739							
λ _α =	$(\phi > 0) = (1 - (L.H_u)/(L.V_u + B_{eff}.L.c.1/tan)$	(φ)))) ^{nB}	$\lambda_{ci} = (\phi > 0) = \lambda_{ci} - (1 - \lambda_{ci})/2$	(N _c .tan(φ))		$\lambda_{\lambda i} =$	(φ > 0) = (1- ($H_u/(V_u+B_{eff}.L.c.1/tan(\phi))))^{nB+1}$
·u/	0.627		= 0.600				0.480	
	an factors							
ouriu inclinatio λ =	$(D_{\lambda} > 2_{\lambda} _{\lambda \to \lambda}) = \lambda = \lambda = \lambda = 1$		λ= (D > 2 Ι.) = λ -	$\lambda_{} = \lambda_{} = 1$		λ -	(D. > 21.)	= λ = λ = λ = 1
∼ _{qg} =	$v_{e} \sim 2 \cdot v_{foot}$ $r = n_{cg} = n_{qg} = n_{gg} = 1$	_	$\gamma_{cg} = (U_e > 2.L_{foot}) = \Lambda_{cg} =$		-	ν _{γg} –	, ∽e < ∠.∟ _{foot}) 1 ∩∩	cg - /qg - /.gg = 1
=	1.00	=	1.00		=		1.00	
								2 2 2 N
q _{uq} =	$q.\lambda_{qs}.\lambda_{qd}.\lambda_{qi}.\lambda_{qg}.Nq$		$q_{uc} = c.\lambda_{cs}.\lambda_{cd}.\lambda_{cl}.\lambda_{cg}.Nc$			q _u ,=	υ.5 γ.Β _{eff} .λ _{γs} .	$\lambda_{\gamma d} \cdot \lambda_{\gamma i} \cdot \lambda_{\gamma g} \cdot N_{\gamma}$
=	58.1 kPa		= 0.0 kPa			=	124.2 kPa	
a -	n + n + n -		- 197 2 kp-					
q _u =	$q_{uq} + q_{uc} + q_{u\lambda}$		= 182.3 kPa					
q _u =	$q_{uq} + q_{uc} + q_{u\lambda}$		= 182.3 kPa = <mark>300 kP</mark> a	ch	neck agginst ult	imate hearing		
q _u = q _u =	$q_{uq} + q_{uc} + q_{u\lambda}$ 210.0 kPa		= 182.3 kPa = <mark>300 kPa</mark>	ch	neck against ult	imate bearing	g pressure	

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300 110 .	. 20000			By.	CONSULTANTS
Wall Sliding (Gra	avity Case)				calleterice inclinedult cellet collonies.
W _{slide} =	(L _{foot} - L _{base}). L _{key} .γ _{soil}	=	0.0 kN/m	Weight of soil tra	pped under footing
P _p =	0.5 .K _p .γ _{soil} .(L _{base} +L _{key}) ²	=	3.1 kN/m	Passive resistance	2
P _{ph} =	$P_p .cos(\delta_p)$	=	2.9 kN/m	Horizontal compo	inent
P _{pv} =	$P_p .sin(\delta_p)$	=	0.9 kN/m	Vertical compone	nt
H _s =	$(V_u + W_{slide} \cdot \alpha_{G stab} - P_{pv}) \cdot tan(\phi)$	=	36.1 kN/m	Friction under for	oting
H _{star} =	$P_{nb} \cdot \phi_n + H_s \cdot \phi_{sl}$	=	30.4 kN/m	Factored ultimate	resistance Check H _{star} >H ₁₁
	burne and			=>> OK	
				BUT OK AS RESTR	AINED BY SLAB
alculate maxim	num bending moment in wall stem	stion			
issume waterpr	roor memorane with padding, ite negligible interface in	δ. =	0		
		K =	0.33		
P =	$0.5 K \times 10^{-2}$	- "ds	6.2 kN/m	Active thrust	
r _{as} –	D ====(S)	-	0.3 KN/III	Active timust	
P _{ahs} =	Pas .COS(0 _s)	=	6.3 KN/M	Horizontai compo	inent
P _{aωs} =	ω _g .K _{as} .H _w	=	3.0 kN/m	Active thrust, sure	:harge component
P _{ahos} =	$P_{a\omega s} .cos(\delta_s)$	=	3.0 kN/m	Horizontal compo	nent
M _{uG} =	$(P_{ahs} .H_w/3 + P_{ahos} .H_w/2).\alpha_{EP_static}$	=	8.1 KNm/m	Ultimate bending	moment in stem
oundation has	ving (Forthquako caso)				
K _h =	see previous working	=	0 308	harizontal acceler	ration
 К _{ағ} =	see previous working	=	0.508	nonzontai acceler	
- *dE	see previous working		0.001		
heck 'middle th	hird rule'				
P _{aE} =	0.5 $k_{aE} \cdot \gamma_{soli} \cdot H_T^2$	=	18.2 kN/m	Active thrust, soil	weight component
P _{aEv} =	P_{aF} .sin (δ_a) =	=	8.5 kN/m	Vertical compone	ints
Park =	$P_{\rm er}(\cos(\delta_{\rm e})) =$	-	16.1 kN/m	Horizontal compo	onents
• atn =	$\omega_{ac} = K = (H + 1, \pm 1)$	_	10.1 KIN/III	Active the set	charge component
- aEω -	$w_{EQ} \cdot w_{aE} \cdot (1^{+}ret^{+} + base^{+} + key)$ $P_{eq} \cdot rin (\delta_{eq}) = 0$	-	5.9 KN/M	Active thrust, sure	narge component
P _{aEvo} =	$P_{aE\omega}$. Sin (O_a) =	=	2.8 KN/m	verticai compone	nts
P _{aEhw} =	$P_{aE\omega}$.cos (δ_a) =	=	5.2 kN/m	Horizontal compo	inents
$P_{E\omega} =$	ω _{gs} . L _{heel}	=	0.0 kN/m	Surcharge above	heel
M _{aEh} =	$(P_{aEh}.(H_T/3-L_{key}) + P_{aEh\omega}.(H_T/2-L_{key}))$	=	14.4 kN/m	Moment from hor	rizontal active pressure (+ve)
M _{aEv} =	$(P_{aEv} + P_{aEv\omega}).L_{foot}$	=	20.9 kN/m	Moment from ver	tical active pressure (-ve)
M _{Eω} =	$P_{E_{ib}}$.(L_{foot} - $L_{heel}/2$)	=	0.0 kN/m	Moment from sur	charge above heel (-ve)
M _I =	$(W_{stem}.C_d(T_1))(H_w/2+L_{base})+(W_{soil}.K_h).(H_w/2+L_{base})+W_{foc}$	=	13.6 kN/m	Moment from ine	rtia forces (+ve)
	$_{t}$.Kh.L _{base} /2 - W _{key} .k _h .L _{key} /2				
				Restoring momen	nt from self weight of wall and soil above heel (-
M _{EG} =	as above	=	34.1 kN/m	ve)	
M _{net} =	$M_{aEh} + M_I - M_{aEv} - M_{EG} - M_{E\omega}$	=	-26.9 kN/m	Net moment mus	t be < 0 for stability
P _{vert} =	$W_{total} + P_{aEv} + P_{aEvco} + P_{Eco}$	=	36.5 kN/m	factored vertical l	oad on footing
L _{net} =	-M _{net} / P _{vert}	=	0.7 m	Line of action of n	net vertical force (distance from toe)
heck bearing c	apacity				
L _{third} =	1/3 .L _{foot} =	0.6 m	<< L _{net} =	0.7 m << 2.L _{third} =	1.2 m =>> OK
B _{eff} =	2. L _{net}	=	1.5 m	Effective footing v	width Check B _{eff} < <l<sub>foot</l<sub>
					=>> OK
footing is ecce	entric		2.40		
к =	1+6.Lnet/Ltoot	=	3.40	eccentric ioda fac	tor
V _{u,eccentricity} =	K Pvert / Lfoot	=	67.6 KN/M	factorea vertical i	odding for eccentricty
V -	Puort	_	28.4 kN/m	Ultimate vertical	load on facting
v _{uEq} -		-	20.4 KN/III	Ultimate barizont	tal load on footing
n _{uEq} –	Paeh T Paeho TVV stem Kh TVV soil Kh TVV foot Kh TVV key Kh	=	29.1 KN/m	Unimale nonzoni	ar load on jooting
Indrained heari	ing capacity shallow footing - Vesic				
L=		=	6.00 m	Length of wall	
				min horizontal di	stance from edge of underside of footing to foo
D _e =		=	4.00 m	of adjacent down	ward slope
β=		=	0.0 deg	Ground slone in fi	ront of footing
r s =		-	0.0 ucg	undrained character	strength
		_	00.0 KP3	Coil offective	acingai
u -	э _ц	-	SU.U KPa	Son effective cohe	:51011
q =	γ _{soil} .L _{base}	=	5.1 kPa	Surcharge	
φ =		=	0.0 deg	undrained frictior	i angie
N -	$= e^{\pi \cdot tan(\phi)} \cdot tan(\phi/2+45)^2$	N = (m = 0) = 5.14	N = (m =	= 0) = 5.14
- PN -	= 1,000	= 5.14	,	- Ο Ο	-,
-		- 5.14		- 0.0	-
hape factors					
	= 1+ (B _{eff} /L).tan(ϕ)	$\lambda_{cs} = 1 + (B_{cs})$	_{eff} .N _q)/(L.N _c)	$\lambda_{\gamma s} = 1 - 0$).4(B _{eff} /L)
λ _{qs} =	= 1.000	= 1.048		= 0.9	02
λ _{qs} =					
λ _{qs} = =					
λ _{qs} = = Depth factors					
λ _{qs} = = Depth factors λ _{qd} =	= $(L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^2(L_{base}/B_{eff}))$	$\lambda_{cd} = (\phi > 0)$	$) = \lambda_{qd} - (1 - \lambda_{qd}) / (N_q \cdot tan(\phi))$	$\lambda_{\gamma d} = 1$	
λ _{qs} = = Depth factors λ _{qd} = =	= $(L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^{2}(L_{base}/B_{eff}))$ = 1.056	$\lambda_{cd} = (\phi > 0$ = 1.161	$)=\lambda_{\rm qd}\text{-}(1\text{-}\lambda_{\rm qd})/(N_{\rm q}\text{-}\tan(\varphi))$	$\lambda_{\gamma d}$ = 1	
λ _{qs} = = Depth factors λ _{qd} = =	= $(L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^{2}(L_{base}/B_{eff}))$ = 1.056	$\lambda_{cd} = (\phi > 0$ $= 1.161$) = λ_{qd} -(1- λ_{qd})/(N _q .tan(ϕ))	$\lambda_{\gamma d} = 1$	
λ _{qs} = = Depth factors λ _{qd} = = oad Inclination	= $(L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^2(L_{base}/B_{eff}))$ = 1.056	$\lambda_{cd} = (\phi > 0)$ = 1.161) = λ_{qd} -(1- λ_{qd})/(N _q -tan(ϕ))	$\lambda_{yd} = 1$	
λ _{qs} = = Depth factors λ _{qd} = = oad Inclination η _R =	$= (L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^{2}(L_{base}/B_{eff}))$ = 1.056 factors = (2+B_{eff}/L)/(1+B_{eff}/L)	$\lambda_{cd} = (\phi > 0$ = 1.161	$)=\lambda_{qd}(1-\lambda_{qd})/(N_{q}\tan(\phi))$	$\lambda_{\gamma d} = 1$	
λ _{es} = = Depth factors λ _{eq} = = oad Inclination n _B =	$= (L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^{2}(L_{base}/B_{eff}))$ = 1.056 factors = (2+B_{eff}/L)/(1+B_{eff}/L) = 1.803	$\lambda_{cd} = (\phi > 0$ = 1.161	$) = \lambda_{qd} (1 - \lambda_{qd}) / (N_q \cdot tan(\phi))$	$\lambda_{\gamma d} = 1$	
$\lambda_{qs} =$ Depth factors $\lambda_{qd} =$.oad Inclination $n_B =$ $\lambda_{cd} =$ $\lambda_{cd} =$	$ = (L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^{2}(L_{base}/B_{eff})) $ $ = 1.056 $ factors $ = (2+B_{eff}/L)/(1+B_{eff}/L) $ $ = 1.803 $ $ = (\phi = 0) = 1 $	$\lambda_{cd} = (\phi > 0$ = 1.161 $\lambda_{ci} = 1-(n_B)$	$) = \lambda_{qd} \cdot (1 - \lambda_{qd}) / (N_q \cdot tan(\phi))$ $H_{uEq} \cdot L) / (C \cdot N_c \cdot B \cdot L)$	$\lambda_{\gamma d} = 1$ $\lambda_{\gamma i} = \lambda_{\alpha i}$	

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JOD	NO: 235655					Ву :	DA	CONSULTAN	ΤS
Ground Incl	ination factors							Experience Knowledge, Better Cuto	omes.
	λ_{qg} = (D _e > 2.L _{foot}) = λ_{cg} = λ_{qg} = λ_{gg} = 1	λ	$L_{cg} = (D_e > 2.L_{fo})$	$\lambda_{\rm ot}$) = $\lambda_{\rm cg}$ = $\lambda_{\rm qg}$ = $\lambda_{\rm gg}$ =	1	$\lambda_{\gamma g} = ($	$D_e > 2.L_{foot}$) =	$\lambda_{cg} = \lambda_{qg} = \lambda_{gg} = 1$	
	= 1.000		= 1.000			= 1	L.000		
	$q_{uq} = q.\lambda_{qs}.\lambda_{qd}.\lambda_{qi}.\lambda_{qg}.Nq$	q	$u_{c} = c.\lambda_{cs}.\lambda_{cd}.\lambda$	ι _{ci} .λ _{cg} .Nc		q _{uλ} = 0	0.5γ.B _{eff} .λ _{γs} .λ _{γd}	$\lambda_{\gamma i} \lambda_{\gamma g} N_{\gamma}$	
	= 5.4 kPa		= 457.1 kPa	1		= ().0 kPa		
	$q_{11} = q_{111} + q_{111} + q_{12}$		= 462 5 kPa						
	an and are any	= 300 kPa	- 402.5 Ki 0						
	q _u = 210.0 kPa		check ago	ainst ultimate bearin	g press	ure			
V _{ustar} =	B_{eff} . q_u . Φ_{bc}	=		154.8 kN/m				Check V _{ustar} >V _u	=>> OK
Wall Sliding	y (Farthquake Case)								
Passive p	ressure neglected due to possible desiccation and d	isturbance		k _n =	1	as $\phi = 0$			
				S _u =		70 kPa Undrained she	ar strength (a:	s stated in getotechnic	al report)
				C _a =		70 kPa (where $C_a = Su$)		
P _p =	$0.5 .K_p .\gamma_{soil} .(L_{base}+L_{key})^2 + 2.S_u .L_{key}$	=		0.8 kN/m		Passive resista	nce		
H _{star} =	$P_p + c_a.B_{eff}$	=		104.0 kN/m		Factored ultim	ate resistance	Check H _{star} >H _u	=>> OK
Calculate m	aximum bending moment in wall stem								
Assume v	waterproof membrane with padding, i.e negligible in	nterface friction							
		δ _s =	0						
	0.5. V	K _{aEs} =	= 0.792						
$P_{aEs} =$	$0.5 \cdot K_{aEs} \cdot \gamma_{soll} \cdot H_w$	=		15.2 kN/m		Active thrust			
P _{aEhs} –	P_{aES} .cos(σ_s)	=		15.2 KN/m		Horizontal con	iponent		
P _{aEωs} –	W_{EQ} . N_{aES} . ($\Pi_W + L_{base} + L_{key}$)	-		5.9 KN/m		Active trirust, s	urchurge com	ponent	
FaEhωs =	P_{aEws} . $US(0_s)$	-		22.7 KNm/m		Ultimate bend	iponent ina moment in	stam	
WILLEU -	Taens	-		22.7 KNIII/III		Onimate bena	ing moment in	stem	
Design of W	/all - Flexural Capacity								
M _{max} =	Max(M _{uG} , M _{UEQ})	=		22.7 KNm/m					
	Try Vertical Rein	forcing HD16 B	ars @400crs	(503mm2/m)		φ =	0.8	5	
ė	$Mi = \phi As fv (d - 0.59 As fv / f'm h)$	-		23.0 KNm/m		cover = d =	120 mr 120 mr	n n	
1	φ.ο., (α ο.ο., ο, γ · ο γ	M _{max} >> ∲ Mi	=>> OK	2010 1111/11		fc =	25 MP	а	
						fy =	500 MP	а	
						f'm =	12 MP	а	
						b =	1000 mr	n	
						As =	503 mm2/r	n	

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		CONSULIANIS

Height of wall

Retaining Wall Design Cantilever Wall Parameters Allow atotal wall height, with varying retaining heights. Extension of wall to act as a fence/barrier

H _w =	2.70 m
H _{ret} =	1.00 m
L _{stem} =	0.24 m
L _{toe} =	1.20 m
L _{base} =	0.30 m
L _{heel} =	0.00 m
L _{key} =	0.00 m
$\gamma_{soll} =$	17.0 kN/m3
γ _{conc} =	21.0 kN/m3
ω _g =	6.00 kPa
ω _{gs} =	4.50 kPa
ω _{eq} =	5.00 kPa

Height of retained ground Thickness of wall Length of toe Thickness of base Length of heel Depth of shear key Soil unit weight Masonry unit weight

Seismic Coefficients for the Ove	rturning	of Wall Itself
$C_{d}(T_{1}) =$	0.58	Ultimate
$C_{d}(T_{1}) =$	0.13	Serviceability

Factored Surcharge, gravity case, destabilising (1.2G+1.5Q) Factored Surcharge, gravity case, stabilising (0.9G)

Factored Surcharge, EQ, destabilising (G+Eu+0.3Q)

w m 2.5m ₩ Pp 1

Lst	em
K	*
\uparrow	1 1
Hw	нт
Ltoe.	Lheel
Lbase to	1 Lkey
	k A Lbaie H

Reinforcement Summary Wall Reinforcement

wan kennore	ement
A _{wv} =	HD16 Bars @400crs (503mm2/m)
A _{wallv} =	HD16 Bars @400crs (503mm2/m)
A _{wh} =	HD12 Bars @400crs (283mm2/m)

Footing Reinforcement

- HD16 Bars @400crs (503mm2/m) A_{ft} =
- A_{fl} = 5 x HD12 Bars

LRFD parameters

$\Phi_{\rm bc}$ =	0.5
$\Phi_{sl} =$	0.8
Φ _p =	0.5
α _{G_stab} =	0.9
$\alpha_{G_{destab}} =$	1.2
$\alpha_{\text{EP_static}} =$	1.5

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omnuted Paran	neters						Experience Knowledge Better Outcomes
L _{foot} =	Ltna + Lttam + Lhaal	=	1.4 m	и	Vidth of footi	na	
H ₊ =	Hw + I have + I have	=	13 m	T	otal retained	neiaht	
W _{foot} =		=	9.1 kPa	и	Veiaht of foot	ina	
Wkay =		=	0.0 kPa	и	Veiaht of kev	(same thickne	ess as base)
Watara =		=	13.6 kPa	и	Veiaht of wal	l stem	,
W _{soil} =	Lheel .Hw .Ysoil	=	0.0 kPa	и	Veight of soil	above heel	
501	neer w raam						
eck 'middle th	ird rule'						
P _a =	0.5 .ka . ysoil .HT ²	=	4.6 kN/m	A	ctive thrust, s	oil weight co	mponent
P _{av} =	$P_a.sin(\delta_a) =$	=	2.2 kN/m	V	ertical compo	onents	
P _{ah} =	$P_a.cos(\delta_a) =$	=	4.0 kN/m	н	lorizontal con	nponents	
P _{ao} =	$\omega_g . K_a . H_T$	=	2.5 kN/m	A	ctive thrust, s	urcharge con	nponent
P _{avo} =	$P_{a\omega}$.sin (δ_a) =	=	1.2 kN/m	V	ertical compo	onents	
P _{aho} =	$P_{a\omega}.cos(\delta_a) =$	=	2.2 kN/m	н	orizontal con	nponents	
Ρ _ω =	ω _{gs} . L _{heel}	=	0.0 kN/m	Si	urcharge abo	ve heel	
M _{ab} =	$(P_{ab}.(H_T/3-L_{kev}) + P_{abco}.(H_T/2-L_{kev}))\alpha_{EP}$ static	=	4.8 kN/m	N	1oment from	horizontal ac	tive pressure (+ve)
May =	$(P_{av} + P_{avw})$, Lfoot	=	4.8 kN/m	N	1oment from	vertical active	e pressure (-ve)
M _m =	Prov(Lfoot - Lhool/2)	=	0.0 kN/m	N	10ment from	surcharae ab	ove heel (-ve)
6				R	estorina mon	nent from self	weiaht of wall and soil above he
α _{G stab} .M _G =	see working below	=	22.0 kN/m	V	е)	,	·····j····
			22.0 km/m				
	Weight, W	x	Dist from toe		=	M*	
Footing		9.1 kN/m	$L_{foot}/2 =$	0.7 m	=	6.5 kNm/	'm
Stem		13.6 kN/m	$L_{top} + L_{stem}/2 =$	1.3 m	=	18.0 kNm/	′m
Kev		0.0 kN/m	$L_{foot} - L_{kev}/2 =$	1.4 m	=	0.0 kNm/	′m
Soil		0.0 kN/m	$L_{foot} - L_{heel}/2 =$	1.4 m	=	0.0 kNm/	′m
W =		22.7 kN/m			Mo =	24.5 kNm/	/m
•• total —		22.7 KN/11			iviG =	24.3 KNIII/	
M _{net} =	Mah - May - MG - Mm	=	-22.1 kNm/m	N	let moment n	nust be < 0 for	stability
Punt =	Wratel $\alpha_{\rm G}$ step + Pau + Paus + Pa	=	23.7 kNm/m	fe	actored vertic	al load on foo	otina
. =	-M ./P .	-	0.9 m	,- , ,	ine of action	of net vertical	force (distance from toe)
net	met vert		0.5 11	L,		oj net verticul	Joree (distance from toe)
eck bearing ca	apacity						
L _{third} =	1/3 .L _{foot} =		0.5 m << L _{net} =	0.9 m <	< 2.L _{third} =	1.0	m =>> OK
B _{eff} =	2. L _{net}	=	1.86 m	Ej	ffective footii	ng width	Check B _{eff} < <l<sub>foot</l<sub>
						-	=>> Allow for eccentricity
ooting is eccer	ntric						
k =	1+6.Lnet/Lfoot	=	4.9	e	ccentric load	factor	
V _{u,eccentricity} =	k P _{vert} / L _{foot}	=	80.3 kN/m	fa	actored vertic	al loading for	eccentricty
V _u =	Vu,eccentricity	=	80.3 kN/m	U	Iltimate vertio	cal load on fo	oting
H _u =	$(P_{ah} + P_{ah\omega}).\alpha_{EP_static}$	=	9.4 kN/m	U	Itimate horiz	ontal load on	footing
ained bearing	conscitu challow footing Vocio						
aineo pearing i I =	capacity shallow footing - vesic	-	6.00 m		enath of wall		
-		-	0.00 11	E	in horizonta	l dictanco fror	n adap of underside of feating to t
D =		-	4.00 m	"	f adiacent do	wnward slon	, euge of underside of footing to f
B=		_	4.00 m	o,	round clone i	in front of foo	- ting
р- с=		-	0.0 deg	G G	nil effective c	n front of foo ohesion	ung
s =			80 kPa	и	ndrained she	ar strenath	
n =	Mary L	-	5 1 kPa	5	urcharae		
1 -	/ Sour-Ebase	=	5.1 KPd	3	a. chuiye		
N. =	$e^{\pi.tan(\phi)}$.tan($\phi/2+45$) ²		$N_{-} = (N_{-} - 1)1/tan(\phi)$		N., =	(φ > 0) = 2.(N.	+ 1)tan(\u00fc)
4 =	14.720		= 25.80		=	16.72	/·· (I)
ape factors							
$\lambda_{qs} =$	1+ (B _{eff} /L).tan(ϕ)		$\lambda_{cs} = 1 + (B_{eff} \cdot N_q)/(L \cdot N_c)$		$\lambda_{\gamma s} = 2$	1- 0.4(B _{eff} /L)	
=	1.165		= 1.177		= (0.876	
oth fanta .							
ptn factors	$(1 / P < 1) = 1 + 2 \tan(4) / 4 = - (4) + 2^{2}$	/P \\	$\lambda = (h > 0) = \lambda = (1, 1) + (1)$		1 –	1	
λ _{qd} =	$(L_{base} / D_{eff} \land 1) = 1 + 2 tari(\phi)(1 - Sin(\phi)) (L_{base})$	/ Peff//	$n_{cd} - (\psi \neq 0) = n_{qd} - (1 - n_{qd})/(N_q \cdot tan(\phi))$		$\lambda_{\gamma d} = 1$	1 I	
=	1.044		= 1.050				
ad Inclination f	factors - (loading parallel to B _{eff})						
n _B =	: (2+B _{eff} /L)/(1+B _{eff} /L)						
=	1.763						
$\lambda_{qi} =$	$(\phi > 0) = (1 - (L.H_u/(L.V_u+B_{eff}.L.c.1/tan(\phi)))$) ^{nB}	$\lambda_{ci} = \ (\varphi > 0) = \lambda_{qi} - (1 - \lambda_{qi}) / (N_c.tan(\varphi))$		$\lambda_{\lambda i} =$	(φ > 0) = (1- (H	$I_u/(V_u+B_{eff}.L.c.1/tan(\phi))))^{nB+1}$
=	0.804		= 0.789		(0.710	
ound Inclinatio	on factors						
λ=	$(D_p > 2.L_{foot}) = \lambda_{ra} = \lambda_{na} = \lambda_{na} = 1$		$\lambda_{cg} = (D_p > 2.L_{foot}) = \lambda_{cg} = \lambda_{cg} = \lambda_{cg} = 1$	1	λ	(D _p > 2.L _{foot}) =	$\lambda_{c\sigma} = \lambda_{\alpha\sigma} = \lambda_{\alpha\sigma} = 1$
`чб =	1.00	=	1.00	=	16	1.00	d6 or
-		-		-			
	αλλ.λ.λΝα		$a = c\lambda + \lambda + \lambda + \lambda$ No		c	0.5 v R ג	.λ.λ N
q _{uq} =	· 4.2045.004.004.004		$q_{uc} = c.n_{cs}.n_{cd}.n_{cg}.NC$		q _{uλ} = 1	0.0 γ.0 _{eff} .Λ _{γs} .Λ 164 3 μρο	γd•••γi••νg••ι ¤ γ
=	· /J.4 KFd		- U.U KPd		=	104.5 KPa	
a =	$q_{\mu\alpha} + q_{\muc} + q_{\mu\lambda}$		= 237.6 kPa				
q _u =	$q_{uq} + q_{uc} + q_{u\lambda}$		= 237.6 kPa = 300 kPa				
q _u = q _u =	: q _{uq} + q _{uc} + q _{uλ} . : 210.0 kPa		= 237.6 kPa = <mark>300 kP</mark> a	check against ulti	imate bearing	g pressure	
q _u = q _u =	$q_{uq} + q_{uc} + q_{u\lambda}$ 210.0 kPa B = 0 - 0		= 237.6 kPa = 300 kPa	check against ulti	imate bearing	g pressure	Cherk V SV

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Mall Eliding (Cr	avity (acc)				Experience. Knowledge, Better Outcomes.
Wall Sliding (Gr Welldo =	(Least - Lhara), Likow Yrail	=	0.0 kN/m	Weight of soil t	trapped under footing
P. =	$(-1001 - 00000 + 10000 + 10000)^2$	-	3.1 kN/m	Passive resista	nce
гр — Р. —	P cos(8)	_	3.1 kN/m	Horizontal com	nonent
P =	$P_{p} \cdot \cos(\delta_{p})$	-	0.9 kN/m	Vertical compo	nent
г _{ру} —	$(\gamma_p, \sin(\phi_p))$	_	42.2 kN/m	Friction under	facting
п _s –	(V _u + W _{slide} .u _{G_stab} - P _{pv}).uan(ψ)	-	42.2 KN/m	Friction under	Jooung
n _{star} –	r _{ph} .ψ _p τ Π _s .ψ _{sl}	=	35.2 KN/III		ble resistance Check h _{star} >h _u
				BUT OK AS RES	STRAINED BY SLAB
alculate maxin	num bending moment in wall stem				
ssume waterp	roof membrane with padding, i.e negligible interface f	riction			
		δ _s =	0		
	2	K _{as} =	0.33		
P _{as} =	0.5 K_{as} · γ_{soil} · H_{w}^{2}	=	2.8 kN/m	Active thrust	
P _{ahs} =	P _{as} .cos(δ _s)	=	2.8 kN/m	Horizontal com	iponent
P _{aws} =	$\omega_g . K_{as} . H_w$	=	2.0 kN/m	Active thrust, s	urcharge component
P _{ahos} =	$P_{a\omega s}$.cos(δ_s)	=	2.0 kN/m	Horizontal com	iponent
M _{uG} =	$(P_{ahs}.H_w/3 + P_{ahws}.H_w/2).\alpha_{EP_{static}}$	=	2.9 KNm/m	Ultimate bendi	ing moment in stem
oundation bea	aring (Earthquake case)				
K _h =	see previous working	=	0.308	horizontal acce	leration
K _{aE} =	see previous working	=	0.661		
	11.1.1.1				
neck 'middle t	chird rule'				
P _{aE} =	U.S. K _{aE} . _{Ysoll} .H _T	=	9.5 kN/m	Active thrust, s	oil weight component
P _{aEv} =	P_{aE} .sin (δ_a) =	=	4.5 kN/m	Vertical compo	nents
P _{aEh} =	P_{aE} .cos (δ_a) =	=	8.4 kN/m	Horizontal com	iponents
P _{aE} =	ω_{EQ} . K_{aE} . (H _{ret} + L _{base} + L _{key})	=	4.3 kN/m	Active thrust, s	urcharge component
P _{aEvo} =	$P_{aE\omega}$.sin (δ_a) =	=	2.0 kN/m	Vertical compo	nents
P _{aEho} =	$P_{aE\omega}$.cos (δ_a) =	=	3.8 kN/m	Horizontal com	ponents
P _{Em} =	ω _{gs} . L _{heel}	=	0.0 kN/m	Surcharge abov	ve heel
M _{aEh} =	$(P_{aEh}.(H_T/3-L_{kev}) + P_{aEh}.(H_T/2-L_{kev}))$	=	6.1 kN/m	Moment from I	horizontal active pressure (+ve)
Mary =	$(P_{aEv} + P_{aEvo}).L_{foot}$	=	9.3 kN/m	, Moment from v	vertical active pressure (-ve)
M _E =	Preu(Lfoot -Lhool/2)	=	0.0 kN/m	Moment from	surcharge above heel (-ve)
M.=	(M) C (T))(H /2+1)+(M K) (H /2+1)+(M	=	13.5 kN/m	Moment from i	inertia forces (+ve)
	(W stem. Cd (1))(Gw/2+Lbase)+(W soil.Nh).(Gw/2+Lbase)+W	00	2010 101/11	memencyrenn	
	t to key to key to key to			0	
M _e o=	as above	-	24.5 kN/m	Restoring mom	ient from self weight of wall and soil above heel (
111EG	33 850 40	-	24.5 KN/11	vc)	
M _{eet} =	M_{3} + M_{1} - M_{3} - M_{5} - M_{6} - M_{6}	=	-14.2 kN/m	Net moment m	nust be < 0 for stability
P	$W_{\text{heath}} + P_{\text{heath}} + P_{\text{heath}} + P_{\text{heath}}$	=	29.2 kN/m	factored vertice	al load on footing
l+ =	-M	=	0.5 m	Line of action of	of net vertical force (distance from toe)
Het	whet vert		0.5 11	Line of decion o	
heck bearing c	capacity				
L _{third} =	1/3 .L _{foot} =	0.5 m	<< L _{net} =	0.5 m << 2.L _{third} =	1.0 m =>> OK
B _{eff} =	2. L _{net}	=	1.0 m	Effective footin	ng width Check B _{eff} < <l<sub>foot</l<sub>
cii	10.4			"	=>> OK
footing is ecce	<u>entric</u>				
k =	1+6.Lnet/Lfoot	=	3.03	eccentric load j	factor
$V_{u,eccentricity} =$	k P _{vert} / L _{foot}	=	61.3 kN/m	factored vertice	al loading for eccentricty
V _{uEq} =	Pvert	=	23.7 kN/m	Ultimate vertic	al load on footing
H _{uEq} =	$P_{aeh} + P_{aeho} + W_{stem} \cdot k_{h} + W_{soil} \cdot K_{h} + W_{foot} \cdot K_{h} + W_{key} \cdot k_{h}$	=	19.1 kN/m	Ultimate horizo	ontal load on footing
marained bear	ing capacity snallow footing - Vesic	-	£ 00 ~	langth of w-11	
L -		-	0.00 m	Length of Wall	
D =		_	4.00 -	min horizontal	aistance from edge of underside of footing to fac
0 _e -		-	4.00 m	oj udjačent dov	
h=		=	U.U deg	Ground slope in	n jront of footing
s _u =		=	80.0 kPa	undrained shee	ar strength
c =	Su	=	80.0 kPa	Soil effective co	ohesion
q =	γ _{soil} .L _{base}	=	5.1 kPa	Surcharge	
φ =		=	0.0 deg	undrained frict	ion angle
	$= e^{\pi \tan(\phi)} \tan(\phi/2 + 45)^2$	NI - 12 -	0) = 5.14	NI /	$(\phi = 0) = 5.14$
N _q :	- ε .tan(ψ/2τ45)	$N_c = (\phi = \phi)$	01 - 2.14	$N_{\gamma} = 0$	$\psi = 0_1 = 3.14$
:	= 1.000	= 5.14	ł	= 0	1.00
hape factors					
λ	= 1+ (B _{eff} /L).tan(φ)	$\lambda_{cr} = 1 + 0$	Beff.Ng)/(L.Nc)	λ = 1	L- 0.4(B _{eff} /L)
**qs	= 1.000	= 1 0	2		.935
		1.03		- 0	
Pepth factors					
λ_{qd}	= $(L_{base}/B_{eff} < 1) = 1+2tan(\phi)(1-sin(\phi))^{2}(L_{base}/B_{eff}))$	$\lambda_{cd} = (\phi >$	$0) = \lambda_{qd} - (1 - \lambda_{qd}) / (N_q \cdot tan(\phi))$	$\lambda_{\gamma d} = 1$	L
	= 1.085	= 1.24			
oad Inclination	factors				
	$= (2+B_{\alpha}/I)/(1+B_{\alpha}/I)$				
	- \ Uptt/ L/ (1+ Uptt/ L)				
n _B	= 1.860				
n _B :	= 1.860 = ($\phi = 0$) = 1	$\lambda = 1/2$		3 - 3	
n _B : λ _{qi} :	= 1.860 = $(\phi = 0) = 1$	$\lambda_{ci} = 1 - (n)$	_B .H _{uEq} .L)/(c.N _c .B.L)	$\lambda_{\gamma i} = \lambda$	^L ai

Job Title : Spencer and Lisa Adlam Page :										
Site Address : 33 Great West Road				No of Pages :						
City: Rotorua						Date : Feb		b 22		
JOD	NO: 235655					By :	DA	CONSULTAN	тэ	
Ground Incl	ination factors							Experience, Knowledge, Better Cuto	iomes.	
	λ_{qg} = (D _e > 2.L _{foot}) = λ_{cg} = λ_{qg} = λ_{gg} = 1		$\lambda_{cg}\text{=}$ (D_e > 2.L_{foot}) = λ_{cg} = λ_{qg} = λ_{gg} = 1			$\lambda_{\gamma g}$ = (D _e > 2.L _{foot}) = λ_{cg} = λ_{qg} = λ_{gg} = 1				
	= 1.000		= 1.000			= 1.000				
	a - a)))) Na		2 2 2) No		a - 1	05vB 3 3	2 2 N		
= 5.5 kPa		= 480.8 kPa				= 0.0 kPa				
	0 = 0 + 0 + 0.		- 486 4 40-							
	qu = quq · quc · quì	= 300 kPa	- 400.4 KFC	1						
	q _u = 210.0 kPa		check ago	ainst ultimate bearin	ng pressure					
V _{ustar} =	Beff. qu. Φ_{hc}	=		102.3 kN/m				Check Vustar>Vu	=>> OK	
Wall Sliding	g (Earthquake Case)	:		k -		$ac \phi = 0$				
Passive p	ressure neglected due to possible desiccation and d	isturbance		к _р –	1 70	$\psi = 0$	ar strongth (g	stated in actotochnic	al report)	
				5 _u =	70	kPa (where C = Si	ur strengtn (u. d	s statea in getotecrinic	ui report)	
P =	0.5 K $\gamma_{\rm eff} (1 + 1)^2 + 2.5 \text{ L}$	-		0.8 kN/m	,0	Passive resisto	ince			
Heter =	$P_{n} + C_{n}B_{nff}$	-		69.0 kN/m		Factored ultim	nce ate resistance	Check Heter>H.	=>> OK	
stai	p a en							stai u		
Calculate m	aximum bending moment in wall stem									
Assume v	waterproof membrane with padding, i.e negligible in	nterface friction	0							
		0 _s =	0 702							
D -	05 K v H ²	R _{aEs} -	0.792	6.7 kN/m		Activo thrust				
P =	$P = \cos(\delta)$	-		6.7 kN/m		Horizontal con	nonant			
P = =	$m_{aES} = K_{aES} = (H_{aES} + I_{aES})$	-		4.2 kN/m		Active thrust	urcharae com	nonent		
P =	$P = cos(\delta)$	-		4.3 kN/m		Horizontal con	nonant	ponent		
FaEhωs =	P_{aEws} . $US(0_s)$	-		4.3 KN/III		Illtimate bend	iponent ina moment in	stom		
WILLIG -	Taens	-		13.1 KNIII/III		ontinute benu	ing moment in	stem		
Design of W	/all - Flexural Capacity									
M _{max} =	Max(M _{uG} , M _{UEQ})	=		15.1 KNm/m						
Try Vertical Reinforcing HD16 Bars @400				(503mm2/m)		φ =	0.8	5		
$\oint Mi = \oint \Delta s f_V (d_0 0.59 \Delta s f_V (f'm h)) = -$				22.0 KNm/m		cover =	120 mi	n		
¢	μινιι – ψΑς ιγ (α - 0.59 Ας.ιγ / ΤΠΙ α)	= M>> M.Mi	=>> 0K	23.0 KNM/M		a = fc =	120 MI 25 MI	и а		
		····max··· ψ ••••				fv =	500 MP	a		
						f'm =	12 MP	- a		
						b =	1000 mi	n		