

Structural Calculations

Design Stage March 2026

FOR

RETAINING WALL

AT

18 PEN Y CAE ROAD
PORT TALBOT

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All Calculation should be checked by Building control officer for Approval.

All measurement to be carried out by the Contractor and agreed by the Engineer Prior ordering the Steel.

Retaining Wall Design 1

Retaining Wall support the highway

Existing masonry wall is in a good condition

Add 450mm blockwork to the existing wall and this will support the bison beams.

Wall height = 1.60m

Angle of fill above wall = 0 degrees

Surcharge= 10.0KN/m²

Load from bay

DL = 4.0 KN/m

LL = 1.50KN/m

From computer output use blockwork concrete wall as shown on detailed drawing.

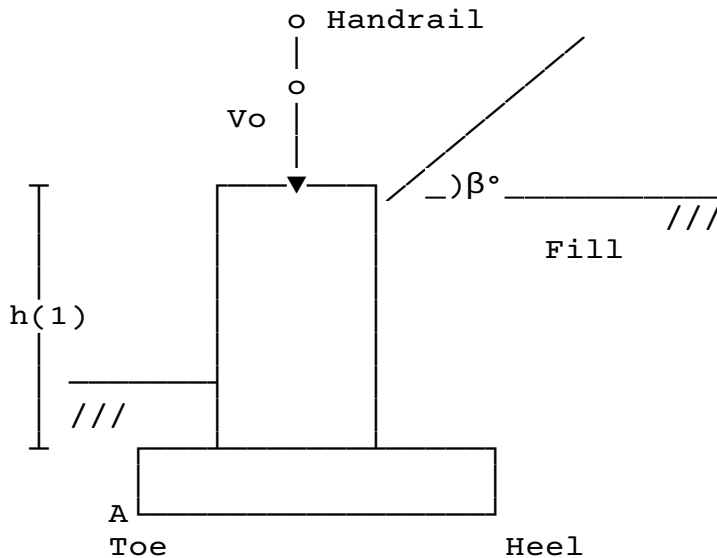
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Location: retaining wall

Masonry gravity wall

Designed in accordance with BS5628:Part 1:1992.

Soil details



Constant wall thickness

$h(1)$ = height of wall
 $t(1)$ = thickness of wall
 V_o = vert point load on wall

As a masonry wall has limited capacity the design assumes the backfill is drained i.e. no water pressure behind the wall.

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

Internal angle of friction (fill) $\phi=35^\circ$

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=cal silicate 3=conc brick 4=block)

typ(1)=4

Concrete block dimensions:

Height $hb=100 \text{ mm}$

Least horizontal dimension $lhd=215 \text{ mm}$

ratio height/least horiz. dim $rb=hb/lhd=100/215=0.4651$

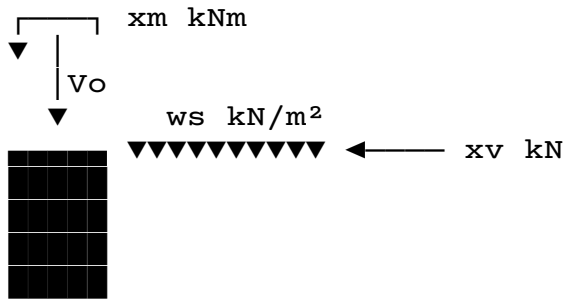
Compressive strength of blocks $po=7.3 \text{ N/mm}^2$

Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3 $fb(a)=\text{TABLE 3.71 for } po=7.3, \text{ mortar}=3$
 $= 0.15 \text{ N/mm}^2$

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

0

External loading



Applied moment at top of wall	$x_m = 0$ kNm
Applied vertical load on the wall	$V_o = 5$ kN
Applied shear at top of wall	$x_v = 0$ kN
Weight/unit area of surcharge	$w_s = 10$ kN/m ²
Load factor external loads at top	$\gamma_{mx} = 1.6$
Load factor surcharge	$\gamma_{ms} = 1.6$
Load factor earth pressure	$\gamma_{me} = 1.4$
Load factor self weight	$\gamma_{mf} = 0.9$

Wall design

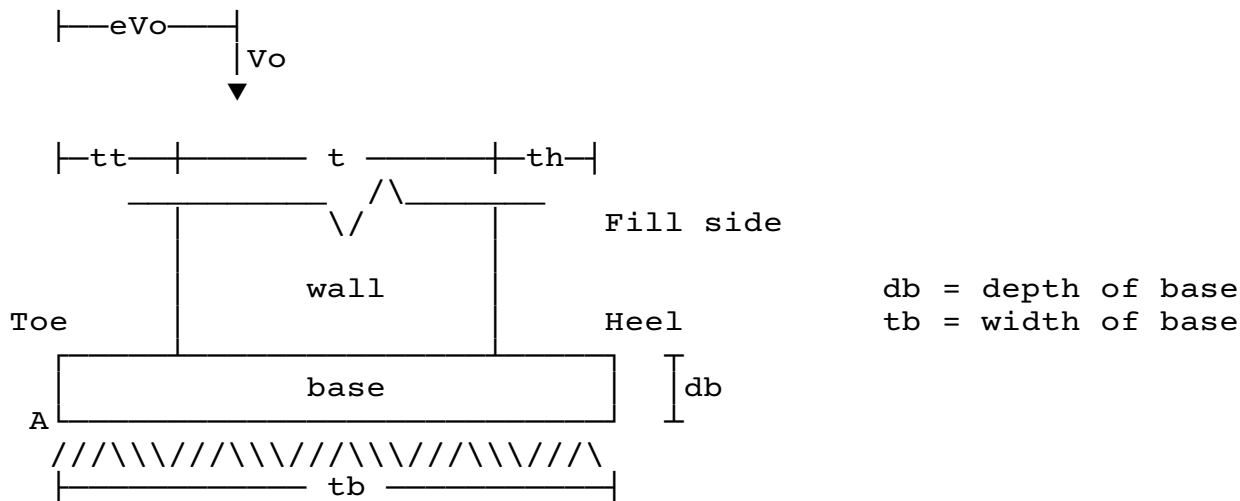
Step 1 Typical Analysis which is repeated for each step

Proposed height of wall	$h(1) = 1.6$ m
Proposed thickness of wall	$t(1) = 0.9$ m
Moment at height h	earth
	$m_e = c_e * w_e * h(a)^3 / 6 = 0.271 * 18 * 1.6^3 / 6$
	$= 3.33$ kNm
	surcharge
	$m_s = c_s * w_s * h(a)^2 / 2 = 0.271 * 10 * 1.6^2 / 2$
	$= 3.469$ kNm
Ultimate moment at height h :	
	$\mu = m_e * \gamma_{me} + m_s * \gamma_{ms} + (x_m + x_v * h(a)) * \gamma_{mx}$
	$= 3.33 * 1.4 + 3.469 * 1.6 + (0 + 0 * 1.6) * 1.6$
	$= 10.21$
Section modulus at thickness t	$z = t(a)^2 / 6 = 0.9^2 / 6 = 0.135$ m ³
Weight/unit area at depth h	$g_d = (w_s + w_e * h(a) + V_o / t(a)) * \gamma_{mf} / 1000$
	$= (10 + 18 * 1.6 + 5 / 0.9) * 0.9 / 1000$
	$= 0.0399$ N/mm ²
Moment of resistance	$m_r = (f_b(1) / \gamma_{mam} + g_d) * z * 1000$
	$= (0.15 / 3.5 + 0.0399) * 0.135 * 1000$
	$= 11.17$ kNm
Applied moment less than moment of resistance ($10.21 \leq 11.17$)	
therefore section is satisfactory.	

Step 1	width	0.9 m
	height	1.6 m

Step height (m)	Step thickness (m)	0	
		Ultimate Moments (kNm) Resistance	Applied
1.6	0.9	11.17	10.21

Stability and bearing check



Width of toe	tt=0.15 m
Width of heel	th=0.15 m
Point of application of Vo from A	eVo=0.5 m
Thickness of wall	t=0.9 m
Height of wall	h=1.6 m
Width of base	tb=t+tt+th=0.9+0.15+0.15 =1.2
Depth of base	db=0.3 m
Overall depth	od=h+db=1.6+0.3=1.9 m
Weight of fill and wall	wf=we*(t+th)*h=18*(0.9+0.15)*1.6 =30.24 kN
Eccentricity from A (fill & wall)	ef=tt+(t+th)/2=0.15+(0.9+0.15)/2 =0.675 m
Density of base	denb=24 kN/m ³
Weight of base	wb=tb*db*denb=1.2*0.3*24 =8.64 kN
Earth horizontal force	sfe=ce*we*od ² /2=0.271*18*1.9 ² /2 =8.804 kN
Moment due to earth pressure	me=sfe*od/3=8.804*1.9/3=5.576 kNm
Surcharge horizontal force	sfs=ws*ce*od=10*0.271*1.9 =5.149 kN
Moment due to surcharge	ms=sfs*od/2=5.149*1.9/2=4.891 kNm

Wall shear

Horizontal shear force	usf=(sfe*game)+(sfs*gams) =(8.804*1.4)+(5.149*1.6) =20.56 kN
Shear stress at bottom of wall	uss=usf/(t(steps)*1000) =20.56/(0.9*1000) =0.0228 N/mm ²

Sliding force		$sf = sfe + sfs + xv = 8.804 + 5.149 + 0 = 13.95$
Details of bearing strata:		
Angle of friction (u/s of base)		$\phi_{ib} = 40^\circ$
Soil cohesion		$c_u = 0 \text{ kN/m}^2$
Coefficient of friction		$cf = \tan(\text{RAD}(\phi_{ib} \times 2/3)) = \tan(\text{RAD}(40 \times 2/3)) = 0.5022$
Resisting force	fill	$r_{ff} = w_f \times cf = 30.24 \times 0.5022 = 15.19 \text{ kN}$
	base	$r_{fb} = w_b \times cf + t_b \times c_u / 2 = 8.64 \times 0.5022 + 1.2 \times 0 / 2 = 4.339 \text{ kN}$
	surcharge	$r_{fs} = w_s \times (t + t_h) \times cf = 10 \times (0.9 + 0.15) \times 0.5022 = 5.273 \text{ kN}$
	total	$r_f = r_{ff} + r_{fb} + r_{fs} = 15.19 + 4.339 + 5.273 = 24.8 \text{ kN}$
Factor of safety		$f_{ss} = r_f / sf = 24.8 / 13.95 = 1.777$

0

Bearing pressure

Weight of surcharge	$sw = ws * (t + th) = 10 * (0.9 + 0.15)$ $= 10.5 \text{ kN}$
Moments about centre of base	$m = om + (wf + sw) * (tb/2 - ef) + Vo * (tb/2 - eVo)$ $= 10.47 + (30.24 + 10.5) * (1.2/2 - 0.675) + 5$ $* (1.2/2 - 0.5)$ $= 7.912 \text{ kNm}$
Section modulus of base	$zb = tb^2/6 = 1.2^2/6 = 0.24 \text{ m}^3$
Total weight	$tw = wf + sw + wb + Vo = 30.24 + 10.5 + 8.64 + 5$ $= 54.38 \text{ kN}$
Pressure due to weight	$pw = tw/tb = 54.38/1.2 = 45.32 \text{ kN/m}^2$
Pressure due to BM (+ve or -ve)	$pm = m/zb = 7.912/0.24 = 32.97 \text{ kN/m}^2$
Maximum pressure	$pmax = pw + pm = 45.32 + 32.97 = 78.28 \text{ kN/m}^2$
Minimum pressure	$pmin = pw - pm = 45.32 - 32.97 = 12.35 \text{ kN/m}^2$

DESIGN SUMMARY

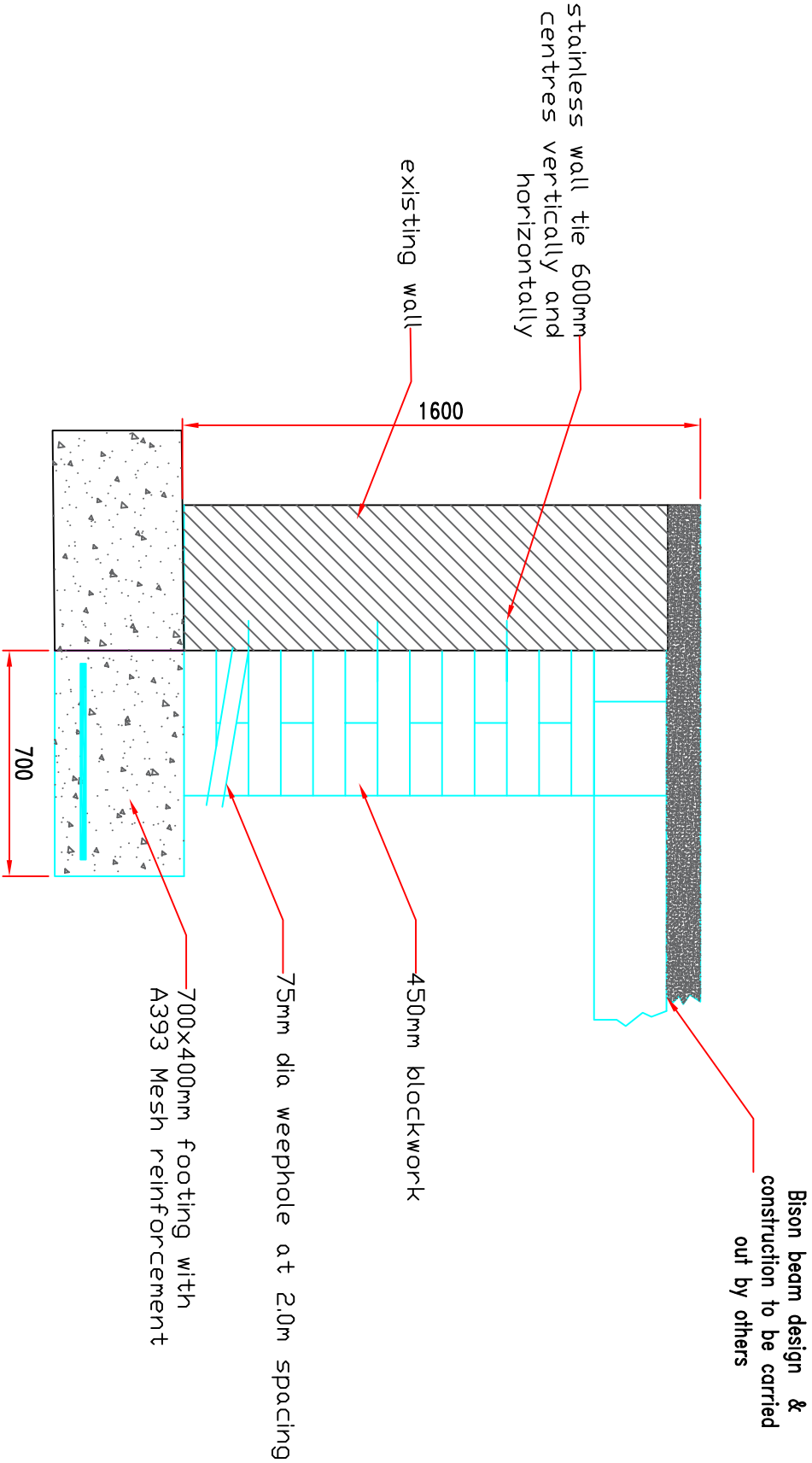
Wall height	1.6 m		
Step height (m)	Step thickness (m)	Ultimate Moments (kNm)	
		Resistance	Applied
1.6	0.9	11.17	10.21

Summary of stability check

Factor of safety overturning	3.361
Factor of safety sliding	1.777
Maximum base pressure	78.28 kN/m ²

No554

This drawing is for illustration only. NOT detailed drawing.
The Contractor must Consult the Engineer and Building
control officer for specific details if required.



PROPOSED BLOCKWORK
RETAINING WALL
1.60m High
M.T.S.

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