

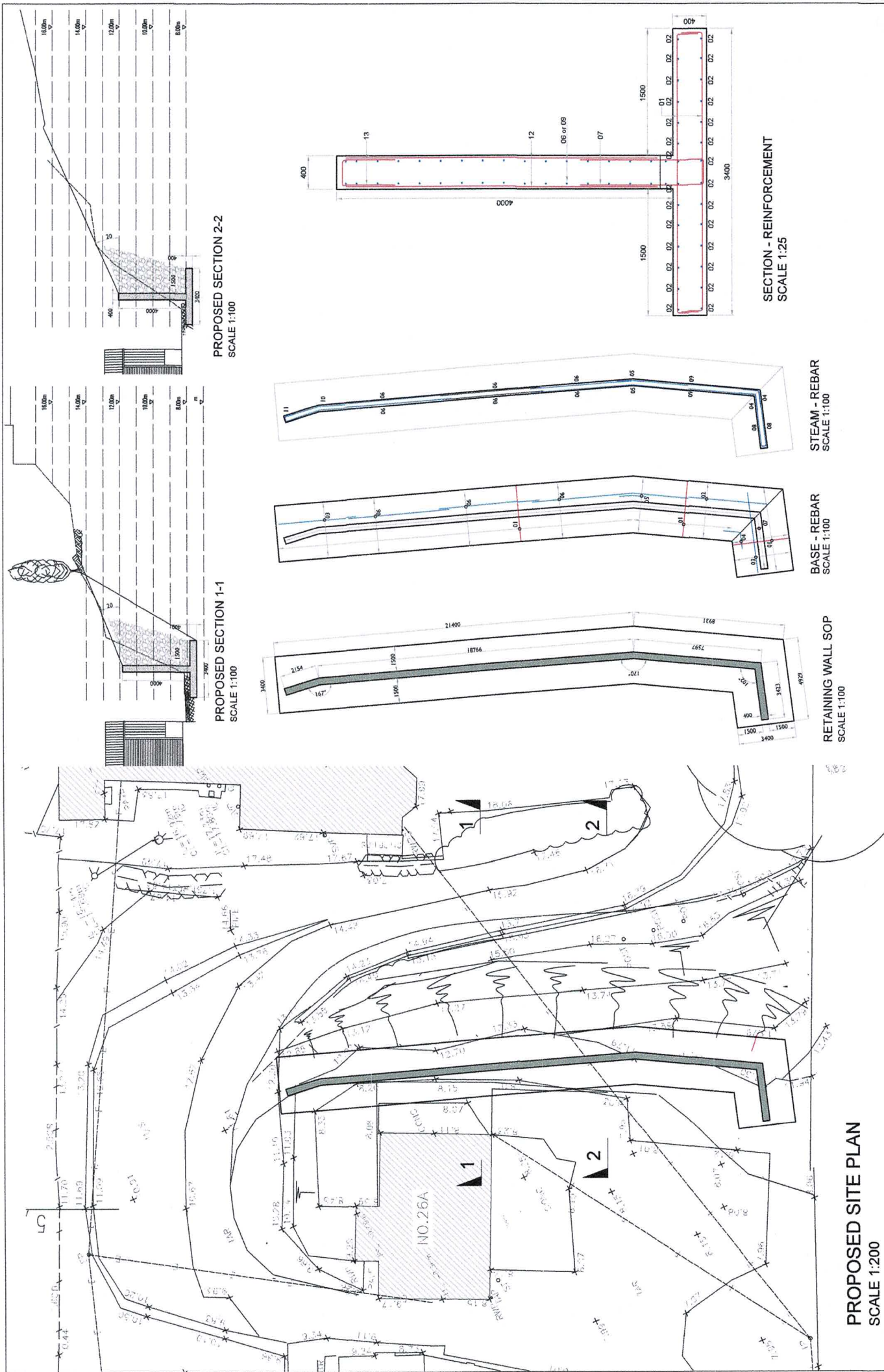
22-1796



Structural Calculations

4m High RC Wall - 26A Glassworks Gottages, Newport, NP20 5NL

Richard Parker



PROPOSED SITE PLAN
SCALE 1:200

PROPOSED SECTION 1-1
SCALE 1:100

PROPOSED SECTION 2-2
SCALE 1:100

STEAM - REBAR
SCALE 1:100

BASE - REBAR
SCALE 1:100

SECTION - REINFORCEMENT
SCALE 1:25

REINFORCING WALL S.O.P
SCALE 1:100

- Notes:
1. All dimensions are in millimeters unless otherwise stated.
 2. All dimensions shown in millimeters and this drawing must not be scaled off.
 3. Any dimensional discrepancies to be reported to Keystone Structural Engineering.
 4. All reinforcement to be installed to the design of the retaining wall.
 5. All external dimensions to be given to the centerline of the retaining wall.
 6. The retaining wall is to be constructed in concrete.
 7. The retaining wall is to be constructed in concrete.
 8. The retaining wall is to be constructed in concrete.
 9. The retaining wall is to be constructed in concrete.
 10. The retaining wall is to be constructed in concrete.

RETAINING WALL, PLANS & SECTIONS

26A GLASSWORKS COTTAGES, NEWPORT, NP20 5NL

Drawn By: DLH
Date: OCT 2024
Checked: [Signature]
Scale: 1:200 @A1

22-1796-DWG-10
PRICING

Keystone House
201 Rye Road
South Wales
NP20 3PQ
T 01633 378259
M 0797826245
www.keystone.co.uk
Email: audrey@keystone.co.uk

Keystone
Structural Engineering

Keystone Structural Eng Ltd

201 Risca Road
Newport
South Wales
NP20 3PQ

Tel:01633 378059 Fax:dudley@keystonese.co.uk

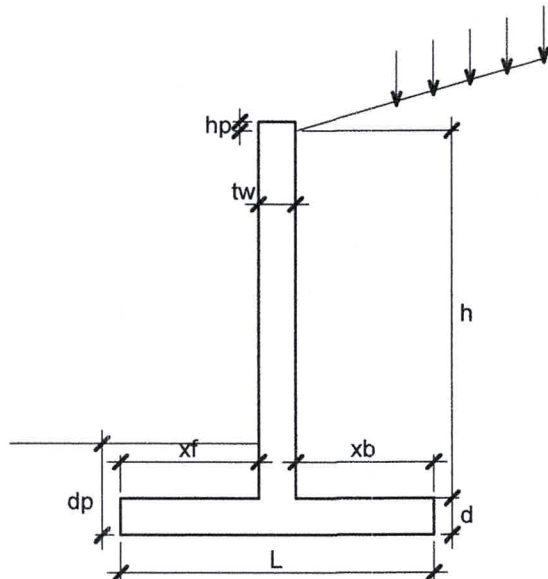
Proj: 22-1796

Ref : RC Wall

Date: 05/10/24

Page: 3

26 Glassworks Cottages, Newport, NP20 5NL
General components

RC cantilever retaining wall stability check to CP2**Geometry** (All dimension in metres)

$tw = 0.4$; $d = 0.4$; $h = 4$; $xb = 1.5$; $xf = 1.5$; $hp = 0.1$; $wk = 0$; $hk = 0$; $dp = 1$; $L = 3.4$

Additional loads (kN and m)

$p = 2.5$; $Va = 0$; $Ha = 0$; $hh = 0$

Restoring effect of surcharge - Considered

Soil properties

Unit weight of drained/moist soil
Internal friction angle of soil
Angle of slope

Retained soil

19
30
25

Passive soil

19
30

Unit

kN/m^3
degrees
degrees

Foundation soil properties

Angle of base friction = 30 degrees
Cohesion = 10 kN/m^2
Base adhesion = 25 kN/m^2
Allowable bearing pressure = 200 kN/m^2
Check sliding below - Base slab
Pressure coefficient by - Coulomb theory
Pressure resultant angle - 0 degrees

Factor of safety

Overturning = 2
Sliding = 1.5 (including passive)
Sliding = 1.5 (excluding passive)
Redn. factor = 0.5 (passive resistance)

For Coulomb's theory, the line of action of P is taken as angle of pressure resultant (δ) of the retained soil.

Angle of P $\delta = 0$ degrees

Pressure diagram

Keystone Structural Eng Ltd

201 Risca Road
Newport
South Wales
NP20 3PQ

Tel:01633 378059 Fax:dudley@keystonese.co.uk

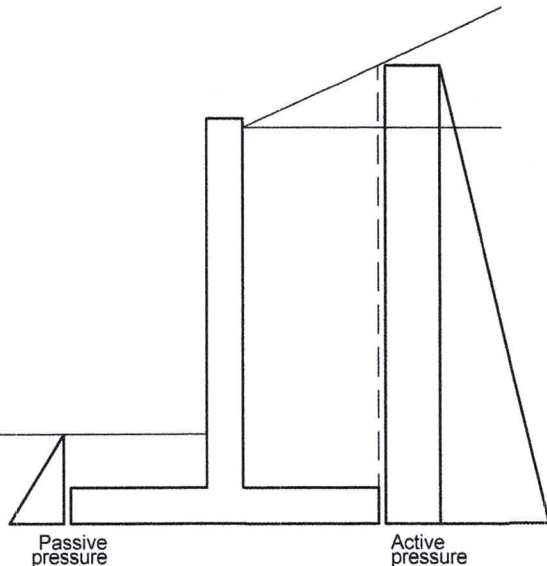
Proj: 22-1796

Ref : RC Wall

Date: 05/10/24

Page: 4

26 Glassworks Cottages, Newport, NP20 5NL
General components



Active pressure from retained soil

Coulomb (extended by Muller-Breslau) gives the formula for resultant earth pressure as $P = C_e \cdot \gamma_m \cdot (h+d)^2 / 2$ where C_e is a pressure coefficient

Intermediate factor

$$f_i = \cos(\delta) \cdot (1 + \sqrt{\sin(\phi + \delta) \cdot \sin(\phi - \beta) / (\cos(\delta) \cdot \cos(\beta))})^2 = 1.487$$

Pressure coefficient

$$C_e = (\cos(\phi)^2) / f_i = 0.504$$

Active pressure due to surcharge

The lateral pressure corresponding to the surcharge is assumed uniform throughout the height and calculated as the vertical surcharge * C_e

Resultant soil force (surcharge)

$$P_s = C_e \cdot p \cdot (h+d+d_s) = 6.43 \text{ kN/m run}$$

Horizontal component

$$P_{sh} = P_s \cdot \cos(\delta) = 6.43 \text{ kN/m run}$$

Vertical component

$$P_{sv} = P_s \cdot \sin(\delta) = 0 \text{ kN/m run}$$

Active pressure of soil

Resultant (active) soil force

$$P_1 = C_e \cdot \gamma_m \cdot (h+d+d_s)^2 / 2 = 124.63 \text{ kN/m run}$$

Horizontal component

$$P_{h1} = P_1 \cdot \cos(\delta) = 124.63 \text{ kN/m run}$$

Vertical component

$$P_{v1} = P_1 \cdot \sin(\delta) = 0 \text{ kN/m run}$$

Passive resistance

Passive resistance is assumed to act in the horizontal direction.

Angle of line of action of P

$$\delta_p = 0 \text{ degrees}$$

Coulomb gives the formula for resultant earth pressure as $P_3 = C_p \cdot \gamma_{mp} \cdot d_p^2 / 2$ where C_p is a pressure coefficient

Pressure coefficient

$$C_p = (1 + \sin(\phi_p)) / (1 - \sin(\phi_p)) = 3$$

Vertical forces

Keystone Structural Eng Ltd

201 Risca Road
Newport
South Wales
NP20 3PQ

Tel:01633 378059 Fax:dudley@keystonese.co.uk

Proj: 22-1796

Ref : RC Wall

Date: 05/10/24

Page: 5

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General components

Weight of wall stem & load above

$$V_w = (h+hp)*tw*RC_WT + V_a = 38.7 \text{ kN/m run}$$

Weight due to surcharge

$$V_s = p*xb = 3.75 \text{ kN/m run}$$

Self weight of base

$$S_w = L*d*RC_WT = 32.1 \text{ kN/m run}$$

On the active side

Weight of retained soil (slope)

$$w_{bs} = \gamma_m * x_b^2 * \tan(\beta) / 2 = 9.97 \text{ kN/m run}$$

Weight of retained soil

$$w_{be1} = h * x_b * \gamma_m = 114 \text{ kN/m run}$$

Total weight of soil above base

$$w_b = w_{be1} + w_{bs} = 123.97 \text{ kN/m run}$$

On the passive side

Weight of soil

$$w_{ps} = db * x_f * \gamma_{mp} = 17.1 \text{ kN/m run}$$

Total weight of soil above base

$$w_f = w_{ps} = 17.1 \text{ kN/m run}$$

Overturning moment

Due to horizontal component of earth pressure on active side

Surcharge

$$Moh1 = P_{sh} * (hk + (h+d+ds)/2) = 16.4 \text{ kNm/m run}$$

Soil

$$Moh2 = Ph1 * ((ds+h+d)/3 + hk) = 211.85 \text{ kNm/m run}$$

Total

$$Moh = Moh1 + Moh2 = 228.25 \text{ kNm/m run}$$

Due to horizontal load acting at the top of the wall

$$Mol = Ha * (hk + d + h + hp + hh) = 0 \text{ kNm/m run}$$

Due to vertical component of earth pressure on active side

$$Mov = (P_{sv} + P_{v1}) * L = 0 \text{ kNm/m run}$$

Overturning moment about toe

$$Mot = Moh + Mol - Mov = 228.25 \text{ kNm/m run}$$

Restoring moment

Rotation is assumed to occur about the toe, restraining moments:

Due to soil behind wall

$$M_{re1} = w_{be1} * (L - x_b / 2) = 302.1 \text{ kNm/m}$$

Due to soil in slope

$$M_{re2} = w_{bs} * (L - x_b / 3) = 28.91 \text{ kNm/m}$$

$$M_{re} = M_{re1} + M_{re2} = 331.01 \text{ kNm/m}$$

Due to base and stem

$$M_{rw} = V_w * (x_f + tw / 2) + S_w * L / 2 = 120.36 \text{ kNm/m}$$

Due to surcharge

$$M_{rs} = V_s * (x_f + tw + x_b / 2) = 9.94 \text{ kNm/m}$$

Due to soil on toe

$$M_{ro} = w_f * x_f / 2 = 12.83 \text{ kNm/m}$$

Restoring moment

$$M_r = M_{re} + M_{rw} + M_{rs} + M_{ro} = 474.13 \text{ kNm/m}$$

Factor of safety against overturning

$$FS_{ot} = M_r / Mot = 2.08$$

FOS > 2 - OK

Bearing pressure

Overturning moment about toe

$$Mot = 228.25 \text{ kNm/m run}$$

Restoring moment about toe

$$Mrt = 474.13 \text{ kNm/m run}$$

Total load on foundation strata

$$T1 = V_w + V_s + S_w + w_b + w_f = 215.62 \text{ kN/m run}$$

$$T2 = P_{sv} + P_{v1} = 0 \text{ kN/m run}$$

$$T = T1 + T2 = 215.62 \text{ kN/m run}$$

Position of the resultant force from toe

$$x_t = (Mrt - Mot) / T = 1.14 \text{ m}$$

The load centroid lies within middle third.

The pressure varies from ph at the heel to pt at the toe

Eccentricity of resultant vertical force

Keystone Structural Eng Ltd

201 Risca Road
Newport
South Wales
NP20 3PQ

Tel:01633 378059 Fax:dudley@keystonese.co.uk

Proj: 22-1796

Ref : RC Wall

Date: 05/10/24

Page: 6

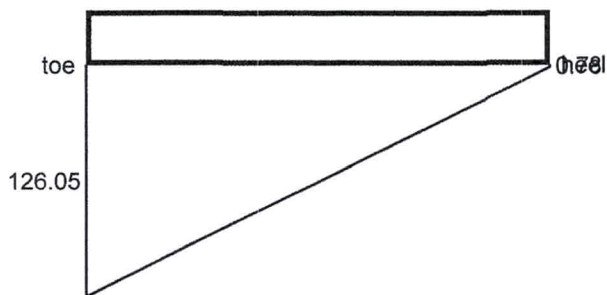
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General components

Length of base in contact

Pressure at heel

Pressure at toe

Pressure diagram (kN/m²)



$$ecc = L/2 - xt = 0.56 \text{ m}$$

$$lb = L = 3.4 \text{ m}$$

$$ph = (T/L) * (1 - (6 * ecc/L)) = 0.78 \text{ kN/m}^2$$

$$pt = (T/L) * (1 + (6 * ecc/L)) = 126.05 \text{ kN/m}^2$$

Pressure beneath base; 126.05 < allowable; 200 - OK

Check Sliding

Sliding force

Passive resistance

Weight of soil below the base

Total load on foundation strata

Friction factor under base

Sliding resistance

FOS sliding (including passive)

FOS sliding (excluding passive)

$$St = Psh + Ph1 + Ha = 131.06 \text{ kN/m run}$$

$$Pp = (Cp * \gamma_{mp} * dp^2 / 2) * rpr = 14.25 \text{ kN/m}$$

$$wsb = 0 \text{ kN/m run}$$

$$T = 215.62 \text{ kN/m}$$

$$ff = \tan(\delta_f) = 0.58$$

$$F = ff * T + cw * lb = 209.49 \text{ kN/m run}$$

$$FSs = (F + Pp) / St = 1.71$$

$$FSf = F / St = 1.6$$

Result summary

Active pressure coefficient

$$= 0.5$$

FOS against overturning

$$= 2.08 > 2 - \text{OK}$$

Combined vertical load in middle third

Pressure at heel

$$= 0.78 \text{ kN/m}^2$$

Pressure at toe

$$= 126.05 \text{ kN/m}^2$$

Maximum pressure beneath base < allowable (200) - **OK**

FOS sliding (including passive)

$$= 1.71 > 1.5 - \text{OK}$$

FOS sliding (excluding passive)

$$= 1.6 > 1.5 - \text{OK}$$

Stability check status - Passed

Unfactored forces**Shear (kN)****Moment (kNm)**

Stem base

111.77

179.73

Base slab - toe side

116.37

97.64

(at the face of stem)

Base slab - heel side

99.25

87.29

(at the face of stem)

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201 Risca Road
Newport
South Wales
NP20 3PQ

Tel:01633 378059 Fax:dudley@keystonese.co.uk

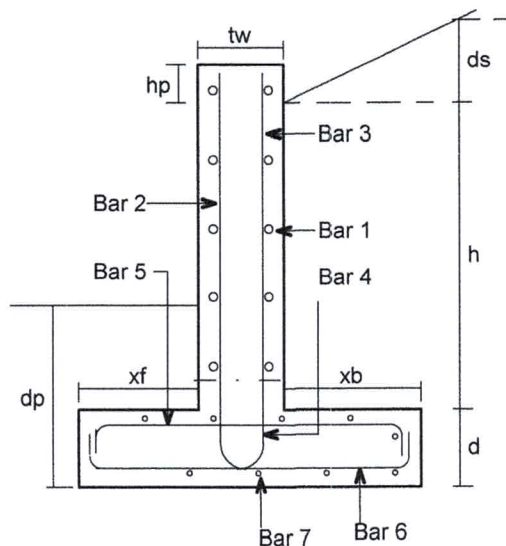
Proj: 22-1796

Ref : Rebar - 4m High

Date: 07/10/24

Page: 7

26 Glassworks Cottages, Newport, NP20 5NL
General components

RC cantilever retaining wall strength check to BS 8110-1

Key diagram

Geometry (All dimension in metres)

$tw = 0.4$; $d = 0.4$; $h = 4$; $xb = 1.5$; $xf = 1.5$; $hp = 0$; $wk = 0$; $hk = 0$;

Retained soil properties

Angle of slope of retained soil = 25 degrees
Unit weight of drained/moist soil = 19 kN/m³
Angle of pressure resultant = 30 degrees
Active pressure coefficient = 0.27

RC design parameters

Ultimate load factor = 1.4
Char. cube strength of concrete = 30 N/mm²
Char. yield strength of steel = 460 N/mm²
PSF for concrete in compression = 1.5
PSF for reinforcement strength = 1.05
PSF for RC shear strength = 1.25

Design forces and additional loads

	Stem base	Heel slab	Toe slab	Key
Unfactored shear (kN)	111.77	99.25	116.37	0
Unfactored moment (kNm)	179.73	87.29	97.64	0

Surcharge = 2.5 kN/m² ; Vertical load = 0 kN/m ; Horizontal load = 0 kN/m ; Pos. above wall/parapet = 0 m

Bar arrangement (All dimension in metres)

	Bar diameter	Spacing	Layer	Cover to layer 1
Stem lacers (Bar 1)	16	250		

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	Date: 07/10/24	Page: 8
	26 Glassworks Cottages, Newport, NP20 5NL General components	

Stem front face verticals (Bar 2)	16	250	1	50
Stem back face verticals (Bar 3)	16	250	1	50
Stem back face starters (Bar 4)	25	250		
Base Top face / Key (Bar 5)	20	250	1	50
Base bottom face (Bar 6)	20	250	1	50
Base lacers (Bar 7)	16	250		
Projection of starter bars	= 1300 mm (from base top)			
Kicker height from base top	= 150 mm			

Results summary

Ultimate moments(kNm/m)	Design	Resistance	Status
Stem starter bar	251.62	261.63	OK
Base slab - heel	122.21	175.32	OK
Base slab - toe	136.7	175.32	OK
Ultimate shears(kN/m)	Design	Resistance	Status
Stem starter bar	156.48	197.13	OK
Base slab - heel	138.95	170.46	OK
Base slab - toe	162.92	170.46	OK

Check for curtailment of stem back face starter and continuing bars

Lap length provided above kicker	= 1150 mm	>= required value 976.13 mm ; OK	
		Shear(kN)	Moment(kNm)
Forces at effective curtailment point of starter bars	= 46.46		59.75
Forces at actual curtailment point of starter bars	= 38.72		45.45
Resistance of continuing bars (back face verticals)	= 147.29		114.21
Shear capacity at the effective curtailment point of starter bars is greater than the design shear force. OK			
Moment capacity at the effective curtailment point of starter bars is greater than the design moment. OK			
Shear capacity at the actual curtailment point of starter bars is greater than twice the design shear force. OK			
Moment capacity at the actual curtailment point of starter bars is greater than twice the design moment. OK			

Check for reinforcement (minimum and maximum percentage)

	Reinforcement(mm ² /m)	Percentage	Status
Stem back face starter bars	= 1963.5	0.49	OK
Stem back face vertical bars	= 804.25	0.2	OK
Stem front face vertical bars	= 804.25	0.2	OK
Stem lacers	= 804.25	0.2	OK
Base slab top bars	= 1256.64	0.31	OK
Base slab bottom bars	= 1256.64	0.31	OK
Base slab lacer bars	= 804.25	0.2	OK

Check for bar spacing to control crack width

	Spacing provided(mm)	Allowable	Status
Stem back face starter bars	250	293.64	OK
Stem back face vertical bars	250	766	OK
Stem front face vertical bars	250	766	OK
Stem lacer bars	250	766	OK

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	Date: 07/10/24	Page: 9
	26 Glassworks Cottages, Newport, NP20 5NL General components	

Base slab top bars	250	607.84	OK
Base slab lacer bars	250	766	OK
Base slab bottom bars	250	545.52	OK

RC design check status - Passes

Keystone Structural Engineering

Bar schedule ref :

Raft 01

Rev
letter

Site ref : RC wall - NP20 5NL

Date prepared : 07-Oct-24

Job no : 22-1796

Prepared by : DJLH Checked by : RDH

Member	Bar mark	Type and size	No. of mbrs	No. of bars in each	Total no.	Length of each bar † mm	Shape code	A *	B *	C *	D *	E/R *	Rev letter
Base	01	H 20	1	258	258	3700	21	250	3300	250			
	02	H 16	1	28	28	8000	00	8000					
	03	H 16	1	56	56	5025	11	4800	250				
	04	H 16	1	28	28	2000	15	1000	970	1000			
	05	H 16	1	28	28	2000	15	1000	135	1000			
	06	H 16	1	84	84	1900	00	1900					
Starter	07	H 20	1	90	90	3200	21	1500	300	1500			
Stem	04	H 16	1	28	28	2000	15	1000	970	1000			
	05	H 16	1	28	28	2000	15	1000	135	1000			
	06	H 16	1	84	84	6000	00	6000					
	08	H 16	1	28	28	3225	11	3000	250				
	09	H 16	1	28	28	7200	00	7200					
	10	H 16	1	28	28	4550	15	2050	510	2500			
	11	H 12	1	14	14	1475	21	600	300	600			
	12	H 16	1	250	250	3700	00	3700					
	13	H 12	1	125	125	1275	21	500	300	500			

This schedule conforms to BS 8666:2005

Bar Schedule 8666 v5.04

* Specified in multiples of 5mm.

† Specified in multiples of 25mm.

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>> CALCULATIONS <<

Project : 26A Glassworks Cottages, Newport, NP20 5NL

Element : Notes

Date:

Oct-24

Made By:

DJLH

Checked by:

Sheet No.

11

Ref:

22-1796

Construction Notes

1. All steelwork dimensions to be checked on site prior to ordering and fabrication.
2. All dimensions shown in millimeters and this drawing must not be scaled off.
3. Any numerical discrepancies to be reported to Keystone Structural Engineering immediately.
4. All internal steelwork to receive two coats of red oxide before erection.
5. All external steelwork to receive 80um (140um if coastal) thickness of Hot Dip Galvanized coating
6. The span of the beam is the clear distance between supports, the minimum bearing (uso) is 150mm each end.
7. All Twin Beams to be bolted & sleeved together @800mm ctrs
8. All Columns or Posts below DPC to be surrounded with min 100mm Gen3 Concrete
9. All Lintels to be installed in accordance with Manufacturers guidelines
10. The underside of all Foundations MUST be approved by Building Control prior to pouring.
11. All Temporary works and propping is to be designed by others or to main contractors discretion.
12. All assumed span and truss directions indicated within these calculations to be check on site prior to ordering and fabrication.
13. The main contractor is responsible for all methods statements and sequence of works on site.
14. All excavations and associated temporary works to be designed by the main contractor or others.

ALL DIMENSIONS TO BE CHECKED ON SITE PRIOR TO ORDERING OR FABRICATION