

2, Fairwood Drive, Baglan

Calculations for Proposed Retaining Walls

01: Design Information

A] Brief

- To design a blockwork gravity retaining wall to support the rear garden and another wall to support the existing footpath of the road at the side of the property. This will provide additional parking space for the property. See accompanying plan and elevations

B] Proposal

- The wall is to be constructed using dense concrete blocks with a minimum crushing strength of 10.5N/mm² and mortar designation 3
- Mass concrete foundations to the wall are to be concrete grade C40
- Backfill to be a suitable free draining granular material incorporating land drainage system discharging into existing surface water drain and combined with weep-holes through the wall.
- The walls are designed as the Typical Sections shown with these calculations. The design allows for a possible future dig circa 200mm to the front of the wall.

C] Existing Ground Conditions

- No formulated Site Investigation has been carried out but trial digs reveal well compacted ground which will have up to 2000mm of overburden removed to formation level of the new wall. It has therefore been considered to assume a conservative safe bearing pressure of 100kN/m².
- No ground water is present but a drainage system consisting of land drains and weep holes is to be included
- Any ground which in the opinion of the supervising Engineer/Authority is not capable of sustaining 100kN/m² is to be removed and replaced with lean – mix concrete or otherwise improved to give the required bearing pressure by means proposed to and approved by the Local Authority.

D] Control Measures

- Research underground services plans for electric cables, gas mains or drains that may exist within the footprint of the wall.

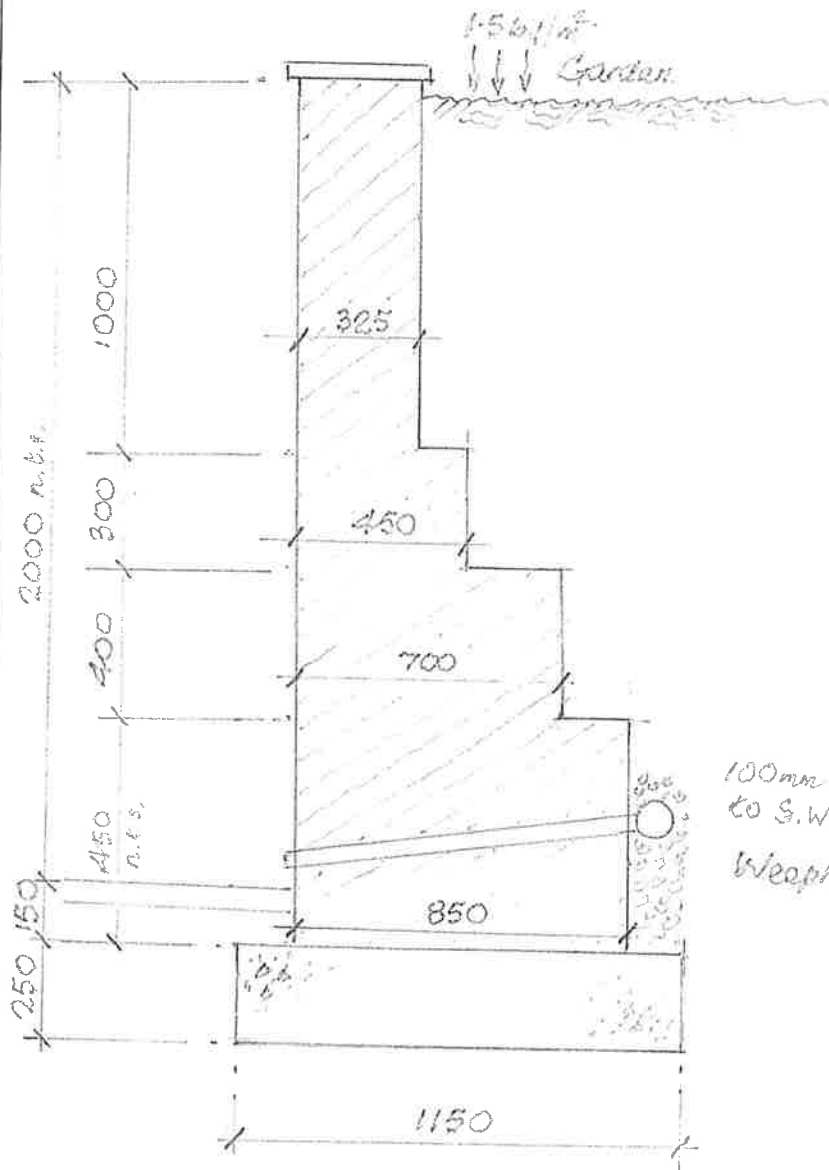
E] Standards, Codes of Practice

- BS5628; Structural Use of Unreinforced Masonry
- CP8002; Earth Retaining Structures
- BS6399, pt. 1; Loading for Buildings
- BS6399, pt. 2; Loading for Buildings (Wind Loads)
- BS8004: Foundations

CALCULATION SHEET				Ref No	Rev
Rev	A	B	C	Page	2 of
Designed <i>DR. LEO. AM. I. S. V. U. K. E.</i>				Project No	
Date <i>Sept '21.</i>				Project	
Checked				<i>MR M. RUGGIERO</i>	

Location

GARDEN WALL

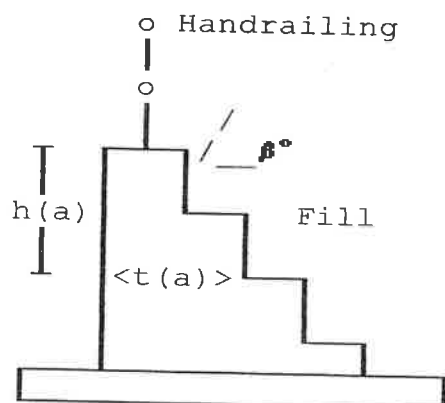


*100mm land drain
to S.W. drainage system.
Weepholes at 1.0m c/c.*

'A-A'

Masonry gravity wall

Designed in accordance with BS5628:Part 1: 1992.
Location: Garden Wall



Steps are numbered down from the top.

$h(a)$ is height at step a (from top)

$t(a)$ is thickness at step a

Soil details

Weight/unit volume of soil & wall $w_e=18 \text{ kN/m}^3$

Internal angle of friction $\phi=35^\circ$

Angle of backfill $\beta=0^\circ$

Active soil pressure is applicable.

Sine angle of internal friction $sp=\sin(\text{RAD}(\phi))=0.5736$

Active pressure coefficient $ce=(1-sp)/(1+sp)$
 $= (1-0.5736)/(1+0.5736)$
 $= 0.271$

Masonry details

Mortar designation to Table 1 $\text{mortar}=3$

Masonry type (1=clay 2=calc silicate 3=conc brick 4=block)
 $\text{typ}(1)=4$

Concrete Blocks Dimensions

Height $hb=215 \text{ mm}$

Least horiz dimension $lhd=100 \text{ mm}$

ratio height/least horiz dim $rb=hb/lhd=215/100=2.15$

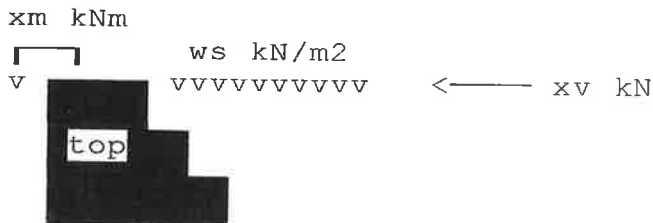
Compressive strength of blocks $po=10.5 \text{ N/mm}^2$

Characteristic flexural strength for bed failure and leaf greater than
250mm thick - Table 3 $fb(a)=\text{TABLE 3.71 for } po=10.5, \text{ mortar}=3$
 $= 0.25 \text{ N/mm}^2$

Partial safety factor material $\gamma_{mam}=3.5$

External loading

Office: 5724



Applied moment at top of wall	$xm = 0.00 \text{ kNm}$
Applied shear at top of wall	$xv = 0.00 \text{ kN}$
Weight/unit area of surcharge	$ws = 1.5 \text{ kN/m}^2$
Load factor external loads at top	$\gamma_{max} = 1.6$
Load factor surcharge	$\gamma_{mas} = 1.6$
Load factor earth pressure	$\gamma_{mae} = 1.4$
Load factor self weight	$\gamma_{maf} = 0.9$

Wall design

Number of steps proposed in wall steps=4

Step 1 Typical Analysis which is repeated for each step

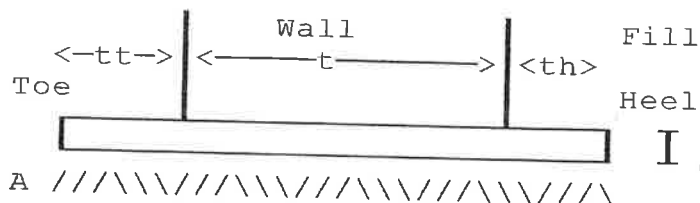
Proposed height at step	$h(1) = 1.00 \text{ m}$
Proposed thickness at step	$t(1) = 0.325 \text{ m}$
Moment at height h earth	$me = ce * we * h(a)^{3/6}$ $= 0.271 * 18 * 1^{3/6}$ $= 0.813 \text{ kNm}$
surcharge	$ms = ce * ws * h(a)^{2/2}$ $= 0.271 * 1.5 * 1^{2/2}$ $= 0.2032 \text{ kNm}$
Ultimate moment at height h	$\mu = me * \gamma_{mae} + ms * \gamma_{mas} + (xm + xv * h(a)) * \gamma_{max}$ $= 0.813 * 1.4 + 0.2032 * 1.6 + (0 + 0 * 1) * 1.6$ $= 1.463$
Section modulus at thickness t	$z = t(a)^{2/6} = 0.325^{2/6} = 0.0176 \text{ m}^3$
Weight/unit area at depth h	$gd = (ws + we * h(a)) * \gamma_{maf} / 1000$ $= (1.5 + 18 * 1) * 0.9 / 1000$ $= 0.01755 \text{ N/mm}^2$
Moment of resistance	$mr = (fb(1) / \gamma_{mam} + gd) * z * 1000$ $= (0.25 / 3.5 + 0.01755) * 0.0176 * 1000$ $= 1.566 \text{ kNm}$
Applied moment less than moment of resistance (1.463 <= 1.566) therefore section is satisfactory.	
Step 1	width 0.325 m
	height 1 m

Garden Retaining Wall
2 Fairwood Drive
Baglan
SA12 8NT

Page: 35
Made by: DC
Date: 27.09.21
Ref No:

Step height (m)	Step thickness (m)	Ultimate Moments (kNm)		Office: 5724
		Resistance	Applied	
1	0.325	1.566	1.463	
1.3	0.45	3.167	3.05	
1.7	0.7	8.193	6.532	
2.1	0.85	12.86	11.97	

Stability and bearing check



db=depth of base

Width of toe	tt=0.15 m
Width of heel	th=0.15 m
Thickness of wall	t=0.85 m
Height of wall	h=2.1 m
Width of base	tb=t+tt+th =0.85+0.15+0.15 =1.15
Depth of base	db=0.25 m
Overall depth	od=h+db=2.1+0.25=2.35 m
Weight of fill and wall	wf=we*(t+th)*h =18*(0.85+0.15)*2.1 =37.8 kN
Eccentricity from A	ef=tt+(t+th)/2 =0.15+(0.85+0.15)/2 =0.65 m
Weight of base	wb=tb*db*24=1.15*0.25*24=6.9 kN
Earth horizontal force	sfe=ce*we*od^2/2 =0.271*18*2.35^2/2 =13.47 kN
Moment due to earth pressure	me=sfe*od/3=13.47*2.35/3=10.55 kNm
Surcharge horizontal force	sfs=ws*ce*od =1.5*0.271*2.35 =0.9552 kN
Moment due to surcharge	ms=sfs*od/2=0.9552*2.35/2=1.122 kNm

Overturning

Office: 5724

Overturning moment about A

$$\begin{aligned} \text{om} &= \text{me} + \text{ms} + (\text{xm} + \text{xv} * \text{od}) \\ &= 10.55 + 1.122 + (0 + 0 * 2.35) \\ &= 11.67 \text{ kNm} \end{aligned}$$

Restoring moment abt A fill/wall
base
surcharge

$$\begin{aligned} \text{rmf} &= \text{wf} * \text{ef} = 37.8 * 0.65 = 24.57 \text{ kNm} \\ \text{rmb} &= \text{wb} * \text{tb} / 2 = 6.9 * 1.15 / 2 = 3.967 \text{ kNm} \\ \text{rms} &= \text{ws} * (\text{t} + \text{th}) * \text{ef} \\ &= 1.5 * (0.85 + 0.15) * 0.65 \\ &= 0.975 \end{aligned}$$

$$\begin{aligned} \text{total rm} &= \text{rmf} + \text{rmb} + \text{rms} \\ &= 24.57 + 3.967 + 0.975 \\ &= 29.51 \end{aligned}$$

Factor of safety

$$\text{fso} = \text{rm} / \text{om} = 29.51 / 11.67 = 2.528$$

Sliding (passive resistance ignored)

Sliding force

$$\begin{aligned} \text{sf} &= \text{sfe} + \text{sfs} + \text{xv} \\ &= 13.47 + 0.9552 + 0 \\ &= 14.42 \end{aligned}$$

Details of bearing stratas
angle of friction
cohesion

$$\text{phib} = 40^\circ$$

$$\text{cu} = 0 \text{ kN/m}^2$$

Coefficient of friction

$$\begin{aligned} \text{cf} &= \text{TAN}(\text{RAD}(\text{phib} * 2 / 3)) \\ &= \text{TAN}(\text{RAD}(40 * 2 / 3)) \\ &= 0.5022 \end{aligned}$$

Resisting force

$$\begin{aligned} \text{fill} \quad \text{rff} &= \text{wf} * \text{cf} = 37.8 * 0.5022 = 18.98 \text{ kN} \\ \text{base} \quad \text{rfb} &= \text{wb} * \text{cf} + \text{tb} * \text{cu} / 2 \\ &= 6.9 * 0.5022 + 1.15 * 0 / 2 \\ &= 3.465 \text{ kN} \\ \text{surcharge} \quad \text{rfs} &= \text{ws} * (\text{t} + \text{th}) * \text{cf} \\ &= 1.5 * (0.85 + 0.15) * 0.5022 \\ &= 0.7533 \text{ kN} \\ \text{total} \quad \text{rf} &= \text{rff} + \text{rfb} + \text{rfs} \\ &= 18.98 + 3.465 + 0.7533 \\ &= 23.2 \text{ kN} \\ \text{fss} &= \text{rf} / \text{sf} = 23.2 / 14.42 = 1.609 \end{aligned}$$

Factor of safety

Bearing pressure

Weight of surcharge

$$\begin{aligned} \text{sw} &= \text{ws} * (\text{t} + \text{th}) \\ &= 1.5 * (0.85 + 0.15) \\ &= 1.5 \text{ kN} \end{aligned}$$

Moments about centre of base

$$\begin{aligned} \text{m} &= \text{om} + (\text{wf} + \text{sw}) * (\text{tb} / 2 - \text{ef}) \\ &= 11.67 + (37.8 + 1.5) * (1.15 / 2 - 0.65) \\ &= 8.726 \text{ kNm} \end{aligned}$$

Section modulus of base

Total weight

$$\begin{aligned} \text{zb} &= \text{tb}^2 / 6 = 1.15^2 / 6 = 0.2204 \text{ m}^3 \\ \text{tw} &= \text{wf} + \text{sw} + \text{wb} \\ &= 37.8 + 1.5 + 6.9 \\ &= 46.2 \text{ kN} \end{aligned}$$

Garden Retaining Wall
2 Fairwood Drive
Baglan
SA12 8NT

Page: 57
Made by: DC
Date: 27.09.21
Ref No:

Pressure due to weight
Pressure due to moment (+/-)
Maximum pressure
Minimum pressure

Office: 5724
 $pw = tw/tb = 46.2/1.15 = 40.17 \text{ kN/m}^2$
 $pm = m/zb = 8.726/0.2204 = 39.59 \text{ kN/m}^2$
 $pmax = pw + pm = 40.17 + 39.59 = 79.76 \text{ kN/m}^2$
 $pmin = pw - pm = 40.17 - 39.59 = 0.5874 \text{ kN/m}^2$

Summary of stability check

Factor of safety overturning 2.528
Factor of safety sliding 1.609
Maximum base pressure 79.76 kN/m²

DESIGN SUMMARY		Wall height 2.1 m	
		Wall design	
Step height (m)	Step thickness (m)	Ultimate Moments (kNm)	
		Resistance	Applied
1	0.325	1.566	1.463
1.3	0.45	3.167	3.05
1.7	0.7	8.193	6.532
2.1	0.85	12.86	11.97

Summary of stability check

Factor of safety overturning 2.528
Factor of safety sliding 1.609
Maximum base pressure 79.76 kN/m²

No554

CALCULATION SHEET				Ref No	Rev
Designed	Rev	A	B	C	Page 8 of
Date					Project No
Checked					Project MR. M. RUGGIERO

Location

WALL TO ROAD

Table 4

2.8.1.

Wind to Close Boarded Fence top of wall.
Assessment of Wind Loads to BS 6399?

Fig 6: Basic wind speed, $V_b = 22 \text{ m/s}$.

2.2.2.2: Altitude factor $S_a = 1 + 0.001 \times 20 = 1.02$

Site wind speed $= 22 \times 1.02 = 22.5 \text{ m/s}$.

Eff height of Fence $= 2.0 \text{ m}$.

$S_k = 1.18$ [Site in town, 5km from sea]

Eff. wind speed, $V_e = 22.5 \times 1.18 = 26.5 \text{ m/s}$

Dynamic pressure, $q_z = 0.613 \times 26.5^2 \times 10^{-3} = 0.43 \text{ kN/m}^2$.

Use pressure coefficient of 1.8

Then design wind pressure $= 0.43 \times 1.8 = 0.73 \text{ kN/m}^2$.

Fence posts at 1.8m centres

Load/post $= 0.73 \times 1.8 = 1.4 \text{ kN/m}$

Moment at base $= 1.4 \times 2^2 / 2 = 2.8 \text{ kNm}$

Shear at base $= 1.4 \times 2 = 2.8 \text{ kN}$.

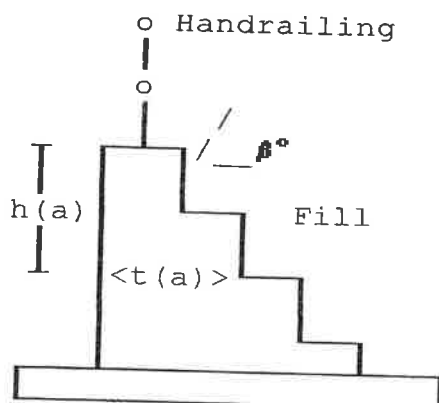
Distribute moment & shear at top of wall

Moment to top of wall $= 2.8 / 1.2 = 1.5 \text{ kNm}$

Shear to top of wall $= 2.8 / 1.2 = 1.5 \text{ kN}$.

Masonry gravity wall

Designed in accordance with BS5628:Part 1: 1992.
Location: Wall to Road



Steps are numbered down from the top.

$h(a)$ is height at step a (from top)

$t(a)$ is thickness at step a

Soil details

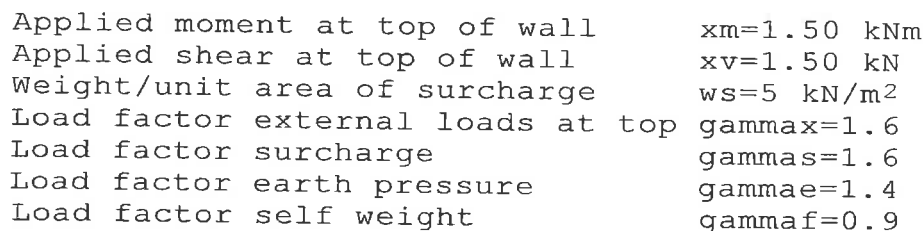
Weight/unit volume of soil & wall $w_e=18 \text{ kN/m}^3$
Internal angle of friction $\phi=35^\circ$
Angle of backfill $\beta=0^\circ$
Active soil pressure is applicable.
Sine angle of internal friction $sp=\sin(\text{RAD}(\phi))=0.5736$
Active pressure coefficient $ce=(1-sp)/(1+sp)$
 $= (1-0.5736)/(1+0.5736)$
 $=0.271$

Masonry details

Mortar designation to Table 1 mortar=3
Masonry type (1=clay 2=calc silicate 3=conc brick 4=block) typ(1)=4
Concrete Blocks Dimensions
Height $hb=215 \text{ mm}$
Least horiz dimension $lhd=100 \text{ mm}$
ratio height/least horiz dim $rb=hb/lhd=215/100=2.15$
Compressive strength of blocks $po=10.5 \text{ N/mm}^2$
Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3 $fb(a)=\text{TABLE 3.71 for } po=10.5, \text{ mortar}=3$
 $=0.25 \text{ N/mm}^2$
Partial safety factor material $\gamma_{mam}=3.5$

Page: 211
Made by: DC
Date: 27.09.21
Ref No:

External loading



Number of steps proposed in wall steps=4

```

Proposed height at step          h(1)=0.70 m
Proposed thickness at step       t(1)=0.600 m
Moment at height h               me=ce*we*h(a)^3/6
                                   =0.271*18*0.7^3/6
                                   =0.2788 kNm
                                   ms=ce*ws*h(a)^2/2
                                   =0.271*5*0.7^2/2
                                   =0.332 kNm
                                   Ultimate moment at height h
                                   mu=me*gammae+ms*gammaas+(xm+xv*h(a))
                                   *gammaax
                                   =0.2788*1.4+0.332*1.6+(1.5+1.5
                                   *0.7)*1.6
                                   =5.002
Section modulus at thickness t   z=t(a)^2/6=0.6^2/6=0.06 m^3
Weight/unit area at depth h     gd=(ws+we*h(a))*gammaaf/1000
                                   =(5+18*0.7)*0.9/1000
                                   =0.01584 N/mm^2
Moment of resistance             mr=(fb(1)/gammam+gd)*z*1000
                                   =(0.25/3.5+0.01584)*0.06*1000
                                   =5.236 kNm

```

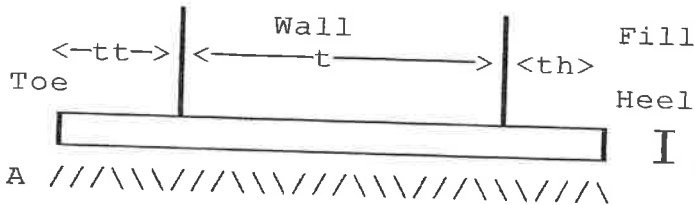
```

Step 1
      width 0.6 m
      height 0.7 m

```

Step height (m)	Step thickness (m)	Office: 5724	
		Ultimate Moments (kNm)	Resistance Applied
0.7	0.6	5.236	5.002
1	0.7	7.524	7.022
1.4	0.85	11.87	11.01
2.1	1.15	24.23	22.76

Stability and bearing check



Width of toe	$tt = 0.15 \text{ m}$
Width of heel	$th = 0.15 \text{ m}$
Thickness of wall	$t = 1.15 \text{ m}$
Height of wall	$h = 2.1 \text{ m}$
Width of base	$tb = t + tt + th$ $= 1.15 + 0.15 + 0.15$ $= 1.45$
Depth of base	$db = 0.25 \text{ m}$
Overall depth	$od = h + db = 2.1 + 0.25 = 2.35 \text{ m}$
Weight of fill and wall	$wf = we * (t + th) * h$ $= 18 * (1.15 + 0.15) * 2.1$ $= 49.14 \text{ kN}$
Eccentricity from A	$ef = tt + (t + th) / 2$ $= 0.15 + (1.15 + 0.15) / 2$ $= 0.8 \text{ m}$
Weight of base	$wb = tb * db * 24 = 1.45 * 0.25 * 24 = 8.7 \text{ kN}$
Earth horizontal force	$sfe = ce * we * od^2 / 2$ $= 0.271 * 18 * 2.35^2 / 2$ $= 13.47 \text{ kN}$
Moment due to earth pressure	$me = sfe * od / 3 = 13.47 * 2.35 / 3 = 10.55 \text{ kNm}$
Surcharge horizontal force	$sfs = ws * ce * od$ $= 5 * 0.271 * 2.35$ $= 3.184 \text{ kN}$
Moment due to surcharge	$ms = sfs * od / 2 = 3.184 * 2.35 / 2 = 3.741 \text{ kNm}$

Overturning

Office: 5724

Overturning moment about A

$$\begin{aligned}om &= me + ms + (xm + xv * od) \\&= 10.55 + 3.741 + (1.5 + 1.5 * 2.35) \\&= 19.32 \text{ kNm}\end{aligned}$$

Restoring moment abt A fill/wall
base
surcharge

$$\begin{aligned}rmf &= wf * ef = 49.14 * 0.8 = 39.31 \text{ kNm} \\rmb &= wb * tb / 2 = 8.7 * 1.45 / 2 = 6.307 \text{ kNm} \\rms &= ws * (t + th) * ef \\&= 5 * (1.15 + 0.15) * 0.8 \\&= 5.2\end{aligned}$$

$$\begin{aligned}\text{total } rm &= rmf + rmb + rms \\&= 39.31 + 6.307 + 5.2 \\&= 50.82\end{aligned}$$

Factor of safety

$$fso = rm / om = 50.82 / 19.32 = 2.631$$

Sliding (passive resistance ignored)

Sliding force

$$\begin{aligned}sf &= sfe + sfs + xv \\&= 13.47 + 3.184 + 1.5 \\&= 18.15\end{aligned}$$

Details of bearing stratas
angle of friction
cohesion

$$\begin{aligned}\text{phib} &= 40^\circ \\cu &= 0 \text{ kN/m}^2 \\cf &= \text{TAN}(\text{RAD}(\text{phib} * 2/3)) \\&= \text{TAN}(\text{RAD}(40 * 2/3)) \\&= 0.5022\end{aligned}$$

Coefficient of friction

Resisting force

$$\begin{aligned}\text{fill } rff &= wf * cf = 49.14 * 0.5022 = 24.68 \text{ kN} \\ \text{base } rfb &= wb * cf + tb * cu / 2 \\&= 8.7 * 0.5022 + 1.45 * 0 / 2 \\&= 4.369 \text{ kN} \\ \text{surcharge } rfs &= ws * (t + th) * cf \\&= 5 * (1.15 + 0.15) * 0.5022 \\&= 3.264 \text{ kN} \\ \text{total } rf &= rff + rfb + rfs \\&= 24.68 + 4.369 + 3.264 \\&= 32.31 \text{ kN} \\fss &= rf / sf = 32.31 / 18.15 = 1.78\end{aligned}$$

Factor of safety

Bearing pressure

Weight of surcharge

$$\begin{aligned}sw &= ws * (t + th) \\&= 5 * (1.15 + 0.15) \\&= 6.5 \text{ kN}\end{aligned}$$

Moments about centre of base

$$\begin{aligned}m &= om + (wf + sw) * (tb / 2 - ef) \\&= 19.32 + (49.14 + 6.5) * (1.45 / 2 - 0.8) \\&= 15.14 \text{ kNm}\end{aligned}$$

Section modulus of base

Total weight

$$\begin{aligned}zb &= tb^2 / 6 = 1.45^2 / 6 = 0.3504 \text{ m}^3 \\tw &= wf + sw + wb \\&= 49.14 + 6.5 + 8.7 \\&= 64.34 \text{ kN}\end{aligned}$$

Garden Retaining Wall
2 Fairwood Drive
Baglan
SA12 8NT

Page: 814
Made by: DC
Date: 27.09.21
Ref No:

Pressure due to weight $p_w = t_w / t_b = 64.34 / 1.45 = 44.37 \text{ kN/m}^2$
Pressure due to moment (+/-) $p_m = m / z_b = 15.14 / 0.3504 = 43.22 \text{ kN/m}^2$
Maximum pressure $p_{\max} = p_w + p_m = 44.37 + 43.22 = 87.59 \text{ kN/m}^2$
Minimum pressure $p_{\min} = p_w - p_m = 44.37 - 43.22 = 1.155 \text{ kN/m}^2$

Office: 5724

Summary of stability check

Factor of safety overturning 2.631
Factor of safety sliding 1.78
Maximum base pressure 87.59 kN/m²

DESIGN SUMMARY		Wall height 2.1 m	
		Wall design	
Step height (m)	Step thickness (m)	Ultimate Moments (kNm)	
		Resistance	Applied
0.7	0.6	5.236	5.002
1	0.7	7.524	7.022
1.4	0.85	11.87	11.01
2.1	1.15	24.23	22.76

Summary of stability check

Factor of safety overturning 2.631
Factor of safety sliding 1.78
Maximum base pressure 87.59 kN/m²

No554

CALCULATION SHEET				Ref No	Rev
Rev	A	B	C	Page	15 of
Designed <u> </u>				Project No	
Date <u> </u>				Project	
Checked <u> </u>				Mr. M. Ruggiero	

Location

2, Fairwood Drive

Stability & Bearing Check

Horiz^l Force due to earth = 13.47 kN

Horiz^l " " " Surcharge = 3.18 kN

Moment due to earth = 10.55 kNm

Moment due to Surcharge = 3.74 kNm

Overturning Mt about A =

$$10.55 + 3.74 + 1.5 + (1.5 \times 2.35) = \underline{19.82 \text{ kNm}}$$

R13

$$\text{Wt. of } \textcircled{1} = 0.18 \times 2.15 \times 18 = 5.8 \text{ kN}$$

$$\text{Wt. of } \textcircled{2} = 0.7 \times 0.6 \times 18 = 7.56 \text{ kN}$$

$$\text{ " " } \textcircled{3} = 0.3 \times 0.7 \times 18 = 3.78 \text{ "}$$

$$\text{ " " } \textcircled{4} = 0.4 \times 1.85 \times 18 = 6.12 \text{ "}$$

$$\text{ " " } \textcircled{5} = 0.7 \times 1.15 \times 18 = 14.5 \text{ "}$$

$$\text{ " " } \textcircled{6} = 0.25 \times 1.45 \times 24 = 8.7 \text{ "}$$

$$\Sigma = \underline{46.45 \text{ kN}}$$

C of Gravity of Loads.

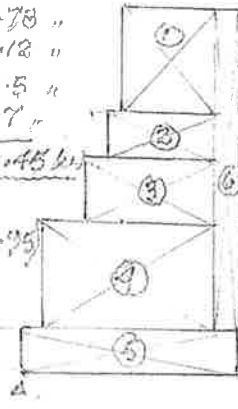
$$46.45 \times = (7.56 \times 1) + (3.78 \times 1.25)$$

$$+ (6.12 \times 0.875)$$

$$+ (14.5 \times 0.725)$$

$$+ (8.7 \times 0.725)$$

$$+ (5.8 \times 1.375)$$



Wt. of base

$$= 1.45^2 / 6$$

$$= 0.35 \text{ m}^3$$

$$\therefore \bar{x} = 0.890 \text{ m from A. } \therefore e = 0.890 - 0.725 = 0.165 \text{ m.}$$

$$\text{Then, Nett Overturning Mt} = 19.82 - (46.45 \times 0.165) = \underline{11.65 \text{ kNm.}}$$

$$\text{Ground Pressure} = \frac{46.45}{1.45} \pm \frac{11.65}{0.35}$$

$$= 32 \pm 33 = +65 \text{ kN/m}^2 \text{ or } 1.0 \text{ "}$$

OK.

Overturning

$$\text{Restoring Mt} = 46.45 \times 0.89 = 41.34 \text{ kNm.}$$

$$\text{Factor of Safety} = \frac{41.34}{11.65} = \underline{3.5}$$