

Barratt Associates Ltd.

Structural, Civil and Geotechnical Engineers

Project reference: 22063

Project Address: 36 The Uplands, Swansea, SA13 2EW

Client: Bryan Smith

Description: 7N Block Retaining wall

Design Code

Design for steel is based on:

Eurocode 3: Design of steel structures

Eurocode 5: Design of timber structures

Details prepared by:

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BSc (Hons) CEng (Build) IEng MCABE MIMechE MCM

Details checked by:

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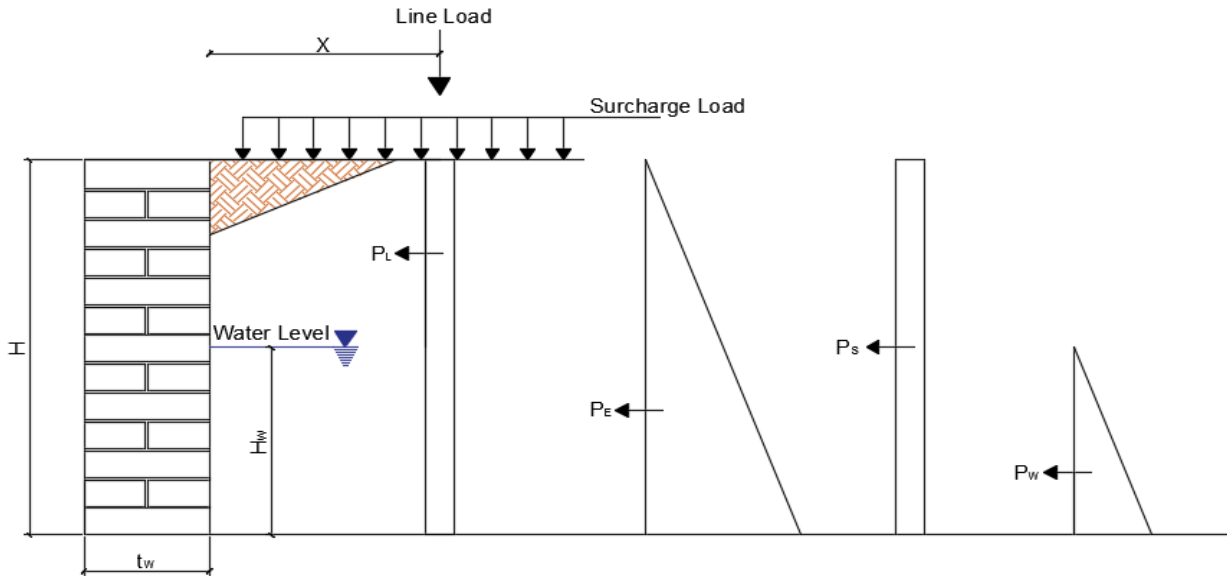
Structural, Civil and Geotechnical Engineers

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Project	36 The Uplands, Swansea, SA13 2EW	Made by	IL	Date	13-3-23	Job No	22063
Client	Bryan Smith	Checked	BA	Revision	-	Page No	1
Description	Retaining wall -						

DESIGN STATUS: OK



Maximum height of masonry retaining wall is

440 mm

DIMENSIONS (mm)

Wall height

H= 440 mm

Wall thickness

T_w= 215 mm

Ground water height

H_w = 0 mm

MATERIAL PROPERTIES

Characteristic flexural strength parallel to the joints

f_{xk1} = 0.17 N/mm²

Shear strength of masonry

f_{vk0} = 0.15 N/mm²

Partial factor

γ_m = 2.5

K value

K = 0.55

f_m^β = 1.71 N/mm² (β=0.3)

f_b^α = 10.75 N/mm² (k=0.7)

Masonry density =

16 kN/m³

SOIL PROPERTIES

Design angle of int'l friction of retained mat'l

Ø = 32 degree

Design cohesion of retained mat'l

C = 0 kN/m²

Density of retained mat'l

q = 16 kN/m³

Submerged Density of retained mat'l

q_s = 16.00 kN/m³

Design angle of int'l friction of base mat'l

Ø_b = 35 degree

Design cohesion of base material

C_b = 0 kN/m²

Density of base material

q_b = 18 kN/m³

Allowable gross ground bearing pressure

GBP = 150 kN/m²

LOADINGS

Surcharge load -- live

SQK = 2 kN/m²

Surcharge load -- dead

SGK = 0 kN/m²

Line load -- live

LQK = 1 kN/m

Line load -- dead

LGK = 0 kN/m

Distance of line load from wall

X = 0 mm

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LATERAL FORCES (unfactored)

Ka =	0.31	[default ka = (1-SIN Ø)/(1+SIN Ø)]
Kp =	3.69	[default kp = (1+SIN Øb)/(1-SIN Øb)]
Kpc =	3.84	[default kpc = 2kp ^{0.5}]
Kac =	1.11	[2ka ^{0.5}]

	Force (kN)	Lever arm (m)	Moment about TOE (kNm)	γ _f	F _{ult} (kN)	M _{ult} (kNm)
PE =	0.48	LE = 0.147	0.07	1.35	0.64	0.09
PS(GK) =	0.00	LS = 0.22	0.00	1.35	0.00	0.00
PS(QK) =	0.27	LS = 0.22	0.06	1.50	0.41	0.09
PL(GK) =	0.00	LL = 0.44	0.00	1.35	0.00	0.00
PL(QK) =	0.31	LL = 0.44	0.14	1.50	0.46	0.20
PW =	0.00	LW = 0.00	0.00	1.35	0.00	0.00
Total	1.05		0.26		1.51	0.39

STRUCTURAL DESIGNS (ultimate)

DESIGN CHECKS : OK

WALL (per metre length)

MOMENT of RESISTANCE :

design flexural strength $f_{xd} = f_{yk1}/\gamma_m =$ 0.07 N/mm²

Bending moment due to lateral forces, M= 0.39 kNm

Moment capacity of wall $M_c =$ 0.52 kNm
> 0.39

OK

SHEAR RESISTANCE:

Characteristic shear strength= $f_{vk} = f_{vko} =$ 0.15 N/mm² (but not greater than 0.065f_b)

Design shear strength $f_v = f_{vk}/\gamma_m =$ 0.060 N/mm²

Lateral shear force $F_v =$ 1.51 kN

Shear capacity $F_{v,c} = f_v A =$ 13 kN

> 1.51

OK

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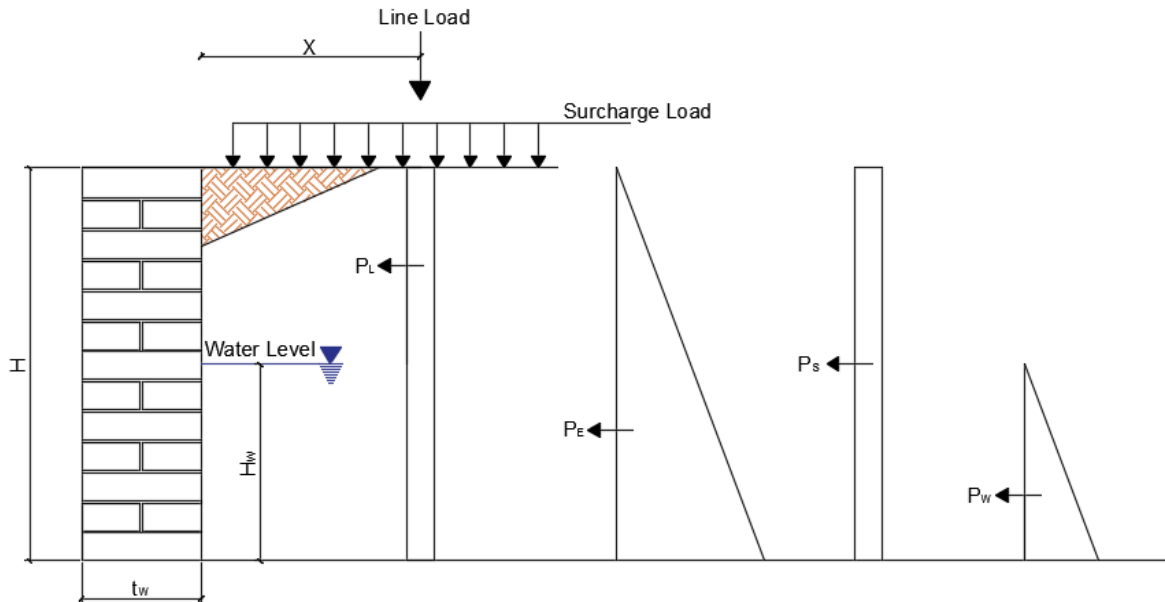
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DESIGN STATUS: OK



Maximum height of masonry retaining wall is

880 mm

DIMENSIONS (mm)

Wall height

H= 880 mm

Wall thickness

T_w= 330 mm

Ground water height

H_w = 0 mm

MATERIAL PROPERTIES

Characteristic flexural strength parallel to the joints

f_{xk1} = 0.30 N/mm²

Shear strength of masonry

f_{vko} = 0.15 N/mm²

Partial factor

γ_m = 2.5

K value

K = 0.55

f_m^β = 1.71 N/mm² (β=0.3)

f_b^α = 10.75 N/mm² (k=0.7)

Masonry density =

16 kN/m³

SOIL PROPERTIES

Design angle of int'l friction of retained mat'l

Ø = 32 degree

Design cohesion of retained mat'l

C = 0 kN/m²

Density of retained mat'l

q = 16 kN/m³

Submerged Density of retained mat'l

q_s = 16.00 kN/m³

Design angle of int'l friction of base mat'l

Ø_b = 35 degree

Design cohesion of base material

C_b = 0 kN/m²

Density of base material

q_b = 18 kN/m³

Allowable gross ground bearing pressure

GBP = 150 kN/m²

LOADINGS

Surcharge load -- live

SQK = 2 kN/m²

Surcharge load -- dead

SGK = 0 kN/m²

Line load -- live

LQK = 1 kN/m

Line load -- dead

LGK = 0 kN/m

Distance of line load from wall

X = 0 mm

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LATERAL FORCES (unfactored)

Ka =	0.31	[default ka = (1-SIN Ø)/(1+SIN Ø)]
Kp =	3.69	[default kp = (1+SIN Øb)/(1-SIN Øb)]
Kpc =	3.84	[default kpc = 2kp ^{0.5}]
Kac =	1.11	[2ka ^{0.5}]

	Force (kN)	Lever arm (m)	Moment about TOE (kNm)	γ _f	F _{ult} (kN)	M _{ult} (kNm)
PE =	1.90	LE = 0.293	0.56	1.35	2.57	0.75
PS(GK) =	0.00	LS = 0.44	0.00	1.35	0.00	0.00
PS(QK) =	0.54	LS = 0.44	0.24	1.50	0.81	0.36
PL(GK) =	0.00	LL = 0.88	0.00	1.35	0.00	0.00
PL(QK) =	0.31	LL = 0.88	0.27	1.50	0.46	0.41
PW =	0.00	LW = 0.00	0.00	1.35	0.00	0.00
Total	2.75		1.07		3.84	1.52

STRUCTURAL DESIGNS (ultimate)

DESIGN CHECKS : OK

WALL (per metre length)

MOMENT of RESISTANCE :

design flexural strength f_{xd}= f_{yk1}/γ_m= 0.12 N/mm²

Bending moment due to lateral forces, M= 1.52 kNm

Moment capacity of wall M_c= 2.18 kNm
> 1.52

OK

SHEAR RESISTANCE:

Characteristic shear strength=	f _{vk} =f _{vk0} =	0.15	N/mm²	(but not greater than 0.065fb)
Design shear strength	f _v =f _{vk} /γ _m =	0.060	N/mm²	
Lateral shear force	F _v =	3.84	kN	
Shear capcicity	F _{vd} =f _v A=	20	kN	
		> 3.84		OK

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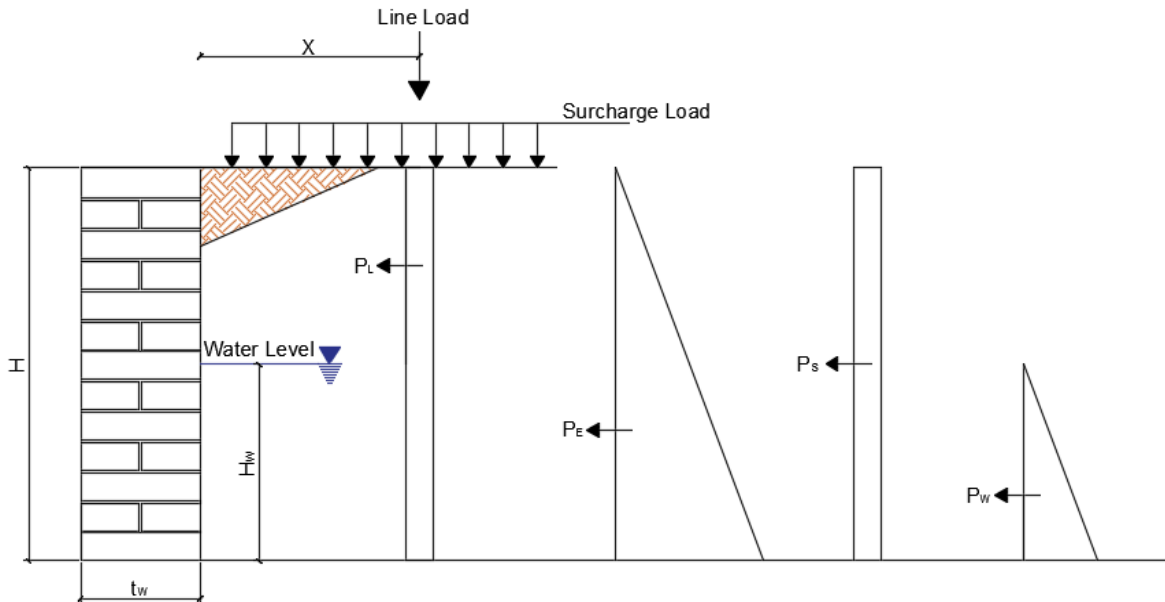
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DESIGN STATUS: OK



Maximum height of masonry retaining wall is

DIMENSIONS (mm)

Wall height

1430 mm

H= 1430 mm

Wall thickness

Tw= 440 mm

Ground water height

Hw = 0 mm

MATERIAL PROPERTIES

Characteristic flexural strength parallel to the joints

f_{xk1} = 0.35 N/mm²

Shear strength of masonry

f_{vko} = 0.15 N/mm²

Partial factor

γ_m = 2.5

K value

K = 0.55

f_m^β = 1.71 N/mm² ($\beta=0.3$)

f_b^α = 10.75 N/mm² ($k=0.7$)

Masonry density =

24 kN/m³

SOIL PROPERTIES

Design angle of int'l friction of retained mat'l

$\emptyset$ = 42 degree

Design cohesion of retained mat'l

C = 0 kN/m²

Density of retained mat'l

q = 16 kN/m³

Submerged Density of retained mat'l

qs = 16.00 kN/m³

Design angle of int'l friction of base mat'l

$\emptyset_b$ = 35 degree

Design cohesion of base material

Cb = 0 kN/m²

Density of base material

qb = 16 kN/m³

Allowable gross ground bearing pressure

GBP = 150 kN/m²

LOADINGS

Surcharge load -- live

SQK = 2 kN/m²

Surcharge load -- dead

SGK = 0 kN/m²

Line load -- live

LQK = 1 kN/m

Line load -- dead

LGK = 0 kN/m

Distance of line load from wall

X = 0 mm

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LATERAL FORCES (unfactored)

Ka = 0.20 [default ka = (1-SIN Ø)/(1+SIN Ø)]
Kp = 3.69 [default kp = (1+SIN Øb)/(1-SIN Øb)]
Kpc = 3.84 [default kpc = 2kp^{0.5}]
Kac = 0.89 [2ka^{0.5}]

	Force (kN)	Lever arm (m)	Moment about TOE (kNm)	γ _f	F _{ult} (kN)	M _{ult} (kNm)
PE =	4.09	LE = 0.477	1.95	1.35	5.52	2.63
PS(GK) =	0.00	LS = 0.72	0.00	1.35	0.00	0.00
PS(QK) =	0.57	LS = 0.72	0.41	1.50	0.85	0.61
PL(GK) =	0.00	LL = 1.43	0.00	1.35	0.00	0.00
PL(QK) =	0.20	LL = 1.43	0.28	1.50	0.30	0.43
PW =	0.00	LW = 0.00	0.00	1.35	0.00	0.00
Total	4.85		2.64		6.67	3.67

STRUCTURAL DESIGNS (ultimate)

DESIGN CHECKS : OK

WALL (per metre length)

MOMENT of RESISTANCE :

design flexural strength $f_{xd} = f_{yk1}/\gamma_m =$ 0.14 N/mm²

Bending moment due to lateral forces, M= 3.67 kNm

Moment capacity of wall M_c= 4.52 kNm
> 3.67

OK

SHEAR RESISTANCE:

Characteristic shear strength= $f_{vk} = f_{vko} =$ 0.15 N/mm² (but not greater than 0.065f_b)

Design shear strength $f_v = f_{vk}/\gamma_m =$ 0.060 N/mm²

Lateral shear force $F_v =$ 6.67 kN

Shear capacity $F_{v,c} = f_v A =$ 26 kN

> 6.67

OK

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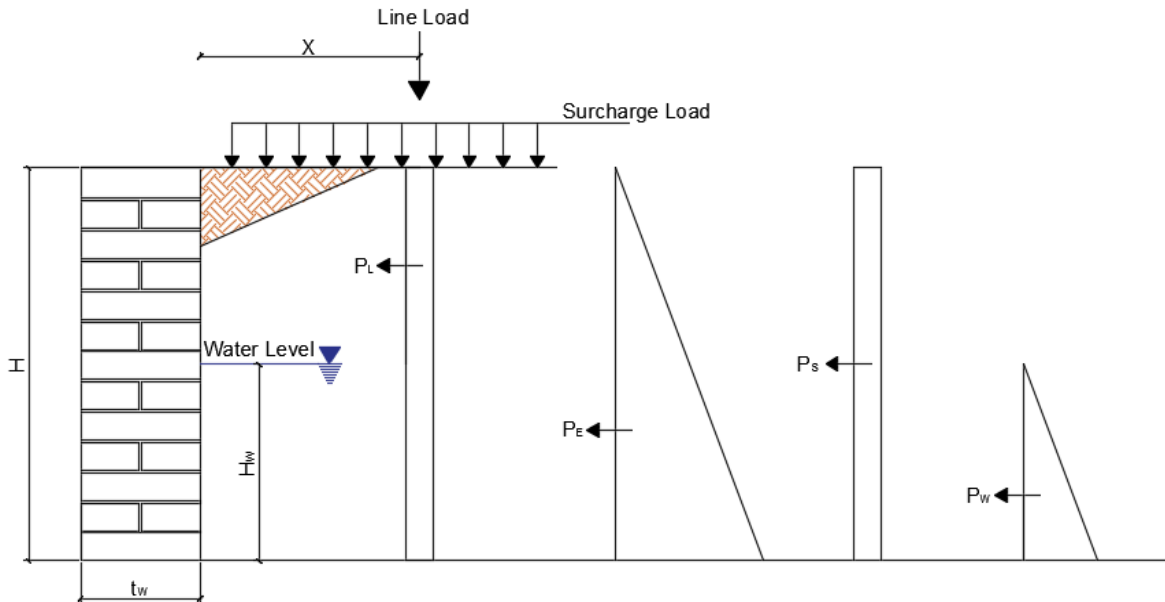
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DESIGN STATUS: OK



Maximum height of masonry retaining wall is

DIMENSIONS (mm)

Wall height

1870 mm

H= 1870 mm

Wall thickness

Tw= 660 mm

Ground water height

Hw = 0 mm

MATERIAL PROPERTIES

Characteristic flexural strength parallel to the joints

f_{xk1} = 0.35 N/mm²

Shear strength of masonry

f_{vko} = 0.15 N/mm²

Partial factor

γ_m = 2.5

K value

K = 0.55

f_m^β = 1.71 N/mm² ($\beta=0.3$)

f_b^a = 10.75 N/mm² ($k=0.7$)

Masonry density =

21 kN/m³

SOIL PROPERTIES

Design angle of int'l friction of retained mat'l

$\emptyset$ = 32 degree

Design cohesion of retained mat'l

C = 0 kN/m²

Density of retained mat'l

q = 16 kN/m³

Submerged Density of retained mat'l

qs = 16.00 kN/m³

Design angle of int'l friction of base mat'l

$\emptyset_b$ = 35 degree

Design cohesion of base material

Cb = 0 kN/m²

Density of base material

qb = 16 kN/m³

Allowable gross ground bearing pressure

GBP = 150 kN/m²

LOADINGS

Surcharge load -- live

SQK = 2 kN/m²

Surcharge load -- dead

SGK = 0 kN/m²

Line load -- live

LQK = 1 kN/m

Line load -- dead

LGK = 0 kN/m

Distance of line load from wall

X = 0 mm

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LATERAL FORCES (unfactored)

Ka =	0.31	[default ka = (1-SIN Ø)/(1+SIN Ø)]
Kp =	3.69	[default kp = (1+SIN Øb)/(1-SIN Øb)]
Kpc =	3.84	[default kpc = 2kp ^{0.5}]
Kac =	1.11	[2ka ^{0.5}]

	Force (kN)	Lever arm (m)	Moment about TOE (kNm)	γ _f	F _{ult} (kN)	M _{ult} (kNm)
PE =	8.60	LE = 0.623	5.36	1.35	11.60	7.23
PS(GK) =	0.00	LS = 0.94	0.00	1.35	0.00	0.00
PS(QK) =	1.15	LS = 0.94	1.07	1.50	1.72	1.61
PL(GK) =	0.00	LL = 1.87	0.00	1.35	0.00	0.00
PL(QK) =	0.31	LL = 1.87	0.57	1.50	0.46	0.86
PW =	0.00	LW = 0.00	0.00	1.35	0.00	0.00
Total	10.05		7.01		13.79	9.71

STRUCTURAL DESIGNS (ultimate)

DESIGN CHECKS : OK

WALL (per metre length)

MOMENT of RESISTANCE :

design flexural strength $f_{xd} = f_{yk1}/\gamma_m =$ 0.14 N/mm²

Bending moment due to lateral forces, M= 9.71 kNm

Moment capacity of wall $M_c =$ 10.16 kNm
> 9.71

OK

SHEAR RESISTANCE:

Characteristic shear strength= $f_{vk} = f_{vko} =$ 0.15 N/mm² (but not greater than 0.065f_b)

Design shear strength $f_v = f_{vk}/\gamma_m =$ 0.060 N/mm²

Lateral shear force $F_v =$ 13.79 kN

Shear capacity $F_{v,c} = f_v A =$ 40 kN

> 13.79

OK

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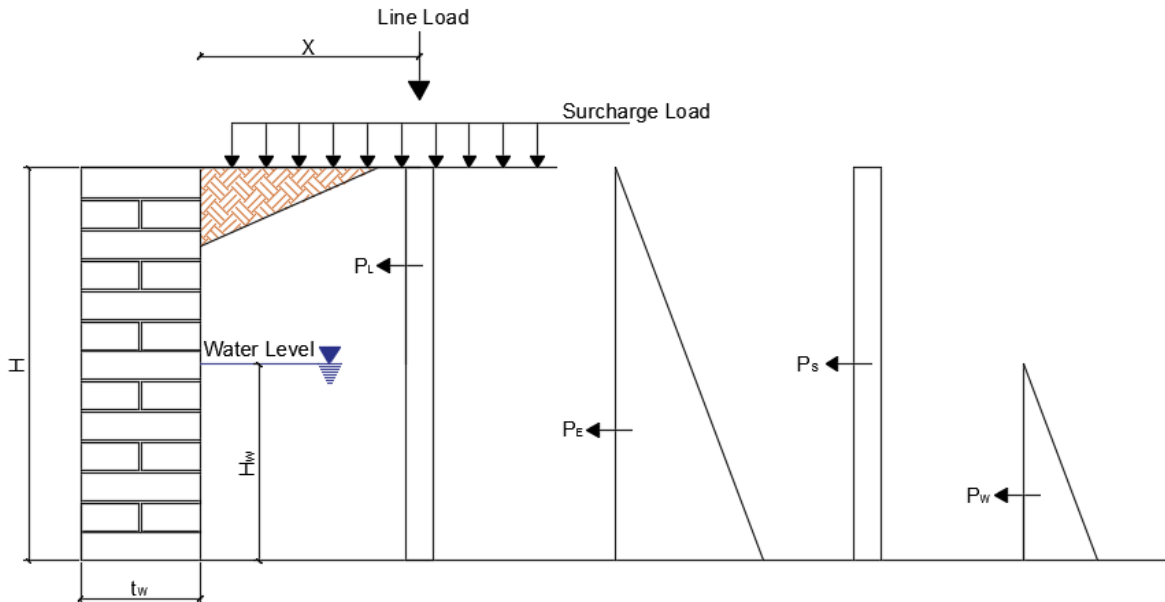
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DESIGN STATUS: OK



Maximum height of masonry retaining wall is

2420 mm

DIMENSIONS (mm)

Wall height

H= 2420 mm

Wall thickness

Tw= 880 mm

Ground water height

Hw = 0 mm

MATERIAL PROPERTIES

Characteristic flexural strength parallel to the joints

f_{xk1} = 0.35 N/mm²

Shear strength of masonry

f_{vko} = 0.15 N/mm²

Partial factor

γ_m = 2.5

K value

K = 0.55

f_m^β = 1.71 N/mm² ($\beta=0.3$)

f_b^a = 10.75 N/mm² ($k=0.7$)

Masonry density =

21 kN/m³

SOIL PROPERTIES

Design angle of int'l friction of retained mat'l

$\emptyset$ = 32 degree

Design cohesion of retained mat'l

C = 0 kN/m²

Density of retained mat'l

q = 16 kN/m³

Submerged Density of retained mat'l

qs = 16.00 kN/m³

Design angle of int'l friction of base mat'l

$\emptyset_b$ = 35 degree

Design cohesion of base material

Cb = 0 kN/m²

Density of base material

qb = 16 kN/m³

Allowable gross ground bearing pressure

GBP = 150 kN/m²

LOADINGS

Surcharge load -- live

SQK = 2 kN/m²

Surcharge load -- dead

SGK = 0 kN/m²

Line load -- live

LQK = 1 kN/m

Line load -- dead

LGK = 0 kN/m

Distance of line load from wall

X = 0 mm

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LATERAL FORCES (unfactored)

$K_a = 0.31$ [default $k_a = (1 - \sin \phi) / (1 + \sin \phi)$]
 $K_p = 3.69$ [default $k_p = (1 + \sin \phi) / (1 - \sin \phi)$]
 $K_{pc} = 3.84$ [default $k_{pc} = 2k_p^{0.5}$]
 $K_{ac} = 1.11$ [$2k_a^{0.5}$]

	Force (kN)	Lever arm (m)	Moment about TOE (kNm)	γ_f	F_{ult} (kN)	M_{ult} (kNm)
PE =	14.40	LE = 0.807	11.61	1.35	19.43	15.68
PS(GK) =	0.00	LS = 1.21	0.00	1.35	0.00	0.00
PS(QK) =	1.49	LS = 1.21	1.80	1.50	2.23	2.70
PL(GK) =	0.00	LL = 2.42	0.00	1.35	0.00	0.00
PL(QK) =	0.00	LL = 2.42	0.00	1.50	0.00	0.00
PW =	0.00	LW = 0.00	0.00	1.35	0.00	0.00
Total	15.88		13.41		21.66	18.38

STRUCTURAL DESIGNS (ultimate)

DESIGN CHECKS : OK

WALL (per metre length)

MOMENT of RESISTANCE :

design flexural strength $f_{xd} = f_{xk1} / \gamma_m =$ 0.14 N/mm²

Bending moment due to lateral forces, M= 18.38 kNm

Moment capacity of wall $M_c =$ 18.43 kNm
> 18.38 OK

SHEAR RESISTANCE:

Characteristic shear strength= $f_{vk} = f_{vko} =$ 0.15 N/mm² (but not greater than 0.065fb)

Design shear strength $f_v = f_{vk} / \gamma_m =$ 0.061 N/mm²

Lateral shear force $F_v =$ 21.66 kN

Shear capacity $F_{v,c} = f_v A =$ 54 kN
> 21.66 OK

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Project	36 The Uplands, Swansea, SA13 2EW	Made by	Date	Job No
Client	Bryan Smith	IL	13-3-23	22063
Description	Overall stability of wall with a concrete base	Checked	Revision	Page No
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LATERAL FORCES (unfactored)

$$\begin{aligned}K_a &= 0.31 & [\text{default } k_a = (1 - \sin \phi) / (1 + \sin \phi)] \\K_p &= 3.69 & [\text{default } k_p = (1 + \sin \phi) / (1 - \sin \phi)] \\K_{pc} &= 3.84 & [\text{default } k_{pc} = 2k_p^{0.5}] \\K_{ac} &= 1.11 & [2k_a^{0.5}]\end{aligned}$$

	Force (kN)	Lever arm (m)	Moment about TOE (kNm)	γ_f	F_{ult} (kN)	M_{ult} (kNm)
PE =	14.40	LE = 0.807	11.61	1.35	19.43	15.68
PS(GK) =	0.00	LS = 1.210	0.00	1.35	0.00	0.00
PS(QK) =	1.49	LS = 1.210	1.80	1.50	2.23	2.70
PL(GK) =	0.00	LL = 2.420	0.00	1.35	0.00	0.00
PL(QK) =	0.00	LL = 2.420	0.00	1.50	0.00	0.00
PW =	0.00	LW = 0.000	0.00	1.35	0.00	0.00
Total	15.88		13.41		21.66	18.38

STABILITY CHECK

Weight of wall + fill (per metre length) = P =

Moment on wall = M =

Plan area of base = A =

Section modulus of base = Z =

Pressure under base at front = $P/A + M/Z$ =

Pressure under base at back = $P/A - M/Z$ =

Bearing capacity of ground under base =

49.342 kN

13.41 kN.m

1.400 m²

0.327 m³

76.300 kN/m²

-5.812 kN/m²

150 kN/m²

Ratio actual ÷ permissible
0.51
-0.04

