

COMPLETE CAD & STRUCTURAL SOLUTIONS LIMITED



Structural Calculations

Design Stage

For

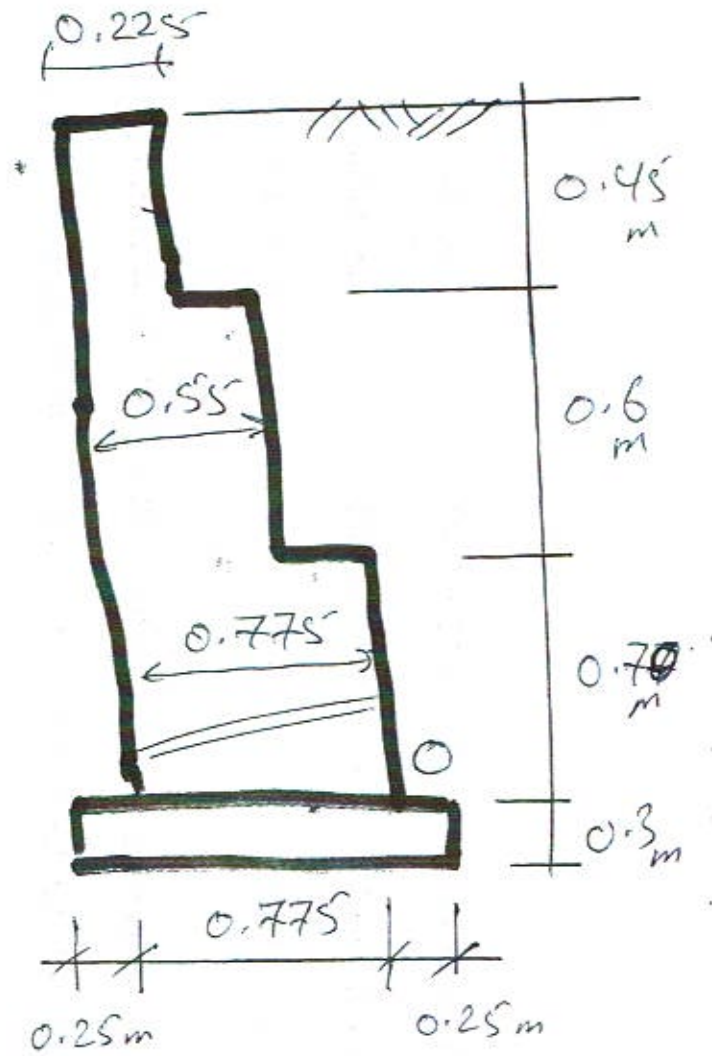
RETAINING WALL – T2

At

8 ST ANNE'S DRIVE,
TONNA,
NEATH,
SA11 3JU

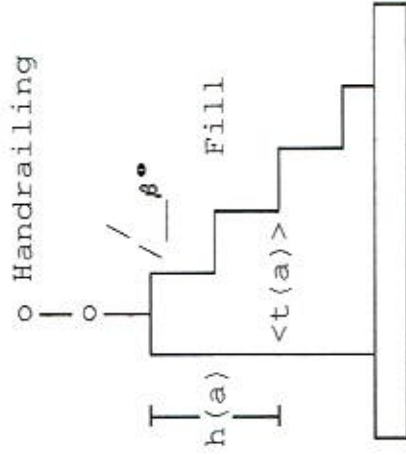
04/01/2024

T2



Masonry gravity wall

Designed in accordance with BS5628:Part 1: 1992.
Location: Masonry Retaining Wall T2



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 $ce = \frac{1-sp}{1+sp} = \frac{1-0.5736}{1+0.5736} = 0.271$

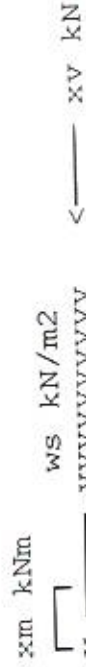
Masonry details

Mortar designation to Table 1 mortar=3
Masonry type (1=clay 2=cal 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 $po = 7.3 \text{ N/mm}^2$

Characteristic flexural strength for bed failure and leaf greater than
250mm thick - Table 3 $f_b(a) = \text{TABLE } 3.71 \text{ for } p_o = 7.3, \text{ mortar} = 3$
 $= 0.1586 \text{ N/mm}^2$

Partial safety factor material $\gamma_{\text{m}} = 3.5$

External loading



Applied moment at top of wall $x_m = 0 \text{ kNm}$
Applied shear at top of wall $x_v = 0 \text{ kN}$
Weight/unit area of surcharge $w_s = 1.5 \text{ kN/m}^2$
Load factor external loads at top $\gamma_{\text{max}} = 1.6$
Load factor surcharge $\gamma_{\text{mas}} = 1.6$
Load factor earth pressure $\gamma_{\text{mae}} = 1.4$
Load factor self weight $\gamma_{\text{maf}} = 0.9$

Wall design

Number of steps proposed in wall $\text{steps} = 3$

Step 1 Typical Analysis which is repeated for each step

Proposed height at step $h(1) = 0.45 \text{ m}$
Proposed thickness at step $t(1) = 0.225 \text{ m}$
Moment at height h earth $m_e = c_e * w_e * h(a)^3 / 6 = 0.271 * 18 * 0.45^3 / 6$
 $= 0.07408 \text{ kNm}$
surcharge $m_s = c_e * w_s * h(a)^2 / 2 = 0.271 * 1.5 * 0.45^2 / 2$
 $= 0.04116 \text{ kNm}$
Ultimate moment at height h $m_u = m_e * \gamma_{\text{mae}} + m_s * \gamma_{\text{mas}} + (x_m + x_v * h(a)) * \gamma_{\text{max}}$
 $= 0.07408 * 1.4 + 0.04116 * 1.6 + (0 + 0$
 $+ 0.45) * 1.6$
 $= 0.1696$

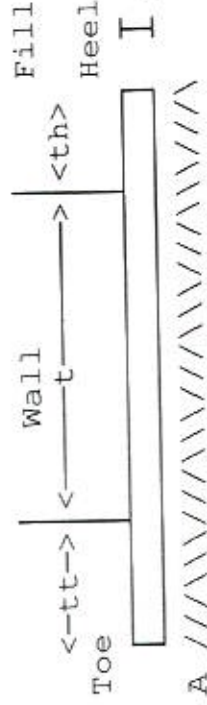
Section modulus at thickness t $z = t(a)^{2/6} = 0.225^{2/6} = 0.008438 \text{ m}^3$
 Weight/unit area at depth h $gd = (ws + we \cdot h(a)) \cdot \text{gamma}f / 1000$
 $= (1.5 + 18 \cdot 0.45) \cdot 0.9 / 1000$
 $= 0.00864 \text{ N/mm}^2$

Moment of resistance $mr = (fb(1) / \text{gamma}m + gd) \cdot z \cdot 1000$
 $= (0.1586 / 3.5 + 0.00864) \cdot 0.008438 \cdot 1000$
 $= 0.4552 \text{ kNm}$

Applied moment less than moment of resistance (0.1696 <= 0.4552)
 therefore section is satisfactory.
 Step 1 width 0.225 m
 height 0.45 m

Step height (m)	Step thickness (m)	Ultimate Moments (kNm) Resistance Applied
0.45	0.225	0.4552 0.1696
1.05	0.55	3.21 1.676
1.75	0.775	7.508 7.096

Stability and bearing check



Width of toe
 Width of heel
 Thickness of wall
 Height of wall
 Width of base

$tt = 0.25 \text{ m}$
 $th = 0.25 \text{ m}$
 $t = 0.775 \text{ m}$
 $h = 1.75 \text{ m}$
 $tb = t + tt + th = 0.775 + 0.25 + 0.25 = 1.275$

Depth of base
 Overall depth
 Weight of fill and wall

$db = 0.30 \text{ m}$
 $od = h + db = 1.75 + 0.3 = 2.05 \text{ m}$
 $wf = we \cdot (t + th) \cdot h = 18 \cdot (0.775 + 0.25) \cdot 1.75 = 32.29 \text{ kN}$
 $ef = tt + (t + th) / 2 = 0.25 + (0.775 + 0.25) / 2 = 0.7625 \text{ m}$

Eccentricity from A

Weight of base

$$wb = tb * db * 24 = 1.275 * 0.3 * 24 = 9.18 \text{ kN}$$

Earth horizontal force

$$sfe = ce * we * od^2 / 2 = 0.271 * 18 * 2.05^2 / 2 = 10.25 \text{ kN}$$

Moment due to earth pressure

$$me = sfe * od / 3 = 10.25 * 2.05 / 3 = 7.004 \text{ kNm}$$

Surcharge horizontal force

$$sfs = ws * ce * od = 1.5 * 0.271 * 2.05 = 0.8333 \text{ kN}$$

Moment due to surcharge

$$ms = sfs * od / 2 = 0.8333 * 2.05 / 2 = 0.8541 \text{ kNm}$$

Wall shear

Horizontal shear force

$$usf = (sfe * gammae) + (sfs * gamma_s) = (10.25 * 1.4) + (0.8333 * 1.6) = 15.68 \text{ kN}$$

Shear stress at bottom of wall

$$uss = usf / (t * steps) * 1000 = 15.68 / (0.775 * 1000) = 0.02024 \text{ N/mm}^2$$

Weight at bottom of step 1

$$uwt = t(a) * we * h(a) * gamma_f = 0.225 * 18 * 0.45 * 0.9 = 1.64 \text{ kN}$$

Weight at bottom of step 2

$$uwt = uwt + (t(a) * we * h(a) * gamma_f) = 1.64 + (0.55 * 18 * 1.05 * 0.9) = 11 \text{ kN}$$

Weight at bottom of step 3

$$uwt = uwt + (t(a) * we * h(a) * gamma_f) = 11 + (0.775 * 18 * 1.75 * 0.9) = 32.97 \text{ kN}$$

Weight per. unit area

$$ga = uwt / (t * steps) * 1000 = 32.97 / (0.775 * 1000) = 0.04254 \text{ N/mm}^2$$

Permissible shear stress

$$fv = 0.15 + 0.6 * ga = 0.15 + 0.6 * 0.04254 = 0.1755 \text{ N/mm}^2$$

Applied shear less than shear resistance { 0.02024 <= 0.1755 }
therefore section is satisfactory.

Overturning

Overturning moment about A $om = me + ms + (xm + xv * od)$
 $= 7.004 + 0.8541 + (0 + 0 * 2.05)$
 $= 7.858 \text{ kNm}$
Restoring moment abt A fill/wall $rmf = wf * ef = 32.29 * 0.7625 = 24.62 \text{ kNm}$
base $rmb = wb * tb / 2 = 9.18 * 1.275 / 2$
 $= 5.852 \text{ kNm}$
surcharge $rms = ws * (t + th) * ef$
 $= 1.5 * (0.775 + 0.25) * 0.7625$
 $= 1.172$
total $rm = rmf + rmb + rms = 24.62 + 5.852 + 1.172$
 $= 31.64$
Factor of safety $fso = rm / om = 31.64 / 7.858 = 4.027$

Sliding (passive resistance ignored)

Sliding force $sf = sfe + sfs + xv = 10.25 + 0.8333 + 0$
 $= 11.08$

Details of bearing stratas
angle of friction
cohesion

Coefficient of friction $phib = 40^\circ$
 $cu = 0 \text{ kN/m}^2$
 $cf = \text{TAN}(\text{RAD}(phib * 2 / 3))$
 $= \text{TAN}(\text{RAD}(40 * 2 / 3))$
 $= 0.5022$

Resisting force

fill $rff = wf * cf = 32.29 * 0.5022 = 16.22 \text{ kN}$
base $rfb = wb * cf + tb * cu / 2$
 $= 9.18 * 0.5022 + 1.275 * 0 / 2$
 $= 4.61 \text{ kN}$

surcharge

$rfs = ws * (t + th) * cf$
 $= 1.5 * (0.775 + 0.25) * 0.5022$
 $= 0.7722 \text{ kN}$

total

$rf = rff + rfb + rfs = 16.22 + 4.61 + 0.7722$
 $= 21.6 \text{ kN}$

Factor of safety

$fss = rf / sf = 21.6 / 11.08 = 1.949$

Proposed Retaining Wall at:
8 St Anne's Drive
Tonna
Neath

Page: 6
Made by:
Date: 04.01.24
Ref No:

Bearing pressure

Weight of surcharge

Moments about centre of base

$$sw=ws*(t+th)=1.5*(0.775+0.25) \\ =1.537 \text{ kN}$$

$$m=om+(wf+sw)*(tb/2-ef)$$

$$=7.858+(32.29+1.537)*(1.275/2-0.7625) \\ =3.63 \text{ kNm}$$

$$zb=tb^2/6=1.275^2/6=0.2709 \text{ m}^3$$

$$tw=wf+sw+wb=32.29+1.537+9.18$$

$$=43.01 \text{ kN}$$

$$pw=tw/tb=43.01/1.275=33.73 \text{ kN/m}^2$$

$$pm=m/zb=3.63/0.2709=13.4 \text{ kN/m}^2$$

$$pmax=pw+pm=33.73+13.4=47.13 \text{ kN/m}^2$$

$$pmin=pw-pm=33.73-13.4=20.33 \text{ kN/m}^2$$

Pressure due to weight

Pressure due to moment (+/-)

Maximum pressure

Minimum pressure

Summary of stability check

Factor of safety overturning

Factor of safety sliding

Maximum base pressure

4.027

1.949

47.13 kN/m²

DESIGN SUMMARY
Step height
(m)

Wall height
Wall design
Step thickness
(m)

1.75 m

Ultimate Moments (kNm)
Resistance Applied

0.45
1.05
1.75

0.225
0.55
0.775

0.4552
3.21
7.508

0.1696
1.676
7.096

Summary of stability check

Factor of safety overturning

Factor of safety sliding

Maximum base pressure

4.027

1.949

47.13 kN/m²

THIS IS AN UPDATE AND NEEDS YOUR OWN L.NAM FILE.