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Appendices

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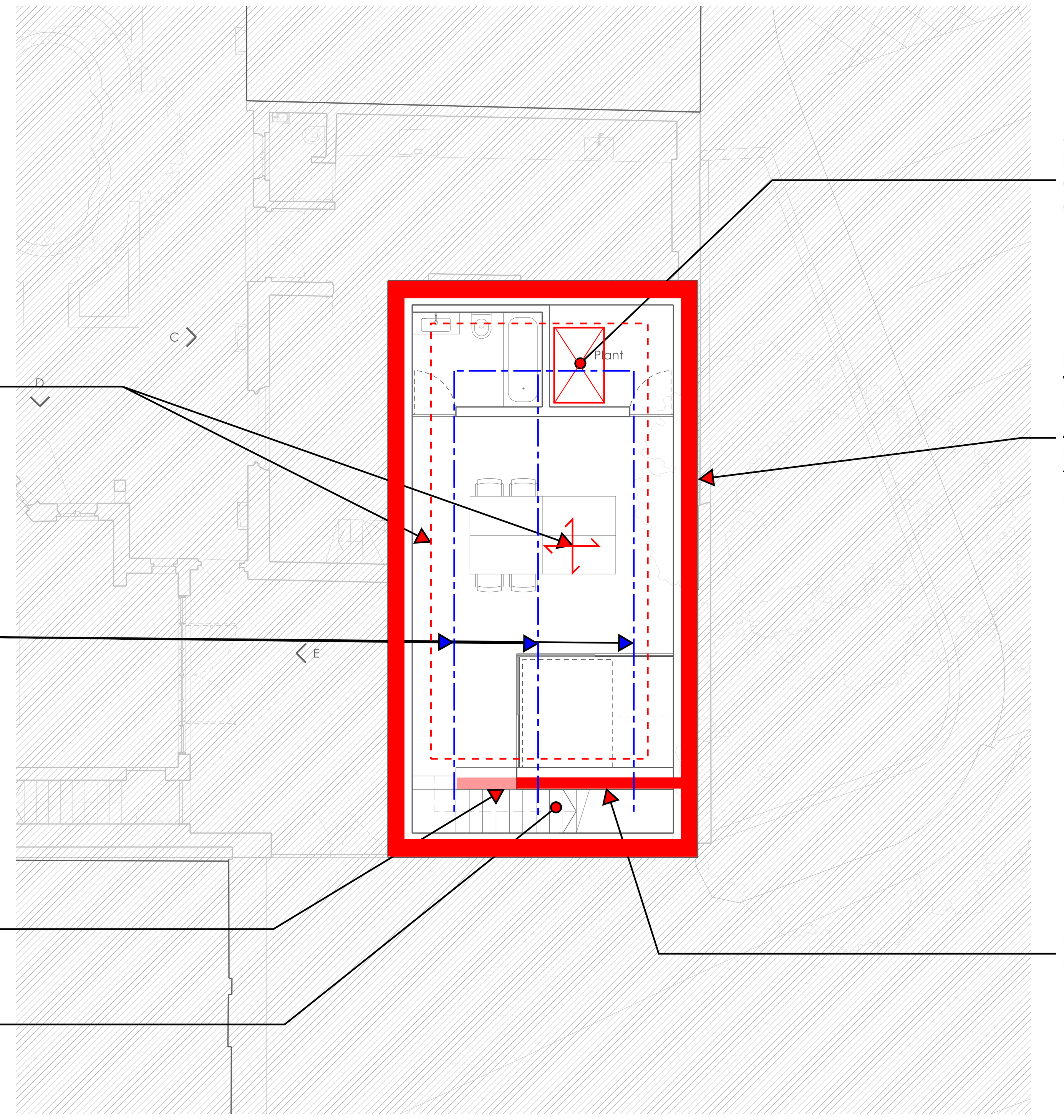
A Proposed Structural Drawings



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Do not scale from this drawing.

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WHERE VIABLE ALL EXISTING TIMBER JOISTS REMOVED AS PART OF THE WORKS SHOULD BE REINSTATED IN PLACE OF NEW JOISTS.

FOR ALL NEW TIMBER FLOORS AND ROOFS ALLOW FOR DOUBLE NOGGINS AND DOUBLE JOISTS AT ALL BOARDED EDGES, NEW WALL PLATES FIXED TO EXISTING MASONRY WITH RESIN ANCHORS @400cc AND NEW BENT AND TWISTED RESTRAINT STRAPS TO FULL PERIMETER @1200cc INSTALLED INTO MASS CONCRETE POCKET PADSTONES.

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ALL NON-LOAD BEARING PARTITIONS SHOULD INCORPERATE A 15mm DEFLECTION HEAD AT THEIR TOP.

ALL STEELWORK IS TO BE GRADE S355.

WHERE STEELWORK IS TO BE BUILT INTO MASONRY EXPOSED TO THE WEATHER, ELEMENT IS TO BE GALVANISED.

ALL GLAZING ELEMENTS ARE TO SPECIALIST DESIGN.

ALL SIZES SUBJECT TO CHANGE DURING DETAILED DESIGN.

ALLOWANCE SHOULD BE MADE FOR MAKING GOOD OF RETAINED STRUCTURE. EXTENT OF ALLOWANCE TO BE QUANITIFIED IN DEFECT LOG BY CONTRACTOR FOLLOWING STRIPOUT.

rev	date	by	chk	description
P1	05/08/22	PDu	WSq	Preliminary

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Project
No.12 & No.13 Primrose Hill Studios

Drawing title
Proposed Basement Plan

Scale (s)	Date	Drawn
1:100@ A1	August 2022	PDu

Drawing status: Preliminary
Status: S2 Revision: P1

Project no. / Originator / Zone / Level / Type / Role / drg no.
2210445-EWP-ZZ-B1-SK-S-0900

APPROPRIATE ENHANCEMENT TO FACILITATE SKYLIGHT OVER. DETAILS TO BE DISCUSSED AND AGREED WITH HERITAGE CONSULTANT AT DETAIL STAGE

REPAIR TO DOUBLE DOOR FLAT ARCH. DETAILS TO BE DISCUSSED AND AGREED WITH HERITAGE CONSULTANT AT DETAIL STAGE

ALLOW FOR 100x100x10 SHS SECTION TO SUPPORT NEW MEZZANINE CONSTRUCTION ABOVE, SUPPORTED OFF BASEMENT CONSTRUCTION. EMBEDDED INTO WALL OR PART OF DOOR CONSTRUCTION.

ALLOW FOR STEPPED MC UNDERPINNING TO EXISTING WALLS PERPENDICULAR TO BASEMENT WALL

POSSIBLE TRENCH FOR NEW CABLING SUBJECT TO CONFIRMATION BY M&E CONSULTANT. SEE CIVILS DRAWINGS FOR BELOW GROUND DRAINAGED PROPOSALS.

250mm THK RC GROUND BEARING SLAB FOR COURTYARD, CAST ON 50mm LEAN MIX BLINDING ON MOT 1 COMPACTED SUBBASE. SUBGRADE TO BE WELL COMPACTED AND SOFT SPOTS REMOVED. CONSIDERATION TO BE MADE FOR DIFFERENTIAL MOVEMENT BETWEEN BASEMENT AND COURTYARD SLAB WITH MOVEMENT JOINT IN FINISHES OR PROVISION FOR CONTINUITY OVER BASEMENT WALL.

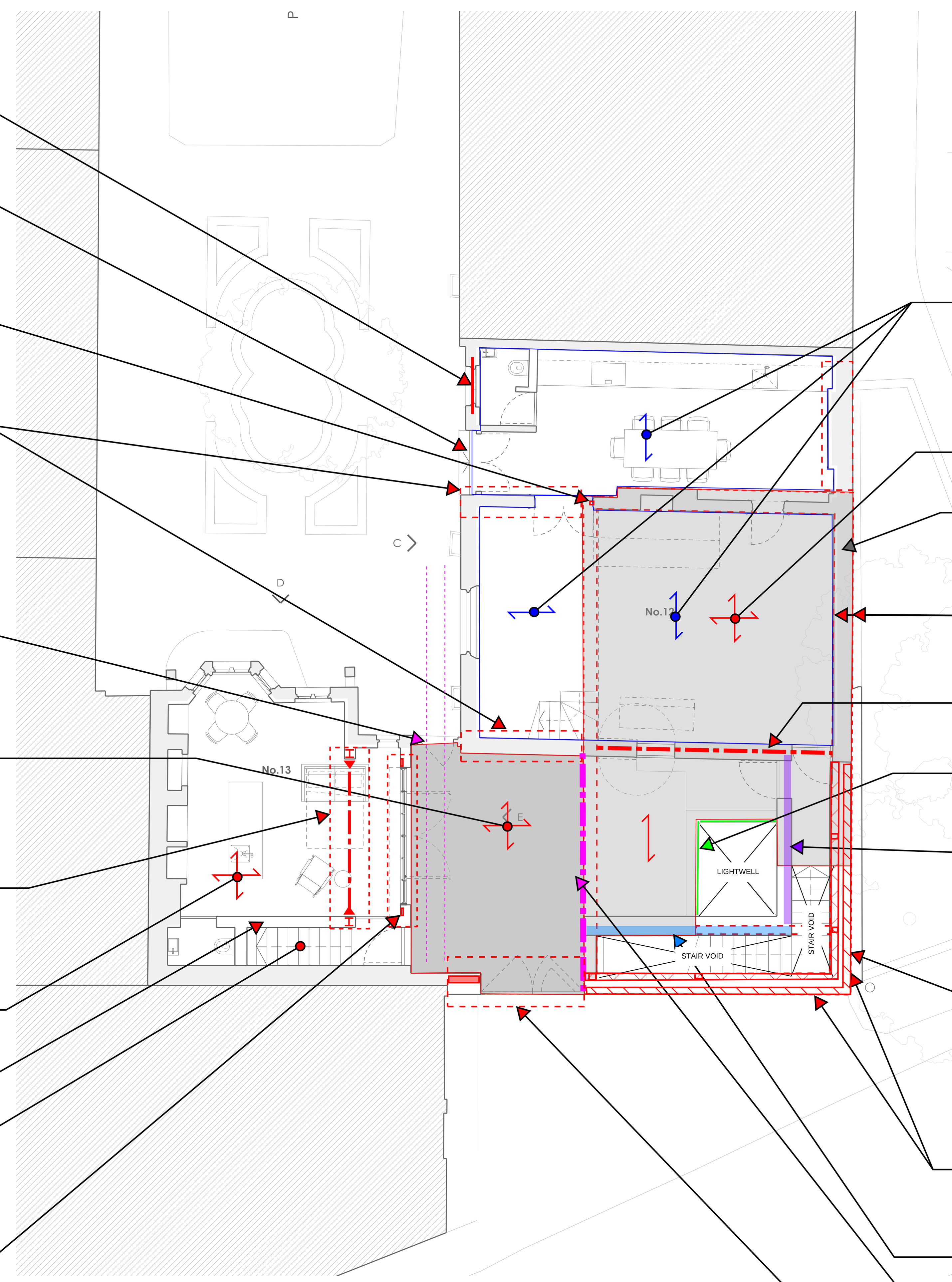
NEW BOX FRAME TO FORM NEW OPENING FORM WITH 203UC86 COLUMNS AND 203UC86 BASE BEAM. BASE BEAM TO BE D49 MESH WRAPPED AND ENCASED IN CONCRETE, 75mm COVER. BASE BEAM FORM ON 1000W x 1000Dp (MINIMUM) MASS CONCRETE STRIP FOUNDATION.

EXISTING GROUND FLOOR CONSTRUCTION TO BE INSPECTED WITH THE INTENTION TO RETAIN

NEW NON-LOAD BEARING PARTITIONS TO BE FORMED OF TIMBER STUD OR SFS

NEW TIMBER STAIRCASE BY OTHERS

FLAT PLATE OR SMALL RHS COLUMNS RECESSED AND RESIN ANCHORED INTO WALL. NEW UNDERPINNING / FOUNDATION BELOW TO SUPPOT COLUMNS AND INCREASE DEPTH TO FACILITATE M&E TRENCH.



NEW 200x50 C24 TIMBER JOISTS OR EXISTING REFURBISHED AND REINSTRATED @ 400cc w/ 18mm PLY. JOISTS TO OVERSAIL BASEMENT CONSTRUCTION, BUILT OFF DWARF WALLS.

250mm THK RC SLAB CAPPING BASEMENT, SUPPORTING GF JOISTS.

EXISTING MASONRY WALLS TO BE RETAINED

EXTENT OF BASEMENT WALLS UNDER. THICKNESS TO MATCH WALL OVER, 300mm MIMIMUM.

MINIMUM 400W x 500Dp RC BEAM UNDER EXISTING WALL. COULD BE FORMED USING EITHER WITH PLUNGE COLUMNS AND NEEDLES OR AS PYNFORD BEAM.

NONSTRUCTURAL BALUSTRADE TO COURTYARD LIGHTWELL TO BASEMENT.

150mm THK CONCRETE WALL TO STAIRCASE FORMING BEAM SPANNING TO NEW RC BEAM WITHIN SLAB BUILD UP. LIGHT WEIGHT BUILD UP OVER. CLAD TO ARCHITECTS DETAILS. DROP TOC TO FACILITATE DOOR WAY.

NEW CAVITY WALL CONSTRUCTION WITH INTERNAL 100mm THK BLOCKWORK, RESTRAINED BY 100x100 SHS BOX SECTION WIND POSTS @MAX 2.4m cc. EXTERNAL LEAF TO ARCHITECTS DETAILS BUT ASSUMED LIME MORTAR MASONRY TO MATCH EXISTING. BED JOINT REINFORCEMENT REQUIRED.

RC CAPPING BEAM CAST WITHIN BASEMENT WALL TO RESTRAIN HEAD OF WALL AROUND STAIRCASE VOID

200mm THK RC WALL ACTING AS DEEP BEAM SUPPORTING SLAB, SPANNING WALL TO WALL. CLAD TO ARCHITECTS DETAILS.

POSSIBLE MOVEMENT JOINT

ALLOW FOR STEPPED MC UNDERPINNING TO EXISTING WALLS PERPENDICULAR TO BASEMENT WALL

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P1	05/08/22	PDu	WSq	Preliminary

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Project
No.12 & No.13 Primrose Hill Studios

Drawing title
Proposed Ground Floor Plan

Scale (s)	Date	Drawn
1:100@ A1	August 2022	PDu

Drawing status	Status	Revision
Preliminary	S2	P1

Project no.	Originator	Zone	Level	Type	Role	drg no.
2210445	EWP	ZZ	00	SK	S	1000

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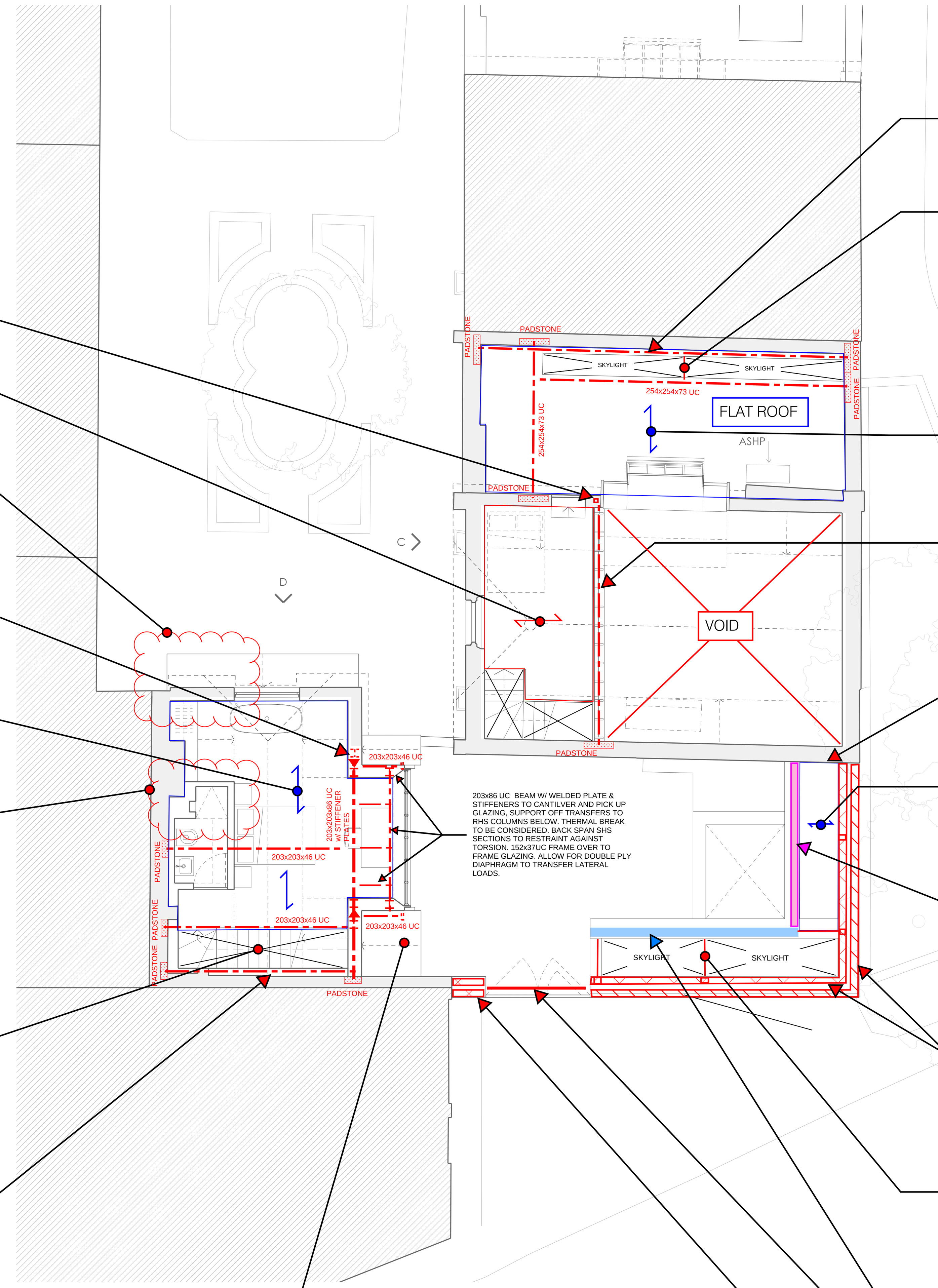

ALLOW FOR 100x100x10 SHS SECTION TO SUPPORT NEW MEZZANINE CONSTRUCTION

NEE STEEL SLIM DECK MEZZANINE FORMED WITH 80x80 SHS JOISTS @400cc. ALLOW FOR 120x80 CRANKED RHS SECTION TO TRIM STAIRCASE VOID.

ASSUMED EXISTING TIMBER BRESSUMER BEAM OVER BAY WINDOW, ALLOW FOR REPLACEMENT WITH PRECAST LINTEL SUBJECT TO INVESTIGATION

STABILITY FRAME CONTINUES WITH 203x86UC FROM 1st to ROOF. MAIN BEAM ACTS AS TRANSFER. COLUMNS FROM 1st TO ROOF INBOARD OF GF TO 1st COLUMNS.

NEW 200x50 C24 TIMBER JOISTS @300cc w/ 18mm THK PLY

CONSIDERATION IS TO BE MADE FOR ANY VARIATION IN TOJ LEVEL REQUIRED TO FACILITATE BATHROOM INSTALLATION

NEW TIMBER STAIRCASE BY OTHERS

STEEL WALING BEAM ALONG PARTY WALL LINE TO RESTRAIN WALL AND ALLOW FOR FORMATION OF NEW STAIR OPENING

ALLOWANCE FOR STEEL AND TIMBER CANOPY. DETAILS TBC.

PFC WALING BEAM TO RESTRAINT PARTY WALL ALONG SKYLIGHT VOID. FIXED WITH RESIN ANCHORS @400cc WITH EMBEDMENT LIMITED TO HALF THE WALL THICKNESS

NEW SKYLIGHTSWITH CROSS SPANNING STEELWORK TO RESTRAIN PARTY WALL

NEW 200x50 C24 TIMBER ROOF JOISTS @ 400cc w/ 18mm PLY.

STEEL BALUSTRADE TRUSS, TO SUPPORT MEZZANINE DECKING. VISUAL INTENT TO BE DETERMINED

NEW WALLS TO BE TIED TO EXISTING MASONRY WALL WITH ANCON STAIFIC MASONRY STARTER SYSTEM WITH SLEEVED TIED AT 225mm cc. ALLOW FOR 10mm MOVEMENT JOINT BETWEEN NEW AND EXISTING MASONRY. ROOF DIAPHRAGM FIXED INTO EXISTING MASONRY VIA NEW WALL PLATE AND RESIN ANCHORS @400cc

NEW 150x50 C24 TIMBER ROOF JOISTS @400cc SHEATHED w/ 18mm THK PLY.

LIGHTWEIGHT TIMBER STUD OR SFS CONSTRUCTION OVER CONCRETE BALUSTRADE WITH SHS WIND POSTS. CLAD IN ACCORDANCE WITH ARCHITECTS DETAILS.

NEW CAVITY WALL WITH PARAPET CONSTRUCTION WITH INTERAL 100mm THK BLOCKWORK, RESTRAINED BY 100x100 SHS BOX SECTION WIND POSTS @MAX 2.4m cc. EXTERNAL LEAF TO ARCHITECTS DETAILS BUT ASSUMED LIME MORTAR MASONRY TO MATCH EXISTING. BED JOINT REINFORCEMENT REQUIRED.

NEW SKYLIGHTS OVER STAIRCASE WITH CROSS SPANNING STEELWORK TO TRANSFER PORTALISED STABILITY LOADS OR STRUT ONTO CONCRETE WALL

200mm THK RC WALL ACTING AS DEEP BEAM, WITH RC COLUMNS WITHIN SECTION TO ACT AS WINDPOSTS. CLAD IN ACCORDANCE WITH ARCHITECTS SPECIFICATIONS

NEW CATNIC OF BESPOKE LINTEL TO ACHIEVE ARCHITECTS INTENT FOR COURTYARD OPENING

NEW WALL CONSTRUCTION WITH OPENING TO BE TIED TO EXISTING WALL WITH ANCON STAFIC STARTER SYSTEM WITH SLEEVED TIES AY 225mm cc. ALLOW FOR 10mm MOVEMENT JOINT.

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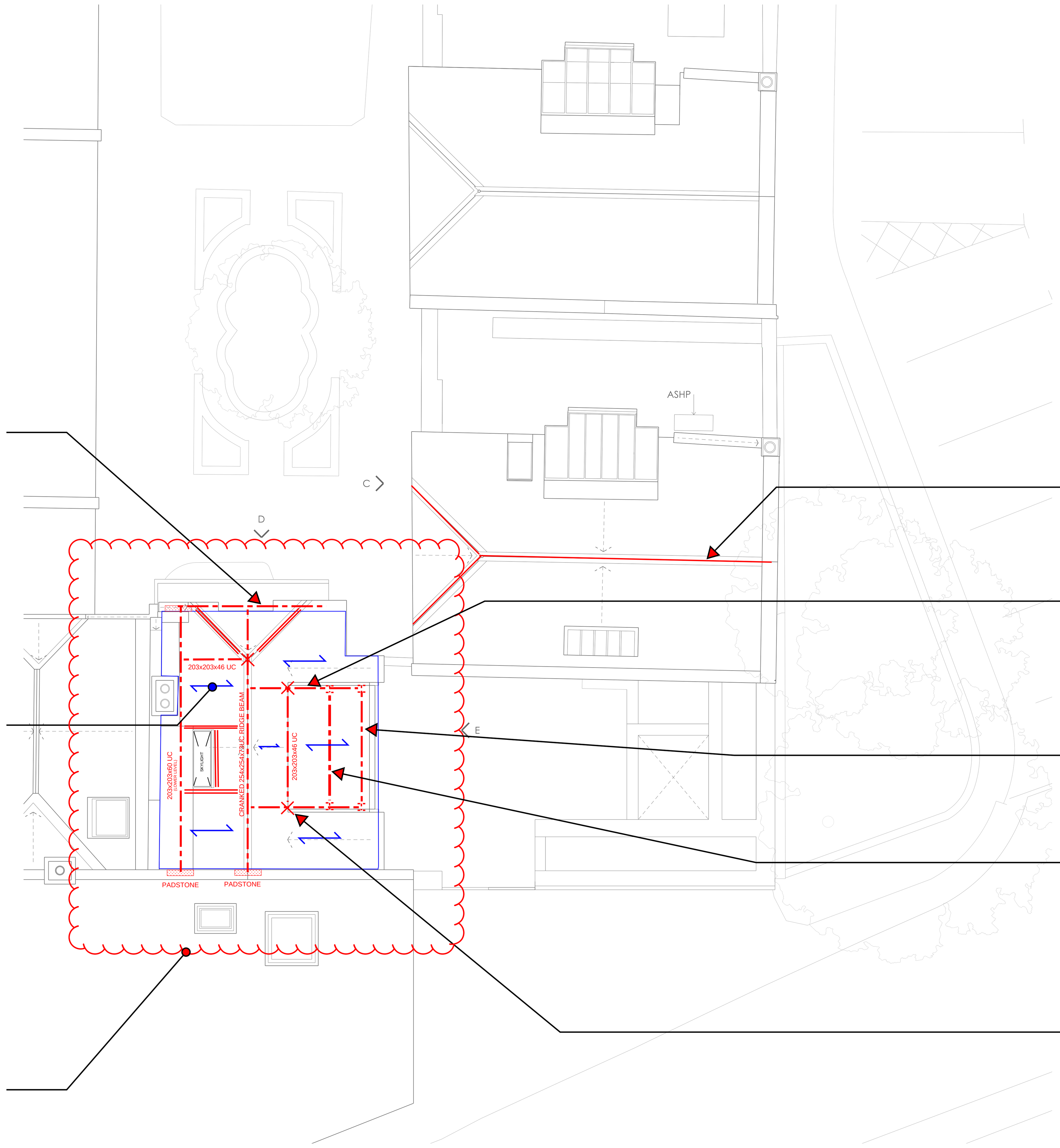
Project
No.12 & No.13 Primrose Hill Studios

Drawing title
Proposed First Floor Plan

Scale (s)	Date	Drawn
1:100@ A1	August 2022	PDu

Drawing status: Preliminary — Status S2 — Revision P1

Project no. / Originator / Zone / Level / Type / Role / drg no.
2210445-EWP-ZZ-01-SK-S-1100



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P1	08/07/22	PDu	WSq	Preliminary

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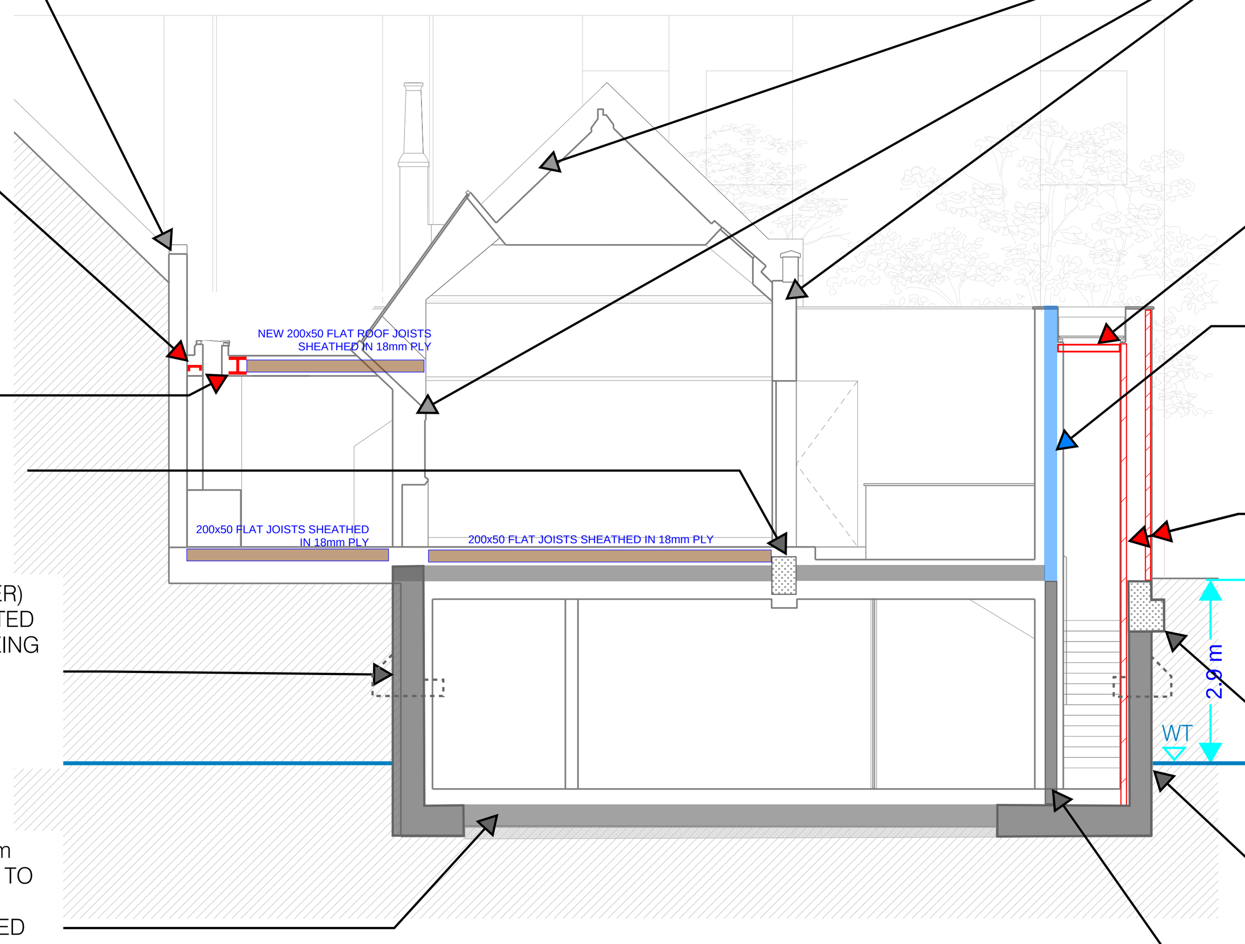
Project
No.12 & No.13 Primrose Hill Studios

Drawing title
Proposed Roof Plan

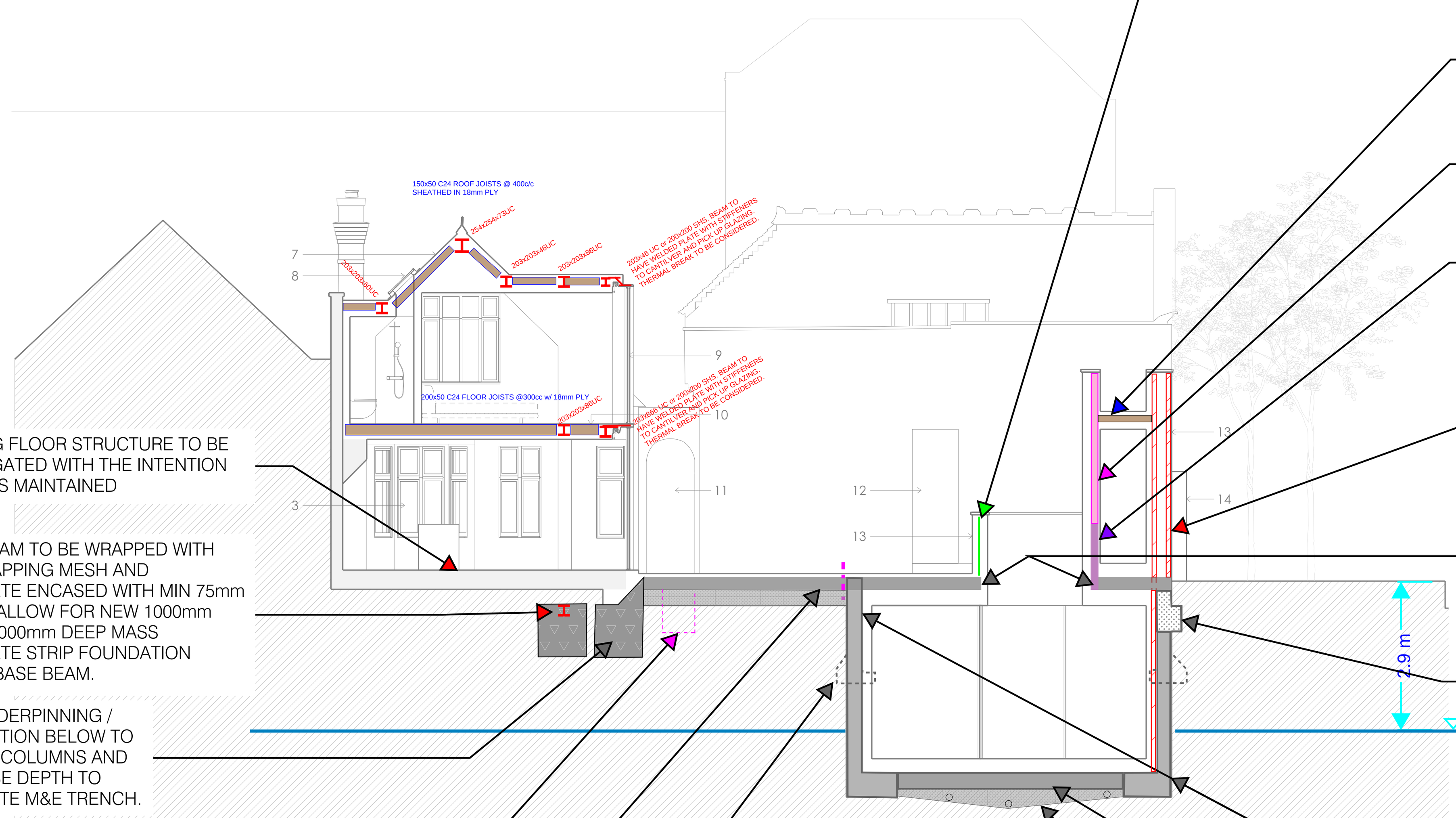
Scale (s)	Date	Drawn
1:100@ A1	July 2022	PDu

Drawing status	Status	Revision
Preliminary	S2	P1

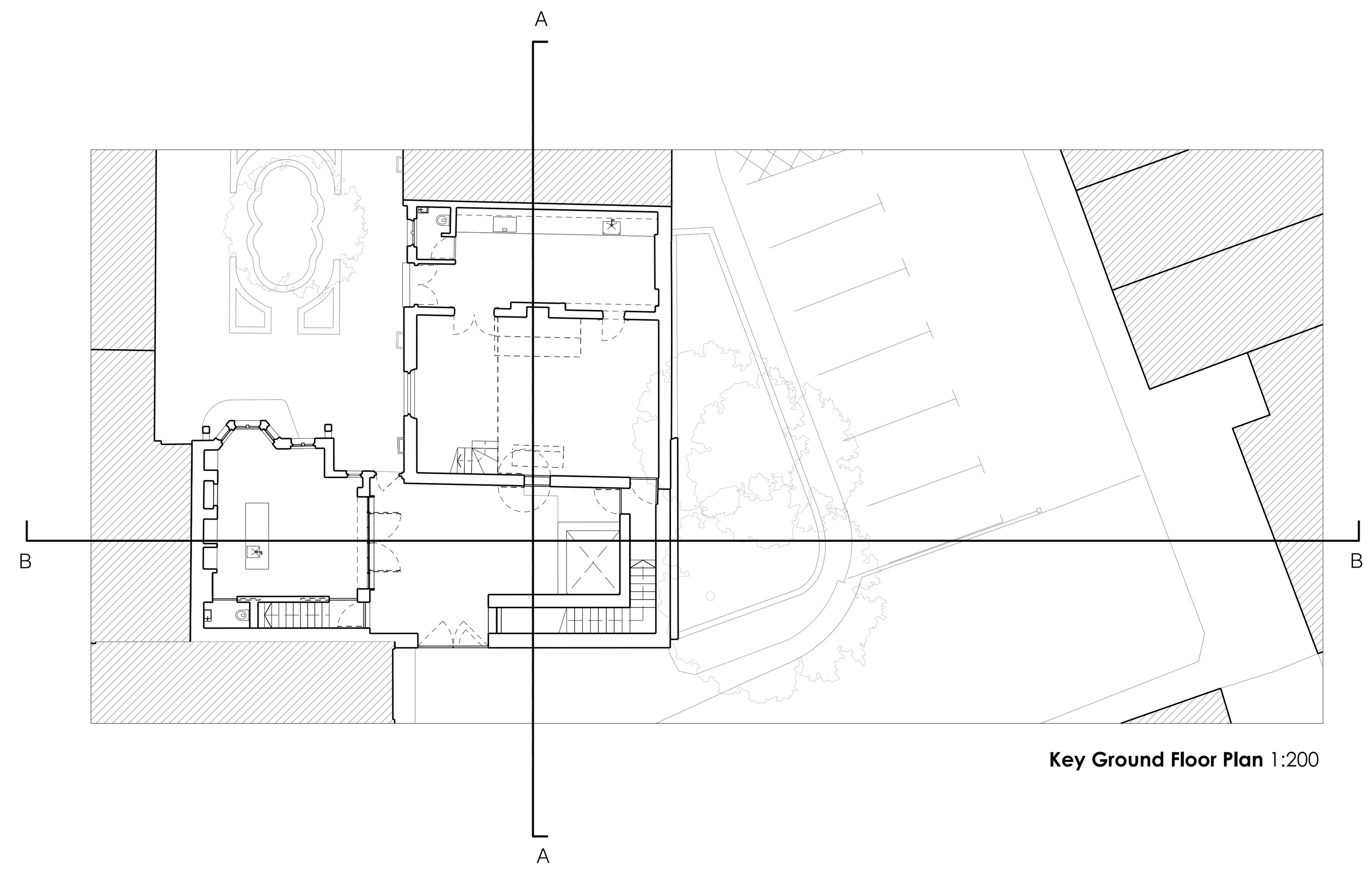
Project no.	Originator	Zone	Level	Type	Role	drg no.
2210445	EWP	ZZ	01	SK	S	1200



Section AA



Section BB



Key Ground Floor Plan 1:200

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Project
No.12 & No.13 Primrose Hill Studios

Drawing title
Sections

Scale (s)	Date	Drawn
1:100@ A1	August 2022	PDu

Drawing status	Status	Revision
Preliminary	S2	P1

Project no. Originator Zone Level Type Role drg no.
2210445-EWP-ZZ-XX-SK-S-2000

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 2.9.11

Retaining wall details

Stem type	Propped cantilever
Stem height	h_{stem} = **4000** mm
Prop height	h_{prop} = **3900** mm
Stem thickness	t_{stem} = **300** mm
Angle to rear face of stem	α = **90** deg
Stem density	γ_{stem} = **25** kN/m^3
Toe length	l_{toe} = **1000** mm
Base thickness	t_{base} = **500** mm
Base density	γ_{base} = **25** kN/m^3
Height of retained soil	h_{ret} = **4000** mm
Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm

Retained soil properties

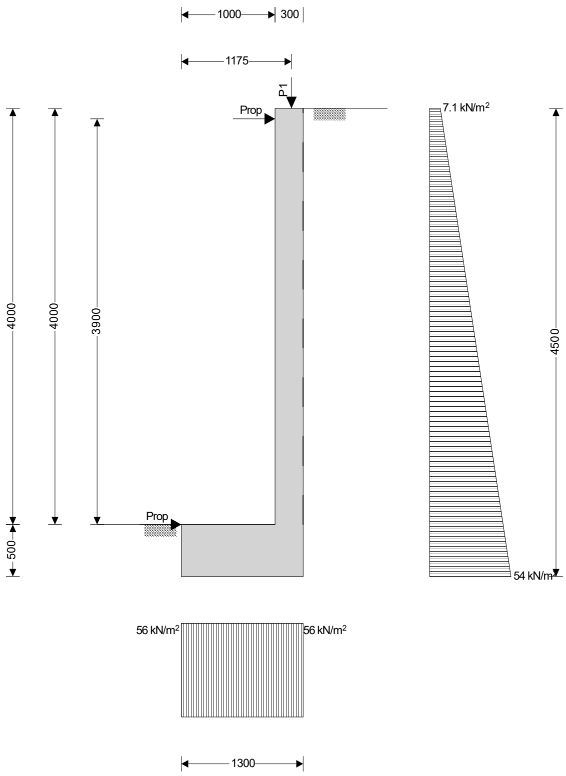
Soil type	Stiff clay
Moist density	γ_{mr} = **19** kN/m^3
Saturated density	γ_{sr} = **19** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{r.k}$ = **18** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **9** deg

Base soil properties

Soil type	Stiff or hard glacial clay
Soil density	γ_b = **21** kN/m^3
Characteristic cohesion	$c'_{b.k}$ = **0** kN/m^2
Characteristic effective shear resistance angle	$\phi'_{b.k}$ = **18** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **9** deg
Characteristic base friction angle	$\delta_{bb.k}$ = **12** deg

Loading details

Variable surcharge load	$Surcharge_Q$ = **10** kN/m^2
Vertical line load at 1175 mm	P_{G1} = **20** kN/m
	P_{Q1} = **5** kN/m



General arrangement

Calculate retaining wall geometry

Base length	$l_{base} = l_{toe} + t_{stem} = \mathbf{1300}$ mm
Moist soil height	$h_{moist} = h_{soil} = \mathbf{4000}$ mm
Length of surcharge load	$l_{sur} = l_{heel} = \mathbf{0}$ mm
- Distance to vertical component	$x_{sur\_v} = l_{base} - l_{heel} / 2 = \mathbf{1300}$ mm
Effective height of wall	$h_{eff} = h_{base} + d_{cover} + h_{ret} = \mathbf{4500}$ mm
- Distance to horizontal component	$x_{sur\_h} = h_{eff} / 2 = \mathbf{2250}$ mm
Area of wall stem	$A_{stem} = h_{stem} \times t_{stem} = \mathbf{1.2}$ m^2
- Distance to vertical component	$x_{stem} = l_{toe} + t_{stem} / 2 = \mathbf{1150}$ mm
Area of wall base	$A_{base} = l_{base} \times t_{base} = \mathbf{0.65}$ m^2
- Distance to vertical component	$x_{base} = l_{base} / 2 = \mathbf{650}$ mm

Design approach 1

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

Partial factor set	A1
Permanent unfavourable action	$\gamma_G = \mathbf{1.35}$
Permanent favourable action	$\gamma_{Gf} = \mathbf{1.00}$
Variable unfavourable action	$\gamma_Q = \mathbf{1.50}$
Variable favourable action	$\gamma_{Qf} = \mathbf{0.00}$

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	γ_{γ} = **1.00**

Library item Partial factors output

Retained soil properties

Design moist density	$\gamma_{mr}' = \gamma_{mr} / \gamma_{\gamma}$ = **19** kN/m^3
Design saturated density	$\gamma_{sr}' = \gamma_{sr} / \gamma_{\gamma}$ = **19** kN/m^3
Design effective shear resistance angle	$\phi'_{r.d} = \text{atan}(\tan(\phi'_{r.k}) / \gamma_{\phi'})$ = **18** deg
Design wall friction angle	$\delta_{r.d} = \text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'})$ = **9** deg

Base soil properties

Design soil density	$\gamma_b' = \gamma_b / \gamma_{\gamma}$ = **21** kN/m^3
Design effective shear resistance angle	$\phi'_{b.d} = \text{atan}(\tan(\phi'_{b.k}) / \gamma_{\phi'})$ = **18** deg
Design wall friction angle	$\delta_{b.d} = \text{atan}(\tan(\delta_{b.k}) / \gamma_{\phi'})$ = **9** deg
Design base friction angle	$\delta_{bb.d} = \text{atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'})$ = **12** deg
Design effective cohesion	$c'_{b.d} = c'_{b.k} / \gamma_{c'}$ = **0** kN/m^2

Using Coulomb theory

Active pressure coefficient	$K_A = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times [1 + \sqrt{[\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))]}]^2)$ = **0.483**
Passive pressure coefficient	$K_P = \sin(90 - \phi'_{b.d})^2 / (\sin(90 + \delta_{b.d}) \times [1 - \sqrt{[\sin(\phi'_{b.d} + \delta_{b.d}) \times \sin(\phi'_{b.d}) / (\sin(90 + \delta_{b.d}))]}]^2)$ = **2.359**

Bearing pressure check

Vertical forces on wall

Wall stem	$F_{stem} = \gamma_G \times A_{stem} \times \gamma_{stem}$ = **40.5** kN/m
Wall base	$F_{base} = \gamma_G \times A_{base} \times \gamma_{base}$ = **21.9** kN/m
Line loads	$F_{P\_v} = \gamma_G \times P_{G1} + \gamma_Q \times P_{Q1}$ = **34.5** kN/m
Total	$F_{total\_v} = F_{stem} + F_{base} + F_{P\_v}$ = **96.9** kN/m

Horizontal forces on wall

Surcharge load	$F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times Surcharge_Q \times h_{eff}$ = **32.2** kN/m
Moist retained soil	$F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times h_{eff}^2 / 2$ = **123.9** kN/m
Base soil	$F_{pass\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (d_{cover} + h_{base})^2 / 2$ = **-6.1** kN/m
Total	$F_{total\_h} = F_{sur\_h} + F_{moist\_h} + F_{pass\_h}$ = **150** kN/m

Moments on wall

Wall stem	$M_{stem} = F_{stem} \times x_{stem}$ = **46.6** kNm/m
Wall base	$M_{base} = F_{base} \times x_{base}$ = **14.3** kNm/m
Surcharge load	$M_{sur} = -F_{sur\_h} \times x_{sur\_h}$ = **-72.5** kNm/m
Line loads	$M_P = (\gamma_G \times P_{G1} + \gamma_Q \times P_{Q1}) \times p_1$ = **40.5** kNm/m
Moist retained soil	$M_{moist} = -F_{moist\_h} \times x_{moist\_h}$ = **-185.9** kNm/m
Total	$M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{moist}$ = **-157** kNm/m

Check bearing pressure

Propping force to stem	$F_{prop\_stem} = (F_{total\_v} \times l_{base} / 2 - M_{total}) / (h_{prop} + t_{base})$ = **50** kN/m
Propping force to base	$F_{prop\_base} = F_{total\_h} - F_{prop\_stem}$ = **100** kN/m
Moment from propping force	$M_{prop} = F_{prop\_stem} \times (h_{prop} + t_{base})$ = **220** kNm/m
Distance to reaction	$\bar{x} = (M_{total} + M_{prop}) / F_{total\_v}$ = **650** mm

Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 = \mathbf{0}$ mm
Loaded length of base	$l_{load} = l_{base} = \mathbf{1300}$ mm
Bearing pressure at toe	$q_{toe} = F_{total\_v} / l_{base} = \mathbf{74.6}$ kN/m^2
Bearing pressure at heel	$q_{heel} = F_{total\_v} / l_{base} = \mathbf{74.6}$ kN/m^2
Effective overburden pressure	$q = (t_{base} + d_{cover}) \times \gamma_b' = \mathbf{10.5}$ kN/m^2
Design effective overburden pressure	$q' = q / \gamma_\gamma = \mathbf{10.5}$ kN/m^2
Bearing resistance factors	$N_q = Exp(\pi \times \tan(\phi'_{b.d})) \times (\tan(45 \text{ deg} + \phi'_{b.d} / 2))^2 = \mathbf{5.258}$
	$N_c = (N_q - 1) \times \cot(\phi'_{b.d}) = \mathbf{13.104}$
	$N_\gamma = 2 \times (N_q - 1) \times \tan(\phi'_{b.d}) = \mathbf{2.767}$
Foundation shape factors	$s_q = 1$
	$s_\gamma = 1$
	$s_c = 1$
Load inclination factors	$H = F_{sur\_h} + F_{moist\_h} + F_{pass\_h} - F_{prop\_stem} - F_{prop\_base} = \mathbf{0}$ kN/m
	$V = F_{total\_v} = \mathbf{96.9}$ kN/m
	$m = 2$
	$i_q = [1 - H / (V + l_{load} \times c'_{b.d} \times \cot(\phi'_{b.d}))]^m = \mathbf{1}$
	$i_\gamma = [1 - H / (V + l_{load} \times c'_{b.d} \times \cot(\phi'_{b.d}))]^{(m+1)} = \mathbf{1}$
	$i_c = i_q - (1 - i_q) / (N_c \times \tan(\phi'_{b.d})) = \mathbf{1}$

Net ultimate bearing capacity

$n_f = c'_{b.d} \times N_c \times s_c \times i_c + q' \times N_q \times s_q \times i_q + 0.5 \times \gamma_b' \times l_{load} \times N_\gamma \times s_\gamma \times i_\gamma = \mathbf{93}$ kN/m^2

Factor of safety $FoS_{bp} = n_f / \max(q_{toe}, q_{heel}) = \mathbf{1.247}$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

Design approach 1

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

Partial factor set	A2
Permanent unfavourable action	$\gamma_G = \mathbf{1.00}$
Permanent favourable action	$\gamma_{Gf} = \mathbf{1.00}$
Variable unfavourable action	$\gamma_Q = \mathbf{1.30}$
Variable favourable action	$\gamma_{Qf} = \mathbf{0.00}$

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

Soil parameter set	M2
Angle of shearing resistance	$\gamma_{\phi'} = \mathbf{1.25}$
Effective cohesion	$\gamma_{c'} = \mathbf{1.25}$
Weight density	$\gamma_\gamma = \mathbf{1.00}$

Library item Partial factors output

Retained soil properties

Design moist density	$\gamma_{mr}' = \gamma_{mr} / \gamma_\gamma = \mathbf{19}$ kN/m^3
Design saturated density	$\gamma_{sr}' = \gamma_{sr} / \gamma_\gamma = \mathbf{19}$ kN/m^3
Design effective shear resistance angle	$\phi'_{r.d} = \text{atan}(\tan(\phi'_{r.k}) / \gamma_{\phi'}) = \mathbf{14.6}$ deg
Design wall friction angle	$\delta_{r.d} = \text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}) = \mathbf{7.2}$ deg

Base soil properties

Design soil density	$\gamma_b' = \gamma_b / \gamma_\gamma = \mathbf{21}$ kN/m^3
Design effective shear resistance angle	$\phi'_{b.d} = \text{atan}(\tan(\phi'_{b.k}) / \gamma_{\phi'}) = \mathbf{14.6}$ deg
Design wall friction angle	$\delta_{b.d} = \text{atan}(\tan(\delta_{b.k}) / \gamma_{\phi'}) = \mathbf{7.2}$ deg

Design base friction angle	$\delta_{bb.d} = \text{atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'}) = \mathbf{9.7}$ deg
Design effective cohesion	$c'_{b.d} = c'_{b.k} / \gamma_{c'} = \mathbf{0}$ kN/m^2

Using Coulomb theory

Active pressure coefficient	$K_A = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times [1 + \sqrt{[}\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))]]^2) = \mathbf{0.553}$
Passive pressure coefficient	$K_P = \sin(90 - \phi'_{b.d})^2 / (\sin(90 + \delta_{b.d}) \times [1 - \sqrt{[}\sin(\phi'_{b.d} + \delta_{b.d}) \times \sin(\phi'_{b.d}) / (\sin(90 + \delta_{b.d}))]]^2) = \mathbf{1.965}$

Bearing pressure check

Vertical forces on wall

Wall stem	$F_{stem} = \gamma_G \times A_{stem} \times \gamma_{stem} = \mathbf{30}$ kN/m
Wall base	$F_{base} = \gamma_G \times A_{base} \times \gamma_{base} = \mathbf{16.3}$ kN/m
Line loads	$F_{P\_v} = \gamma_G \times P_{G1} + \gamma_Q \times P_{Q1} = \mathbf{26.5}$ kN/m
Total	$F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} = \mathbf{72.8}$ kN/m

Horizontal forces on wall

Surcharge load	$F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{eff} = \mathbf{32.1}$ kN/m
Moist retained soil	$F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 = \mathbf{105.5}$ kN/m
Base soil	$F_{pass\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (d_{cover} + h_{base})^2 / 2 = \mathbf{-5.1}$ kN/m
Total	$F_{total\_h} = F_{sur\_h} + F_{moist\_h} + F_{pass\_h} = \mathbf{132.5}$ kN/m

Moments on wall

Wall stem	$M_{stem} = F_{stem} \times x_{stem} = \mathbf{34.5}$ kNm/m
Wall base	$M_{base} = F_{base} \times x_{base} = \mathbf{10.6}$ kNm/m
Surcharge load	$M_{sur} = -F_{sur\_h} \times x_{sur\_h} = \mathbf{-72.2}$ kNm/m
Line loads	$M_P = (\gamma_G \times P_{G1} + \gamma_Q \times P_{Q1}) \times p_1 = \mathbf{31.1}$ kNm/m
Moist retained soil	$M_{moist} = -F_{moist\_h} \times x_{moist\_h} = \mathbf{-158.3}$ kNm/m
Total	$M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{moist} = \mathbf{-154.3}$ kNm/m

Check bearing pressure

Propping force to stem	$F_{prop\_stem} = (F_{total\_v} \times l_{base} / 2 - M_{total}) / (h_{prop} + t_{base}) = \mathbf{45.8}$ kN/m
Propping force to base	$F_{prop\_base} = F_{total\_h} - F_{prop\_stem} = \mathbf{86.7}$ kN/m
Moment from propping force	$M_{prop} = F_{prop\_stem} \times (h_{prop} + t_{base}) = \mathbf{201.6}$ kNm/m
Distance to reaction	$\bar{x} = (M_{total} + M_{prop}) / F_{total\_v} = \mathbf{650}$ mm
Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 = \mathbf{0}$ mm
Loaded length of base	$l_{load} = l_{base} = \mathbf{1300}$ mm
Bearing pressure at toe	$q_{toe} = F_{total\_v} / l_{base} = \mathbf{56}$ kN/m^2
Bearing pressure at heel	$q_{heel} = F_{total\_v} / l_{base} = \mathbf{56}$ kN/m^2
Effective overburden pressure	$q = (t_{base} + d_{cover}) \times \gamma_b' = \mathbf{10.5}$ kN/m^2
Design effective overburden pressure	$q' = q / \gamma_\gamma = \mathbf{10.5}$ kN/m^2
Bearing resistance factors	$N_q = \text{Exp}(\pi \times \tan(\phi'_{b.d})) \times (\tan(45\text{ deg} + \phi'_{b.d} / 2))^2 = \mathbf{3.784}$
	$N_c = (N_q - 1) \times \cot(\phi'_{b.d}) = \mathbf{10.711}$
	$N_\gamma = 2 \times (N_q - 1) \times \tan(\phi'_{b.d}) = \mathbf{1.447}$
Foundation shape factors	$s_q = 1$
	$s_\gamma = 1$
	$s_c = 1$
Load inclination factors	$H = F_{sur\_h} + F_{moist\_h} + F_{pass\_h} - F_{prop\_stem} - F_{prop\_base} = \mathbf{0}$ kN/m
	$V = F_{total\_v} = \mathbf{72.8}$ kN/m

$m = 2$

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

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

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

Net ultimate bearing capacity

$n_f = c'_{b.d} \times N_c \times s_c \times i_c + q' \times N_q \times s_q \times i_q + 0.5 \times \gamma_b' \times l_{load} \times N_\gamma \times s_\gamma \times i_\gamma = \mathbf{59.5}$ kN/m^2

Factor of safety — $FoS_{bp} = n_f / \max(q_{toe}, q_{heel}) = \mathbf{1.063}$

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

Tedds calculation version 2.9.11

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

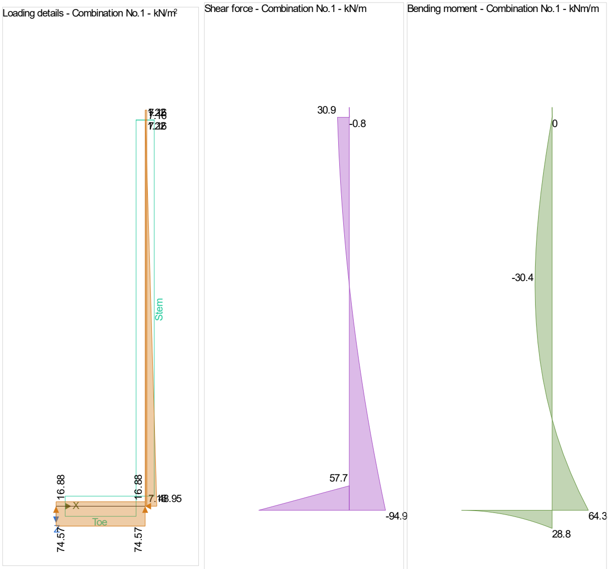
Concrete strength class	C32/40
Characteristic compressive cylinder strength	$f_{ck} = \mathbf{32}$ N/mm^2
Characteristic compressive cube strength	$f_{ck,cube} = \mathbf{40}$ N/mm^2
Mean value of compressive cylinder strength	$f_{cm} = f_{ck} + 8$ N/mm^2 $= \mathbf{40}$ N/mm^2
Mean value of axial tensile strength	$f_{ctm} = 0.3$ N/mm$^2 \times (f_{ck} / 1$ N/mm$^2)^{2/3} = \mathbf{3.0}$ N/mm^2
5% fractile of axial tensile strength	$f_{ctk,0.05} = 0.7 \times f_{ctm} = \mathbf{2.1}$ N/mm^2
Secant modulus of elasticity of concrete	$E_{cm} = 22$ kN/mm$^2 \times (f_{cm} / 10$ N/mm$^2)^{0.3} = \mathbf{33346}$ N/mm^2
Partial factor for concrete - Table 2.1N	$\gamma_C = \mathbf{1.50}$
Compressive strength coefficient - cl.3.1.6(1)	$\alpha_{cc} = \mathbf{0.85}$
Design compressive concrete strength - exp.3.15	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C = \mathbf{18.1}$ N/mm^2
Maximum aggregate size	$h_{agg} = \mathbf{20}$ mm
Ultimate strain - Table 3.1	$\varepsilon_{cu2} = \mathbf{0.0035}$
Shortening strain - Table 3.1	$\varepsilon_{cu3} = \mathbf{0.0035}$
Effective compression zone height factor	$\lambda = \mathbf{0.80}$
Effective strength factor	$\eta = \mathbf{1.00}$
Bending coefficient k_1	$K_1 = \mathbf{0.40}$
Bending coefficient k_2	$K_2 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2}) = \mathbf{1.00}$
Bending coefficient k_3	$K_3 = \mathbf{0.40}$
Bending coefficient k_4	$K_4 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2}) = \mathbf{1.00}$

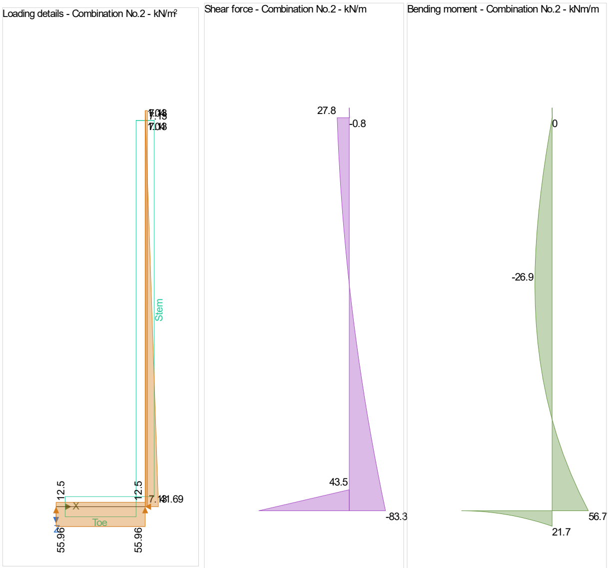
Reinforcement details

Characteristic yield strength of reinforcement	$f_{yk} = \mathbf{500}$ N/mm^2
Modulus of elasticity of reinforcement	$E_s = \mathbf{200000}$ N/mm^2
Partial factor for reinforcing steel - Table 2.1N	$\gamma_S = \mathbf{1.15}$
Design yield strength of reinforcement	$f_{yd} = f_{yk} / \gamma_S = \mathbf{435}$ N/mm^2

Cover to reinforcement

Front face of stem	$c_{sf} = \mathbf{40}$ mm
Rear face of stem	$c_{sr} = \mathbf{50}$ mm
Top face of base	$c_{bt} = \mathbf{50}$ mm
Bottom face of base	$c_{bb} = \mathbf{75}$ mm





Check stem design at 2236 mm

Depth of section — h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — M = **30.4** kNm/m

Depth to tension reinforcement — $d = h - c_{sf} - \phi_{sx} - \phi_{sfM} / 2$ = **244** mm

$K = M / (d^2 \times f_{ck})$ = **0.016**

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

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** mm

Depth of neutral axis — $x = 2.5 \times (d - z)$ = **31** mm

Area of tension reinforcement required — $A_{sfM.req} = M / (f_{yd} \times z)$ = **301** mm²/m

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

Area of tension reinforcement provided — $A_{sfM.prov} = \pi \times \phi_{sfM}^2 / (4 \times s_{sfM})$ = **565** mm²/m

Minimum area of reinforcement - exp.9.1N — $A_{sfM.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **384** mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{sfM.max} = 0.04 \times h$ = **12000** mm²/m

$\max(A_{sfM.req}, A_{sfM.min}) / A_{sfM.prov}$ = **0.678**

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

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio — $\rho_0 = \sqrt{(f_{ck} / 1\ N/mm^2)} / 1000$ = **0.006**

Required tension reinforcement ratio — $\rho = A_{sfM.req} / d$ = **0.001**

Required compression reinforcement ratio — $\rho' = A_{sfM.2.req} / d_2$ = **0.000**

Structural system factor - Table 7.4N — K_b = **1**

Reinforcement factor - exp.7.17 — $K_s = \min(500\ N/mm^2 / (f_{yk} \times A_{sfM.req} / A_{sfM.prov}), 1.5)$ = **1.5**

Limiting span to depth ratio - exp.7.16.a — $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b)$ = **40**

Actual span to depth ratio — h_{prop} / d = **16**

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width — w_{max} = **0.3** mm

Variable load factor - EN1990 – Table A1.1 — ψ_2 = **0.6**

Serviceability bending moment — M_{sls} = **19.9** kNm/m

Tensile stress in reinforcement — $\sigma_s = M_{sls} / (A_{sfM.prov} \times z)$ = **152.1** N/mm²

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** mm²/m

Mean value of concrete tensile strength — $f_{ct.eff} = f_{ctm}$ = **3.0** N/mm²

Reinforcement ratio — $\rho_{p.eff} = A_{sfM.prov} / A_{c.eff}$ = **0.006**

Modular ratio — $\alpha_e = E_s / E_{cm}$ = **5.998**

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 — $s_{r.max} = k_3 \times c_{sf} + k_1 \times k_2 \times k_4 \times \phi_{sfM} / \rho_{p.eff}$ = **460** 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 = **0.21** mm

w_k / w_{max} = **0.7**

PASS - Maximum crack width is less than limiting crack width

Check stem design at base of stem

Depth of section — h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — M = **64.3** kNm/m

Depth to tension reinforcement — $d = h - c_{sr} - \phi_{sr} / 2$ = **242** mm

$K = M / (d^2 \times f_{ck})$ = **0.034**

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

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm	$z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d =$ **230** mm
Depth of neutral axis	$x = 2.5 \times (d - z) =$ **30** mm
Area of tension reinforcement required	$A_{sr.req} = M / (f_{yd} \times z) =$ **643** mm^2/m
Tension reinforcement provided	16 dia.bars @ 200 c/c
Area of tension reinforcement provided	$A_{sr.prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr}) =$ **1005** mm^2/m
Minimum area of reinforcement - exp.9.1N	$A_{sr.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d =$ **381** mm^2/m
Maximum area of reinforcement - cl.9.2.1.1(3)	$A_{sr.max} = 0.04 \times h =$ **12000** mm^2/m
	$\max(A_{sr.req}, A_{sr.min}) / A_{sr.prov} =$ **0.64**

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

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio	$\rho_0 = \sqrt{(f_{ck} / 1 \text{ N/mm}^2)} / 1000 =$ **0.006**
Required tension reinforcement ratio	$\rho = A_{sr.req} / d =$ **0.003**
Required compression reinforcement ratio	$\rho' = A_{sr.2.req} / d_2 =$ **0.000**
Structural system factor - Table 7.4N	$K_b =$ **1**
Reinforcement factor - exp.7.17	$K_s = \min(500 \text{ N/mm}^2 / (f_{yk} \times A_{sr.req} / A_{sr.prov}), 1.5) =$ **1.5**
Limiting span to depth ratio - exp.7.16.a	$\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1 \text{ N/mm}^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1 \text{ N/mm}^2)} \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b) =$ **40**
Actual span to depth ratio	$h_{prop} / d =$ **16.1**

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width	$w_{max} =$ **0.3** mm
Variable load factor - EN1990 – Table A1.1	$\psi_2 =$ **0.6**
Serviceability bending moment	$M_{sls} =$ **43** kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{sr.prov} \times z) =$ **186.1** N/mm^2
Load duration	Long term
Load duration factor	$k_t =$ **0.4**
Effective area of concrete in tension	$A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$
	$A_{c.eff} =$ **89917** mm^2/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm} =$ **3.0** N/mm^2
Reinforcement ratio	$\rho_{p.eff} = A_{sr.prov} / A_{c.eff} =$ **0.011**
Modular ratio	$\alpha_e = E_s / E_{cm} =$ **5.998**
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	$s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p.eff} =$ **413** mm
Maximum crack width - exp.7.8	$w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$
	$w_k =$ **0.231** mm
	$w_k / w_{max} =$ **0.769**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force	$V =$ **94.9** kN/m
	$C_{Rd,c} = 0.18 / \gamma_C =$ **0.120**
	$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) =$ **1.909**
Longitudinal reinforcement ratio	$\rho_l = \min(A_{sr.prov} / d, 0.02) =$ **0.004**

	$v_{min} = 0.035\ N^{1/2}/mm \times k^{3/2} \times f_{ck}^{0.5}$ = **0.522** N/mm^2
Design shear resistance - exp.6.2a & 6.2b	$V_{Rd.c} = \max(C_{Rd.c} \times k \times (100\ N^2/mm^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$
	$V_{Rd.c}$ = **131.3** kN/m
	$V / V_{Rd.c}$ = **0.722**

PASS - Design shear resistance exceeds design shear force

Check stem design at prop

Depth of section	h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1	M = **0** kNm/m
Depth to tension reinforcement	$d = h - c_{sr} - \phi_{sr1} / 2$ = **244** 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** mm
Depth of neutral axis	$x = 2.5 \times (d - z)$ = **31** mm
Area of tension reinforcement required	$A_{sr1.req} = M / (f_{yd} \times z)$ = **0** mm^2/m
Tension reinforcement provided	12 dia.bars @ 200 c/c
Area of tension reinforcement provided	$A_{sr1.prov} = \pi \times \phi_{sr1}^2 / (4 \times s_{sr1})$ = **565** mm^2/m
Minimum area of reinforcement - exp.9.1N	$A_{sr1.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **384** mm^2/m
Maximum area of reinforcement - cl.9.2.1.1(3)	$A_{sr1.max} = 0.04 \times h$ = **12000** mm^2/m
	$\max(A_{sr1.req}, A_{sr1.min}) / A_{sr1.prov}$ = **0.678**

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

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio	$\rho_0 = \sqrt{(f_{ck} / 1\ N/mm^2)} / 1000$ = **0.006**
Required tension reinforcement ratio	$\rho = A_{sr1.req} / d$ = **0.000**
Required compression reinforcement ratio	$\rho' = A_{sr1.2.req} / d_2$ = **0.000**
Structural system factor - Table 7.4N	K_b = **0.4**
Reinforcement factor - exp.7.17	$K_s = \min(500\ N/mm^2 / (f_{yk} \times A_{sr1.req} / A_{sr1.prov}), 1.5)$ = **1.5**
Limiting span to depth ratio - exp.7.16.a	$\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b)$ = **16**
Actual span to depth ratio	$(h_{stem} - h_{prop}) / d$ = **0.4**

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width	w_{max} = **0.3** mm
Variable load factor - EN1990 – Table A1.1	ψ_2 = **0.6**
Serviceability bending moment	M_{sls} = **0** kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{sr1.prov} \times z)$ = **0.1** 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** mm^2/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm}$ = **3.0** N/mm^2
Reinforcement ratio	$\rho_{p.eff} = A_{sr1.prov} / A_{c.eff}$ = **0.006**

Modular ratio $\alpha_e = E_s / E_{cm} =$ **5.998**

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 $s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr1} / \rho_{p.eff} =$ **494** 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** mm

$w_k / w_{max} =$ **0.001**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force V = **30.9** kN/m

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

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

Longitudinal reinforcement ratio $\rho_l = \min(A_{sr1.prov} / d, 0.02) =$ **0.002**

$v_{min} = 0.035\text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} =$ **0.521** N/mm²

Design shear resistance - exp.6.2a & 6.2b $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100\text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c} =$ **127.1** kN/m

$V / V_{Rd.c} =$ **0.243**

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Minimum area of reinforcement – cl.9.6.3(1) $A_{sx.req} = \max(0.25 \times A_{sr.prov}, 0.001 \times t_{stem}) =$ **300** mm²/m

Maximum spacing of reinforcement – cl.9.6.3(2) $s_{sx\_max} =$ **400** mm

Transverse reinforcement provided 10 dia.bars @ 200 c/c

Area of transverse reinforcement provided $A_{sx.prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx}) =$ **393** mm²/m

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

Check base design at toe

Depth of section h = **500** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 M = **28.8** kNm/m

Depth to tension reinforcement $d = h - c_{bb} - \phi_{bb} / 2 =$ **417** mm

$K = M / (d^2 \times f_{ck}) =$ **0.005**

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

$K' =$ **0.207**

K' > K - No compression reinforcement is required

Lever arm $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d =$ **396** mm

Depth of neutral axis $x = 2.5 \times (d - z) =$ **52** mm

Area of tension reinforcement required $A_{bb.req} = M / (f_{yd} \times z) =$ **167** mm²/m

Tension reinforcement provided 16 dia.bars @ 200 c/c

Area of tension reinforcement provided $A_{bb.prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb}) =$ **1005** mm²/m

Minimum area of reinforcement - exp.9.1N $A_{bb.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d =$ **656** mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) $A_{bb.max} = 0.04 \times h =$ **20000** mm²/m

$\max(A_{bb.req}, A_{bb.min}) / A_{bb.prov} =$ **0.652**

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** mm
Variable load factor - EN1990 – Table A1.1	ψ_2 = **0.6**
Serviceability bending moment	M_{sls} = **21.2** kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{bb.prov} \times z)$ = **53.1** N/mm^2
Load duration	Long term
Load duration factor	k_t = **0.4**
Effective area of concrete in tension	$A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$
	$A_{c.eff}$ = **149292** mm^2/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm}$ = **3.0** N/mm^2
Reinforcement ratio	$\rho_{p.eff} = A_{bb.prov} / A_{c.eff}$ = **0.007**
Modular ratio	$\alpha_e = E_s / E_{cm}$ = **5.998**
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	$s_{r.max} = k_3 \times c_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p.eff}$ = **659** 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 = **0.105** mm
	w_k / w_{max} = **0.35**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

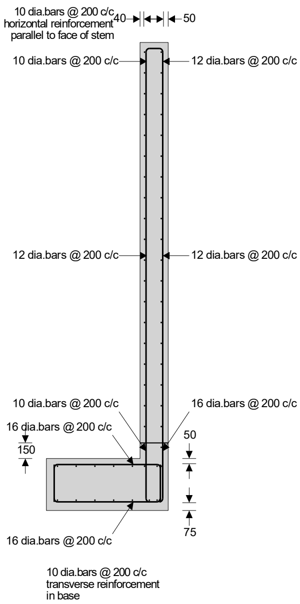
Design shear force	V = **57.7** kN/m
	$C_{Rd,c} = 0.18 / \gamma_C$ = **0.120**
	$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2)$ = **1.693**
Longitudinal reinforcement ratio	$\rho_l = \min(A_{bb.prov} / d, 0.02)$ = **0.002**
	$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5}$ = **0.436** N/mm^2
Design shear resistance - exp.6.2a & 6.2b	$V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$
	$V_{Rd.c}$ = **181.8** kN/m
	$V / V_{Rd.c}$ = **0.317**

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

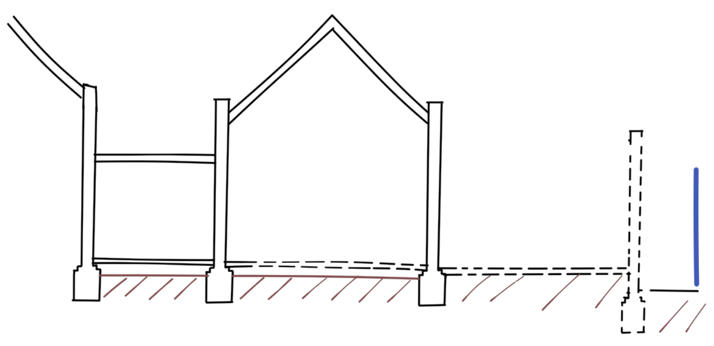
Minimum area of reinforcement – cl.9.3.1.1(2)	$A_{bx.req} = 0.2 \times A_{bb.prov}$ = **201** mm^2/m
Maximum spacing of reinforcement – cl.9.3.1.1(3)	s_{bx_max} = **450** mm
Transverse reinforcement provided	10 dia.bars @ 200 c/c
Area of transverse reinforcement provided	$A_{bx.prov} = \pi \times \phi_{bx}^2 / (4 \times s_{bx})$ = **393** mm^2/m

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



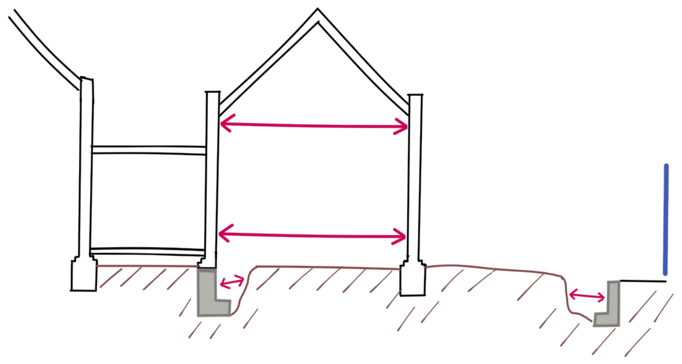
Reinforcement details

B Suggested Sequence of Works



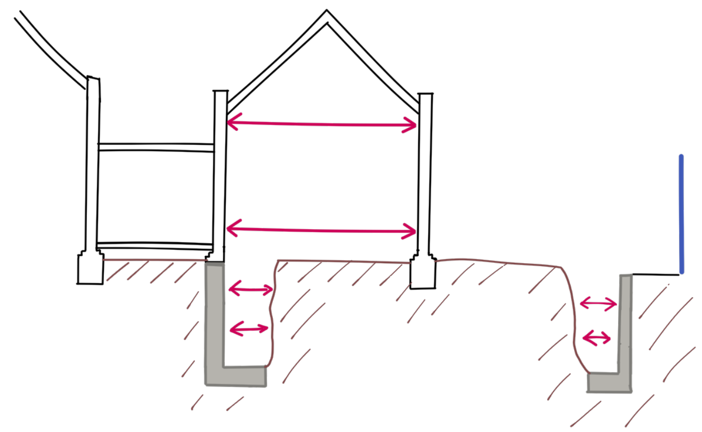
Stage 1 - Site Setup and Enabling Work

- Erect hoarding, set up delivery zone and traffic control measures.
- Install monitoring systems.
- Demolish existing courtyard walls and slab. The timber joist ground floor is to be carefully removed to facilitate the construction.
- Existing floor joists planned to be stored, inspected and reinstated instead of sourcing new graded timber.



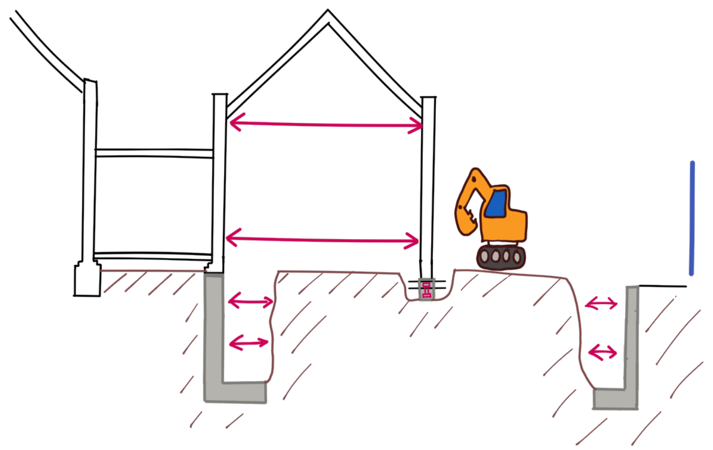
Stage 2 - Underpin (1st Lift)

- Restrain masonry walls at low level and high level with corners braced. Props are to be preloaded.
- Cast new RC wall underpins in hit / multi-miss sequence within shored excavations. A temporary toe is to be incorporated to match the existing foundation width.
- Underpins are to be propped back to central soil mass to maintain stability. All props are to be preloaded.
- Rebar for permanent case waling beam, incorporated in wall profile, is to be included during the casting of the underpins.



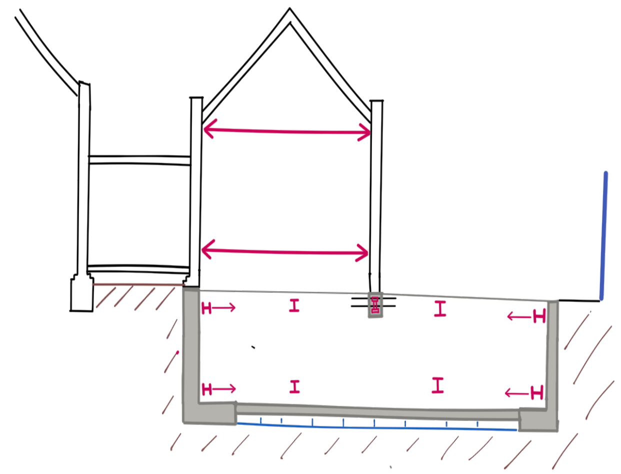
Stage 3 - Underpin (2nd Lift)

- Form deeper shored excavations to basement formation level, cutting out temporary toe and install 2nd lift of underpinning.
- Cast new RC wall underpins in hit / multi-miss sequence with basement slab toe.
- Underpins are to be propped back to soil mass again so there is a prop at low and high level.
- A sump and pump are to be installed to remove water ingress into the excavations. All underpins to be formed in a dry excavation.



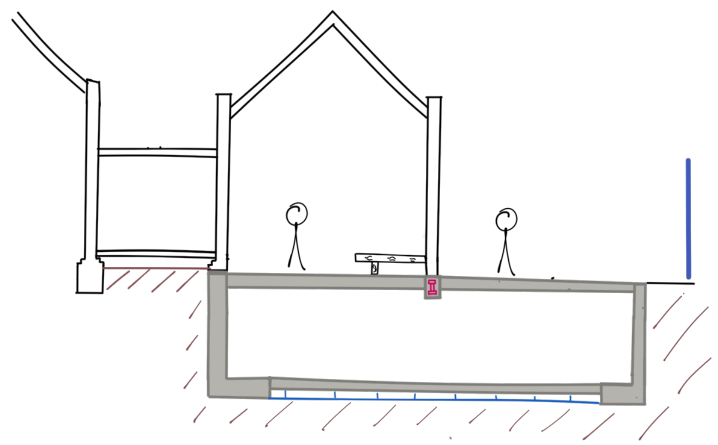
Stage 4 - Form Pynford Beam

- Excavate and install Pynford props within existing wall. A plunge column and needle solution may be preferred by the contractor.
- Cast RC beam with props cast within beam ensuring starter bars for the slab are protruding along length.
- Install waling cross prop members to restrain underpins during soil mass excavation by forming shored trenches within soil mass.



Stage 5 - Excavate and Basement Slab

- Ensure restraint props are in place prior to complete soil mass excavation with props at both high and low level.
- Install below ground drainage and heave solution (as required).
- Cast basement slab.
- Low level props can be removed once the basement slab has cured to sufficient strength to transfer the horizontal thrust loads through the slab.



Stage 6 - Cast Ground Floor Slab

- Cast ground floor slab.
- Once up to strength props can be removed and remaining superstructure works can proceed.
- Timber floor including floorboards reinstated.

This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.

Do not scale from this drawing.

rev	date	by	chk	description
P1	09/06/22	PDu	WSq	Preliminary

Drawing title
Basement Construction Sequence

Scale	Date	Drawn
NTS	June 2022	PDu

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Project
12/13 Primrose Hill Studios

Drawing status	Status	Revision
Preliminary	S2	P1

Project no. Originator Zone Level Type Role drg no.
2210445 - EWP - ZZ - XX - SK - S - 3000