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Structural Design

23 Main Rd, Bryncoch

September 2025

23 Main Rd, Bryncoch
September 2025

Site name: 23 Main Rd, Bryncoch

Client name: Mr. Richard Cridland
Type of report: Structural Design

Prepared by: Iwan Griffiths BEng (Hons) ICE IStructE

Signed



Date: 8th September 2025

Revision History:

Rev.	Date	Comments
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1.INTRODUCTION

1.1. Brief

A request was received from Mr. Richard Cridland to provide structural specifications for a retaining wall at the front of 23 Main Rd, Bryncoch in order to create a parking space.

The calculations that follow are based on architect's drawings sent by the client (APPENDIXA).

2. SPECIFICATIONS

Retaining Wall

See technical drawing provided in APPENDIX B.

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3. CALCULATIONS

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RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.21

Retaining wall details

Stem type	Cantilever
Stem height	$h_{\text{stem}} = 1400 \text{ mm}$
Stem thickness	$t_{\text{stem}} = 215 \text{ mm}$
Angle to rear face of stem	$\alpha = 90 \text{ deg}$
Stem density	$\gamma_{\text{stem}} = 25 \text{ kN/m}^3$
Toe length	$l_{\text{toe}} = 1400 \text{ mm}$
Heel length	$l_{\text{heel}} = 375 \text{ mm}$
Base thickness	$t_{\text{base}} = 300 \text{ mm}$
Base density	$\gamma_{\text{base}} = 25 \text{ kN/m}^3$
Height of retained soil	$h_{\text{ret}} = 1400 \text{ mm}$
Angle of soil surface	$\beta = 0 \text{ deg}$
Depth of cover	$d_{\text{cover}} = 0 \text{ mm}$

Retained soil properties

Soil type	Medium dense gravel
Moist density	$\gamma_{\text{mr}} = 17 \text{ kN/m}^3$
Saturated density	$\gamma_{\text{sr}} = 20.5 \text{ kN/m}^3$
Characteristic effective shear resistance angle	$\phi'_{\text{r,k}} = 30 \text{ deg}$
Characteristic wall friction angle	$\delta_{\text{r,k}} = 15 \text{ deg}$

Base soil properties

Soil type	Medium dense gravel
Soil density	$\gamma_{\text{b}} = 17 \text{ kN/m}^3$
Characteristic cohesion	$c'_{\text{b,k}} = 0 \text{ kN/m}^2$
Characteristic effective shear resistance angle	$\phi'_{\text{b,k}} = 30 \text{ deg}$
Characteristic wall friction angle	$\delta_{\text{b,k}} = 15 \text{ deg}$
Characteristic base friction angle	$\delta_{\text{bb,k}} = 20 \text{ deg}$

Loading details

Permanent surcharge load	Surcharge _G = 1.5 kN/m ²
Variable surcharge load	Surcharge _Q = 1.5 kN/m ²
Vertical line load at 700 mm	$P_{Q1} = 10 \text{ kN/m}$



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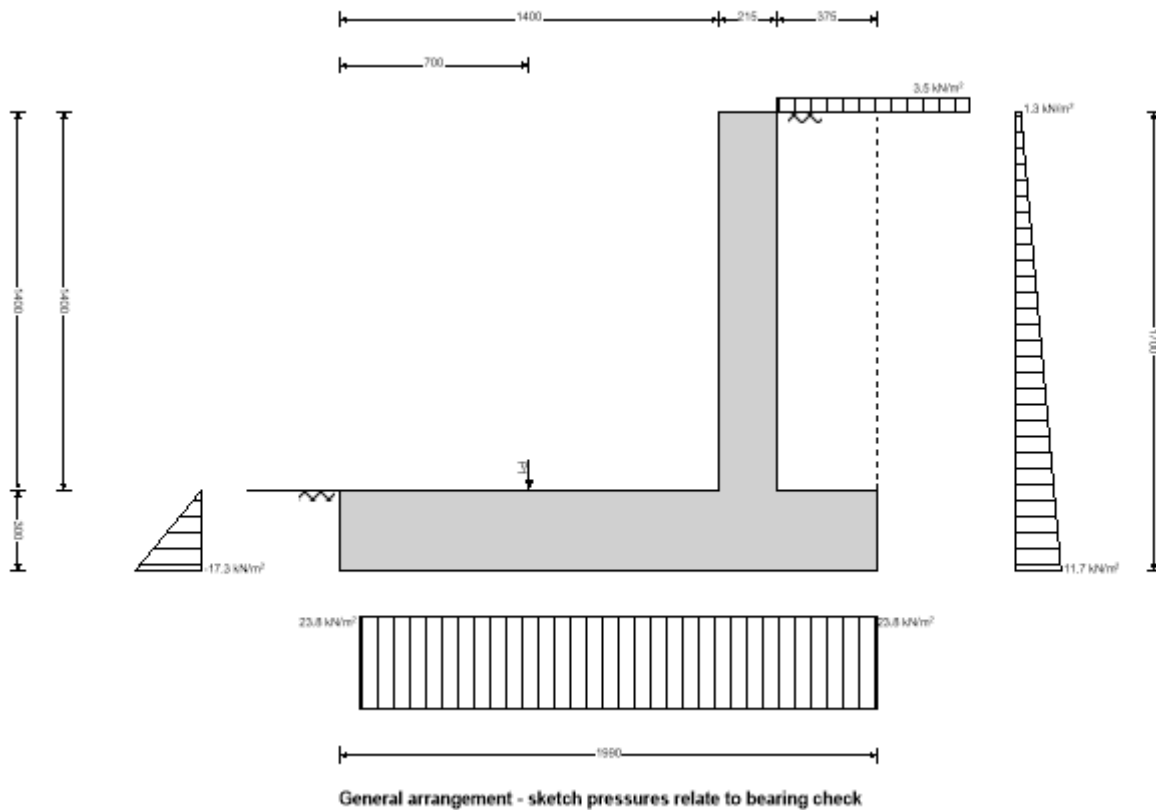
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Calculate retaining wall geometry

Base length

$$l_{\text{base}} = l_{\text{toe}} + t_{\text{stem}} + l_{\text{heel}} = \mathbf{1990 \text{ mm}}$$

Moist soil height

$$h_{\text{moist}} = h_{\text{soil}} = \mathbf{1400 \text{ mm}}$$

Length of surcharge load

$$l_{\text{sur}} = l_{\text{heel}} = \mathbf{375 \text{ mm}}$$

- Distance to vertical component

$$x_{\text{sur}_v} = l_{\text{base}} - l_{\text{heel}} / 2 = \mathbf{1803 \text{ mm}}$$

Effective height of wall

$$h_{\text{eff}} = h_{\text{base}} + d_{\text{cover}} + h_{\text{ret}} = \mathbf{1700 \text{ mm}}$$

- Distance to horizontal component

$$x_{\text{sur}_h} = h_{\text{eff}} / 2 = \mathbf{850 \text{ mm}}$$

Area of wall stem

$$A_{\text{stem}} = h_{\text{stem}} \times t_{\text{stem}} = \mathbf{0.301 \text{ m}^2}$$

- Distance to vertical component

$$x_{\text{stem}} = l_{\text{toe}} + t_{\text{stem}} / 2 = \mathbf{1508 \text{ mm}}$$

Area of wall base

$$A_{\text{base}} = l_{\text{base}} \times t_{\text{base}} = \mathbf{0.597 \text{ m}^2}$$

- Distance to vertical component

$$x_{\text{base}} = l_{\text{base}} / 2 = \mathbf{995 \text{ mm}}$$

Area of moist soil

$$A_{\text{moist}} = h_{\text{moist}} \times l_{\text{heel}} = \mathbf{0.525 \text{ m}^2}$$

- Distance to vertical component

$$x_{\text{moist}_v} = l_{\text{base}} - (h_{\text{moist}} \times l_{\text{heel}}^2 / 2) / A_{\text{moist}} = \mathbf{1803 \text{ mm}}$$

- Distance to horizontal component

$$x_{\text{moist}_h} = h_{\text{eff}} / 3 = \mathbf{567 \text{ mm}}$$

Design approach 1

Partial factors on actions - Table A.3 - Combination 1

Partial factor set

A1

Permanent unfavourable action

$$\gamma_G = \mathbf{1.350}$$

Permanent favourable action

$$\gamma_{Gf} = \mathbf{1.000}$$

Variable unfavourable action

$$\gamma_Q = \mathbf{1.500}$$

Variable favourable action

$$\gamma_{Qf} = \mathbf{0.000}$$

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Partial factors for soil parameters – Table A.4 - Combination 1

Soil parameter set	M1
Angle of shearing resistance	$\gamma_{\phi} = 1.00$
Effective cohesion	$\gamma_{c'} = 1.00$
Weight density	$\gamma_{\gamma} = 1.00$

Retained soil properties

Design moist density	$\gamma_{mr}' = \gamma_{mr} / \gamma_{\gamma} = 17 \text{ kN/m}^3$
Design saturated density	$\gamma_{sr}' = \gamma_{sr} / \gamma_{\gamma} = 20.5 \text{ kN/m}^3$
Design effective shear resistance angle	$\phi'_{r,d} = \text{atan}(\tan(\phi'_{r,k}) / \gamma_{\phi}) = 30 \text{ deg}$
Design wall friction angle	$\delta_{r,d} = \text{atan}(\tan(\delta_{r,k}) / \gamma_{\phi}) = 15 \text{ deg}$

Base soil properties

Design soil density	$\gamma_b' = \gamma_b / \gamma_{\gamma} = 17 \text{ kN/m}^3$
Design effective shear resistance angle	$\phi'_{b,d} = \text{atan}(\tan(\phi'_{b,k}) / \gamma_{\phi}) = 30 \text{ deg}$
Design wall friction angle	$\delta_{b,d} = \text{atan}(\tan(\delta_{b,k}) / \gamma_{\phi}) = 15 \text{ deg}$
Design base friction angle	$\delta_{bb,d} = \text{atan}(\tan(\delta_{bb,k}) / \gamma_{\phi}) = 20 \text{ deg}$
Design effective cohesion	$c'_{b,d} = c'_{b,k} / \gamma_{c'} = 0 \text{ kN/m}^2$

Using Coulomb theory

Active pressure coefficient	$K_A = \sin(\alpha + \phi'_{r,d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r,d}) \times [1 + \sqrt{(\sin(\phi'_{r,d} + \delta_{r,d}) \times \sin(\phi'_{r,d} - \beta) / (\sin(\alpha - \delta_{r,d}) \times \sin(\alpha + \beta))}]^2) = 0.301$
Passive pressure coefficient	$K_P = \sin(90 - \phi'_{b,d})^2 / (\sin(90 + \delta_{b,d}) \times [1 - \sqrt{(\sin(\phi'_{b,d} + \delta_{b,d}) \times \sin(\phi'_{b,d} - \beta) / (\sin(90 + \delta_{b,d}))}]^2) = 4.977$

Sliding check

Vertical forces on wall

Wall stem	$F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = 7.5 \text{ kN/m}$
Wall base	$F_{\text{base}} = \gamma_{Gf} \times A_{\text{base}} \times \gamma_{\text{base}} = 14.9 \text{ kN/m}$
Surcharge load	$F_{\text{sur}_v} = (\gamma_{Gf} \times \text{Surcharge}_G + \gamma_{Qf} \times \text{Surcharge}_Q) \times l_{\text{heel}} = 0.6 \text{ kN/m}$
Moist retained soil	$F_{\text{moist}_v} = \gamma_{Gf} \times A_{\text{moist}} \times \gamma_{mr}' = 8.9 \text{ kN/m}$
Total	$F_{\text{total}_v} = F_{\text{stem}} + F_{\text{base}} + F_{\text{sur}_v} + F_{\text{moist}_v} = 31.9 \text{ kN/m}$

Horizontal forces on wall

Surcharge load	$F_{\text{sur}_h} = K_A \times \cos(\delta_{r,d}) \times (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times h_{\text{eff}} = 2.1 \text{ kN/m}$
Moist retained soil	$F_{\text{moist}_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{\text{eff}}^2 / 2 = 9.7 \text{ kN/m}$
Total	$F_{\text{total}_h} = F_{\text{sur}_h} + F_{\text{moist}_h} = 11.8 \text{ kN/m}$

Check stability against sliding

Base soil resistance	$F_{\text{exc}_h} = \gamma_{Gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{\text{pass}} + h_{\text{base}})^2 / 2 = 3.7 \text{ kN/m}$
Base friction	$F_{\text{friction}} = F_{\text{total}_v} \times \tan(\delta_{bb,d}) = 11.6 \text{ kN/m}$
Resistance to sliding	$F_{\text{rest}} = F_{\text{exc}_h} + F_{\text{friction}} = 15.3 \text{ kN/m}$
Factor of safety	$FoS_{\text{sl}} = F_{\text{rest}} / F_{\text{total}_h} = 1.3$

PASS - Resistance to sliding is greater than sliding force

Overturning check

Vertical forces on wall

Wall stem	$F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = 7.5 \text{ kN/m}$
Wall base	$F_{\text{base}} = \gamma_{Gf} \times A_{\text{base}} \times \gamma_{\text{base}} = 14.9 \text{ kN/m}$

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Surcharge load

$$F_{sur_v} = (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times l_{heel} = \mathbf{0.6 \text{ kN/m}}$$

Moist retained soil

$$F_{moist_v} = \gamma_G \times A_{moist} \times \gamma_{mr}' = \mathbf{8.9 \text{ kN/m}}$$

Total

$$F_{total_v} = F_{stem} + F_{base} + F_{sur_v} + F_{moist_v} = \mathbf{31.9 \text{ kN/m}}$$

Horizontal forces on wall

Surcharge load

$$F_{sur_h} = K_A \times \cos(\delta_{r,d}) \times (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times h_{eff} = \mathbf{2.1 \text{ kN/m}}$$

Moist retained soil

$$F_{moist_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 = \mathbf{9.7 \text{ kN/m}}$$

Base soil

$$F_{exc_h} = -\gamma_G \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{pass} + h_{base})^2 / 2 = \mathbf{-3.7 \text{ kN/m}}$$

Total

$$F_{total_h} = F_{sur_h} + F_{moist_h} + F_{exc_h} = \mathbf{8.1 \text{ kN/m}}$$

Overturning moments on wall

Surcharge load

$$M_{sur_OT} = F_{sur_h} \times X_{sur_h} = \mathbf{1.8 \text{ kNm/m}}$$

Moist retained soil

$$M_{moist_OT} = F_{moist_h} \times X_{moist_h} = \mathbf{5.5 \text{ kNm/m}}$$

Total

$$M_{total_OT} = M_{sur_OT} + M_{moist_OT} = \mathbf{7.3 \text{ kNm/m}}$$

Restoring moments on wall

Wall stem

$$M_{stem_R} = F_{stem} \times X_{stem} = \mathbf{11.3 \text{ kNm/m}}$$

Wall base

$$M_{base_R} = F_{base} \times X_{base} = \mathbf{14.9 \text{ kNm/m}}$$

Moist retained soil

$$M_{moist_R} = F_{moist_v} \times X_{moist_v} = \mathbf{16.1 \text{ kNm/m}}$$

Base soil

$$M_{exc_R} = -F_{exc_h} \times X_{exc_h} = \mathbf{0.4 \text{ kNm/m}}$$

Total

$$M_{total_R} = M_{stem_R} + M_{base_R} + M_{moist_R} + M_{exc_R} = \mathbf{42.6 \text{ kNm/m}}$$

Check stability against overturning

Factor of safety

$$FoS_{ot} = M_{total_R} / M_{total_OT} = \mathbf{5.867}$$

PASS - Maximum restoring moment is greater than overturning moment

Bearing pressure check

Vertical forces on wall

Wall stem

$$F_{stem} = \gamma_G \times A_{stem} \times \gamma_{stem} = \mathbf{10.2 \text{ kN/m}}$$

Wall base

$$F_{base} = \gamma_G \times A_{base} \times \gamma_{base} = \mathbf{20.1 \text{ kN/m}}$$

Surcharge load

$$F_{sur_v} = (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times l_{heel} = \mathbf{1.6 \text{ kN/m}}$$

Line loads

$$F_{P_v} = \gamma_Q \times P_{Q1} = \mathbf{15 \text{ kN/m}}$$

Moist retained soil

$$F_{moist_v} = \gamma_G \times A_{moist} \times \gamma_{mr}' = \mathbf{12 \text{ kN/m}}$$

Total

$$F_{total_v} = F_{stem} + F_{base} + F_{sur_v} + F_{P_v} + F_{moist_v} = \mathbf{59 \text{ kN/m}}$$

Horizontal forces on wall

Surcharge load

$$F_{sur_h} = K_A \times \cos(\delta_{r,d}) \times (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times h_{eff} = \mathbf{2.1 \text{ kN/m}}$$

Moist retained soil

$$F_{moist_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 = \mathbf{9.7 \text{ kN/m}}$$

Base soil

$$F_{pass_h} = -\gamma_G \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (d_{cover} + h_{base})^2 / 2 = \mathbf{-3.7 \text{ kN/m}}$$

Total

$$F_{total_h} = \max(F_{sur_h} + F_{moist_h} + F_{pass_h} - F_{total_v} \times \tan(\delta_{bb,d}), 0 \text{ kN/m}) = \mathbf{0 \text{ kN/m}}$$

Moments on wall

Wall stem

$$M_{stem} = F_{stem} \times X_{stem} = \mathbf{15.3 \text{ kNm/m}}$$

Wall base

$$M_{base} = F_{base} \times X_{base} = \mathbf{20 \text{ kNm/m}}$$

Surcharge load

$$M_{sur} = F_{sur_v} \times X_{sur_v} - F_{sur_h} \times X_{sur_h} = \mathbf{1.1 \text{ kNm/m}}$$

Line loads

$$M_P = \gamma_Q \times P_{Q1} \times p_1 = \mathbf{10.5 \text{ kNm/m}}$$

Moist retained soil

$$M_{moist} = F_{moist_v} \times X_{moist_v} - F_{moist_h} \times X_{moist_h} = \mathbf{16.2 \text{ kNm/m}}$$

Base soil

$$M_{pass} = -F_{pass_h} \times X_{pass_h} = \mathbf{0.4 \text{ kNm/m}}$$

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Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{moist} + M_{pass} = \mathbf{63.6 \text{ kNm/m}}$

Check bearing pressure

Distance to reaction $\bar{x} = M_{total} / F_{total_v} = \mathbf{1078 \text{ mm}}$

Eccentricity of reaction $e = \bar{x} - l_{base} / 2 = \mathbf{83 \text{ mm}}$

Loaded length of base $l_{load} = 2 \times (l_{base} - \bar{x}) = \mathbf{1824 \text{ mm}}$

Bearing pressure at toe $q_{toe} = \mathbf{0 \text{ kN/m}^2}$

Bearing pressure at heel $q_{heel} = F_{total_v} / l_{load} = \mathbf{32.3 \text{ kN/m}^2}$

Effective overburden pressure $q = (t_{base} + d_{cover}) \times \gamma'_b = \mathbf{5.1 \text{ kN/m}^2}$

Design effective overburden pressure $q' = q / \gamma_\gamma = \mathbf{5.1 \text{ kN/m}^2}$

Bearing resistance factors $N_q = \text{Exp}(\pi \times \tan(\phi'_{b,d})) \times (\tan(45 \text{ deg} + \phi'_{b,d} / 2))^2 = \mathbf{18.401}$

$N_c = (N_q - 1) \times \cot(\phi'_{b,d}) = \mathbf{30.14}$

$N_\gamma = 2 \times (N_q - 1) \times \tan(\phi'_{b,d}) = \mathbf{20.093}$

Foundation shape factors $S_q = 1$

$S_\gamma = 1$

$S_c = 1$

Load inclination factors $H = F_{sur_h} + F_{moist_h} + F_{pass_h} = \mathbf{8.1 \text{ kN/m}}$

$V = F_{total_v} = \mathbf{59 \text{ kN/m}}$

$m = 2$

$i_q = [1 - H / (V + l_{load} \times c'_{b,d} \times \cot(\phi'_{b,d}))]^m = \mathbf{0.744}$

$i_\gamma = [1 - H / (V + l_{load} \times c'_{b,d} \times \cot(\phi'_{b,d}))]^{(m+1)} = \mathbf{0.642}$

$i_c = i_q - (1 - i_q) / (N_c \times \tan(\phi'_{b,d})) = \mathbf{0.73}$

Net ultimate bearing capacity

$n_f = c'_{b,d} \times N_c \times S_c \times i_c + q' \times N_q \times S_q \times i_q + 0.5 \times \gamma'_b \times l_{load} \times N_\gamma \times S_\gamma \times i_\gamma = \mathbf{269.8 \text{ kN/m}^2}$

Factor of safety

$FoS_{bp} = n_f / \max(q_{toe}, q_{heel}) = \mathbf{8.347}$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

Design approach 1

Partial factors on actions - Table A.3 - Combination 2

Partial factor set A_2

Permanent unfavourable action $\gamma_G = \mathbf{1.000}$

Permanent favourable action $\gamma_{Gf} = \mathbf{1.000}$

Variable unfavourable action $\gamma_Q = \mathbf{1.300}$

Variable favourable action $\gamma_{Qf} = \mathbf{0.000}$

Partial factors for soil parameters – Table A.4 - Combination 2

Soil parameter set M_2

Angle of shearing resistance $\gamma_\phi = \mathbf{1.25}$

Effective cohesion $\gamma_{c'} = \mathbf{1.25}$

Weight density $\gamma_\gamma = \mathbf{1.00}$

Retained soil properties

Design moist density $\gamma_{mr}' = \gamma_{mr} / \gamma_\gamma = \mathbf{17 \text{ kN/m}^3}$

Design saturated density $\gamma_{sr}' = \gamma_{sr} / \gamma_\gamma = \mathbf{20.5 \text{ kN/m}^3}$

Design effective shear resistance angle $\phi'_{r,d} = \text{atan}(\tan(\phi'_{r,k}) / \gamma_\phi) = \mathbf{24.8 \text{ deg}}$

Design wall friction angle $\delta_{r,d} = \text{atan}(\tan(\delta_{r,k}) / \gamma_\phi) = \mathbf{12.1 \text{ deg}}$

Base soil properties

Design soil density $\gamma'_b = \gamma_b / \gamma_\gamma = \mathbf{17 \text{ kN/m}^3}$

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Design effective shear resistance angle

$$\phi'_{b,d} = \text{atan}(\tan(\phi'_{b,k}) / \gamma_{\phi}) = \mathbf{24.8 \text{ deg}}$$

Design wall friction angle

$$\delta_{b,d} = \text{atan}(\tan(\delta_{b,k}) / \gamma_{\phi}) = \mathbf{12.1 \text{ deg}}$$

Design base friction angle

$$\delta_{bb,d} = \text{atan}(\tan(\delta_{bb,k}) / \gamma_{\phi}) = \mathbf{16.2 \text{ deg}}$$

Design effective cohesion

$$c'_{b,d} = c'_{b,k} / \gamma_c = \mathbf{0 \text{ kN/m}^2}$$

Using Coulomb theory

Active pressure coefficient

$$K_A = \sin(\alpha + \phi'_{r,d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r,d}) \times [1 + \sqrt{[\sin(\phi'_{r,d} + \delta_{r,d}) \times \sin(\phi'_{r,d} - \beta) / (\sin(\alpha - \delta_{r,d}) \times \sin(\alpha + \beta))]}]^2) = \mathbf{0.371}$$

Passive pressure coefficient

$$K_P = \sin(90 - \phi'_{b,d})^2 / (\sin(90 + \delta_{b,d}) \times [1 - \sqrt{[\sin(\phi'_{b,d} + \delta_{b,d}) \times \sin(\phi'_{b,d}) / (\sin(90 + \delta_{b,d}))]}]^2) = \mathbf{3.473}$$

Sliding check

Vertical forces on wall

Wall stem

$$F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = \mathbf{7.5 \text{ kN/m}}$$

Wall base

$$F_{\text{base}} = \gamma_{Gf} \times A_{\text{base}} \times \gamma_{\text{base}} = \mathbf{14.9 \text{ kN/m}}$$

Surcharge load

$$F_{\text{sur}_v} = (\gamma_{Gf} \times \text{Surcharge}_G + \gamma_{Qf} \times \text{Surcharge}_Q) \times l_{\text{heel}} = \mathbf{0.6 \text{ kN/m}}$$

Moist retained soil

$$F_{\text{moist}_v} = \gamma_{Gf} \times A_{\text{moist}} \times \gamma_{mr'} = \mathbf{8.9 \text{ kN/m}}$$

Total

$$F_{\text{total}_v} = F_{\text{stem}} + F_{\text{base}} + F_{\text{sur}_v} + F_{\text{moist}_v} = \mathbf{31.9 \text{ kN/m}}$$

Horizontal forces on wall

Surcharge load

$$F_{\text{sur}_h} = K_A \times \cos(\delta_{r,d}) \times (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times h_{\text{eff}} = \mathbf{2.1 \text{ kN/m}}$$

Moist retained soil

$$F_{\text{moist}_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr'} \times h_{\text{eff}}^2 / 2 = \mathbf{8.9 \text{ kN/m}}$$

Total

$$F_{\text{total}_h} = F_{\text{sur}_h} + F_{\text{moist}_h} = \mathbf{11 \text{ kN/m}}$$

Check stability against sliding

Base soil resistance

$$F_{\text{exc}_h} = \gamma_{Gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{\text{pass}} + h_{\text{base}})^2 / 2 = \mathbf{2.6 \text{ kN/m}}$$

Base friction

$$F_{\text{friction}} = F_{\text{total}_v} \times \tan(\delta_{bb,d}) = \mathbf{9.3 \text{ kN/m}}$$

Resistance to sliding

$$F_{\text{rest}} = F_{\text{exc}_h} + F_{\text{friction}} = \mathbf{11.9 \text{ kN/m}}$$

Factor of safety

$$F_{\text{oSsl}} = F_{\text{rest}} / F_{\text{total}_h} = \mathbf{1.078}$$

PASS - Resistance to sliding is greater than sliding force

Overtuning check

Vertical forces on wall

Wall stem

$$F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = \mathbf{7.5 \text{ kN/m}}$$

Wall base

$$F_{\text{base}} = \gamma_{Gf} \times A_{\text{base}} \times \gamma_{\text{base}} = \mathbf{14.9 \text{ kN/m}}$$

Surcharge load

$$F_{\text{sur}_v} = (\gamma_{Gf} \times \text{Surcharge}_G + \gamma_{Qf} \times \text{Surcharge}_Q) \times l_{\text{heel}} = \mathbf{0.6 \text{ kN/m}}$$

Moist retained soil

$$F_{\text{moist}_v} = \gamma_{Gf} \times A_{\text{moist}} \times \gamma_{mr'} = \mathbf{8.9 \text{ kN/m}}$$

Total

$$F_{\text{total}_v} = F_{\text{stem}} + F_{\text{base}} + F_{\text{sur}_v} + F_{\text{moist}_v} = \mathbf{31.9 \text{ kN/m}}$$

Horizontal forces on wall

Surcharge load

$$F_{\text{sur}_h} = K_A \times \cos(\delta_{r,d}) \times (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times h_{\text{eff}} = \mathbf{2.1 \text{ kN/m}}$$

Moist retained soil

$$F_{\text{moist}_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr'} \times h_{\text{eff}}^2 / 2 = \mathbf{8.9 \text{ kN/m}}$$

Base soil

$$F_{\text{exc}_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{\text{pass}} + h_{\text{base}})^2 / 2 = \mathbf{-2.6 \text{ kN/m}}$$

Total

$$F_{\text{total}_h} = F_{\text{sur}_h} + F_{\text{moist}_h} + F_{\text{exc}_h} = \mathbf{8.4 \text{ kN/m}}$$

Overtuning moments on wall

Surcharge load

$$M_{\text{sur}_OT} = F_{\text{sur}_h} \times X_{\text{sur}_h} = \mathbf{1.8 \text{ kNm/m}}$$

Moist retained soil

$$M_{\text{moist}_OT} = F_{\text{moist}_h} \times X_{\text{moist}_h} = \mathbf{5 \text{ kNm/m}}$$

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Total	$M_{total_OT} = M_{sur_OT} + M_{moist_OT} = 6.9 \text{ kNm/m}$
Restoring moments on wall	
Wall stem	$M_{stem_R} = F_{stem} \times X_{stem} = 11.3 \text{ kNm/m}$
Wall base	$M_{base_R} = F_{base} \times X_{base} = 14.9 \text{ kNm/m}$
Moist retained soil	$M_{moist_R} = F_{moist_v} \times X_{moist_v} = 16.1 \text{ kNm/m}$
Base soil	$M_{exc_R} = -F_{exc_h} \times X_{exc_h} = 0.3 \text{ kNm/m}$
Total	$M_{total_R} = M_{stem_R} + M_{base_R} + M_{moist_R} + M_{exc_R} = 42.5 \text{ kNm/m}$
Check stability against overturning	
Factor of safety	$FoS_{ot} = M_{total_R} / M_{total_OT} = 6.204$
PASS - Maximum restoring moment is greater than overturning moment	
Bearing pressure check	
Vertical forces on wall	
Wall stem	$F_{stem} = \gamma_G \times A_{stem} \times \gamma_{stem} = 7.5 \text{ kN/m}$
Wall base	$F_{base} = \gamma_G \times A_{base} \times \gamma_{base} = 14.9 \text{ kN/m}$
Surcharge load	$F_{sur_v} = (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times l_{heel} = 1.3 \text{ kN/m}$
Line loads	$F_{P_v} = \gamma_Q \times P_{Q1} = 13 \text{ kN/m}$
Moist retained soil	$F_{moist_v} = \gamma_G \times A_{moist} \times \gamma_{mr}' = 8.9 \text{ kN/m}$
Total	$F_{total_v} = F_{stem} + F_{base} + F_{sur_v} + F_{P_v} + F_{moist_v} = 45.7 \text{ kN/m}$
Horizontal forces on wall	
Surcharge load	$F_{sur_h} = K_A \times \cos(\delta_{r,d}) \times (\gamma_G \times \text{Surcharge}_G + \gamma_Q \times \text{Surcharge}_Q) \times h_{eff} = 2.1 \text{ kN/m}$
Moist retained soil	$F_{moist_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 = 8.9 \text{ kN/m}$
Base soil	$F_{pass_h} = -\gamma_{gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (d_{cover} + h_{base})^2 / 2 = -2.6 \text{ kN/m}$
Total	$F_{total_h} = \max(F_{sur_h} + F_{moist_h} + F_{pass_h} - F_{total_v} \times \tan(\delta_{bb,d}), 0 \text{ kN/m}) = 0 \text{ kN/m}$
Moments on wall	
Wall stem	$M_{stem} = F_{stem} \times X_{stem} = 11.3 \text{ kNm/m}$
Wall base	$M_{base} = F_{base} \times X_{base} = 14.9 \text{ kNm/m}$
Surcharge load	$M_{sur} = F_{sur_v} \times X_{sur_v} - F_{sur_h} \times X_{sur_h} = 0.5 \text{ kNm/m}$
Line loads	$M_P = \gamma_Q \times P_{Q1} \times p_1 = 9.1 \text{ kNm/m}$
Moist retained soil	$M_{moist} = F_{moist_v} \times X_{moist_v} - F_{moist_h} \times X_{moist_h} = 11 \text{ kNm/m}$
Base soil	$M_{pass} = -F_{pass_h} \times X_{pass_h} = 0.3 \text{ kNm/m}$
Total	$M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{moist} + M_{pass} = 47.1 \text{ kNm/m}$
Check bearing pressure	
Distance to reaction	$\bar{x} = M_{total} / F_{total_v} = 1032 \text{ mm}$
Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 = 37 \text{ mm}$
Loaded length of base	$l_{load} = 2 \times (l_{base} - \bar{x}) = 1917 \text{ mm}$
Bearing pressure at toe	$q_{toe} = 0 \text{ kN/m}^2$
Bearing pressure at heel	$q_{heel} = F_{total_v} / l_{load} = 23.8 \text{ kN/m}^2$
Effective overburden pressure	$q = (t_{base} + d_{cover}) \times \gamma_b' = 5.1 \text{ kN/m}^2$
Design effective overburden pressure	$q' = q / \gamma_\gamma = 5.1 \text{ kN/m}^2$
Bearing resistance factors	$N_q = \text{Exp}(\pi \times \tan(\phi'_{b,d})) \times (\tan(45 \text{ deg} + \phi'_{b,d} / 2))^2 = 10.431$
	$N_c = (N_q - 1) \times \cot(\phi'_{b,d}) = 20.418$
	$N_\gamma = 2 \times (N_q - 1) \times \tan(\phi'_{b,d}) = 8.712$

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Foundation shape factors

$$S_q = 1$$

$$S_\gamma = 1$$

$$S_c = 1$$

Load inclination factors

$$H = F_{sur_h} + F_{moist_h} + F_{pass_h} = 8.4 \text{ kN/m}$$

$$V = F_{total_v} = 45.7 \text{ kN/m}$$

$$m = 2$$

$$i_q = [1 - H / (V + I_{load} \times c'_{b,d} \times \cot(\phi'_{b,d}))]^m = 0.665$$

$$i_\gamma = [1 - H / (V + I_{load} \times c'_{b,d} \times \cot(\phi'_{b,d}))]^{(m+1)} = 0.542$$

$$i_c = i_q - (1 - i_q) / (N_c \times \tan(\phi'_{b,d})) = 0.629$$

Net ultimate bearing capacity

$$n_f = c'_{b,d} \times N_c \times S_c \times i_c + q' \times N_q \times S_q \times i_q + 0.5 \times \gamma'_b \times I_{load} \times N_\gamma \times S_\gamma \times i_\gamma = 112.2 \text{ kN/m}^2$$

Factor of safety

$$FoS_{bp} = n_f / \max(q_{toe}, q_{heel}) = 4.71$$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1 and EN1996-1-1:2005 incorporating Corrigenda dated February 2006 and July 2009 and the UK National Annex

Tedds calculation version 2.9.21

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class

C28/35

Characteristic compressive cylinder strength

$$f_{ck} = 28 \text{ N/mm}^2$$

Characteristic compressive cube strength

$$f_{ck,cube} = 35 \text{ N/mm}^2$$

Mean value of compressive cylinder strength

$$f_{cm} = f_{ck} + 8 \text{ N/mm}^2 = 36 \text{ N/mm}^2$$

Mean value of axial tensile strength

$$f_{ctm} = 0.3 \text{ N/mm}^2 \times (f_{ck} / 1 \text{ N/mm}^2)^{2/3} = 2.8 \text{ N/mm}^2$$

5% fractile of axial tensile strength

$$f_{ctk,0.05} = 0.7 \times f_{ctm} = 1.9 \text{ N/mm}^2$$

Secant modulus of elasticity of concrete

$$E_{cm} = 22 \text{ kN/mm}^2 \times (f_{cm} / 10 \text{ N/mm}^2)^{0.3} = 32308 \text{ N/mm}^2$$

Partial factor for concrete - Table 2.1N

$$\gamma_c = 1.50$$

Compressive strength coefficient - cl.3.1.6(1)

$$\alpha_{cc} = 0.85$$

Design compressive concrete strength - exp.3.15

$$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_c = 15.9 \text{ N/mm}^2$$

Maximum aggregate size

$$h_{agg} = 20 \text{ mm}$$

Ultimate strain - Table 3.1

$$\epsilon_{cu2} = 0.0035$$

Shortening strain - Table 3.1

$$\epsilon_{cu3} = 0.0035$$

Effective compression zone height factor

$$\lambda = 0.80$$

Effective strength factor

$$\eta = 1.00$$

Bending coefficient k_1

$$K_1 = 0.40$$

Bending coefficient k_2

$$K_2 = 1.00 \times (0.6 + 0.0014/\epsilon_{cu2}) = 1.00$$

Bending coefficient k_3

$$K_3 = 0.40$$

Bending coefficient k_4

$$K_4 = 1.00 \times (0.6 + 0.0014/\epsilon_{cu2}) = 1.00$$

Reinforcement details

Characteristic yield strength of reinforcement

$$f_{yk} = 500 \text{ N/mm}^2$$

Modulus of elasticity of reinforcement

$$E_s = 200000 \text{ N/mm}^2$$

Partial factor for reinforcing steel - Table 2.1N

$$\gamma_s = 1.15$$

Design yield strength of reinforcement

$$f_{yd} = f_{yk} / \gamma_s = 435 \text{ N/mm}^2$$

Cover to reinforcement

Top face of base

$$c_{bt} = 50 \text{ mm}$$

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Bottom face of base

$C_{bb} = 75 \text{ mm}$

Masonry details - Section 3.1

Masonry type

Aggregate concrete - Group 1

Normalised mean compressive strength

$f_b = 10.4 \text{ N/mm}^2$

Characteristic flexural strength - cl.6.3.4(1)

$f_{xk} = 0 \text{ N/mm}^2$

Initial shear strength - Table NA.5

$f_{vko} = 0.15 \text{ N/mm}^2$

Mortar details - Section 3.2

Mortar type

General purpose - M4, prescribed mix

Compressive strength of mortar

$f_m = 4 \text{ N/mm}^2$

Ultimate limit states - Table NA.1

Class of execution control

1

Category of manufacture control

1

Partial factor for direct or flexural compression

$\gamma_{Mc} = 2.0$

Partial factor for flexural tension

$\gamma_{Mt} = 2.3$

Partial factor for shear

$\gamma_{Mv} = 2.0$

Characteristic strengths of concrete infill - Table 3.2

Concrete infill strength class

C20/25

Characteristic compressive strength

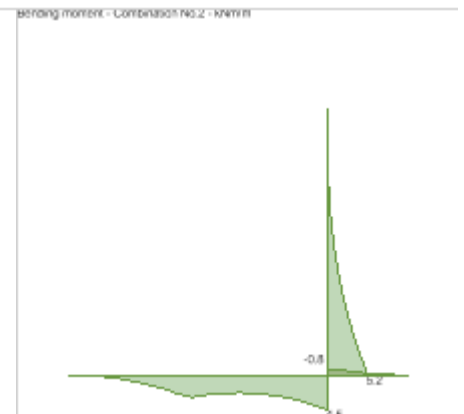
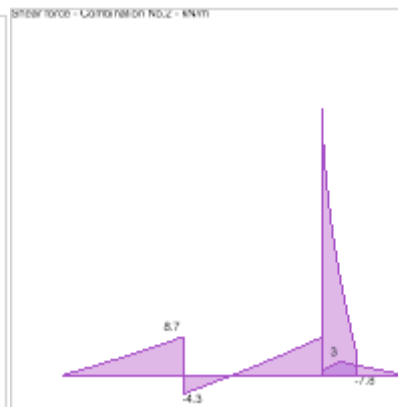
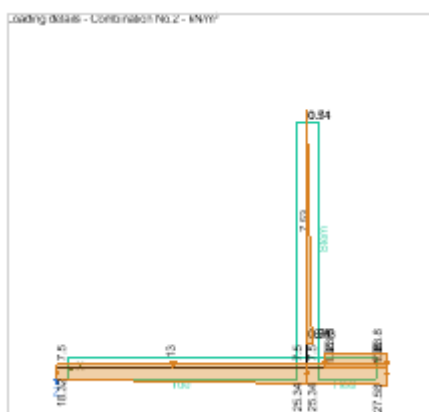
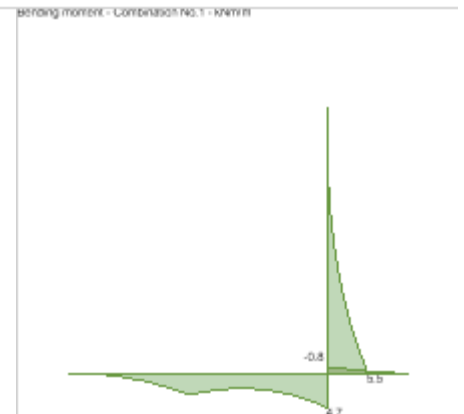
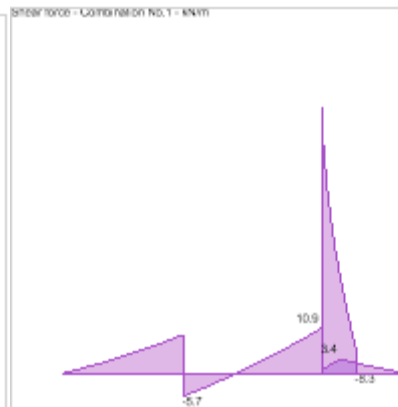
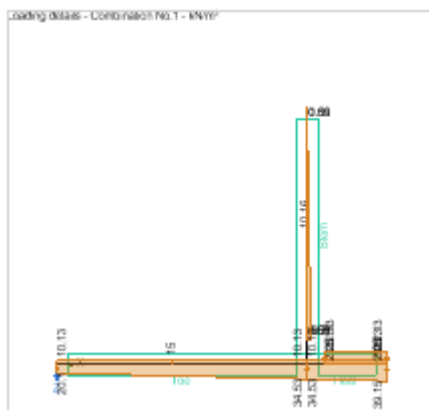
$f_{ck, \text{infill}} = 20 \text{ N/mm}^2$

Characteristic shear strength

$f_{cvk, \text{infill}} = 0.39 \text{ N/mm}^2$

Design shear strength

$f_{cvd, \text{infill}} = f_{cvk, \text{infill}} / \gamma_{Mv} = 0.195 \text{ N/mm}^2$



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Check stem design at base of stem

Depth of section $t = 215 \text{ mm}$

Hollow wall details

Face shell thickness $t_{\text{shell}} = 35 \text{ mm}$

Web shell thickness $t_{\text{web}} = 35 \text{ mm}$

Masonry characteristics

Compressive strength constants - Table NA.4 $K = 0.750$

Characteristic compressive strength - cl.3.6.1.2(1) $f_k = K \times f_b^{0.7} \times f_m^{0.3} = 5.856 \text{ N/mm}^2$

Design compressive strength $f_d = \min(f_k, f_{ck, \text{infill}}) / \gamma_{Mc} = 2.928 \text{ N/mm}^2$

Design flexural strength $f_{xd} = f_{xk} / \gamma_{Mt} = 0 \text{ N/mm}^2$

Height of masonry $h_{wt} = h_{\text{stem}} = 1400 \text{ mm}$

Compressive axial force combination 0 $F_x = \gamma_{Gf} \times \gamma_{\text{stem}} \times h_{wt} \times t = 7.5 \text{ kN/m}$

Moment combination 0 $M_x = \gamma_{Gf} \times \gamma_{\text{stem}} \times h_{wt} \times t^2 / 2 = 0.8 \text{ kNm/m}$

Eccentricity of axial load $e = \max(\text{abs}(t / 2 - M_x / F_x), 0.05 \times t) = 10.8 \text{ mm}$

Capacity reduction factor - exp.6.4 $\Phi = 1 - 2 \times e / t = 0.9$

Design vertical resistance - exp.6.2 $N_{Rd} = \Phi \times t \times f_d = 566.6 \text{ kN/m}$

Design vertical compressive stress $\sigma_d = \min(F_x / t, 0.15 \times N_{Rd} / t) = 0.035 \text{ N/mm}^2$

Apparent design flexural strength - exp.6.16 $f_{xd, \text{app}} = f_{xd} + \sigma_d = 0.035 \text{ N/mm}^2$

Limit of charact. shear strength - exp. 3.1 $f_{vk, \text{lim}} = 0.065 \times f_b = 0.676 \text{ N/mm}^2$

Characteristic shear strength - exp.3.5 $f_{vk} = \min(f_{vko} + 0.4 \times \sigma_d, f_{vk, \text{lim}}) = 0.164 \text{ N/mm}^2$

Design shear strength $f_{vd} = f_{vk} / \gamma_{Mv} = 0.082 \text{ N/mm}^2$

Library item: Masonry characteristics output

Reinforced masonry members subjected to bending, bending and axial loading, or axial loading - Section 6.6

Design bending moment combination 1 $M = 4.3 \text{ kNm/m}$

Tension reinforcement provided 12 dia.bars @ 200 c/c

Area of tension reinforcement provided $A_{sr, \text{prov}} = \pi \times \phi_{sr}^2 / (4 \times S_{sr}) = 565 \text{ mm}^2/\text{m}$

Depth to tension reinforcement $d = 108 \text{ mm}$

Minimum area of reinforcement - cl.8.2.3(1) $A_{sr, \text{min}} = 0.0005 \times d = 54 \text{ mm}^2/\text{m}$

Lever arm - exp.6.23 $z = d \times \min(1 - 0.5 \times A_{sr, \text{prov}} \times f_{yd} / (d \times f_d), 0.95) = 66 \text{ mm}$

Moment of resistance - exp.6.22 and exp.6.24a $M_{Rd} = \min(A_{sr, \text{prov}} \times f_{yd} \times z, 0.4 \times f_d \times d^2) = 13.5 \text{ kNm/m}$

$M / M_{Rd} = 0.316$

PASS - Moment of resistance exceeds applied design moment

Reinforced masonry members subjected to shear loading - Section 6.7

Design shear force $V = 8.291 \text{ kN/m}$

Design shear resistance - exp.6.40 $V_{Rd} = \min(f_{vd}, f_{cvd, \text{infill}}) \times d = 8.815 \text{ kN/m}$

$V / V_{Rd} = 0.941$

PASS - Design shear resistance exceeds applied design shear force

Horizontal reinforcement parallel to face of stem

Minimum area of reinforcement - cl.8.2.3(4) $A_{sx, \text{req}} = 0.0005 \times d = 54 \text{ mm}^2/\text{m}$

Transverse reinforcement provided 12 dia.bars @ 200 c/c

Area of transverse reinforcement provided $A_{sx, \text{prov}} = \pi \times \phi_{sx}^2 / (4 \times S_{sx}) = 565 \text{ mm}^2/\text{m}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section $h = 300 \text{ mm}$

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Rectangular section in flexure - Section 6.1

Design bending moment combination 1

Depth to tension reinforcement

$$M = 3.7 \text{ kNm/m}$$

$$d = h - C_{bb} - \phi_{bb} / 2 = 219 \text{ mm}$$

$$K = M / (d^2 \times f_{ck}) = 0.003$$

$$K' = (2 \times \eta \times \alpha_{cc} / \gamma_c) \times (1 - \lambda \times (\delta - K_1) / (2 \times K_2)) \times (\lambda \times (\delta - K_1) / (2 \times K_2))$$

$$K' = 0.207$$

K' > K - No compression reinforcement is required

Lever arm

$$z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_c))^{0.5}, 0.95) \times d = 208 \text{ mm}$$

Depth of neutral axis

$$x = 2.5 \times (d - z) = 27 \text{ mm}$$

Area of tension reinforcement required

$$A_{bb,req} = M / (f_{yd} \times z) = 40 \text{ mm}^2/\text{m}$$

Tension reinforcement provided

$$12 \text{ dia.bars @ } 200 \text{ c/c}$$

Area of tension reinforcement provided

$$A_{bb,prov} = \pi \times \phi_{bb}^2 / (4 \times S_{bb}) = 565 \text{ mm}^2/\text{m}$$

Minimum area of reinforcement - exp.9.1N

$$A_{bb,min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = 315 \text{ mm}^2/\text{m}$$

Maximum area of reinforcement - cl.9.2.1.1(3)

$$A_{bb,max} = 0.04 \times h = 12000 \text{ mm}^2/\text{m}$$

$$\max(A_{bb,req}, A_{bb,min}) / A_{bb,prov} = 0.557$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Crack control - Section 7.3

Limiting crack width

$$w_{max} = 0.3 \text{ mm}$$

Variable load factor - EN1990 – Table A1.1

$$\psi_2 = 0.6$$

Serviceability bending moment

$$M_{sls} = 2.4 \text{ kNm/m}$$

Tensile stress in reinforcement

$$\sigma_s = M_{sls} / (A_{bb,prov} \times z) = 20.5 \text{ N/mm}^2$$

Load duration

Long term

Load duration factor

$$k_t = 0.4$$

Effective area of concrete in tension

$$A_{c,eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$$

$$A_{c,eff} = 90875 \text{ mm}^2/\text{m}$$

Mean value of concrete tensile strength

$$f_{ct,eff} = f_{ctm} = 2.8 \text{ N/mm}^2$$

Reinforcement ratio

$$\rho_p,eff = A_{bb,prov} / A_{c,eff} = 0.006$$

Modular ratio

$$\alpha_e = E_s / E_{cm} = 6.19$$

Bond property coefficient

$$k_1 = 0.8$$

Strain distribution coefficient

$$k_2 = 0.5$$

$$k_3 = 3.4$$

$$k_4 = 0.425$$

Maximum crack spacing - exp.7.11

$$s_{r,max} = k_3 \times C_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_p,eff = 583 \text{ mm}$$

Maximum crack width - exp.7.8

$$w_k = s_{r,max} \times \max(\sigma_s - k_t \times (f_{ct,eff} / \rho_p,eff) \times (1 + \alpha_e \times \rho_p,eff), 0.6 \times \sigma_s) / E_s$$

$$w_k = 0.036 \text{ mm}$$

$$w_k / w_{max} = 0.12$$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force

$$V = 8.4 \text{ kN/m}$$

$$C_{Rd,c} = 0.18 / \gamma_c = 0.120$$

$$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) = 1.956$$

Longitudinal reinforcement ratio

$$\rho_l = \min(A_{bb,prov} / d, 0.02) = 0.003$$

$$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} = 0.506 \text{ N/mm}^2$$

Design shear resistance - exp.6.2a & 6.2b

$$V_{Rd,c} = \max(C_{Rd,c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$$

$$V_{Rd,c} = 110.9 \text{ kN/m}$$

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$$V / V_{Rd,c} = 0.075$$

PASS - Design shear resistance exceeds design shear force

Check base design at heel

Depth of section

$$h = 300 \text{ mm}$$

Rectangular section in flexure - Section 6.1

Design bending moment combination 1

$$M = 0.6 \text{ kNm/m}$$

Depth to tension reinforcement

$$d = h - c_{bt} - \phi_{bt} / 2 = 244 \text{ mm}$$

$$K = M / (d^2 \times f_{ck}) = 0.000$$

$$K' = (2 \times \eta \times \alpha_{cc} / \gamma_c) \times (1 - \lambda \times (\delta - K_1) / (2 \times K_2)) \times (\lambda \times (\delta - K_1) / (2 \times K_2))$$

$$K' = 0.207$$

K' > K - No compression reinforcement is required

Lever arm

$$z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_c))^{0.5}, 0.95) \times d = 232 \text{ mm}$$

Depth of neutral axis

$$x = 2.5 \times (d - z) = 31 \text{ mm}$$

Area of tension reinforcement required

$$A_{bt,req} = M / (f_{yd} \times z) = 6 \text{ mm}^2/\text{m}$$

Tension reinforcement provided

$$12 \text{ dia. bars @ } 200 \text{ c/c}$$

Area of tension reinforcement provided

$$A_{bt,prov} = \pi \times \phi_{bt}^2 / (4 \times s_{bt}) = 565 \text{ mm}^2/\text{m}$$

Minimum area of reinforcement - exp.9.1N

$$A_{bt,min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = 351 \text{ mm}^2/\text{m}$$

Maximum area of reinforcement - cl.9.2.1.1(3)

$$A_{bt,max} = 0.04 \times h = 12000 \text{ mm}^2/\text{m}$$

$$\max(A_{bt,req}, A_{bt,min}) / A_{bt,prov} = 0.621$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Crack control - Section 7.3

Limiting crack width

$$w_{max} = 0.3 \text{ mm}$$

Variable load factor - EN1990 – Table A1.1

$$\psi_2 = 0.6$$

Serviceability bending moment

$$M_{sls} = 0.4 \text{ kNm/m}$$

Tensile stress in reinforcement

$$\sigma_s = M_{sls} / (A_{bt,prov} \times z) = 3.4 \text{ N/mm}^2$$

Load duration

Long term

Load duration factor

$$k_t = 0.4$$

Effective area of concrete in tension

$$A_{c,eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$$

$$A_{c,eff} = 89833 \text{ mm}^2/\text{m}$$

Mean value of concrete tensile strength

$$f_{ct,eff} = f_{ctm} = 2.8 \text{ N/mm}^2$$

Reinforcement ratio

$$\rho_{p,eff} = A_{bt,prov} / A_{c,eff} = 0.006$$

Modular ratio

$$\alpha_e = E_s / E_{cm} = 6.19$$

Bond property coefficient

$$k_1 = 0.8$$

Strain distribution coefficient

$$k_2 = 0.5$$

$$k_3 = 3.4$$

$$k_4 = 0.425$$

Maximum crack spacing - exp.7.11

$$s_{r,max} = k_3 \times c_{bt} + k_1 \times k_2 \times k_4 \times \phi_{bt} / \rho_{p,eff} = 494 \text{ mm}$$

Maximum crack width - exp.7.8

$$w_k = s_{r,max} \times \max(\sigma_s - k_t \times (f_{ct,eff} / \rho_{p,eff}) \times (1 + \alpha_e \times \rho_{p,eff}), 0.6 \times \sigma_s) / E_s$$

$$w_k = 0.005 \text{ mm}$$

$$w_k / w_{max} = 0.017$$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force

$$V = 3.4 \text{ kN/m}$$

$$C_{Rd,c} = 0.18 / \gamma_c = 0.120$$

$$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) = 1.905$$

 GRADE CONSULTING STRUCTURAL & CIVIL ENGINEERING Grade Consulting Ltd.	Project				Job no.	
	23 Main Rd, Bryncoch				GC-604	
	Calcs for				Start page no./Revision	
	Mr. Richard Cridland				13	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
IG	08/09/2025	IG	08/09/2025	IG	08/09/2025	

Longitudinal reinforcement ratio

$$\rho_l = \min(A_{bt,prov} / d, 0.02) = \mathbf{0.002}$$

$$v_{min} = 0.035 N^{1/2}/mm \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.487 N/mm^2}$$

Design shear resistance - exp.6.2a & 6.2b

$$V_{Rd,c} = \max(C_{Rd,c} \times k \times (100 N^2/mm^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$$

$$V_{Rd,c} = \mathbf{118.9 kN/m}$$

$$V / V_{Rd,c} = \mathbf{0.029}$$

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

Minimum area of reinforcement – cl.9.3.1.1(2)

$$A_{bx,req} = 0.2 \times A_{bb,prov} = \mathbf{113 mm^2/m}$$

Maximum spacing of reinforcement – cl.9.3.1.1(3)

$$S_{bx,max} = \mathbf{450 mm}$$

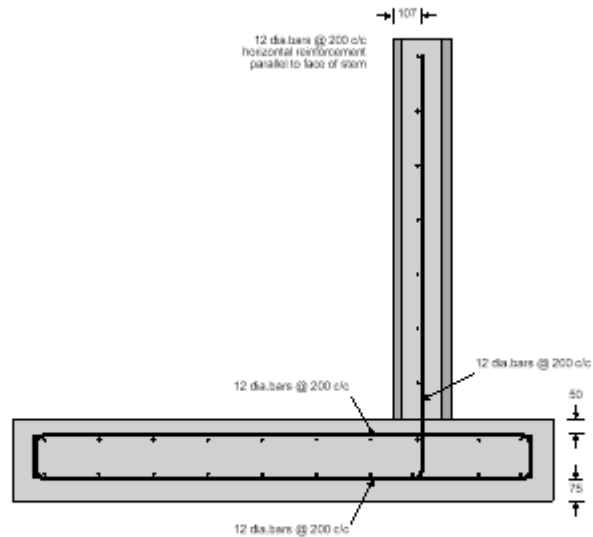
Transverse reinforcement provided

$$\mathbf{12 \text{ dia. bars @ } 200 \text{ c/c}}$$

Area of transverse reinforcement provided

$$A_{bx,prov} = \pi \times \phi_{bx}^2 / (4 \times S_{bx}) = \mathbf{565 mm^2/m}$$

PASS - Area of reinforcement provided is greater than area of reinforcement required



12 dia. bars @ 200 c/c
transverse reinforcement
in base

Reinforcement details

4. OTHER NOTES

All dimensions shall be checked against site dimensions before construction by the Main Contractor. Any discrepancies to be reported to the Engineer.

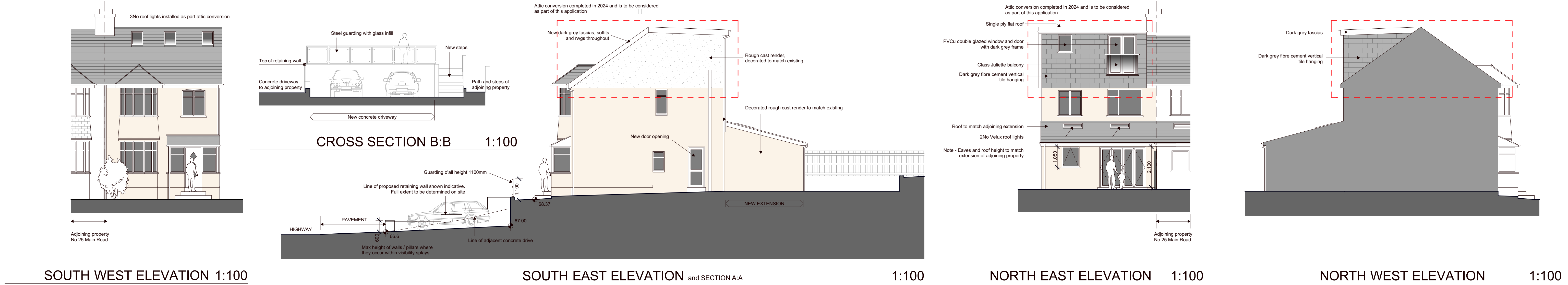
Construction work not to be started until calculations have been approved by Building Control. All construction work should be carried out by a competent builder. The builder is responsible for all temporary supports and is to ensure that the structure is adequately supported during the works.

Walls exceeding 9m long should be provided with intermediate buttressing support (wall, pier, chimney). Intermediate buttressing walls should not be less than 550mm long.

For Domestic clients, the client duties pass on to the Principal Contractor or Sole Contractor. For more information visit www.hse.gov.uk.

23 Main Rd, Bryncoch
September 2025

APPENDIX A



NOTES

GENERAL

- All work is to be carried out in accordance with all current regulations & legislation and to the approval of LA Building Control Officer (BCO).
- All materials, systems etc must be installed in strict accordance with Manufacturers instructions / details

FOUNDATIONS

- Refer to engineers details

BELOW GROUND DRAINAGE

- To the approval of the Local Authority

ABOVE GROUND DRAINAGE

- To fully comply with current Building Regulations Approved Document H and all other relevant legislation and bye-laws

GROUND FLOOR

- Refer to details for typical floor construction.
- DPM to be lapped and sealed to DPC
- U value 0.15w/m²k (compliant with ADL1, November 22)
- Refer to U value calculations

EXTERNAL WALLS

- Refer to details for wall construction
- DPC to be installed at ground level, generally 150mm above external FFL. DPC to be lapped and sealed to DPM.
- Cavities and ties to be kept clear of mortar and other debris.
- Stainless steel wall ties as Ancon Stalfix RT2, Type 2 (length 275mm) or equal to be installed at a density of no less 2.5 ties / m². Generally 900mm horizontal centres and 450mm vertical centres. Ties to be positioned within 225mm of openings and installed at every block course (225mm).
- Insulation retaining clips to be used where partial fill cavity insulation is installed.
- Pre-insulated lintels as IG Hi-Therm+ or similar to be used above all external openings. Trayed DPCs to be fitted above lintels.
- Insulated cavity closers as Thermabate or similar to be used at all jambs and cills of external openings. Closer to suit cavity width.
- U value 0.18w/m²k (compliant with ADL1, November 22)
- Refer to U value calculations

ROOF

- Joist size to be confirmed, sized to suit clear spans. Minimum depth 200mm
- Lateral and vertical restraint to be installed in accordance with Approved Document A, Diagram 16.
- 100 x 50mm Wall plates bedded on mortar and fixed down. Vertical restraint straps to be installed in accordance with Approved Document A, Diagram 16.
- U Value 0.13w/m²k (compliant with ADL1, November 22)
- Refer to U value calculations for build-up

FASCIAS & SOFFITS

- Dark grey PVCu to match existing

WINDOWS (NEW & REPLACEMENT)

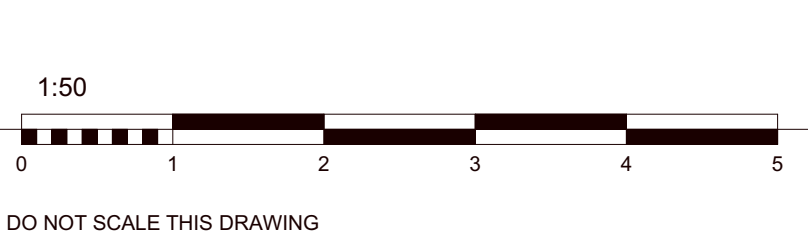
- Dark grey uPVC double glazed windows to match existing
- U Value 1.4w/m²k

BI-FOLD & FRENCH DOORS

- Type to be agreed with client
- U Value 1.4w/m²k

MECHANICAL AND ELECTRICAL

- All work is to be undertaken by suitably qualified professionals and designed and installed in strict accordance with current regulations and legislation.
- Existing heating, water and electrical installation to be extended into new extension
- Electrical installation requirements, layout etc to be agreed with client



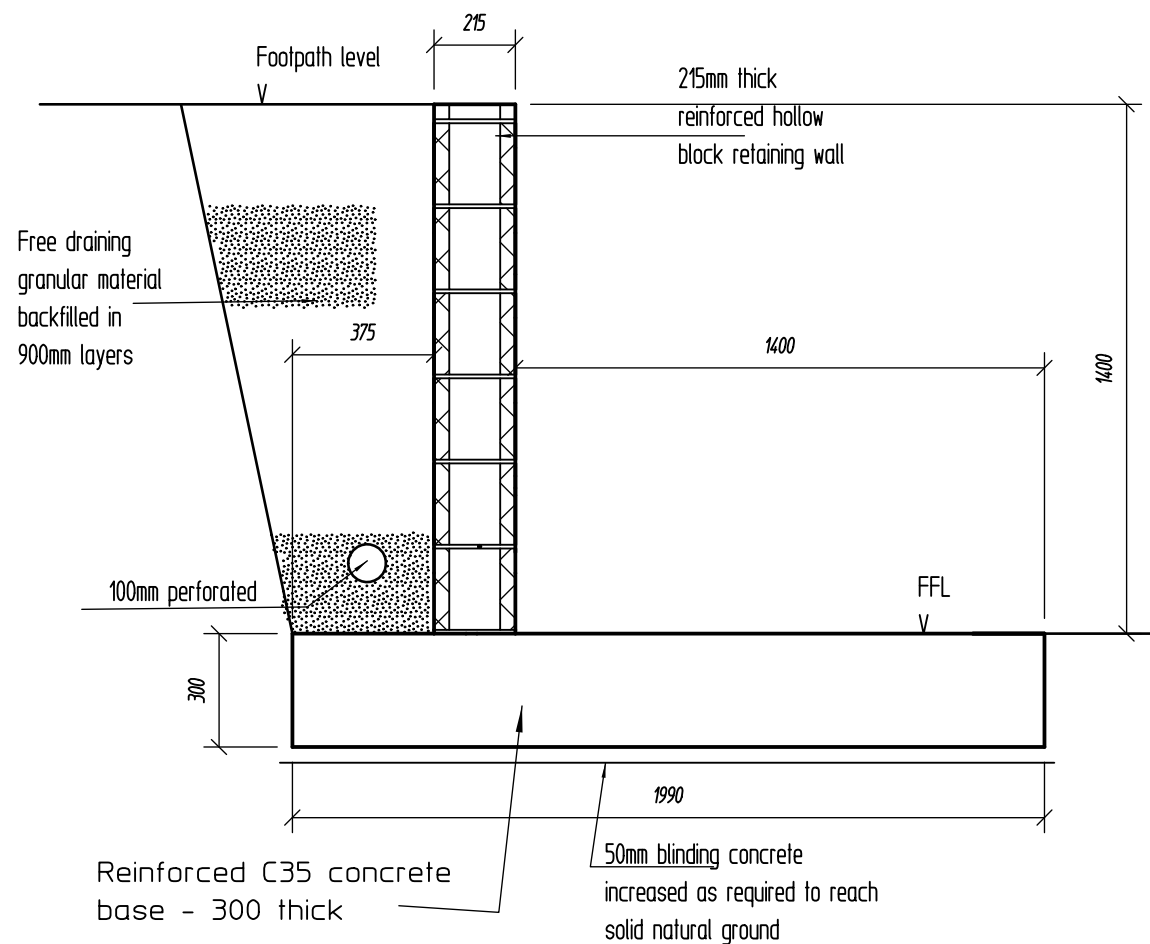
IMPORTANT NOTE

Due to irregularities and variations in wall thicknesses, ceiling heights and floor levels etc, please allow for tolerances in the drawings. Drawings may not be 100% accurate. Dimensions should be checked and verified on site prior to any work commencing.

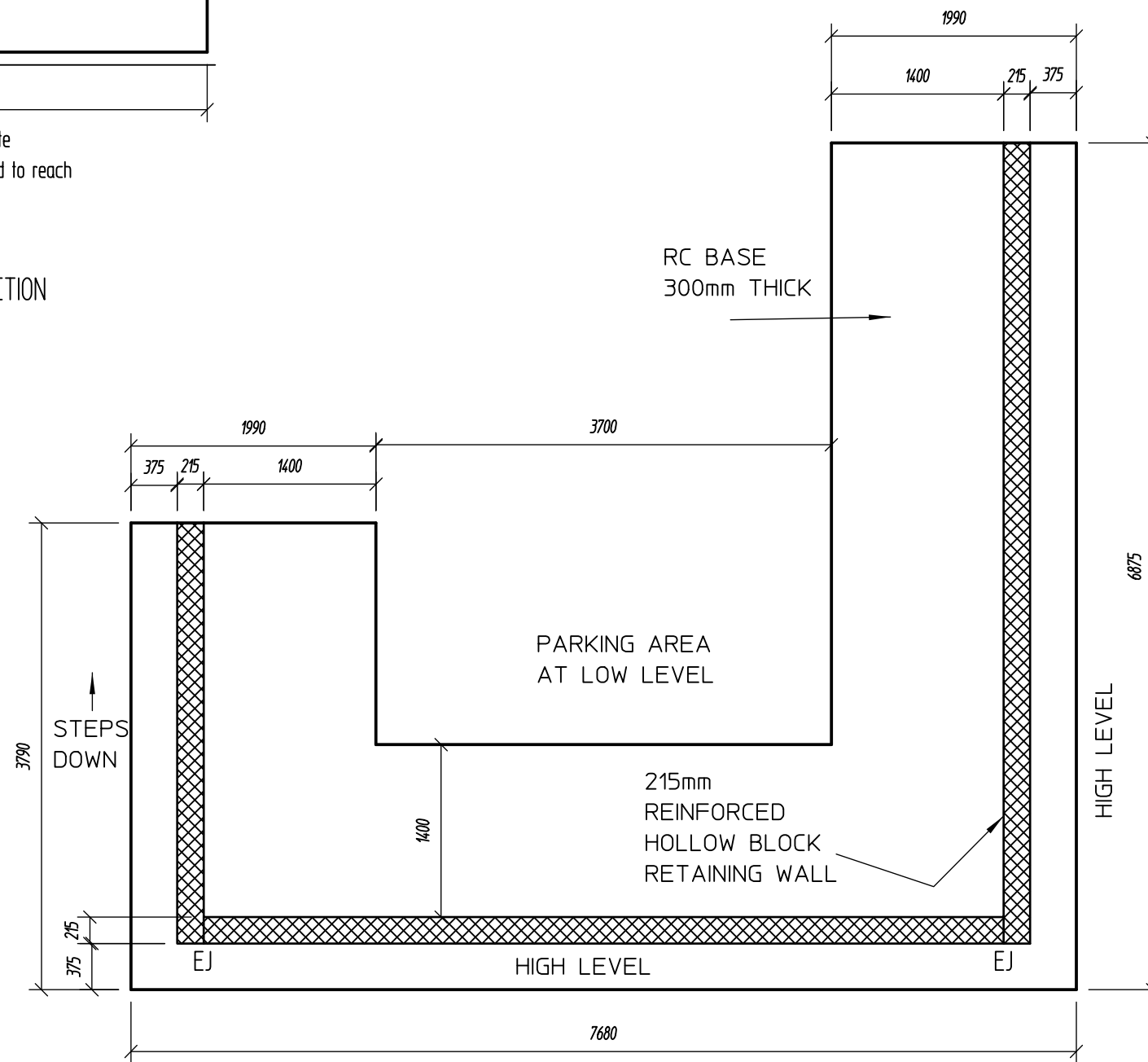
Project 23 Main Road, Bryncoch Mr R Cridland	Project No 2501	Drawing No 101	Revision A
Drawing Description PROPOSED PLANS, ELEVATIONS AND DETAILS	Drawn By	Scale 1:100, 1:50, 1:10 @ A1	Date May 25

23 Main Rd, Bryncoch
September 2025

APPENDIX B



TYPICAL CROSS SECTION



PLAN ON RETAINING WALL

Notes

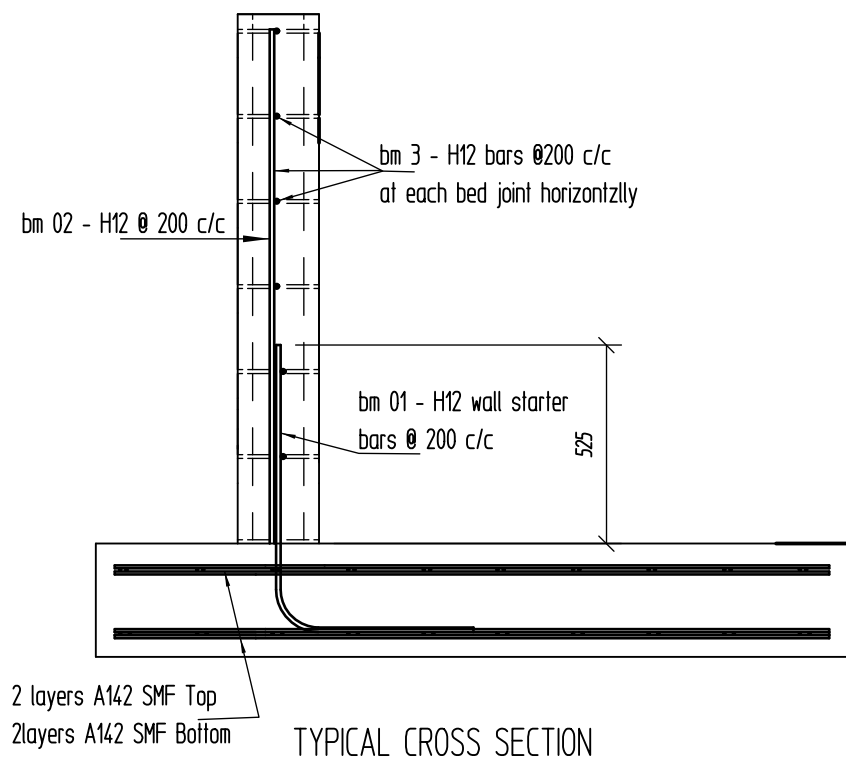
1. All dimensions shall be checked against site dimensions. Any discrepancies to be reported to the Engineer.
2. Concrete for foundation and cavity fill shall be designated mix RC35.
3. Concrete base shall be founded on solid natural ground. any soft spots shall be backfilled in lean-mix concrete.
4. Reinforced base shall sit on 50mm thick blinding concrete.
5. Wall to be constructed in increments of no more than 900mm high and allowed to fully set before hollows are filled with concrete and laying of granular backfilling.
6. 100mm perforated land drain at base level to the rear of the wall with 50mm weepholes at 2m centres along retaining wall.
7. Blockwork shall have a compressible strength of 7N.
8. This drawing to be read in conjunction with Bar Bending Schedule GC-1019 / RX1(S).
9. Reinforcement shall have a minimum concrete cover of 50mm for base and 120mm for wall stem. Minimum lap lengths for bars shall be 42d.
10. Mesh shall be supplied in 4.8 x 2.4m sheets and cut to size on site.
11. Top mesh mat shall be supported off purpose made chairs supplied by Main Contractor.

Rev	Description	Date	Rev by
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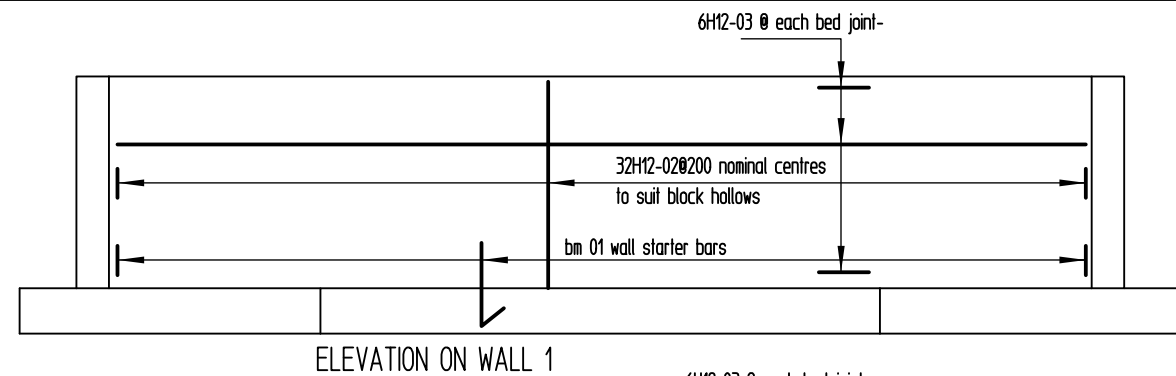


STRUCTURAL & CIVIL ENGINEERING

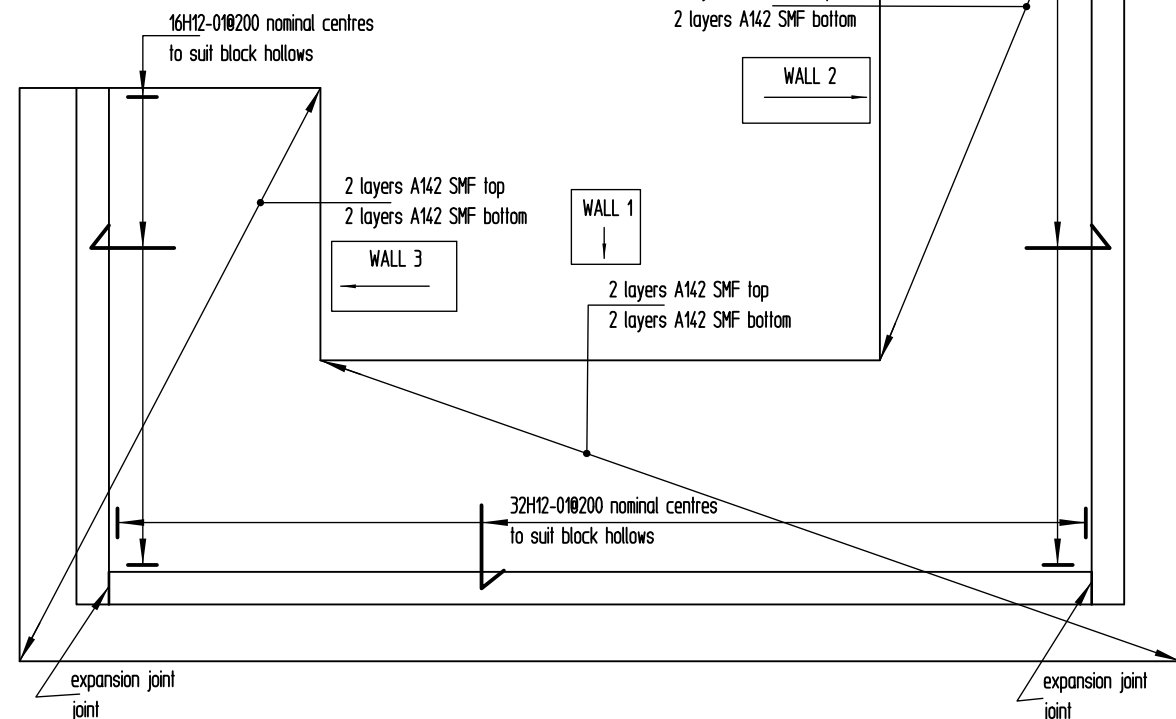
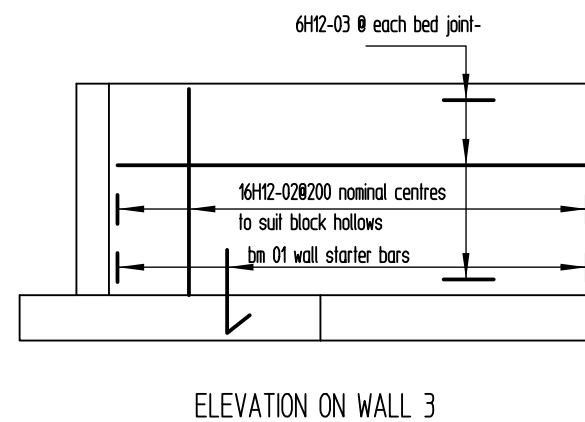
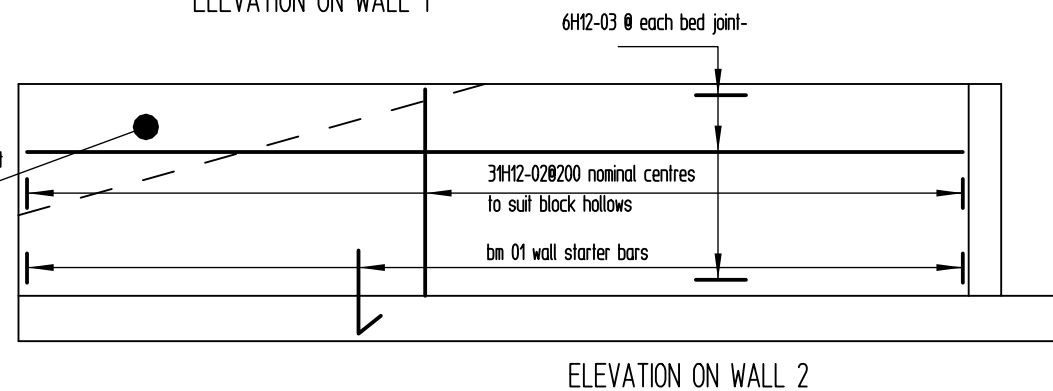
Project	23 MAIN ROAD BRYNCOCH		
Title	DETAILS OF RETAINING WALL AS PROPOSED		
Client			
Status			
Date	09/25		
Drawn by	LD	Checked by	LD
DRAWING Number	GC-604A / BX1		Rev.
Scale	1/50; 1/20		A3



Additional Note
Mesh reinforcement mats in base shall be laid so as to maintain a minimum lap of 400mm and shall be cut to suit on site accordingly.



This section of wall can be reduced as required to suit site levels and reinforcement cut to suit.



Notes

1. All dimensions shall be checked against site dimensions. Any discrepancies to be reported to the Engineer.
2. Concrete for foundation and cavity fill shall be designated mix RC35.
3. Concrete base shall be founded on solid natural ground. any soft spots shall be backfilled in lean-mix concrete.
4. Reinforced base shall sit on 50mm thick blinding concrete.
5. Wall to be constructed in increments of no more than 900mm high and allowed to fully set before hollows are filled with concrete and laying of granular backfilling.
6. 100mm perforated land drain at base level to the rear of the wall with 50mm weepholes at 2m centres along retaining wall.
7. Blockwork shall have a compressible strength of 7N.
8. This drawing to be read in conjunction with Bar Bending Schedule GC-604a / RX1(S).
9. Reinforcement shall have a minimum concrete cover of 50mm for base and 120mm in wall stem. Minimum lap lengths for bars shall be 42d.
10. Mesh shall be supplied in 4.8 x 2.4m sheets and cut to size on site.
11. Top mesh mat shall be supported off purpose made chairs supplied by Main Contractor.

Rev	Description	Date	Rev by
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STRUCTURAL & CIVIL ENGINEERING

Project	23 MAIN ROAD BRYNCOCH		
Title	DETAILS OF RETAINING WALL AS PROPOSED - REINFORCEMENT		
Client			
Status			
Date	09/25		
Drawn by	LD	Checked by	LD
DRAWING Number	GC-604A / RX1		Rev.
Scale	1/50; 1/20		A3

