32 The Green,
Richmond, London

Mr Shaun Brown

224260

Structural Calculations

224260 – MNP – XX – XX – CA – S – 0001

Status S2

Rev P01

November 2024

Revision History

Revision	Date	Description
P01	18/11/2024	Initial issue.

Document Verification

	Name / Qualifications	Signature
Prepared by	Caspar More	Caspar More
Checked by	James Lennon	
Approved by	James Lennon	

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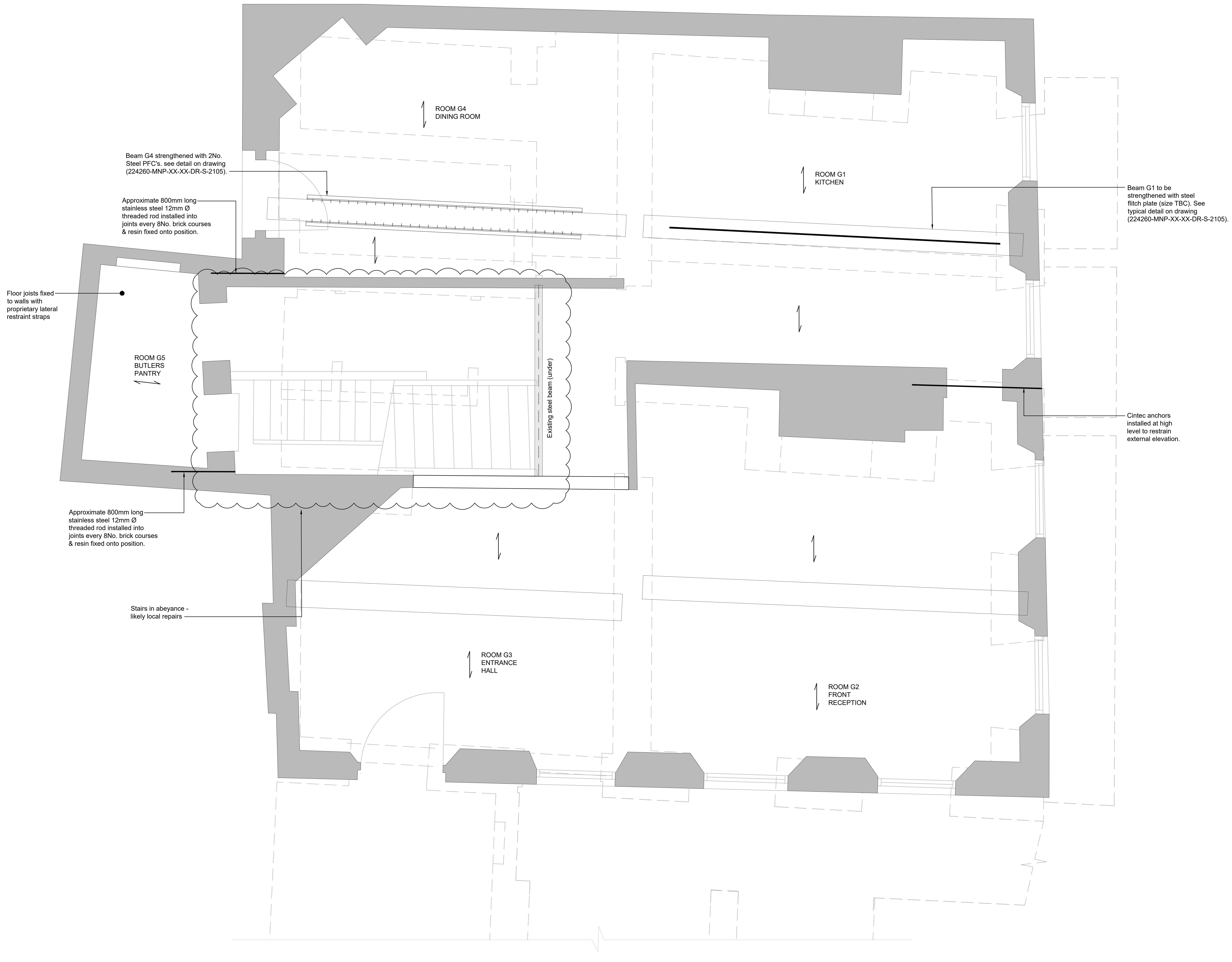
Appendix A – Drawing



General
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1.5. All materials to comply with the relevant British Standard.

Key	
⇌	Existing joists

Note:
Allow for fixing all joists to main beams & walls with 90 x 90 x 60 proprietary steel cleats

Note:
Allow for internal cracking to be repaired with helical ties with 500mm embedment length either side of the cracks.

Note:
Once timber paneling is removed in accordance with conservation architects requirement. MNP to inspect, an allowance for internal cracking to be repaired with Helical ties, with a 500mm embedment length either side of cracks. Furthermore allow for any larger cracks to be repaired with cintec anchors.

REV	COMMENTS	DATE	CHK
P01	PRELIMINARY ISSUE	15.11.24	CM

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PROJECT
32 THE GREEN,
RICHMOND
LONDON

DRAWING TITLE
PROPOSED
GROUND FLOOR GA

SCALE @ A1	DRAWN BY	DATE
1:25	JSE	31.07.24
MNP No.	STATUS CODE	REV
224260	S0	**P** 01

Ref No.
224260-MNP-XX- 00 -DR-S-1100

General
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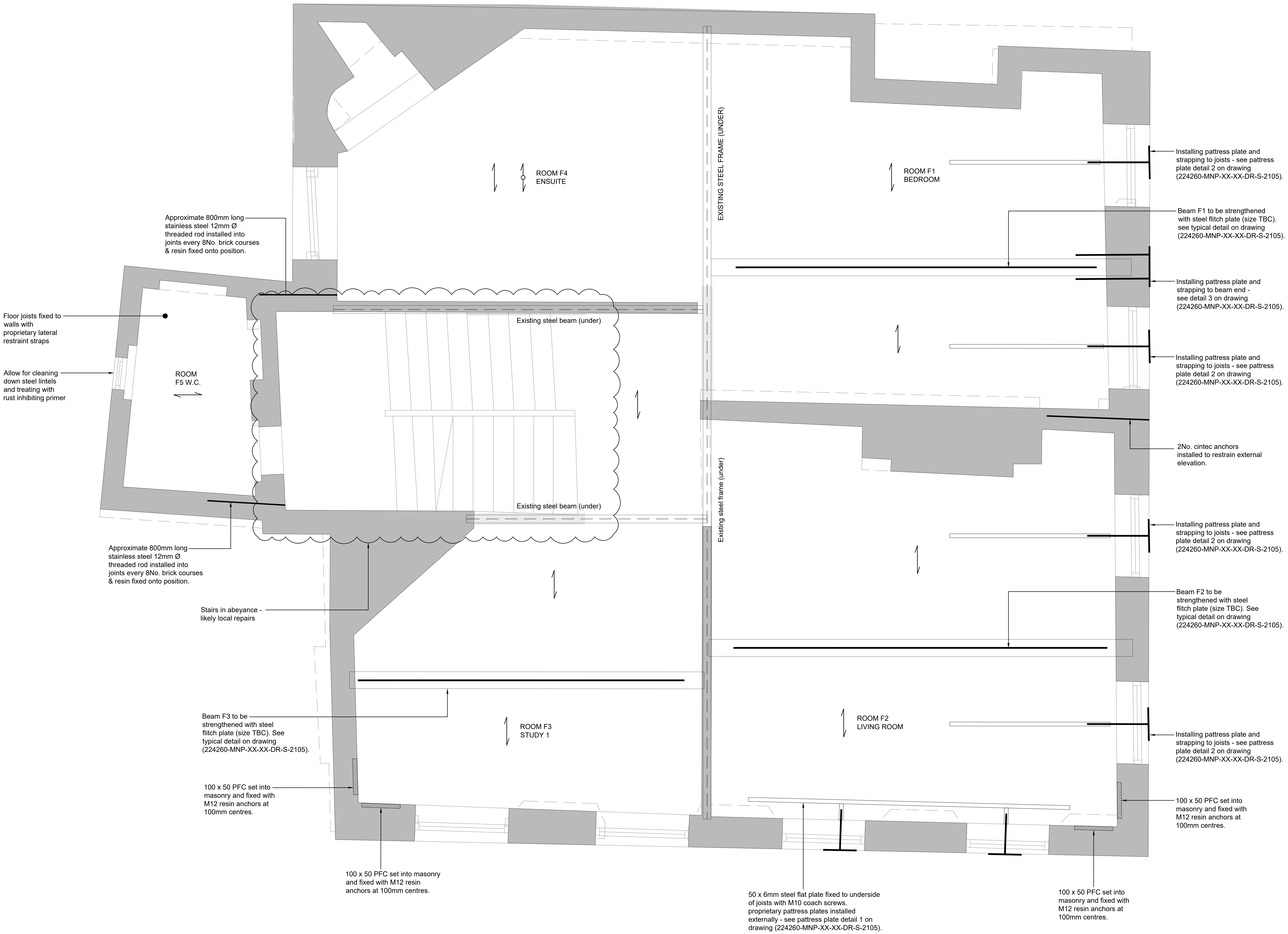

Key	
⇄	Existing joists
⇄○	Existing engineered timber JJ joists

Note:
Allow for fixing all joists to main beams & walls with 90 x 90 x 60 proprietary steel cleats

Note:
Allow for internal cracking to be repaired with helical ties with 500mm embedment length either side of the cracks.

Note:
Once timber paneling is removed in accordance with conservation architects requirement. MNP to inspect, an allowance for internal cracking to be repaired with Helical ties, with a 500mm embedment length either side of cracks. Furthermore allow for any larger cracks to be repaired with cintec anchors.

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DRAWING TITLE
PROPOSED
FIRST FLOOR GA

SCALE @ A1	DRAWN BY	DATE
1:25	JSE	31.07.24
MNP No.	STATUS CODE	REV
224260	S0	P01

Ref No.
224260-MNP-XX-01-DR-S-1101

General
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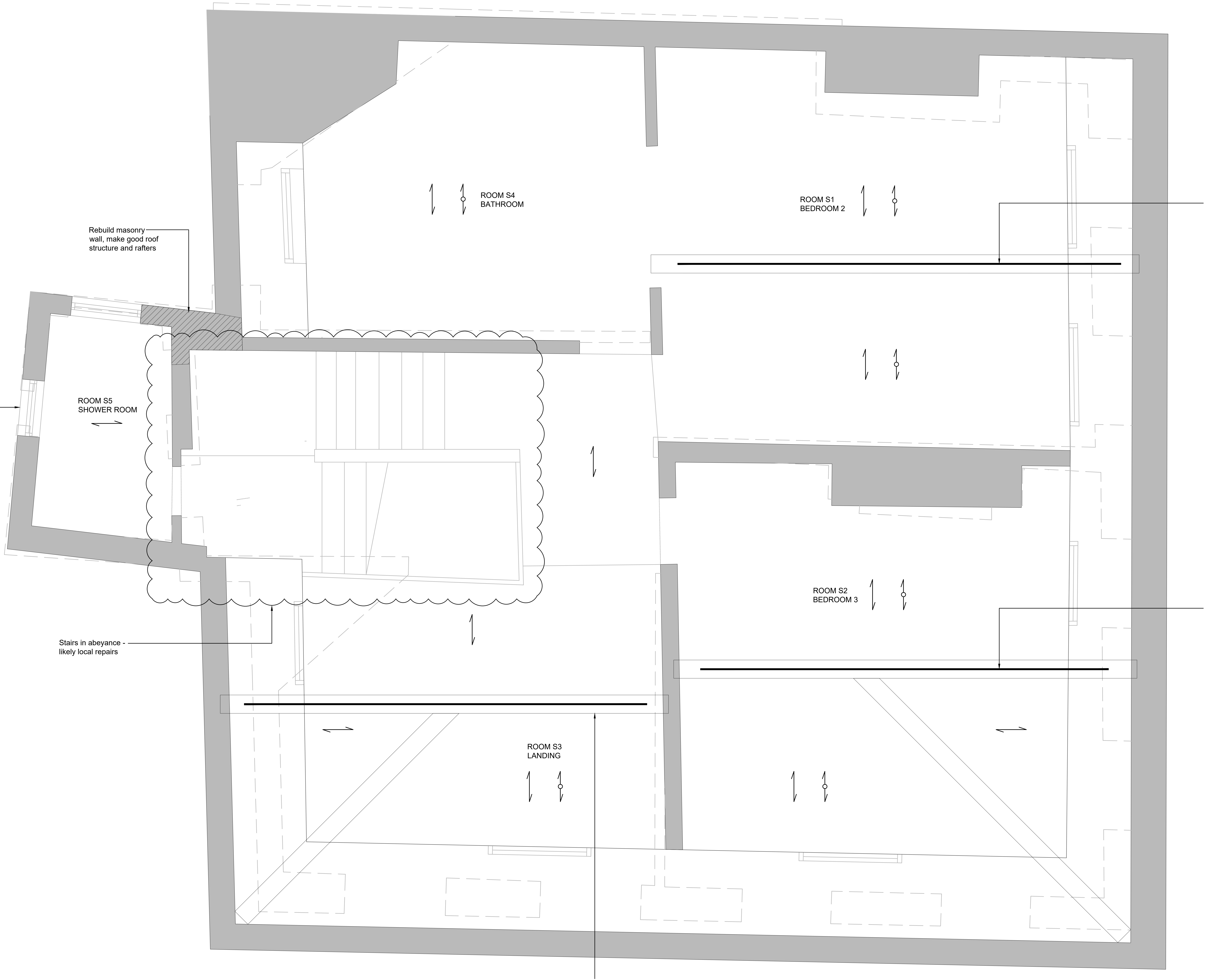

Rebuild masonry wall, make good roof structure and rafters

Allow for cleaning down steel lintels and treating with rust inhibiting primer

Stairs in abeyance - likely local repairs

Beam S1 to be strengthened with steel flitch plate (size TBC). See typical detail on drawing (224260-MNP-XX-XX-DR-S-2105).

Beam S2 to be strengthened with steel flitch plate (size TBC). see typical detail on drawing (224260-MNP-XX-XX-DR-S-2105).

Beam S3 to be strengthened with steel flitch plate (size TBC). See typical detail on drawing (224260-MNP-XX-XX-DR-S-2105).

Key	
⟷	Existing joists
⟷○	Existing engineered timber JJ joists

Note:
Allow for fixing all joists to main beams & walls with 90x90x60 proprietary steel cleats

Note:
Allow for the plate to be fixed down to masonry wall head with 12mm threaded rod & Rawl KEM - II resin. Fixing @ 500mm and embedment 300mm into masonry.

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DRAWING TITLE
PROPOSED
SECOND FLOOR GA

SCALE @ A1	DRAWN BY	DATE
1:25	JSE	31.07.24
MNP No.	STATUS CODE	REV
224260	S0	**P** 01

Ref No.
224260-MNP-XX- 02 -DR-S-1102

General
- 1.1. Refer to MNP drawing S-000 for full notes.
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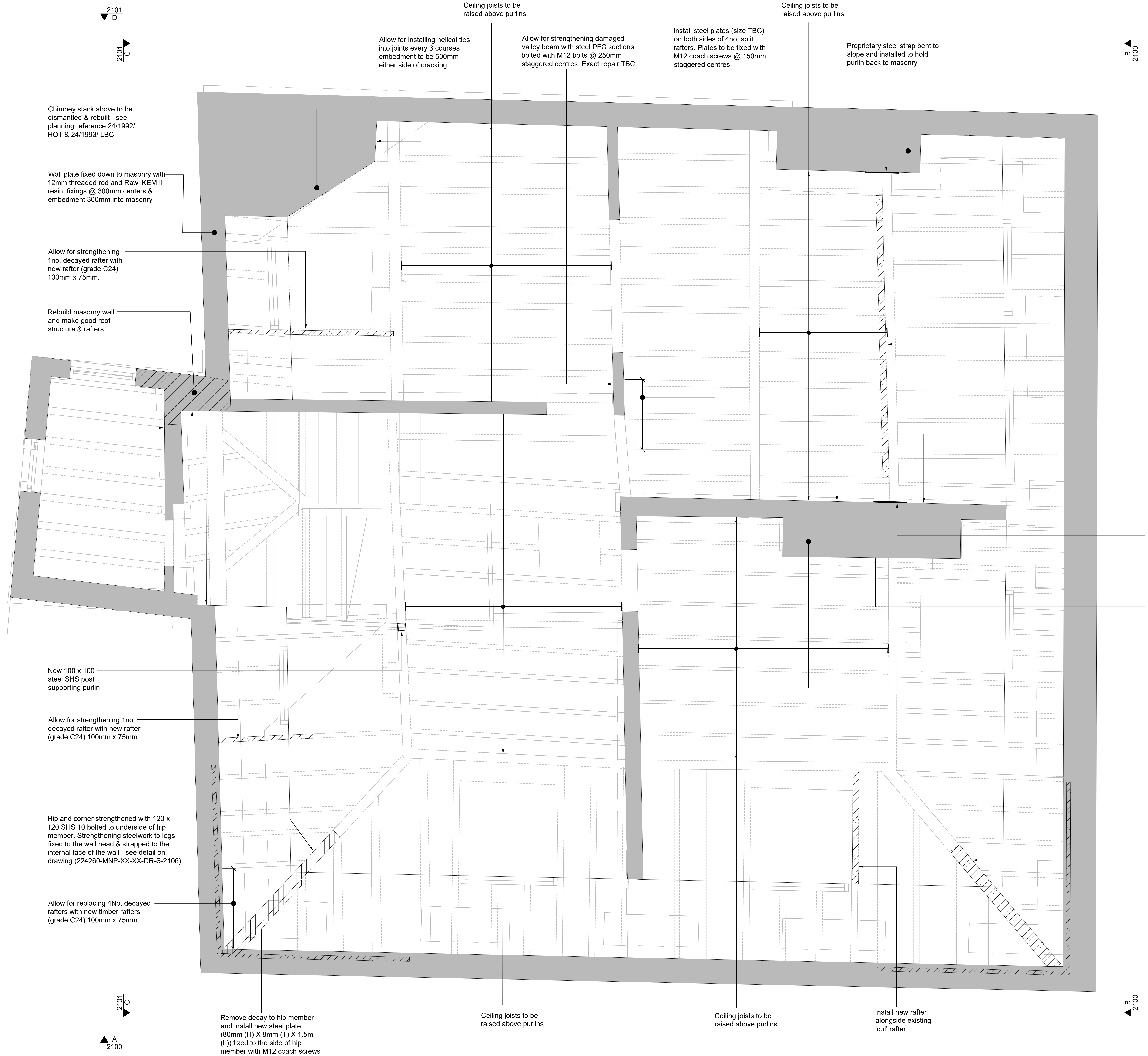

Ceiling joists to be raised above purlins

Allow for installing helical ties into joints every 3 courses embedment to be 500mm either side of cracking.

Allow for strengthening damaged valley beam with steel PFC sections bolted with M12 bolts @ 250mm staggered centres. Exact repair TBC.

Install steel plates (size TBC) on both sides of 4no. split rafters. Plates to be fixed with M12 coach screws @ 150mm staggered centres.

Ceiling joists to be raised above purlins

Proprietary steel strap bent to slope and installed to hold purlin back to masonry

Chimney stack above to be dismantled & rebuilt - see planning reference 24/1992/ HOT & 24/1993/ LBC

Wall plate fixed down to masonry with 12mm threaded rod and Rawl KEM II resin. fixings @ 300mm centers & embedment 300mm into masonry

Allow for strengthening 1no. decayed rafter with new rafter (grade C24) 100mm x 75mm.

Rebuild masonry wall and make good roof structure & rafters.

Strap wall plate to masonry with proprietary steel restraint straps

New 100 x 100 steel SHS post supporting purlin

Allow for strengthening 1no. decayed rafter with new rafter (grade C24) 100mm x 75mm.

Hip and corner strengthened with 120 x 120 SHS 10 bolted to underside of hip member. Strengthening steelwork to legs fixed to the wall head & strapped to the internal face of the wall - see detail on drawing (224260-MNP-XX-XX-DR-S-2106).

Allow for replacing 4No. decayed rafters with new timber rafters (grade C24) 100mm x 75mm.

Remove decay to hip member and install new steel plate (80mm (H) X 8mm (T) X 1.5m (L)) fixed to the side of hip member with M12 coach screws @ 200mm staggered centre

Ceiling joists to be raised above purlins

Ceiling joists to be raised above purlins

Install new rafter alongside existing 'cut' rafter.

Chimney stack above to be dismantled & rebuilt - see planning reference 24/1992/ HOT & 24/1993/ LBC

Strengthen purlin with 1No. steel 150 x 90 PFC 24 channel sections fixed to existing purlin with M12 coach screws @ 250mm staggered centres- see detail (2106.4) on drawing (224260-MNP-XX-XX-DR-S-2106).

Allow for installing helical ties into joints every 3 courses embedment to be 500mm either side of cracking.

Proprietary steel strap bent to slope and installed to hold purlin back to masonry

Allow for installing helical ties into joints every 3 courses embedment to be 500mm either side of cracking.

Chimney stack above to be dismantled & rebuilt - see planning reference 24/1992/ HOT & 24/1993/ LBC

Hip and corner strengthened with 120 x 120 SHS 10 bolted to underside of hip member. Strengthening steelwork to legs fixed to the wall head & strapped to the internal face of the wall - see detail on drawing (224260-MNP-XX-XX-DR-S-2106).

Note:
Install additional timbers 100 x 75 C24 around all roof dormers/ roof lights

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PROJECT
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DRAWING TITLE
PROPOSED
SECOND FLOOR
CEILING GA

SCALE @ A1	DRAWN BY	DATE
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224260	S0	P01

Ref No.
224260-MNP-XX- 03 -DR-S-1103

Rods resin fixed into masonry with Rawl KEM - II resin with 200mm embedment

Rake out and repoint cracking to brickwork vaulting

16mm Ø threaded rod bars installed 70mm below spring point of vaulting to restrain outward movement of wall. Rods installed @ 230mm centres.

100 x 8mm flat steel plate acting to restrain wall head. Plates fixed into place with locking nuts.

Foul drainage sump

Cavity drainage sump

General

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Note:
Allow for internal cracking to be repaired with helical ties with 500mm embedment length either side of the cracks.

REV	COMMENTS	DATE	CHK
P01	PRELIMINARY ISSUE	15.11.24	CM

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DRAWING TITLE
PROPOSED
BASEMENT GA

SCALE @ A1	DRAWN BY	DATE
1:25	JSE	31.07.24
MNP No.	STATUS CODE	REV
224260	S0	P01

Ref No.
224260-MNP-XX-B1-DR-S-1000

General
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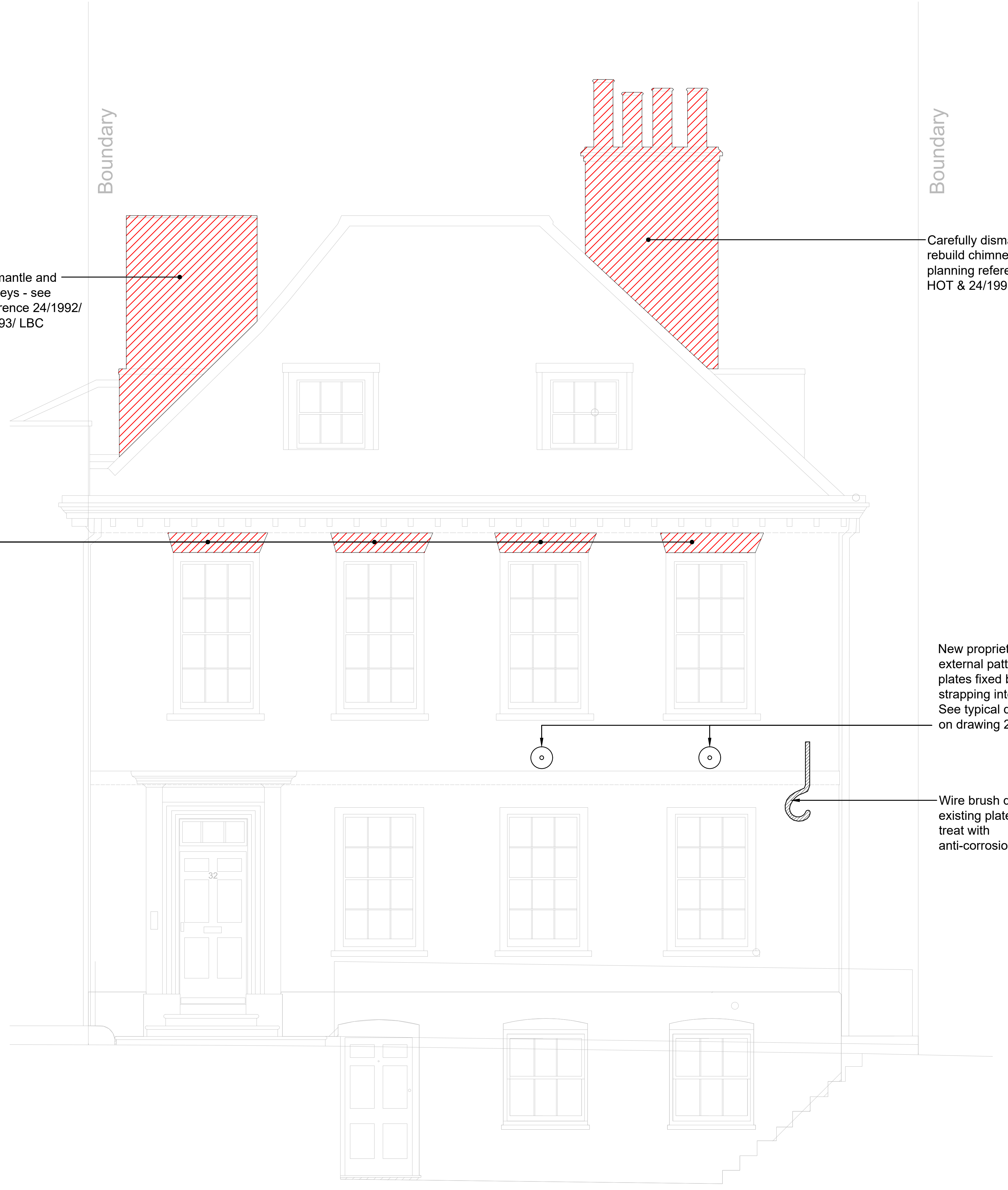


Carefully dismantle and rebuild chimneys - see planning reference 24/1992/ HOT & 24/1993/ LBC

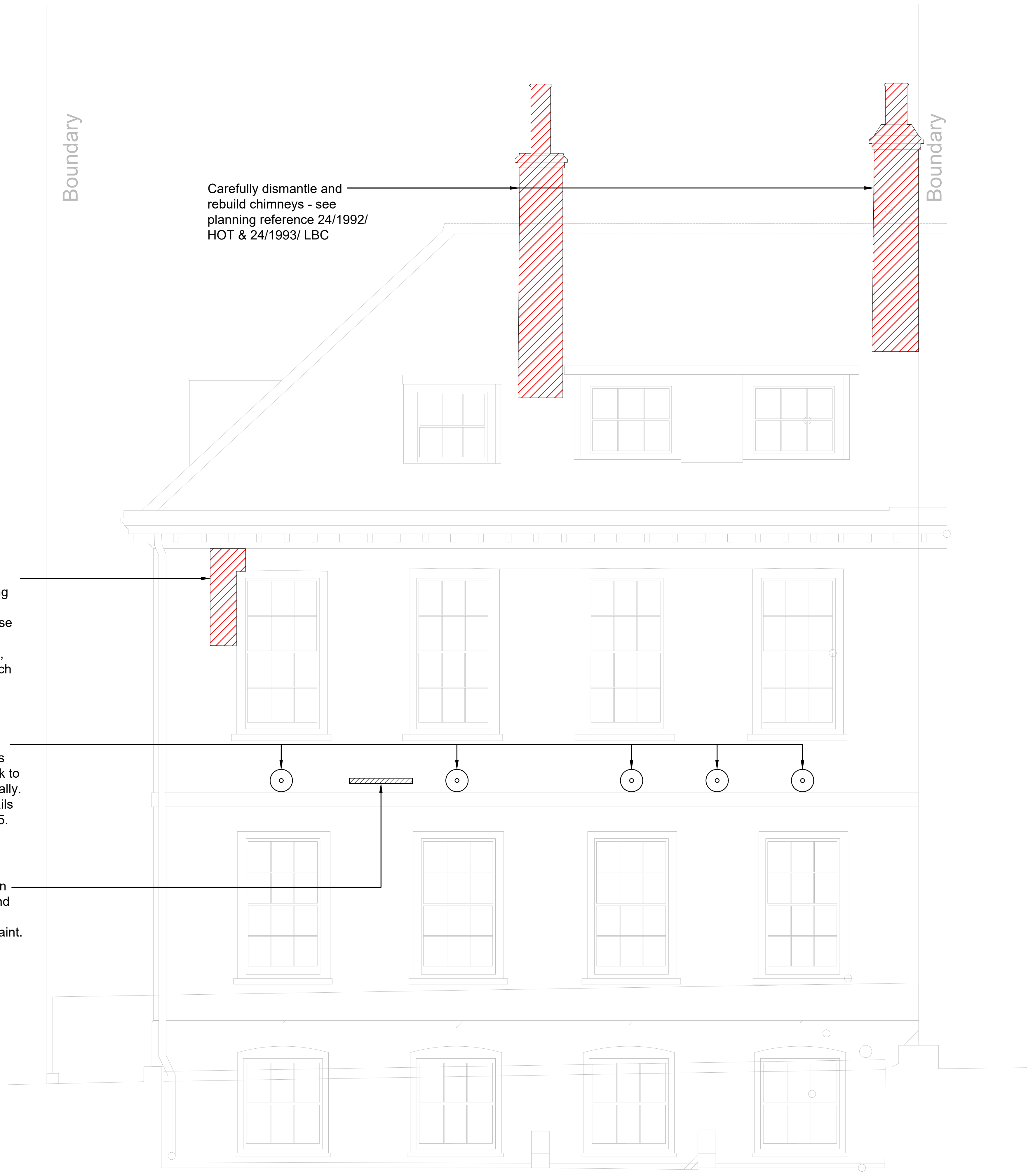
Carefully dismantle and rebuild chimneys - see planning reference 24/1992/ HOT & 24/1993/ LBC

Reset displaced lintels

New proprietary external pattress plates fixed back to strapping internally. See typical details on drawing 2105.

Wire brush down existing plate and treat with anti-corrosion paint.

Elevation A-A
Scale 1:50



Carefully dismantle and rebuild chimneys - see planning reference 24/1992/ HOT & 24/1993/ LBC

Allow for cutting out and replacing damaged brickwork. (Reuse bricks where possible & if not, replaced to match existing)

New proprietary external pattress plates fixed back to strapping internally. See typical details on drawing 2105.

Wire brush down existing plate and treat with anti-corrosion paint.

Elevation B-B
Scale 1:50

Provisional items
Allow for
- Cutting out and replacing 2m^2 of damaged brickwork. replace with bricks that match the existing. (area taken over total area of wall).
- Allow for resettling 3No. displaced lintels.

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DRAWING TITLE
PROPOSED
ELEVATIONS
A-A & B-B

SCALE @ A1	DRAWN BY	DATE
1:50	JSE	31.07.24
MNP No.	STATUS CODE	REV
224260	S0	P 01

Ref No.
224260-MNP-XX- 02 -DR-S-2100

General
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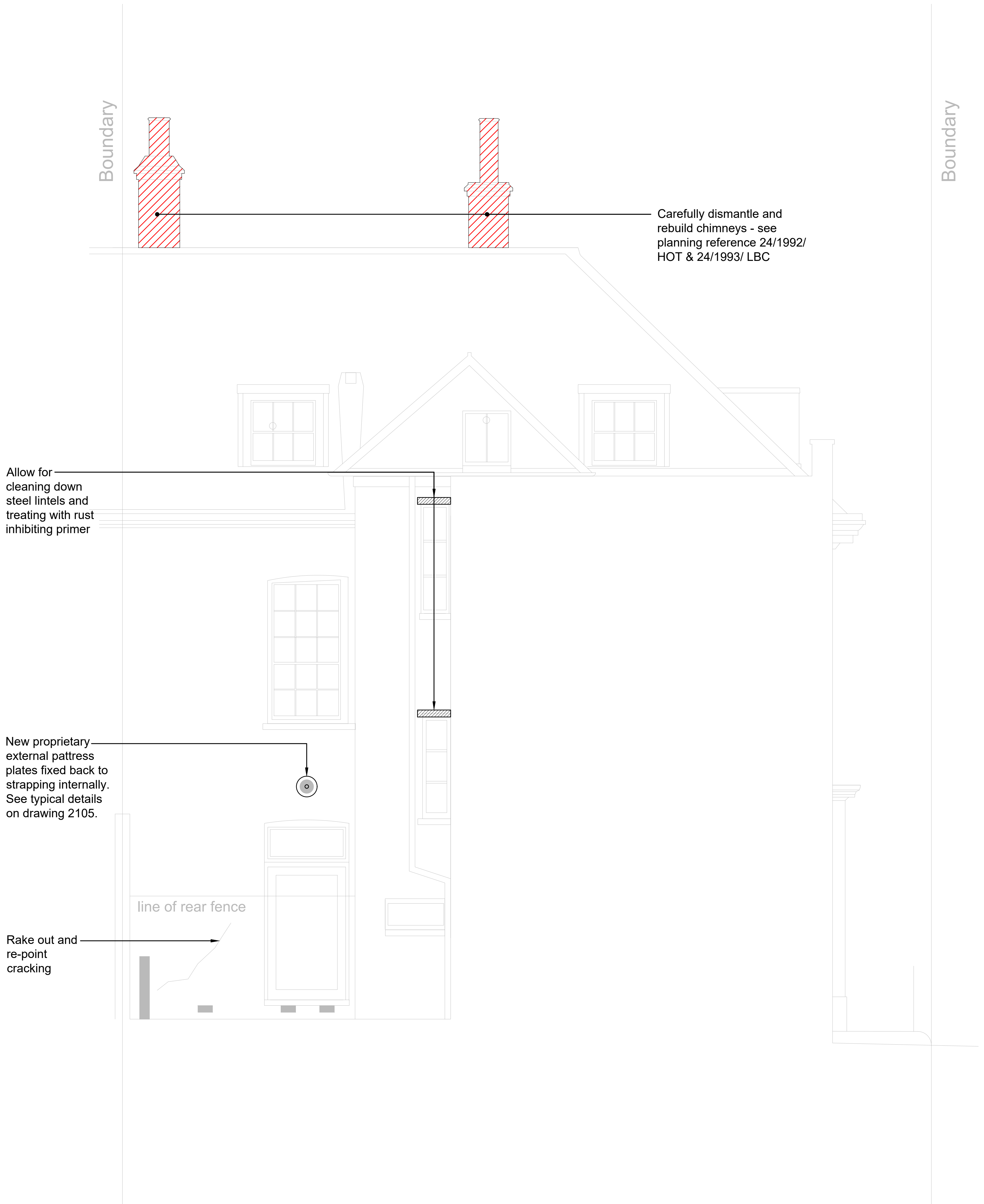


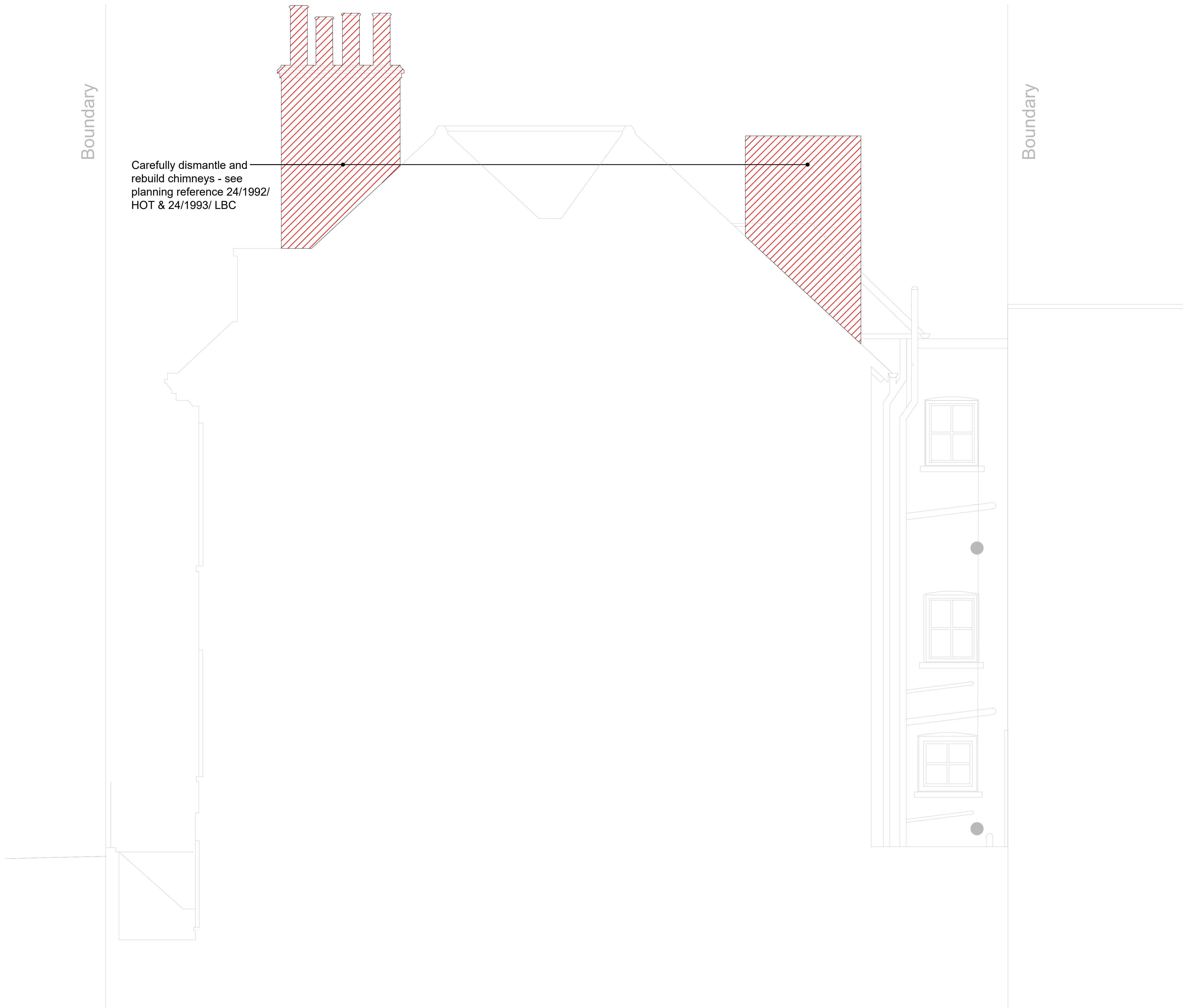
Carefully dismantle and rebuild chimneys - see planning reference 24/1992/ HOT & 24/1993/ LBC

Allow for cleaning down steel lintels and treating with rust inhibiting primer

New proprietary external pattress plates fixed back to strapping internally. See typical details on drawing 2105.

Rake out and re-point cracking

Elevation C-C
Scale 1:50



Carefully dismantle and rebuild chimneys - see planning reference 24/1992/ HOT & 24/1993/ LBC

Elevation D-D
Scale 1:50

Provisional items
Allow for
- Cutting out and replacing 2m^2 of damaged brickwork. replace with bricks that match the existing. (Area taken over total area of wall).
- Allow for resettling 3no. displaced lintels.

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DRAWING TITLE
PROPOSED
ELEVATIONS
C-C & D-D

SCALE @ A1	DRAWN BY	DATE
1:50	JSE	31.07.24
MNP No.	STATUS CODE	REV
224260	S0	P01

Ref No.
224260-MNP-XX- 02 -DR-S-2101

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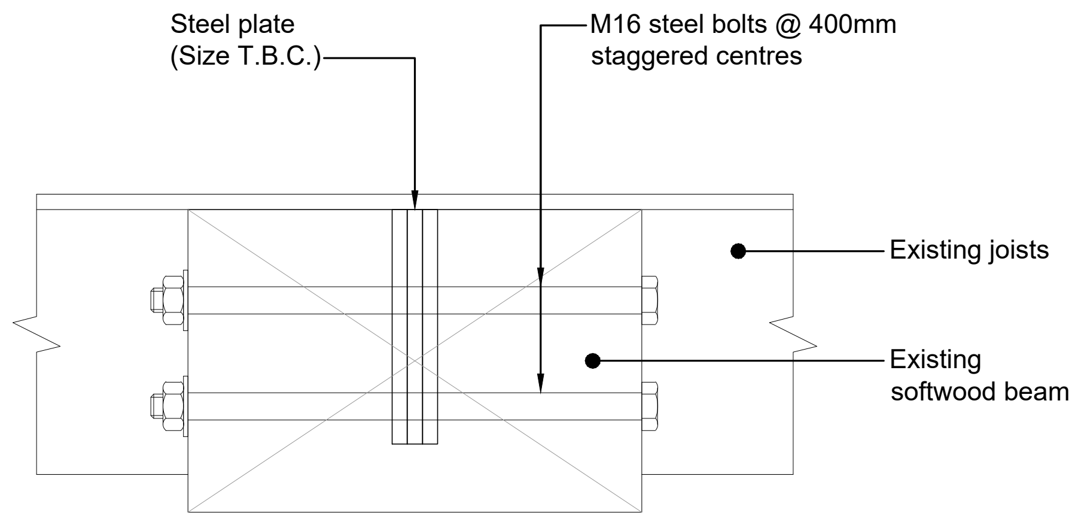
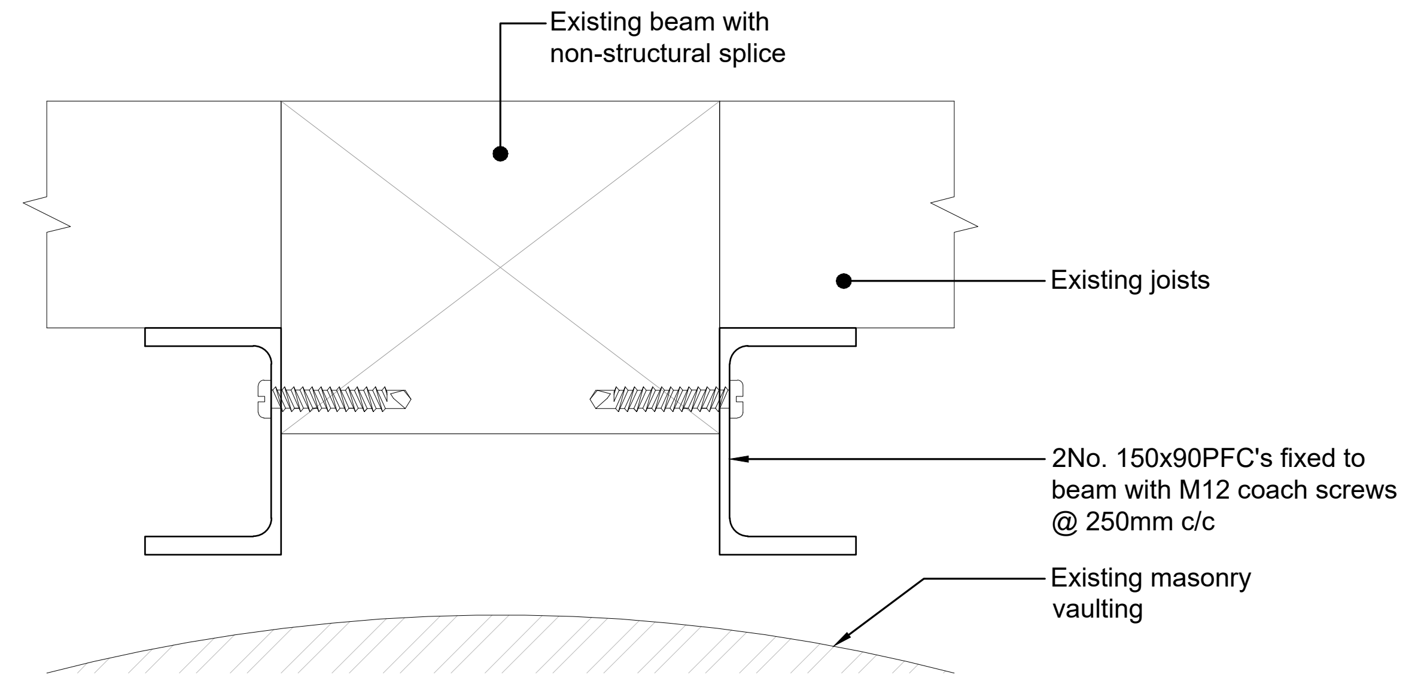
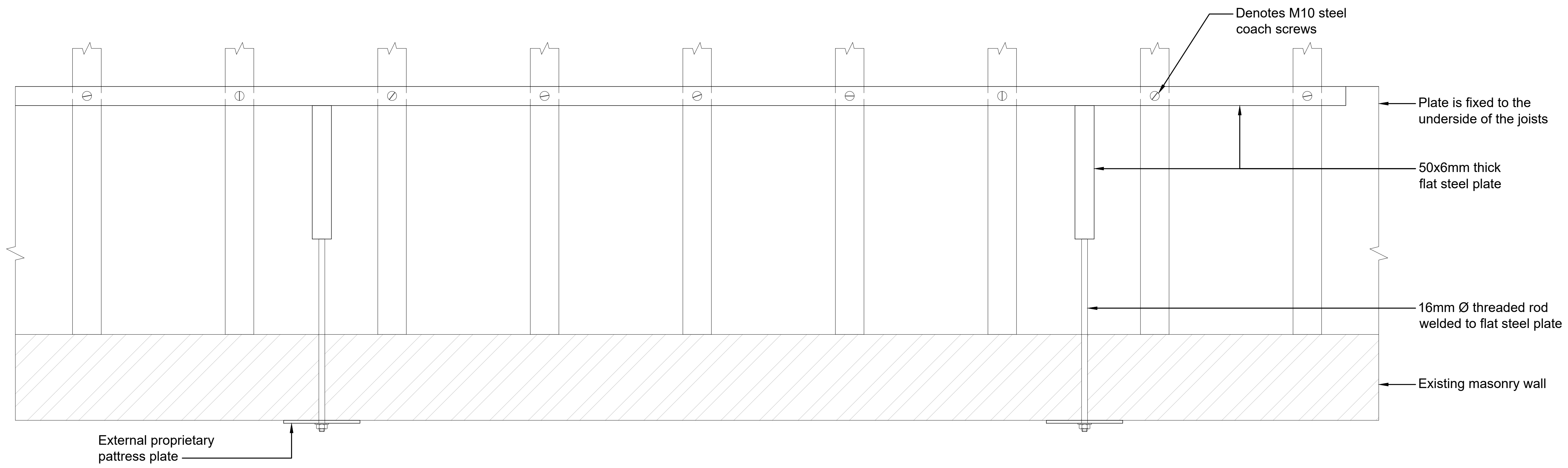


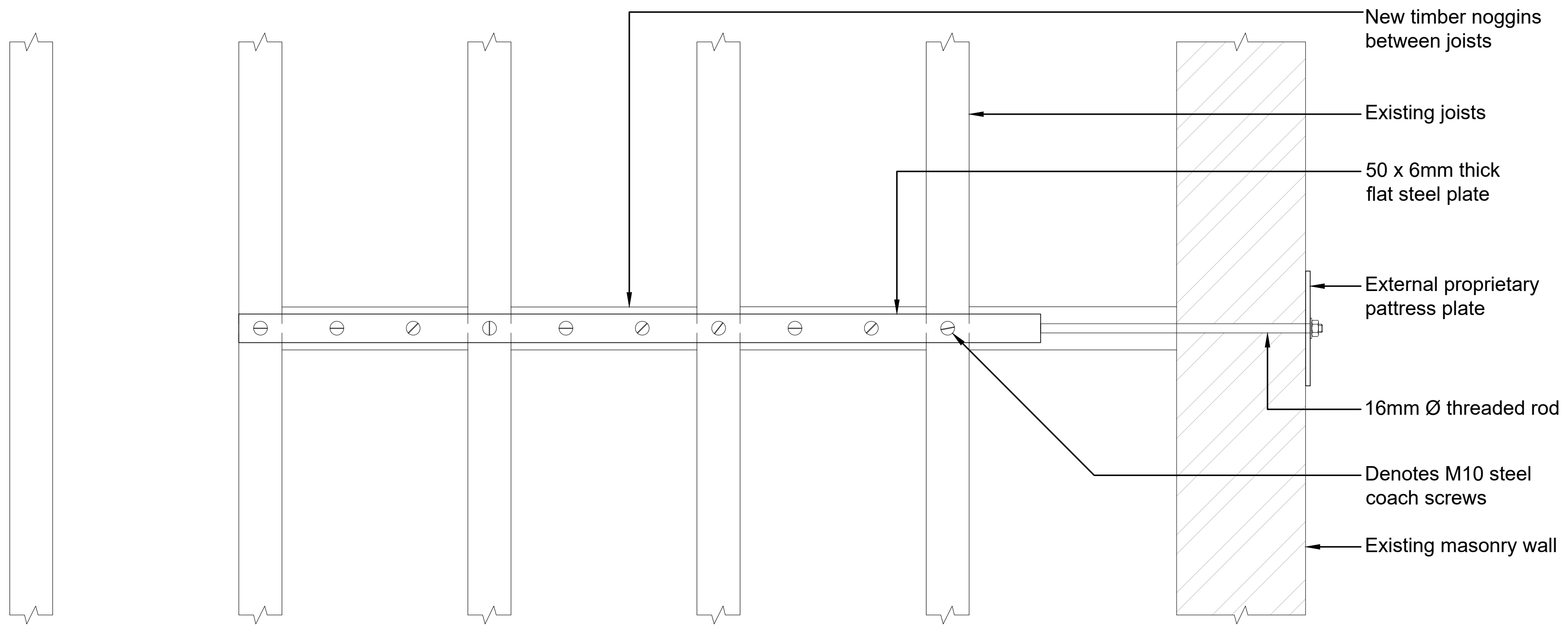
Typical Flitch Plate Detail
Scale 1:5



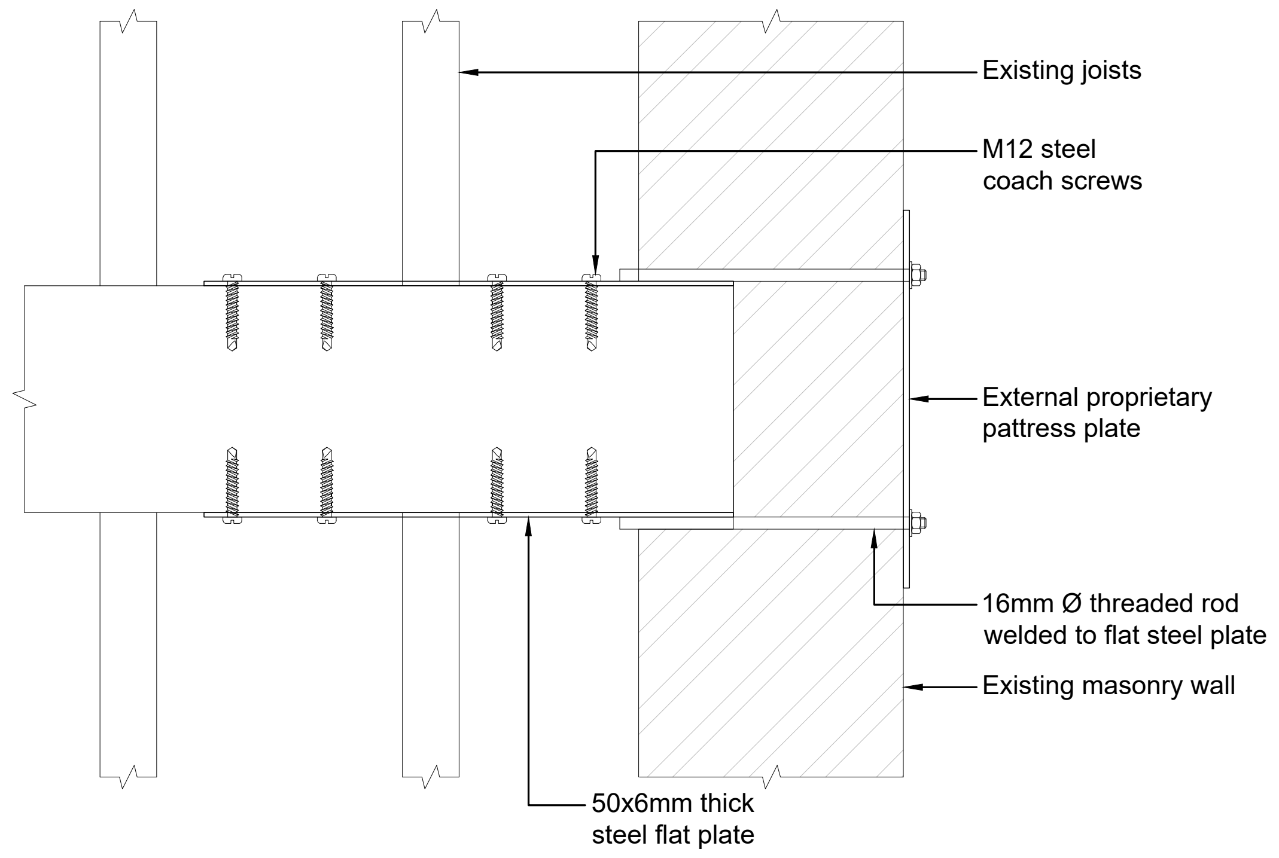
Detail of strengthening to beam in G4
Scale 1:5



Typical pattress plate detail 1 - Joist perpendicular to wall
Scale 1:10



Typical pattress plate detail 2 - Joist parallel to wall
Scale 1:10



Typical pattress plate detail 3 - For main beams
Scale 1:10

P01 First issue 15.11.24 CM
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PROJECT
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DRAWING TITLE
FLOOR STRUCTURE
REPAIR DETAILS

SCALE @ A1	DRAWN BY	DATE
AS NOTED	JSE	13.11.24
MNP No.	STATUS CODE	REV
224260	S0	P01

Ref No.
224260-MNP-XX-XX-DR-S-2105

General
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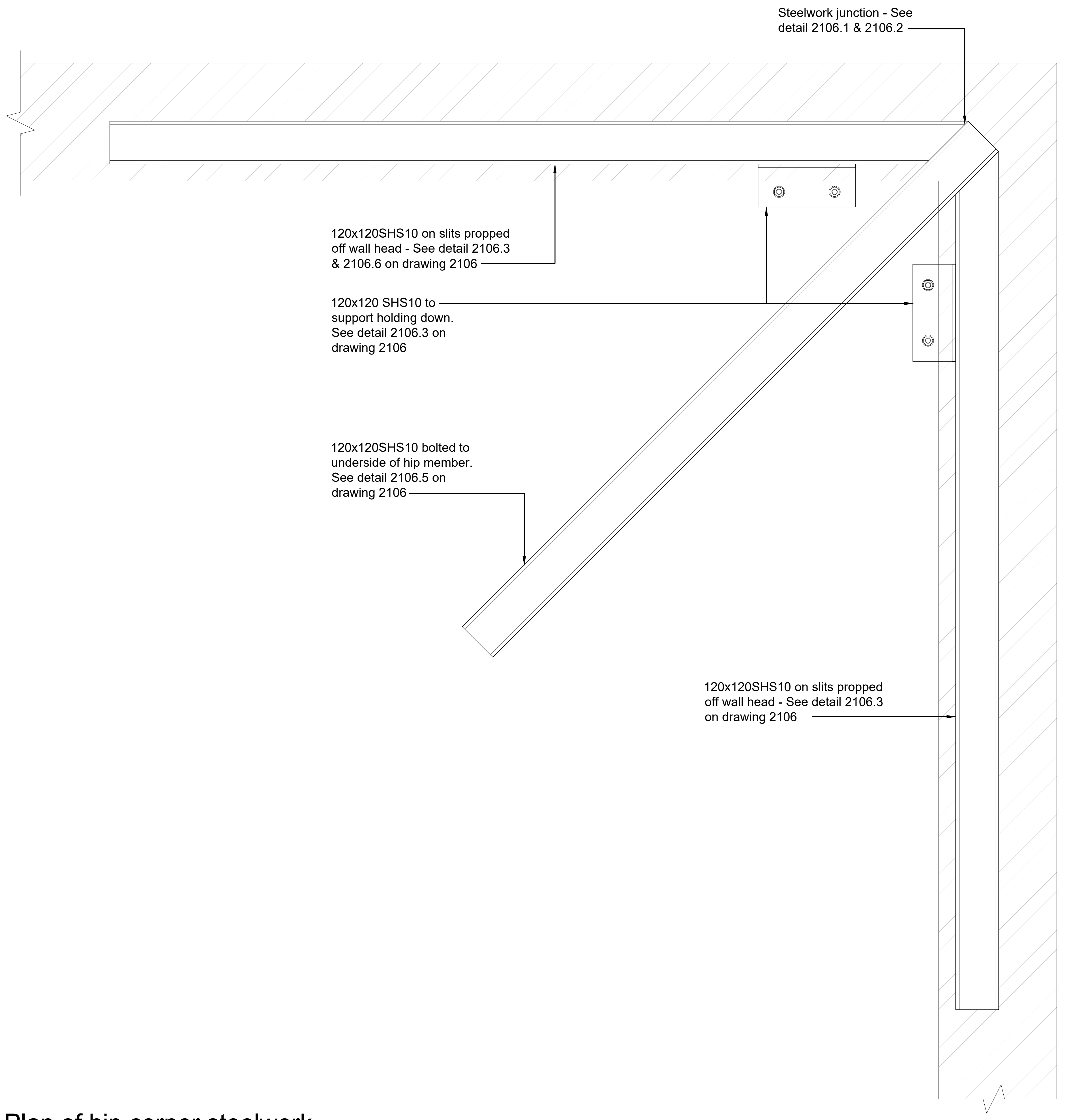
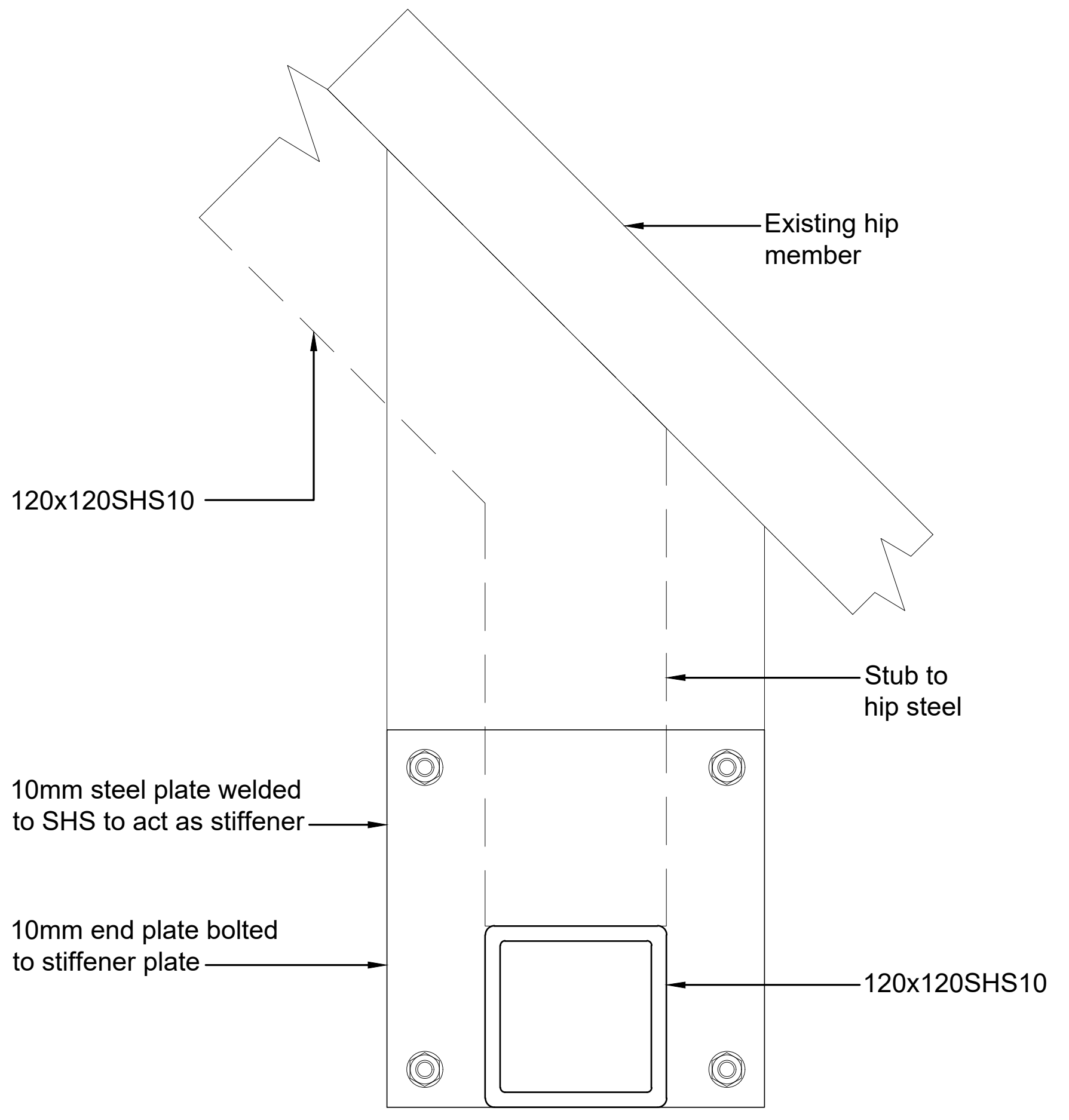
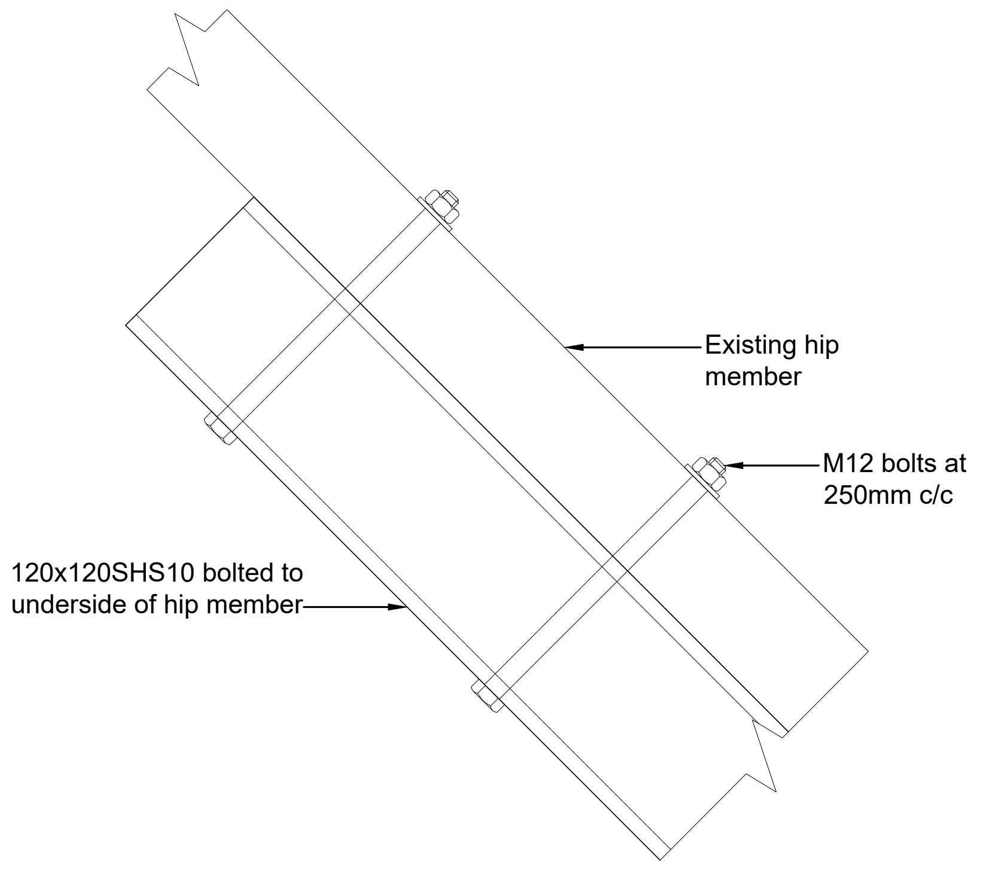


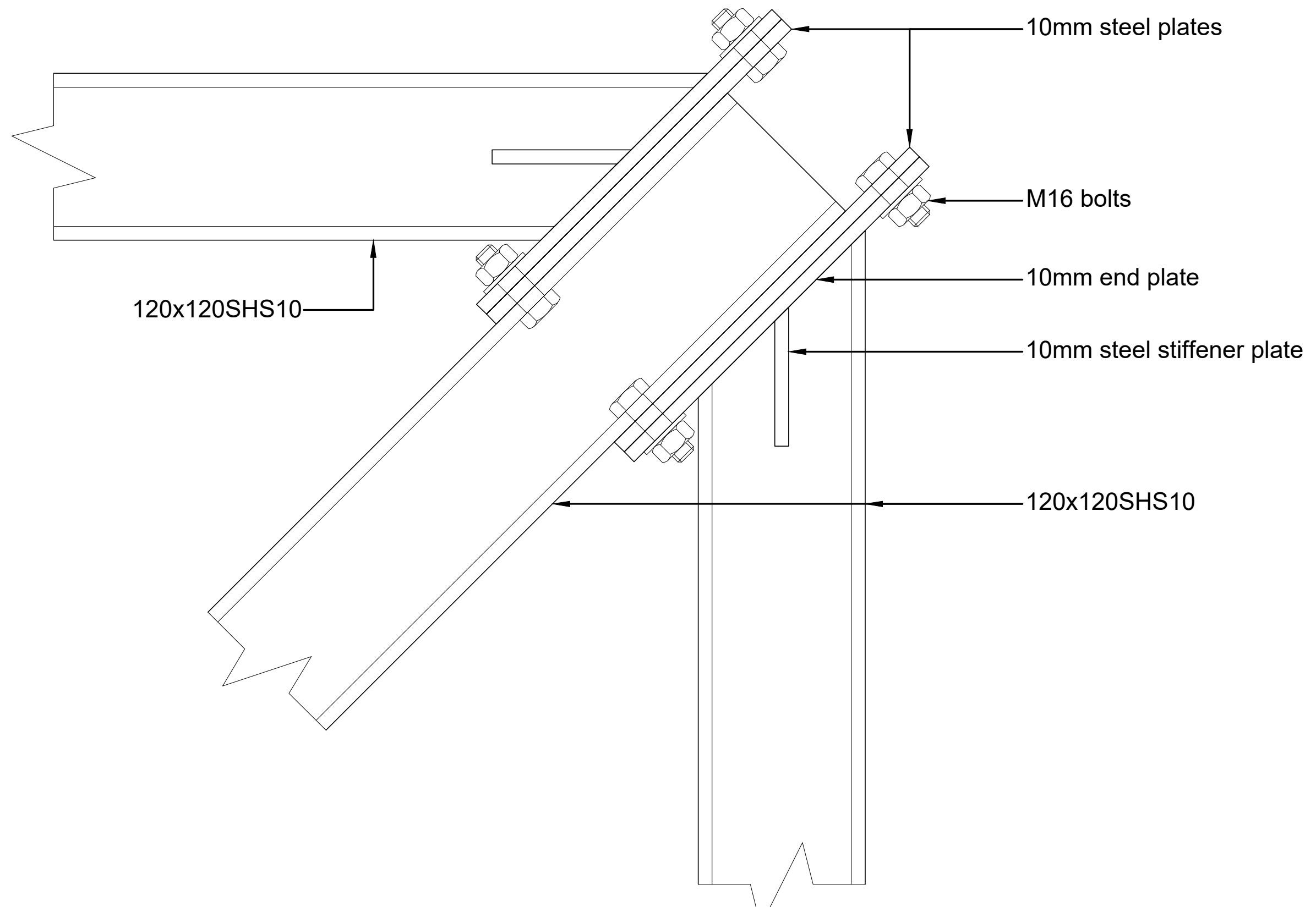
Plan of hip corner steelwork
Scale 1:10



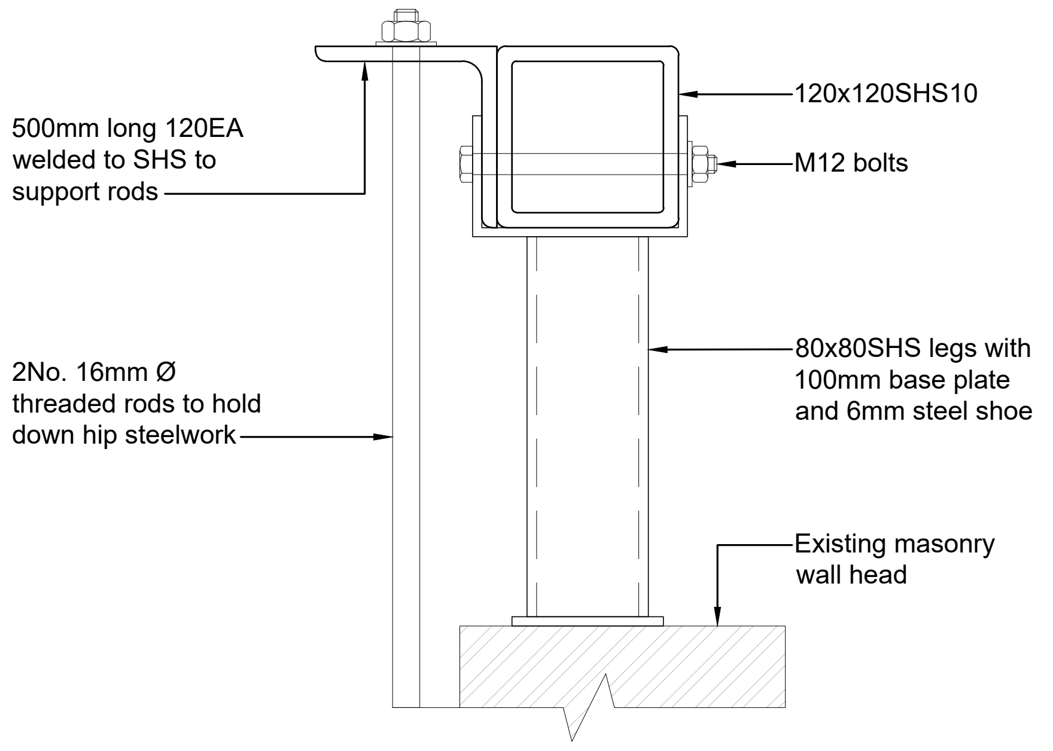
Detail 2106.1
Scale 1:5



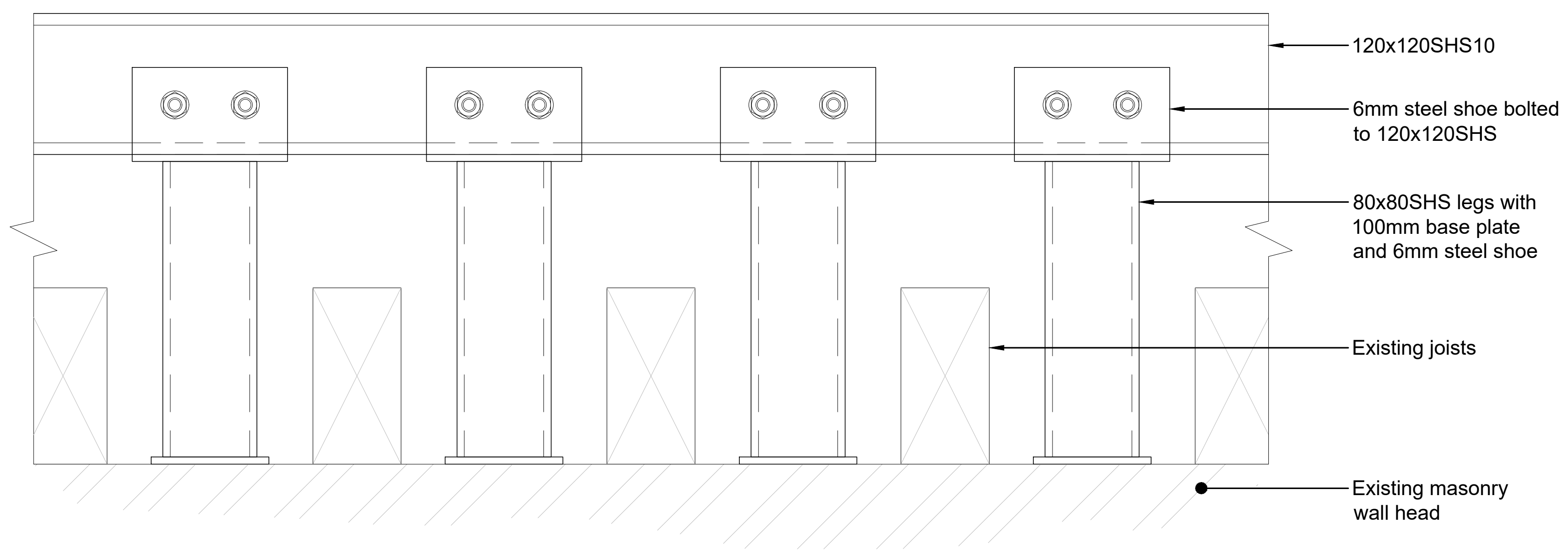
Detail 2106.5 - Elevation On Hip Member
Scale 1:5



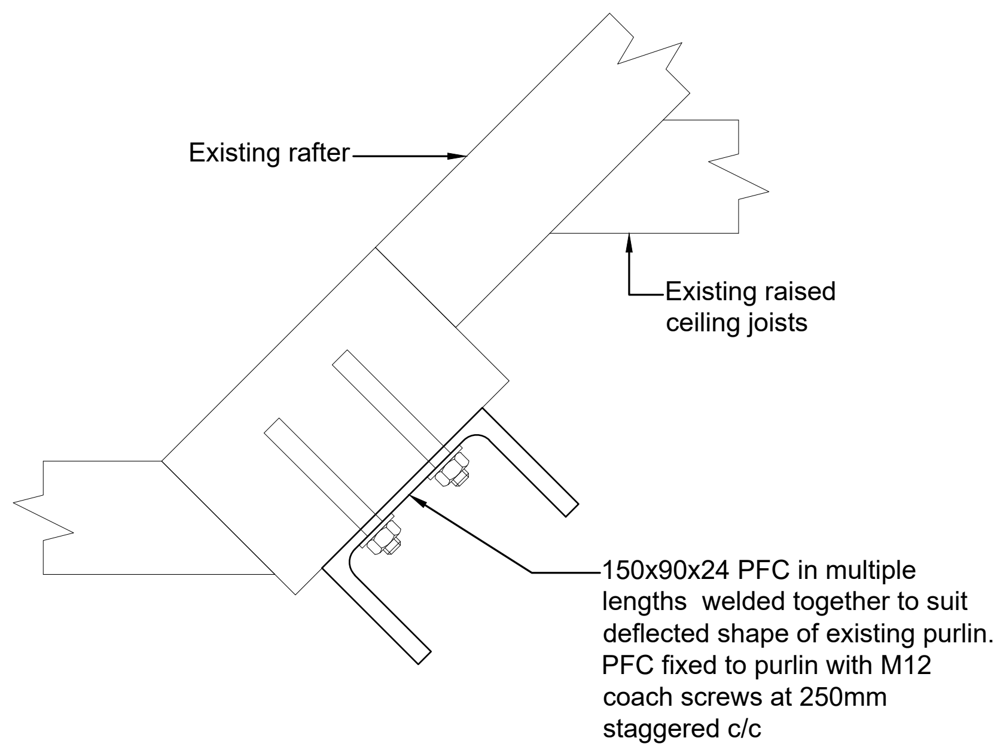
Detail 2106.2 - Plan of steel junction
Scale 1:5



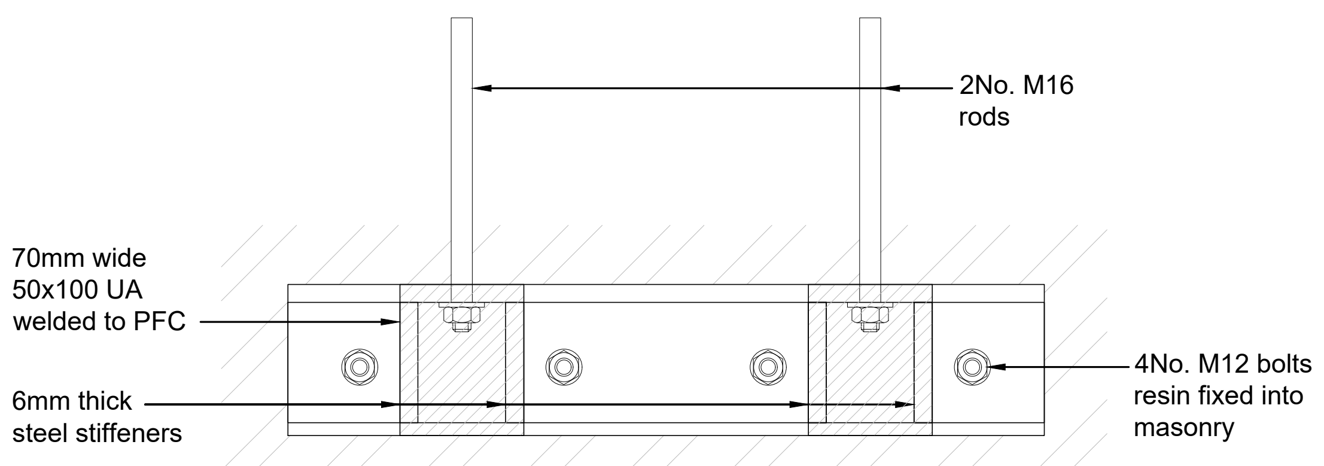
Detail 2106.3 - Section through legs
Scale 1:5



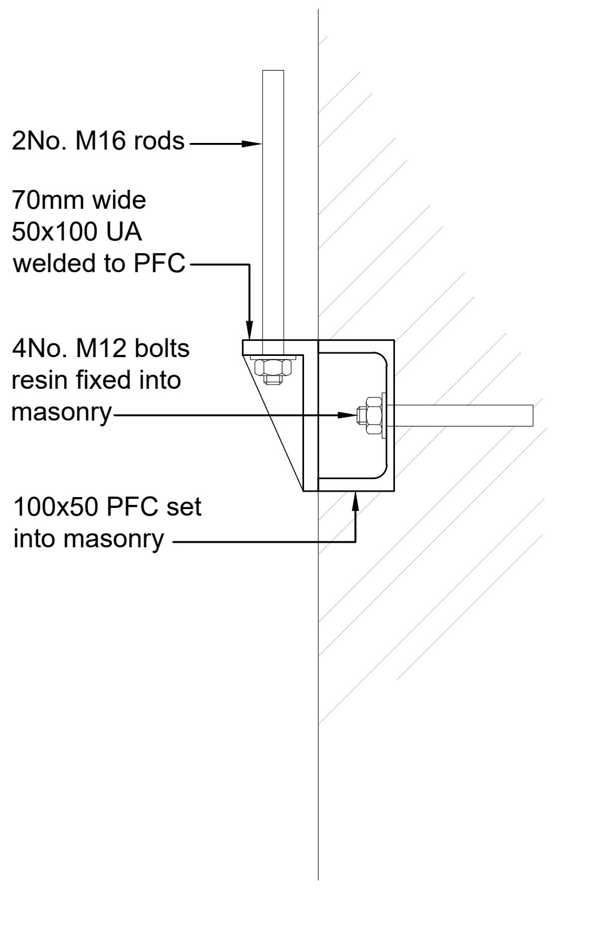
Detail 2106.6 - 120x120SHS Leg Support
Scale 1:5



Detail 2106.4 - Section Through Purlin
Scale 1:5



Detail 2106.7 - Steel Channel anchored into wall
Scale 1:5



Section through channel
Scale 1:5

REV	COMMENTS	DATE	CHK
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PROJECT
32 THE GREEN,
RICHMOND

DRAWING TITLE
ROOF STRUCTURE
REPAIR DETAILS

SCALE @ A1	DRAWN BY	DATE
AS NOTED	JSE	13.11.24
MNP No.	STATUS CODE	REV
224260	S0	P 01

Ref No.
224260-MNP-XX-XX-DR-S-2106

Appendix B – Calculations

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Project: 32 The Green, Richmond
Job No.: 224260
Sheet / Rev.: 1
Design Element: Roof Structure
Calc. Title: Design of purlin & Rafters.
Calc. by: CM
Date: 2/8/24
Chk'd by: JL

Design of purlin & Rafters.

purlin (worst case), 120mm (d) x 190mm (w)

Typical Rafter. 95mm (d) x 75mm (w) @ 390mm c/c.

Typical purlin 115mm (d) x 200mm (w)

Roof Plan (NTS).

S W E N

Notes

- Find max load of members.
- Purlins overdeflect alot on site. practically the worst case.

mason navarro pledge	Project 32 The Green, Richmond, London	Job No. 224260	Sheet / Rev. 2
		Design Element Roof Structure	
Calc. Title Loading	Calc. by CM	Date 18/11/24	Chk'd by JL

Loading			
Roof			
Dead			
Existing Loads			**Units**
Tiles		0.70	kN/m^2
Softwood Batterns		0.02	kN/m^2
Rafters		0.08	kN/m^2
	SUM	**0.80**	kN/m^2
Additional Historic Loads			
Lath + Plaster		0.31	kN/m^2
	SUM	**0.31**	kN/m^2
Additional Future Loads			
Kingspan Membrane		0.00	kN/m^2
2x50mm Insulation		0.03	kN/m^2
Allow for Max of 15mm Fire Board or Lath + Plaster		0.31	kN/m^2
	SUM	**0.34**	kN/m^2
Live			
Snow		0.30	kN/m^2
	SUM	**0.30**	kN/m^2

mason navarro pledge	Project 32 The Green, Richmond, London	Job No. 224260		Sheet / Rev. 3
		Design Element Roof Structure		
Calc. Title Loading		Calc. by CM	Date 18/11/24	Chk'd by JL

Ceiling			
Dead			
Existing Loads			
Ceiling Joists		0.06	kN/m^2
	SUM	**0.06**	kN/m^2
Additional Historic Loads			
Lath + Plaster		0.31	kN/m^2
	SUM	**0.31**	kN/m^2
Additional Future Loads			
200mm Roll of Insulation		0.02	kN/m^2
Allow for Max of 15mm Fire Board or Lath + Plaster		0.31	kN/m^2
	SUM	**0.33**	kN/m^2
Live			
Access		0.25	kN/m^2
	SUM	**0.25**	kN/m^2

Point Load on Hip Through Purlins

	Existing	Historical Loads	Future Loads	Units
Purlin Span	2.80	2.80	2.80	m
Purlin Midspan	1.40	1.40	1.40	m
Loading width Upper (On Slope)	2.59	2.59	2.59	m
Loading width Lower (On Slope)	1.00	1.00	1.00	m
Loading width Upper (On Plan)	1.83	1.83	1.83	m
Loading width Lower (On Plan)	0.70	0.70	0.70	m
Loading width going onto Purlin (On Slope)	3.59	3.59	3.59	m
Loading width going onto Purlin (On Plan)	2.53	2.53	2.53	m
Density of Purlin, Softwood	4.20	4.20	4.20	kN/m^3
Purlin Depth	115	115	115	mm
Purlin Width	200	200	200	mm
Self weight	0.10	0.10	0.10	kN/m
Loading onto Purlin				
Dead Load				
Roof - Max	2.87	3.98	4.10	kN/m
Roof - Min	0.80	1.11	1.14	kN/m
Ceiling	0.12	0.68	0.72	kN/m
Live Load				
Roof - Max	0.76	0.76	0.76	kN/m
Roof - Min	0.21	0.21	0.21	kN/m
Ceiling	0.46	0.46	0.46	kN/m
Left Hand Support Reaction				
Dead				
Full UDL	1.28	2.51	2.60	kN
Partial UDL	0.73	1.01	1.03	kN
Triangluar Load	1.93	2.68	2.76	kN
Self Weight	0.14	0.14	0.14	kN
Live				
Full UDL	0.93	0.93	0.93	kN
Partial UDL	0.19	0.19	0.19	kN
Triangular Load	0.51	0.51	0.51	kN

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Project 32 The Green, Richmond, London

Job No. 224260

Sheet / Rev. 5

Design Element Roof Structure

Calc. Title Loading

Calc. by CM

Date 18/11/24

Chk'd by JL

Right Hand Support Reaction				
Dead				
Full UDL	1.28	2.51	2.60	kN
Partial UDL	2.18	3.02	3.10	kN
Triangular Load	0.48	0.67	0.69	kN
Self Weight	0.14	0.14	0.14	kN
Live				
Full UDL	0.93	0.93	0.93	kN
Partial UDL	0.58	0.58	0.58	kN
Triangular Load	0.13	0.13	0.13	kN
Totals				
LHS Reaction (Dead)	4.08	6.34	6.53	kN
LHS Reaction (Live)	1.64	1.64	1.64	kN
RHS Reaction (Dead)	4.08	6.34	6.53	kN
RHS Reaction (Live)	1.64	1.64	1.64	kN
RHS Reaction (Both)	5.72	7.98	8.17	kN
LHS Reaction (Both)	5.72	7.98	8.17	kN
RHS Reaction (Factored)	7.96	11.01	11.27	kN
LHS Reaction (Factored)	7.96	11.01	11.27	kN
LHS Reaction PL onto Hip				
2X PL onto Hip (Dead)	8.16	12.67	13.06	kN
2X PL onto Hip (Live)	3.28	3.28	3.28	kN
2X PL onto Hip (Both)	11.43	15.95	16.34	kN
2X PL onto Hip (Factored)	15.93	22.03	22.55	kN
Percentage Difference	**Historical to Existing Loads**	**Existing to Future Loads**	**Historical to Future Loads**	
2X PL onto Hip (Dead)	-36	60	3	%
2X PL onto Hip (Live)	0	0	0	%
2X PL onto Hip (Both)	-28	43	2	%
2X PL onto Hip (Factored)	-28	42	2	%

Note:
The point loads from the purlins onto the hip member are to be used to design the steelwork in the hipped corners. When comparing the percentage difference between the historical and future loads, there is only a very small increase.

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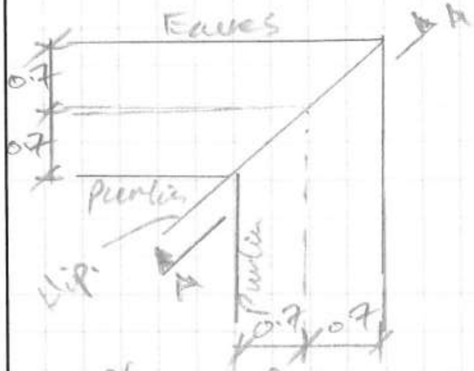
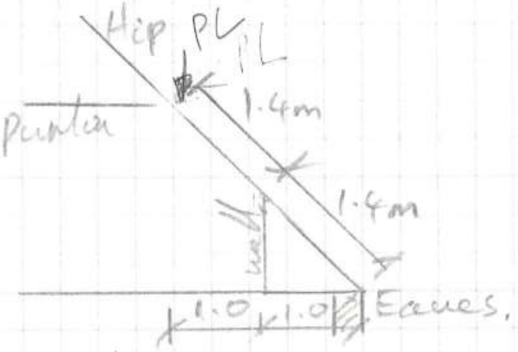
Project: 32 The Green, Richmond
Job No. 224260
Sheet / Rev. 6
Design Element: Roof structure
Calc. Title: Support to hip.
Calc. by: CM
Date: 10/9/24
Chk'd by: JL

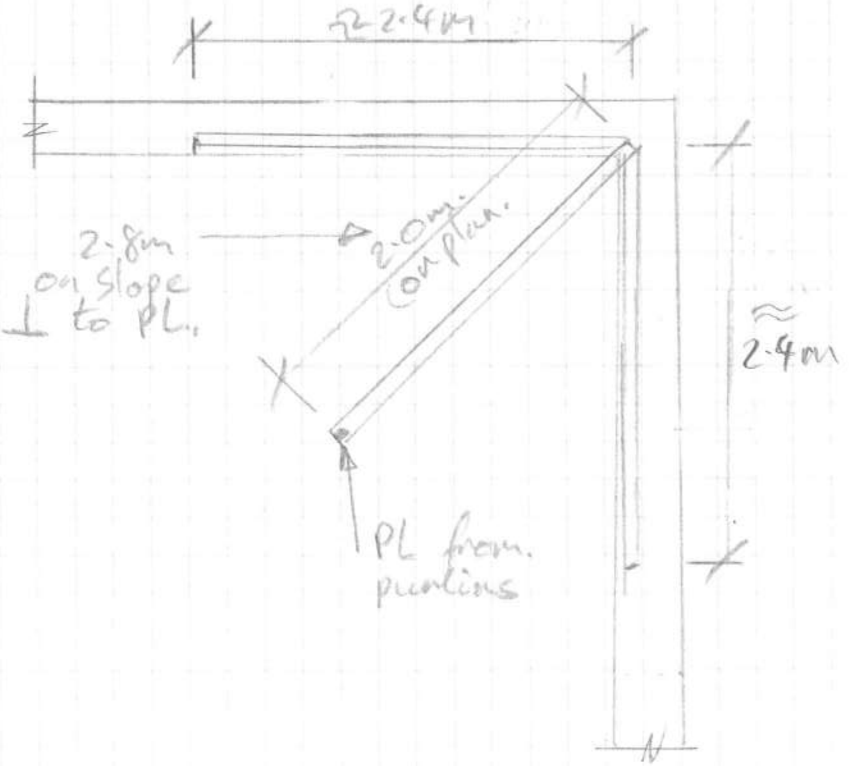
Design of support to hip member in corner of building.



Plan of hip (NTS)



Section A-A (NTS)



plan of steel work (NTS)

mason navarro pledge	Project 32 The Green, Richmond.	Job No. 224260		Sheet / Rev. 7
		Design Element Roof structure		
Calc. Title Support to hip		Calc. by CM	Date 10/9/24	Chk'd by JL

Design of support to hip member in corner of building

Loading

PL = load from purlins on hip.

PL

Dead = 13·06kN

Live = 3·28kN

Results

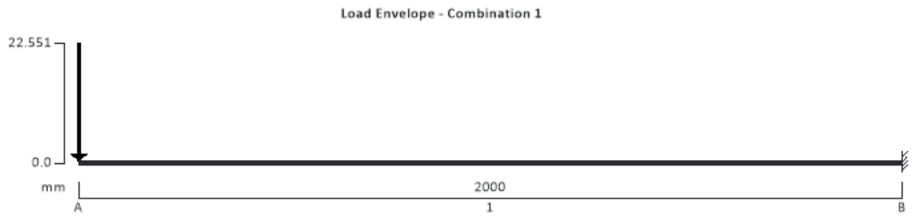
Use SHS 120x120x10·0 S355

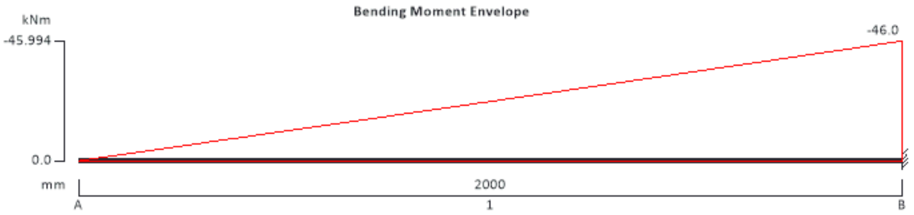
See Tedds calculations over page

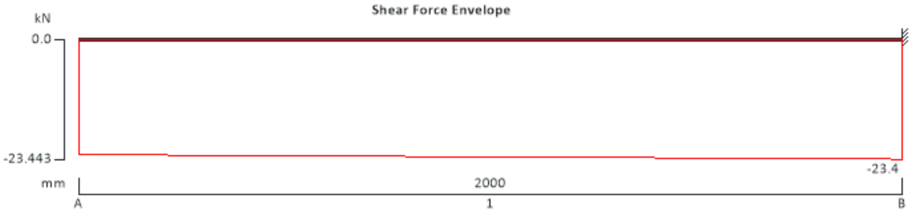
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14







Support conditions

Support A	Vertically free Rotationally free
Support B	Vertically restrained Rotationally restrained

Applied loading

Beam loads	Permanent self weight of beam × 1 Permanent point load 13.06 kN at 0 mm Variable point load 3.28 kN at 0 mm

Load combinations

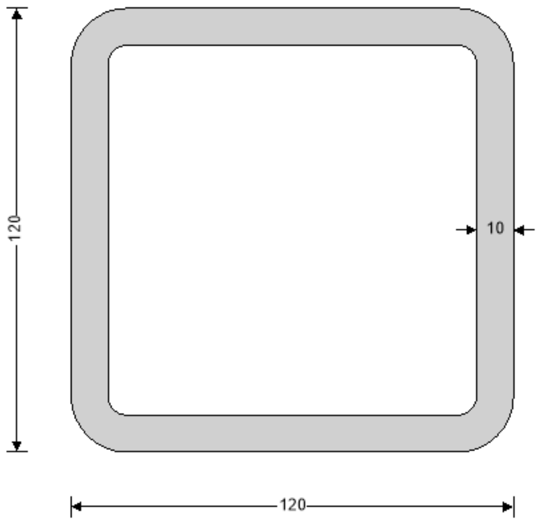
Load combination 1	Support A	Permanent × 1.35 Variable × 1.50
		Permanent × 1.35 Variable × 1.50
	Support B	Permanent × 1.35 Variable × 1.50

Analysis results

Maximum moment	M_{max} = **0** kNm	M_{min} = **-46** kNm
Maximum shear	V_{max} = **-22.6** kN	V_{min} = **-23.4** kN
Deflection	δ_{max} = **4.9** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **0** kN	R_{A_min} = **0** kN
Maximum reaction at support B	R_{B_max} = **23.4** kN	R_{B_min} = **23.4** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **13.7** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **3.3** kN	

Section details

Section type **SHS 120x120x10.0 (Tata Steel Celsius (Gr355 Gr420))** Steel grade **S355H**



Section classification **Class 1**

Check shear - Section 6.2.6

Design shear force	V_{Ed} = **23** kN	Design shear resistance	$V_{c,Rd}$ = **439.9** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment	M_{Ed} = **46** kNm	Des.bending resist.moment	$M_{c,Rd}$ = **62.2** kNm

PASS - Design bending resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

Limiting deflection	δ_{lim} = **5.6** mm	Maximum deflection	δ = **4.888** mm

PASS - Maximum deflection does not exceed deflection limit

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Project: 32 The Green, Richmond
Job No.: 224260
Sheet / Rev.: 10
Design Element: Roof structure
Calc. Title: Support to hip
Calc. by: CM
Date: 10/9/24
Chk'd by: JL

Design of Support to hip member in Corner of building

Moments @ fixed end.

Dead = 13·06kN × 2·0m = 26·1kNm

Live = 3·28kN × 2·0m = 6·6kNm

SUM = 32·7kNm

Factored = 1·35 × 26·1kN + 1·5 × 6·6kN = 45·1 kNm

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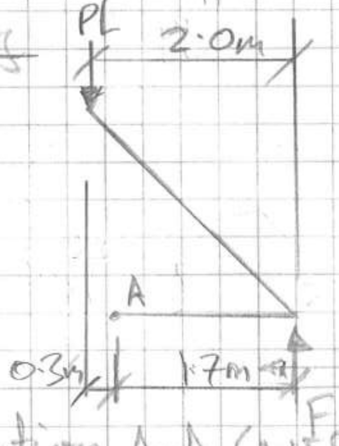
Project: 32 The Green, Richmond.
Job No.: 224260
Sheet / Rev.: 11
Design Element: Roof Structure
Calc. Title: Support to hip.
Calc. by: CM
Date: 10/9/24
Chk'd by: JL

Design of support to hip member in corner of building



$= \sqrt{\frac{2{\cdot}4^2}{2}} = \underline{1{\cdot}7m.}$

Section A-A (NTS)

Calculate uplift, F by taking moments @ A

Dead, PL = 13·06kN

$13{\cdot}06kN \times 0{\cdot}3m = F_D \times 1{\cdot}7m.$

$F_D = (13{\cdot}06kN \times 0{\cdot}3m)/1{\cdot}7m = \underline{2{\cdot}31\ kN}$

Live, PL = 3·28kN

$3{\cdot}28kN \times 0{\cdot}3\ m = F_L \times 1{\cdot}7m$

$F_L = (3{\cdot}28kN \times 0{\cdot}3m)/1{\cdot}7m = \underline{0{\cdot}58kN}$

Sum = 2·31kN + 0·58kN = $\underline{2{\cdot}89\ kN}$

Factored = 1·35 × 2·31kN + 1·5 × 0·58kN = $\underline{4{\cdot}0kN}$

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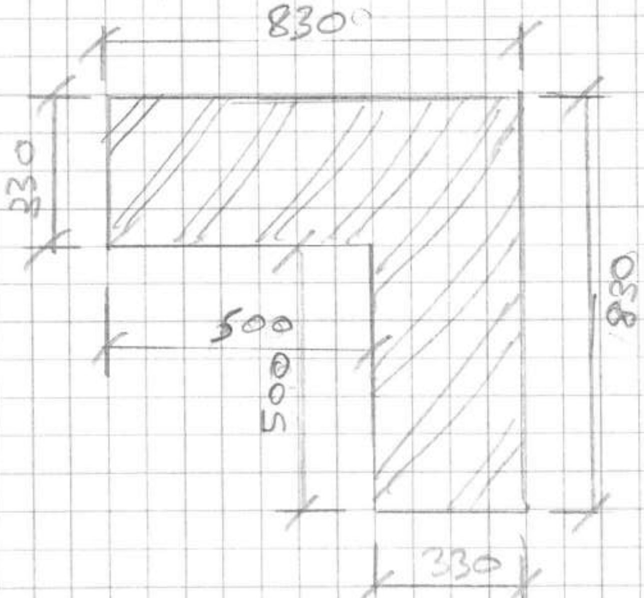
Project: 32 The Green, Richmond
Job No.: 224260
Sheet / Rev.: 12
Design Element: Roof Structure
Calc. Title: Support to hip.
Calc. by: CM
Date: 10/9/24
Chk'd by: JL

Calculate Mass of masonry to hold down uplift, F from steelwork



Area = 830 x 330
+ 500 x 330
= 438900mm²
= 0.44m²

Masonry ρ = 20kN/m³

SLS

Height per m to hold down uplift
= 2.89 kN / (20kN/m³ × 0.44m²)
= 0.33m

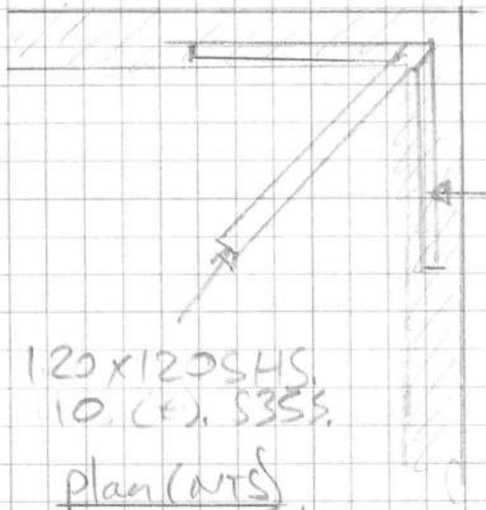
ULS

Height per m to hold down uplift - reduction factor of 0.9.
= 4.0kN / (20kN/m³ × 0.44m² × 0.9)
= 0.51m

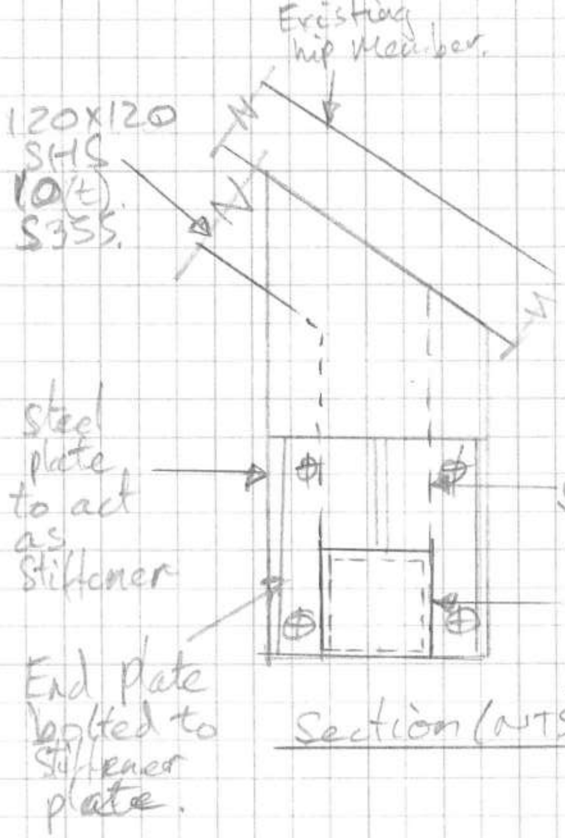
Therefore collect new steelwork down to FF level ≈ 3.0m > 0.51m OK.

mason navarro pledge	Project 32 The Green Richmond	Job No. 224260	Sheet / Rev. 13
		Design Element Roof Structure	
Calc. Title Support to hip.		Calc. by CM	Date 10/9/24	Chk'd by JL

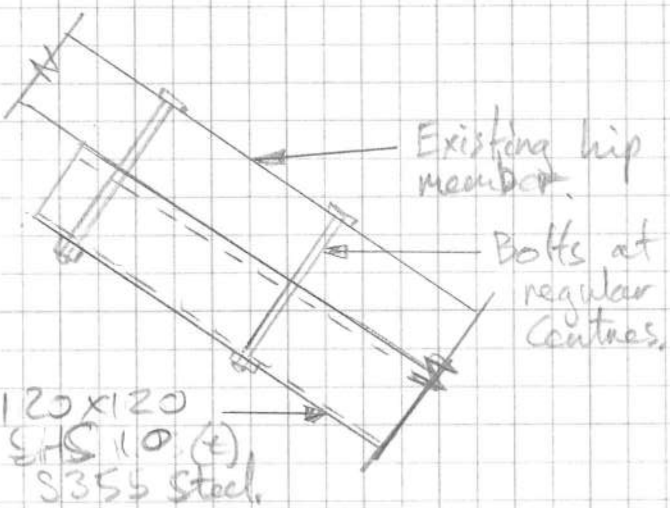
Sketches.



Plan (NTS)



Section (NTS)



Elevation on main hip member (NTS)

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Project: 32 The Green, Richmond.

Job No.: 224260

Sheet / Rev.: 14

Design Element: Roof Structure

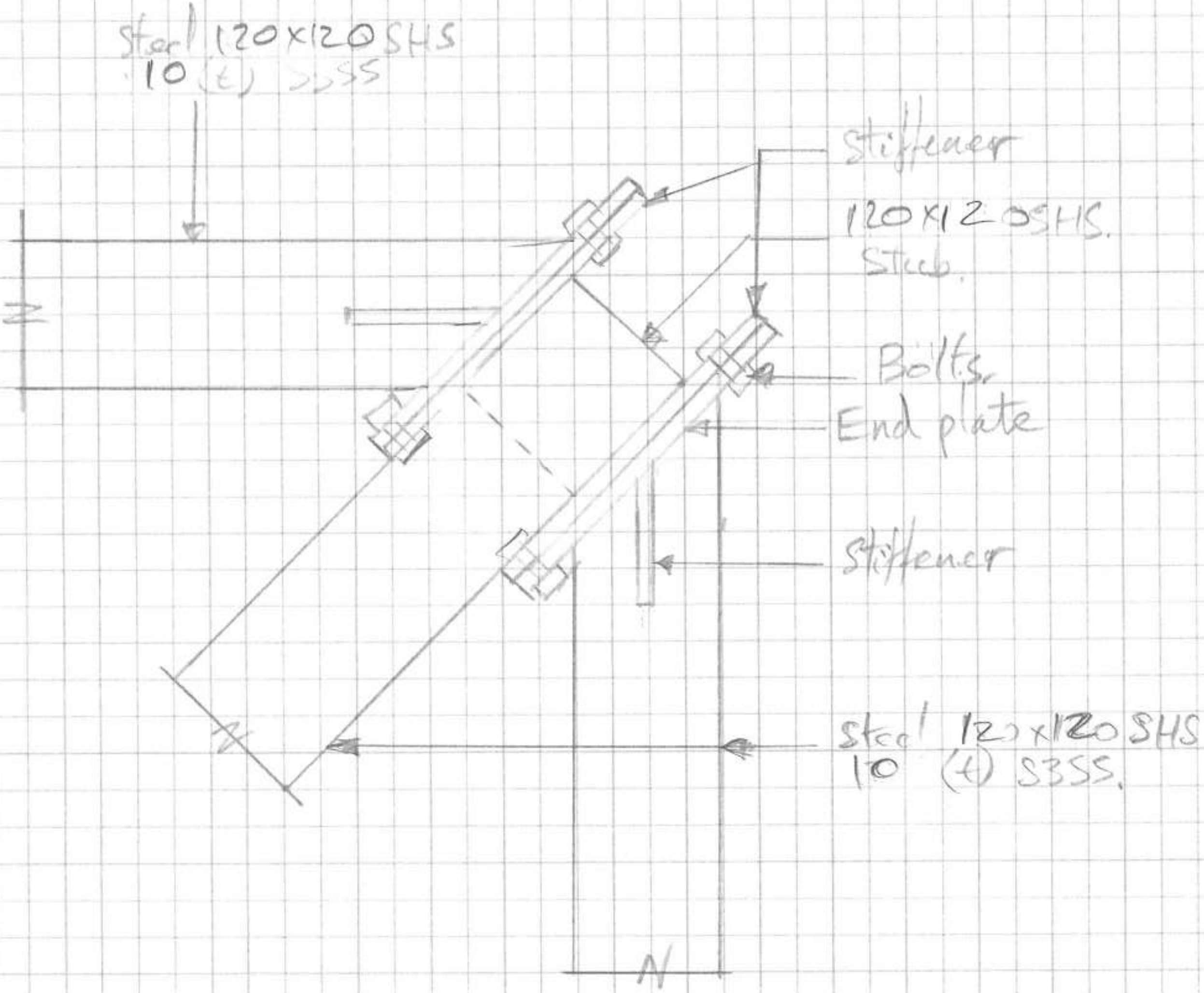
Calc. Title: Support to hip

Calc. by: CM

Date: 11/9/24

Chk'd by: JL

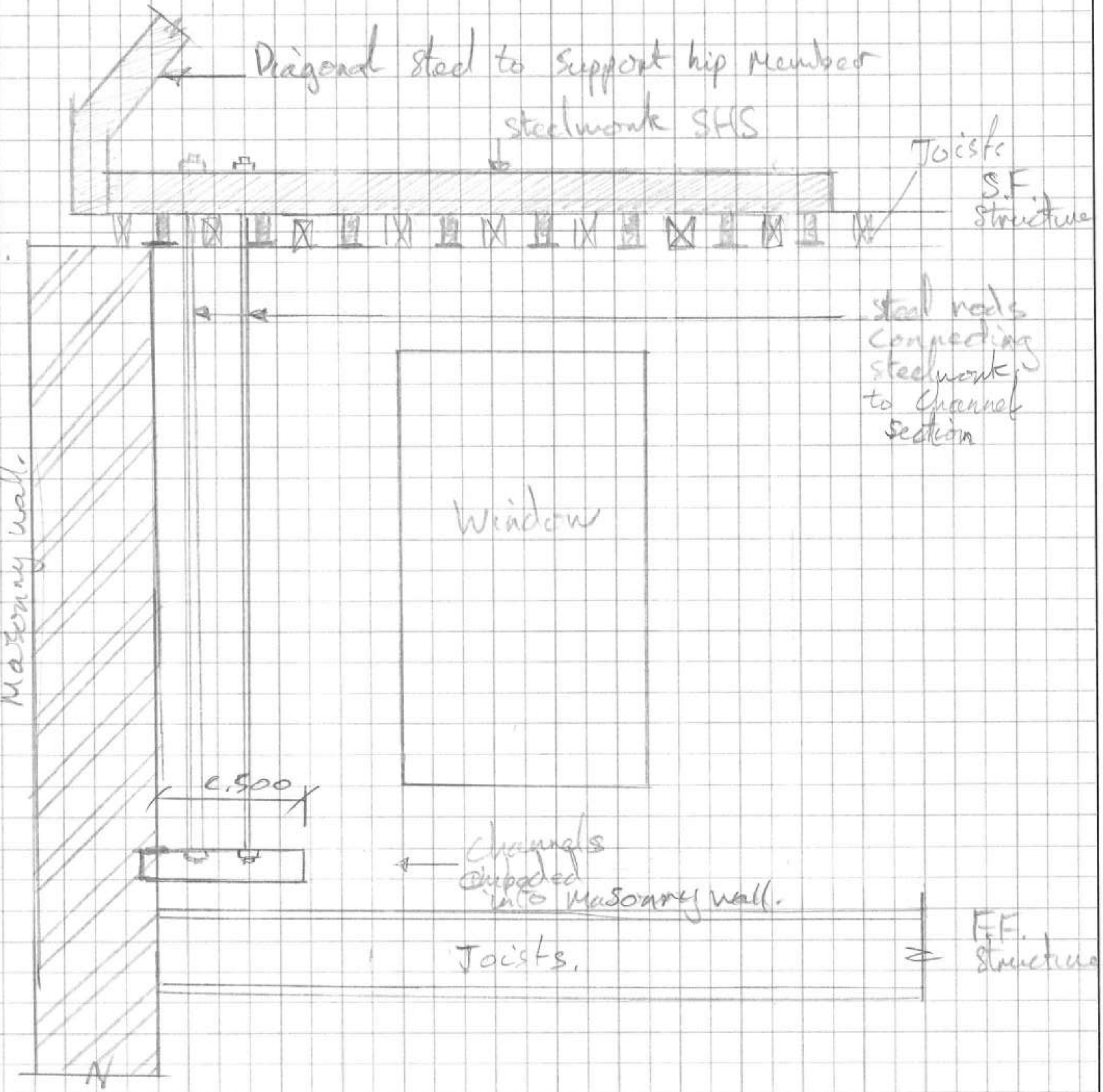
Sketches. (continued)



Plan of junction (NTS).

Project 32 The Green, Richmond
Job No. 224260
Sheet / Rev. 15
Design Element Roof Structure
Calc. Title Support to hip.
Calc. by CM
Date 11/9/24
Chk'd by JL

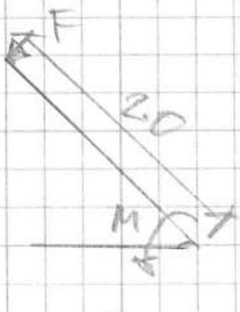
Sketches (continued)



Project	Job No.	Sheet / Rev.
32 The Green, Richmond	224260	16
	Design Element: Roof structure	

Calc. Title	Calc. by	Date	Chk'd by
Support to hip	CM	11/9/24	JL

Design check on bolt group on end plates.



Force on bolts is rotational through moment.

F_{Dead} = 13.06kN

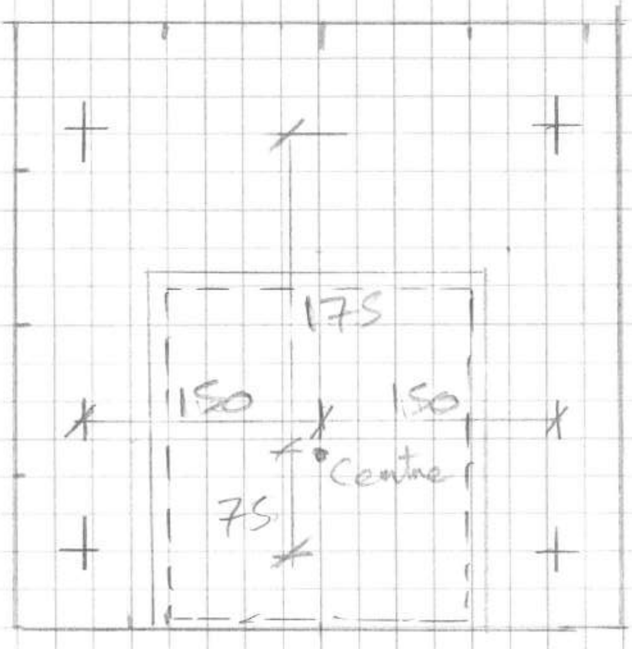
F_{Live} = 3.28kN

Moment (Dead) = 13.06kN × 2.0m = 26.12kNm

Moment (Live) = 3.28kN × 2.0m = 6.56kNm

SUM = 32.68kNm

Bolt group layout



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Project: 32 The Green Richmond
Job No.: 224260
Sheet / Rev.: 17
Design Element: Roof Structure
Calc. Title: Support to hip
Calc. by: CM
Date: 11/9/24
Chk'd by: JL

Design check on bolt group on end plate

Find force on bolt group

Use $F_b = \frac{Mz}{(\Sigma x^2 + \Sigma y^2)}$

z = Furthest distance to centre of group

$z = \sqrt{150^2 + 175^2} = \underline{230mm}$

$\Sigma x^2 = 4 \times 150^2 = \underline{\underline{90000 mm^2}}$

$\Sigma y^2 = 2 \times 175^2 + 2 \times 75^2 = \underline{\underline{72500 mm^2}}$

$F_b = \frac{32.68 \times 10^6 \times 230}{(90000+72500)/1000} = \underline{\underline{46.3kN}}$

Try 4No. M16 bolts (8.8).

1No. M16 in Single Shear = 60.3kN (Bluebook).

check [illegible]

$\underline{\underline{60.3kN > 46.3kN \therefore OK}}$

mnp mason navarro pledge	Project 32 The Green, Richmond	Job No. 224260	Sheet / Rev. 18	
		Design Element Roof Structure		
Calc. Title Support to hip.		Calc. by CM	Date 3/10/24	Chk'd by JL

Calculate rods and channel in masonry.

Applied force down rods from SHS = 2.89kN

Use 2No. 16mm diameter.

Rods by inspection are OK.

Check channel section, use 100x50 PFC

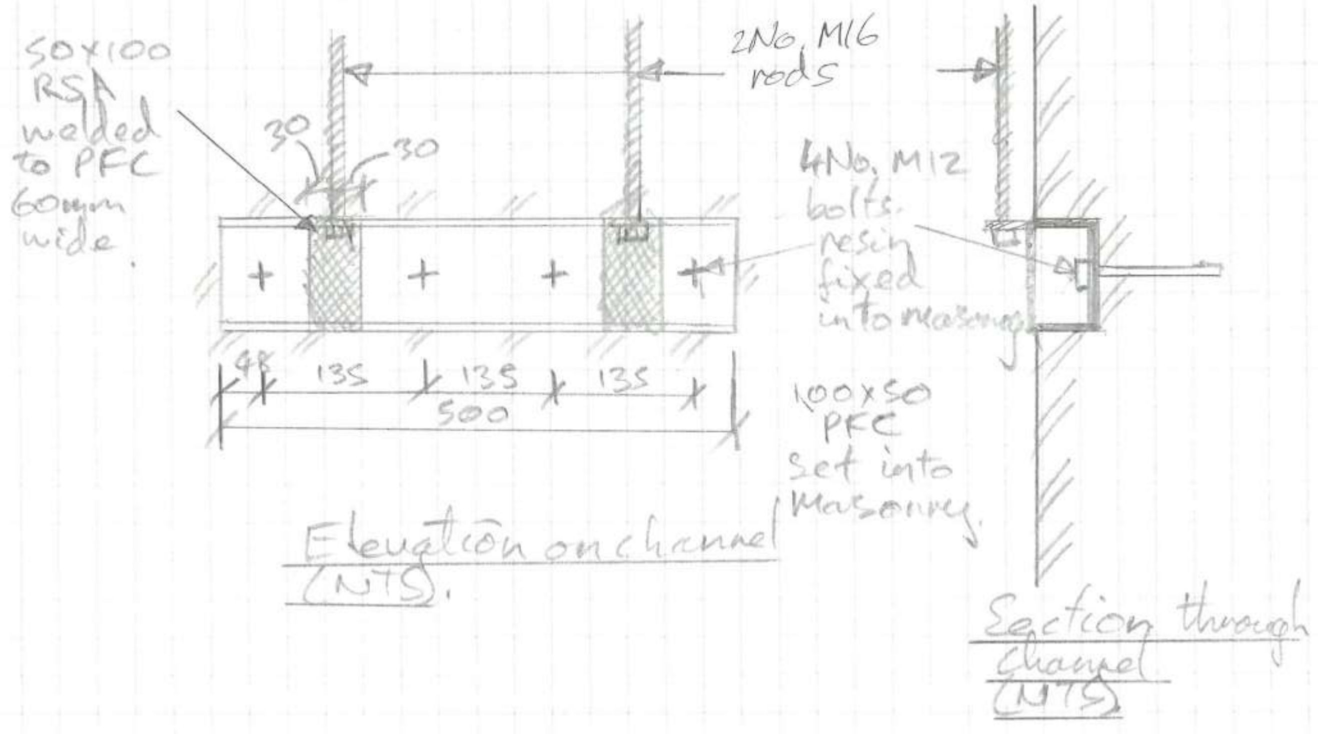
Length = 500mm

Area = 500mm x 50mm = 25000mm²

Stress = (2.89kN x 1000)/25000 mm² = 0.12N/mm²

By inspection ok.

Use say 4No. M12 resin fixings @ 135mm c/c



Elevation on channel (NTS).

Section through channel (NTS)

mason navarro pledge	Project: 32 The Green, Richmond	Job No. 224260	Sheet / Rev. 19
		Design Element: Roof Structure	
Calc. Title: Over Deflecting Purlin		Calc. by: CM	Date: 09/09/24 · Chk'd by: JL

Design of strengthening works to over deflecting purlin

Loading			
Roof			
Dead			
Existing Loads			**Units**
Tiles		0.70	kN/m2
Softwood Batterns		0.02	kN/m2
Rafters		0.08	kN/m2
	SUM	**0.80**	kN/m2
Additional Historic Loads			
Lath + Plaster		0.31	kN/m2
	SUM	**0.31**	kN/m2
Additional Future Loads			
Kingspan Membrane		0.00	kN/m2
2x50mm Insulation		0.03	kN/m2
Allow for Max of 15mm Fire Board or Lath + Plaster		0.31	kN/m2
	SUM	**0.34**	kN/m2
Live			
Snow		0.30	kN/m2
	SUM	**0.30**	kN/m2
Ceiling			
Dead			
Existing Loads			
Ceiling Joists		0.06	kN/m2
	SUM	**0.06**	kN/m2
Additional Historic Loads			
Lath + Plaster		0.31	kN/m2
	SUM	**0.31**	kN/m2
Additional Future Loads			
200mm Roll of Insulation		0.02	kN/m2
Allow for Max of 15mm Fire Board or Lath + Plaster		0.31	kN/m2
	SUM	**0.33**	kN/m2
Live			
Access		0.25	kN/m2
	SUM	**0.25**	kN/m2

mnp mason navarro pledge	Project 32 The Green, Richmond	Job No. 224260		Sheet / Rev. 20
		Design Element Roof Structure		
Calc. Title Worst Case Purlin		Calc. by CM	Date 09/09/24	Chk'd by JL

Worst Case Purlin		
	Amount	**Units**
Purlin Span	4.20	m
Purlin Midspan	2.10	m
Loading width Upper (On Slope)	2.59	m
Loading width Lower (On Slope)	1.00	m
Loading width Upper (On Plan)	1.83	m
Loading width Lower (On Plan)	0.70	m
Loading width going onto Purlin (On Slope)	3.59	m
Loading width going onto Purlin (On Plan)	2.53	m
Density of Purlin, Softwood	4.20	kN/m3
Purlin Depth	120	mm
Purlin Width	190	mm
Self weight	0.10	kN/m
Capacity of Existing Purlin from Tedds		
	Capacity	**Units**
Compressive Stress	1.538	n/mm2
Bending Stress	10.707	n/mm2
Shear Stress	2.462	n/mm2
Deflection	14.000	mm
Capacity of Existing Purlin from Tedds		
Deflection Limited	1.00	kN/m
Strength Limited	3.00	kN/m

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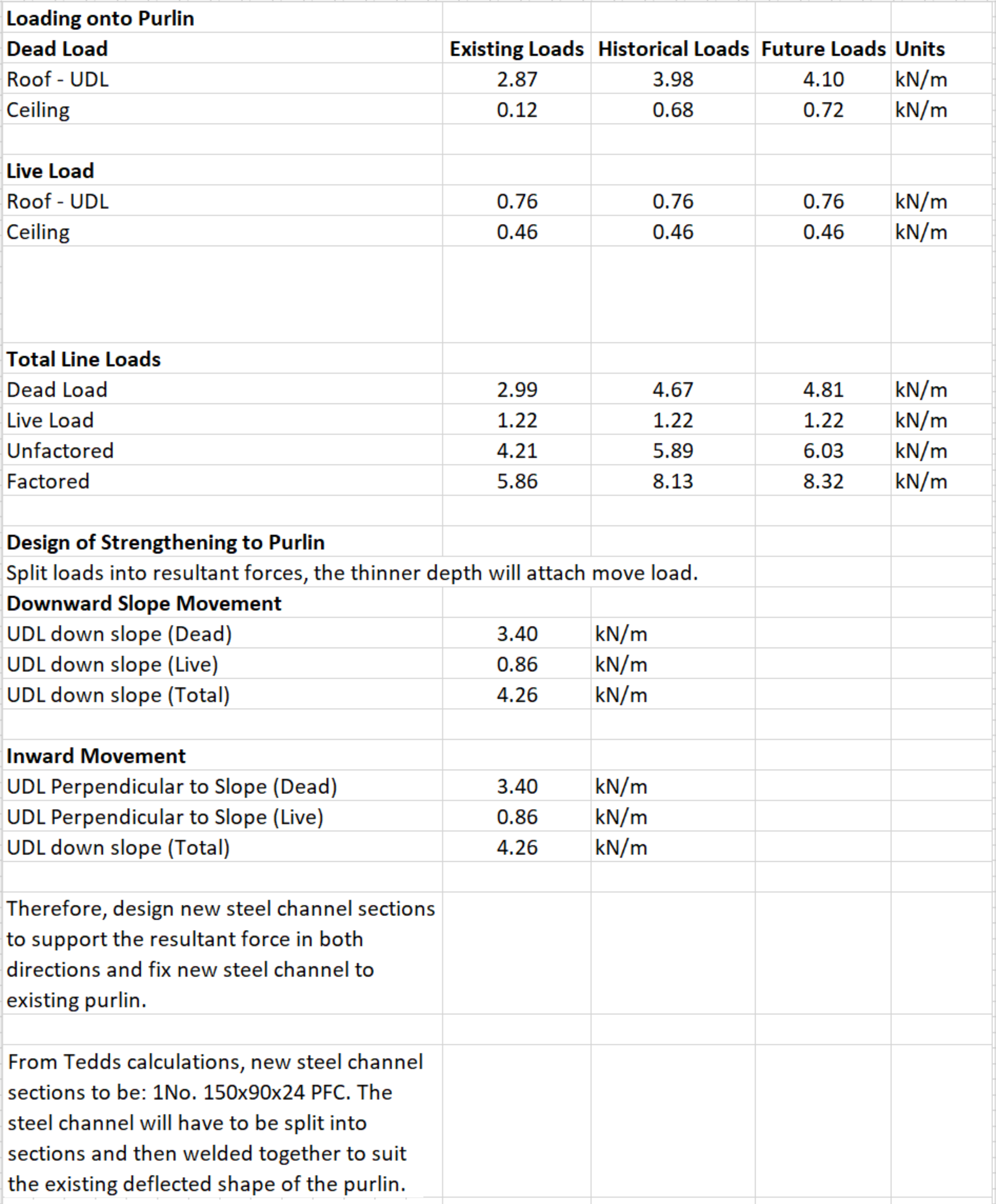
Project: 32 The Green, Richmond
Job No.: 224260
Sheet / Rev.: 21
Design Element: Roof Structure
Calc. Title: Worst Case Purlin
Calc. by: CM
Date: 09/09/24
Chk'd by: JL



Loading onto Purlin				
Dead Load	**Existing Loads**	**Historical Loads**	**Future Loads**	**Units**
Roof - UDL	2.87	3.98	4.10	kN/m
Ceiling	0.12	0.68	0.72	kN/m
Live Load				
Roof - UDL	0.76	0.76	0.76	kN/m
Ceiling	0.46	0.46	0.46	kN/m
Total Line Loads				
Dead Load	2.99	4.67	4.81	kN/m
Live Load	1.22	1.22	1.22	kN/m
Unfactored	4.21	5.89	6.03	kN/m
Factored	5.86	8.13	8.32	kN/m
Design of Strengthening to Purlin				
Split loads into resultant forces, the thinner depth will attach move load.				
Downward Slope Movement				
UDL down slope (Dead)	3.40	kN/m		
UDL down slope (Live)	0.86	kN/m		
UDL down slope (Total)	4.26	kN/m		
Inward Movement				
UDL Perpendicular to Slope (Dead)	3.40	kN/m		
UDL Perpendicular to Slope (Live)	0.86	kN/m		
UDL down slope (Total)	4.26	kN/m		

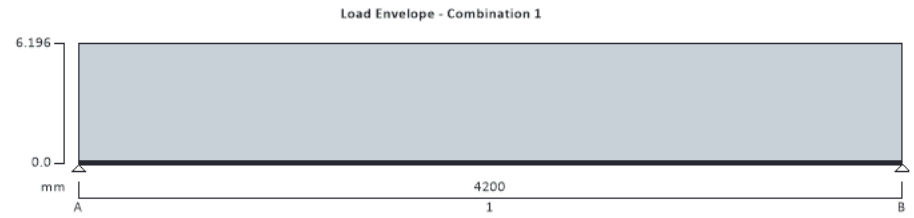
Therefore, design new steel channel sections to support the resultant force in both directions and fix new steel channel to existing purlin.

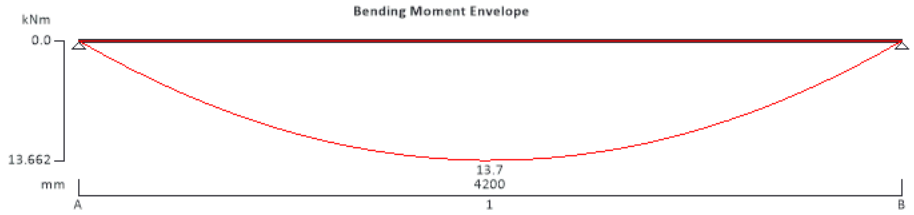
From Tedds calculations, new steel channel sections to be: 1No. 150x90x24 PFC. The steel channel will have to be split into sections and then welded together to suit the existing deflected shape of the purlin.

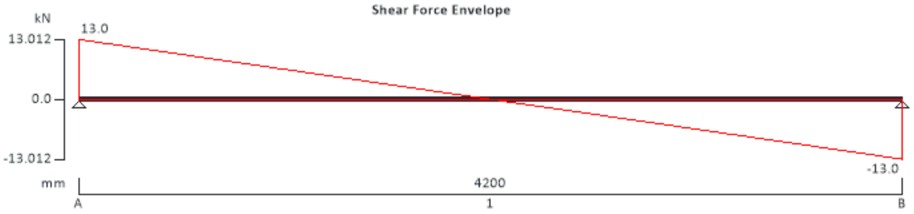
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14







Support conditions

Support A	Vertically restrained Rotationally free
Support B	Vertically restrained Rotationally free

Applied loading

Beam loads	Permanent self weight of beam × 1 Permanent full UDL 3.4 kN/m Variable full UDL 0.86 kN/m

Load combinations

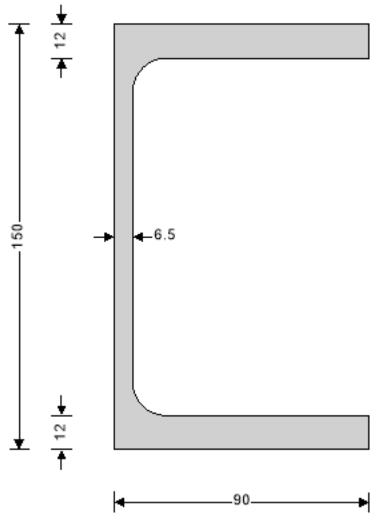
Load combination 1	Support A	Permanent × 1.35 Variable × 1.50
		Permanent × 1.35 Variable × 1.50
	Support B	Permanent × 1.35 Variable × 1.50

Analysis results

Maximum moment	M_{max} = **13.7** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **13** kN	V_{min} = **-13** kN
Deflection	δ_{max} = **1.4** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **13** kN	R_{A_min} = **13** kN
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **7.6** kN	
Unfactored variable load reaction at support A	$R_{A\_Variable}$ = **1.8** kN	
Maximum reaction at support B	R_{B_max} = **13** kN	R_{B_min} = **13** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **7.6** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **1.8** kN	

Section details

Section type **PFC 150x90x24 (British Steel Section Range 2022 (BS4-1))** Steel grade **S355**



Section classification **Class 1**

Check shear - Section 6.2.6

Design shear force V_{Ed} = **13** kN Design shear resistance $V_{c,Rd}$ = **226** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment M_{Ed} = **13.7** kNm Des.bending resist.moment $M_{c,Rd}$ = **63.4** kNm

Slenderness ratio for lateral torsional buckling

LTB slenderness ratio $\bar{\lambda}_{LT}$ = **1.072** Limiting slenderness ratio $\bar{\lambda}_{LT,0}$ = **0.400**

$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ *- Lateral torsional buckling cannot be ignored*

Design resistance for buckling - Section 6.3.2.1

Des.buckling resist.moment $M_{b,Rd}$ = **33.8** kNm

PASS - Design buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

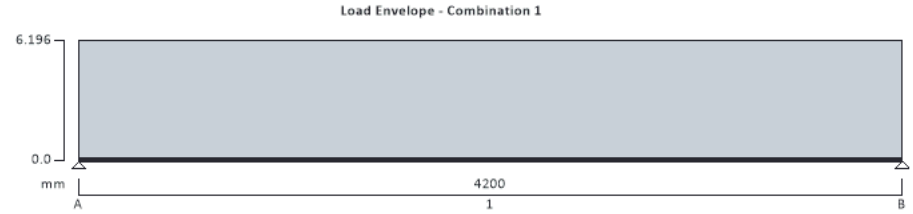
Limiting deflection δ_{lim} = **11.7** mm Maximum deflection δ = **1.428** mm

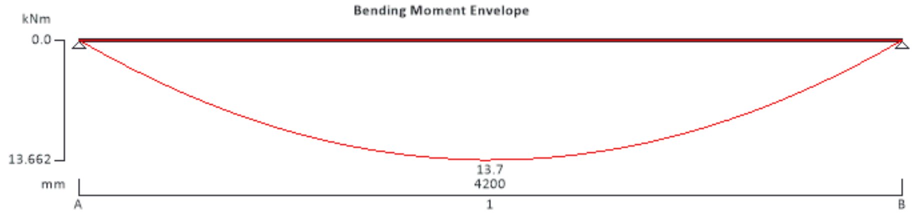
PASS - Maximum deflection does not exceed deflection limit

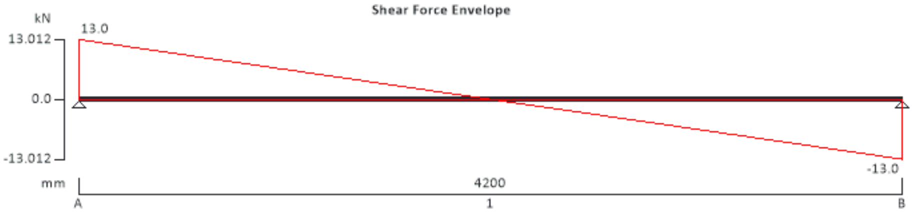
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14







Support conditions

Support A	Vertically restrained Rotationally free
Support B	Vertically restrained Rotationally free

Applied loading

Beam loads	Permanent self weight of beam × 1 Permanent full UDL 3.4 kN/m Variable full UDL 0.86 kN/m

Load combinations

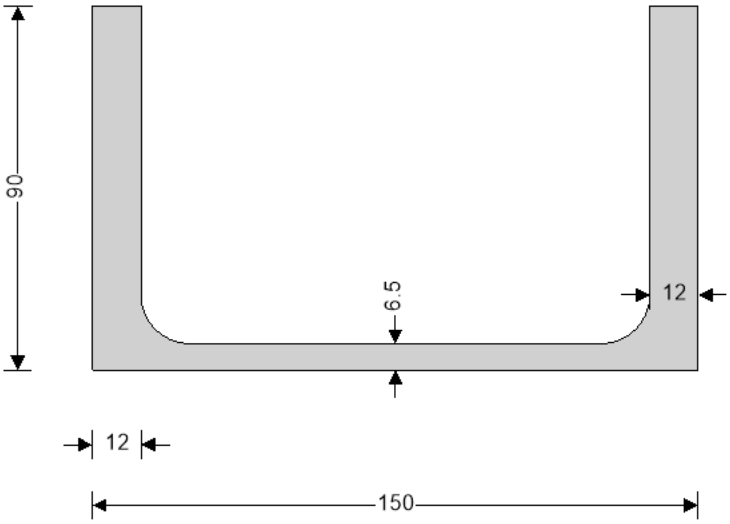
Load combination 1	Support A	Permanent × 1.35 Variable × 1.50
		Permanent × 1.35 Variable × 1.50
	Support B	Permanent × 1.35 Variable × 1.50

Analysis results

Maximum moment	M_{max} = **13.7** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **13** kN	V_{min} = **-13** kN
Deflection	δ_{max} = **6.6** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **13** kN	R_{A_min} = **13** kN
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **7.6** kN	
Unfactored variable load reaction at support A	$R_{A\_Variable}$ = **1.8** kN	
Maximum reaction at support B	R_{B_max} = **13** kN	R_{B_min} = **13** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **7.6** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **1.8** kN	

Section details

Section type **PFC 150x90x24 (British Steel Section Range 2022 (BS4-1))** Steel grade **S355**



Section classification **Class 1**

Check shear - Section 6.2.6

Design shear force V_{Ed} = **13** kN Design shear resistance $V_{c,Rd}$ = **488.2** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment M_{Ed} = **13.7** kNm Des.bending resist.moment $M_{c,Rd}$ = **26.9** kNm

PASS - Design bending resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

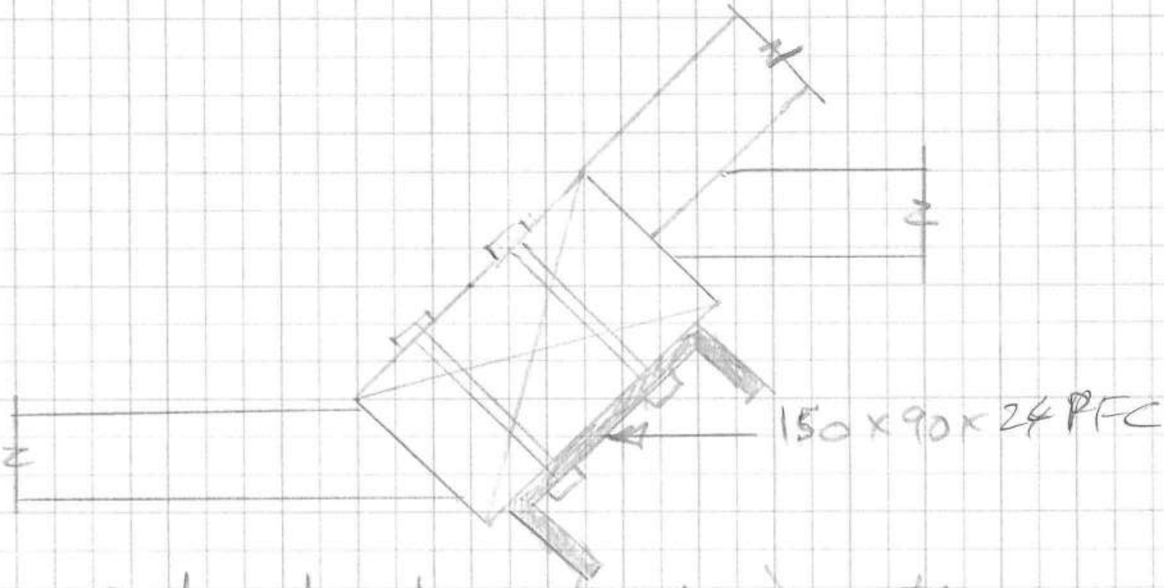
Limiting deflection δ_{lim} = **11.7** mm Maximum deflection δ = **6.554** mm

PASS - Maximum deflection does not exceed deflection limit

mason navarro pledge

Project 32 The Green, Richmond	Job No. 224260	Sheet / Rev. 26	
	Design Element: Roof Structure		
Calc. Title: Dormer Purlin	Calc. by: CM	Date: 09/09/24	Chk'd by: JL

Sketch of strengthening to purlin

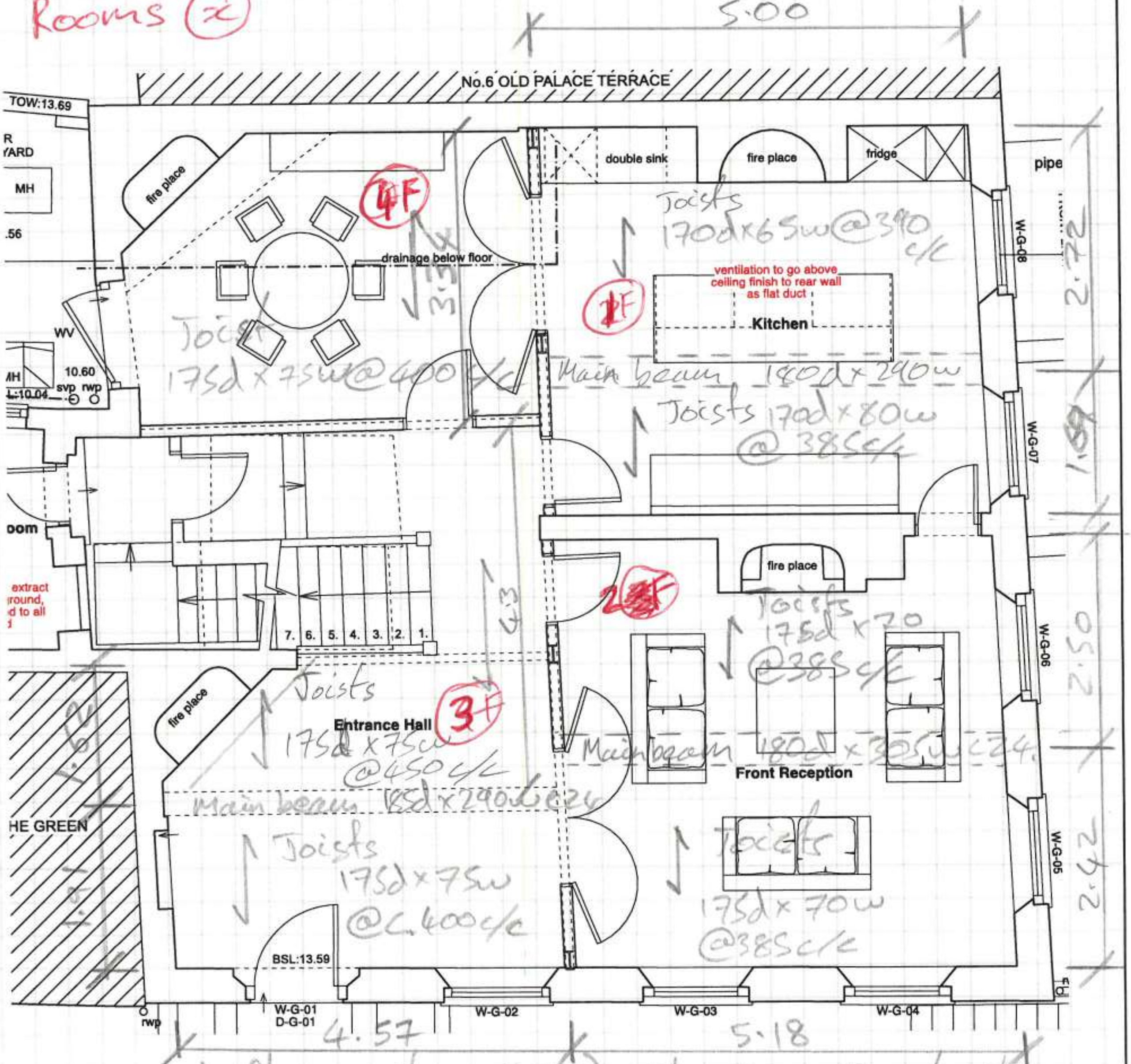


Section through purlin (NTS) - Option 4

Project 32 The Green Richmond		Job No. 224260	Sheet / Rev. 27
		Design Element First floor structure	
Calc. Title First floor structure		Calc. by CM	Date 19/8/24	Chk'd by JL

Design check on capacity of first floor structure

Rooms (x)

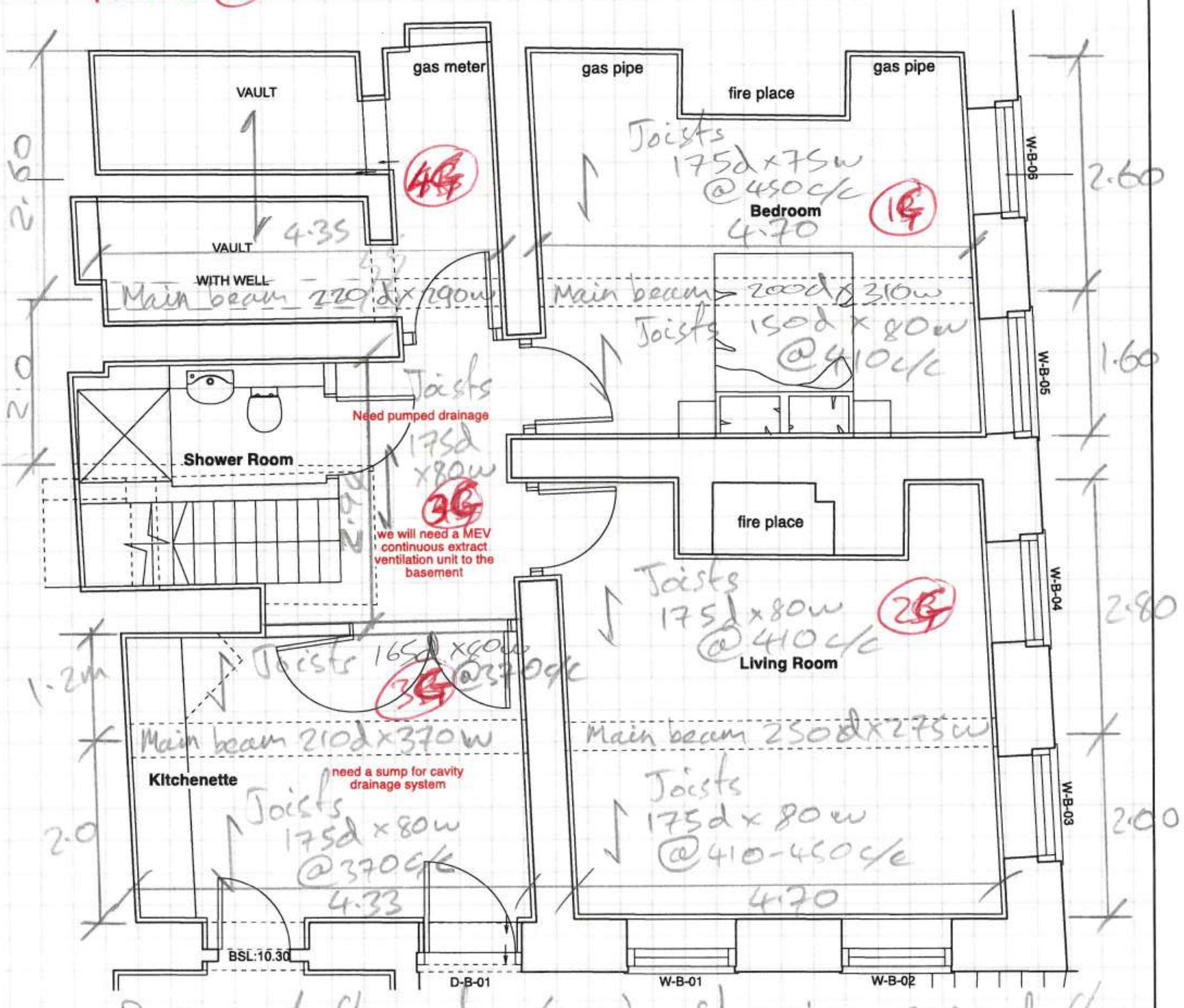


Ground floor plan (NTS) - showing First floor structure

Project 32 The Green Richmond	Job No. 224260	Sheet / Rev. 28	
	Design Element Design of ground floor Structure		
Calc. Title Design of ground floor structure	Calc. by CM	Date 19/8/24	Chk'd by JL

Design check on capacity of ground floor structure

Rooms (x)



Basement floor plan (NTS) - showing ground floor structure

Joists

Carry out design check on existing joists. Limit deflection to 14mm and calculation allowable line load for both deflection and strength.

		Joists				
Room		Depth (mm)	Wide (mm)	Centres (mm)	Span (m)	Timber Grade
4	F	175	75	400	3.34	C24
1	F	170	65	390	2.72	C24
2	F	175	70	385	2.5	C24
3	F	175	75	450	1.91	C24
1	G	150	80	410	2.6	C24
2	G	175	80	450	2.8	C24
3	G	165	80	370	2	C24
3	G	175	80	400	2.94	C24
4	G	No data				C24

		Joists - Max Loading			
		Deflection limited to 14mm			
		or 0.004xSpan		Strength limited	
Room		Capacity (kN/m)	Capacity (kN/m^2)	Capacity (kN/m)	Capacity (kN/m^2)
4	F	1.7	4.25	3.8	9.50
1	F	2.5	6.41	4.7	12.05
2	F	3.8	9.87	6.4	16.62
3	F	8.9	19.78	11.5	25.56
1	G	2.5	6.10	5	12.20
2	G	3.1	6.89	5.8	12.89
3	G	7.1	19.19	10.2	27.57
3	G	2.7	6.75	5.3	13.25
4	G	No data			

mason navarro pledge	Project 32 The Green, Richmond, London	Job No. 224260	Sheet / Rev. 30
		Design Element Floor Structure	
Calc. Title Loading		Calc. by CM	Date 18/11/24
		Chk'd by JL	

Loading			
	Dead		
	Existing Loads		(kN/m^2)
	18mm Plywood		
	(Exclude joists)		0.01
	Additional Historic Loads		(kN/m^2)
	Lath + Plaster		**0.31**
	Additional Future		(kN/m^2)
	Services		0.05
	Insulation		0.05
	Lath + Plaster		0.31
		Sum	**0.41**
	Live		(kN/m^2)
	Domestic Loading		**1.5**

mason navarro pledge	Project: 32 The Green, Richmond, London	Job No. 224260	Sheet / Rev. 31
		Design Element: Floor Structure	
Calc. Title: Loading		Calc. by: CM	Date: 18/11/24 · Chk'd by: JL

Joists - Max Loading

Deflection limited to 14mm
or 0.004xSpan

Room		Capacity Existing (kN/m^2)	Capacity Historically (kN/m^2)	Capacity Future Dead (kN/m^2)	Capacity Future D+L (kN/m^2)	Check
4	F	4.24	3.93	3.83	2.33	PASS
1	F	6.40	6.09	5.99	4.49	PASS
2	F	9.86	9.55	9.45	7.95	PASS
3	F	19.77	19.46	19.36	17.86	PASS
1	G	6.09	5.78	5.68	4.18	PASS
2	G	6.88	6.57	6.47	4.97	PASS
3	G	19.18	18.87	18.77	17.27	PASS
3	G	6.74	6.43	6.33	4.83	PASS
4	G	No data				

Strength limited

Room		Capacity Existing (kN/m^2)	Capacity Historically (kN/m^2)	Capacity Future (kN/m^2)	Capacity Future D+L (kN/m^2)	Check
4	F	9.49	9.18	9.08	7.58	PASS
1	F	12.04	11.73	11.63	10.13	PASS
2	F	16.61	16.30	16.20	14.70	PASS
3	F	25.55	25.24	25.14	23.64	PASS
1	G	12.19	11.88	11.78	10.28	PASS
2	G	12.88	12.57	12.47	10.97	PASS
3	G	27.56	27.25	27.15	25.65	PASS
3	G	13.24	12.93	12.83	11.33	PASS
4	G	No data				

Summary

All joists pass in deflection and bending.

mason navarro pledge	Project 32 The Green, Richmond, London	Job No. 224260	Sheet / Rev. 32
		Design Element Floor Structure	
Calc. Title Loading		Calc. by CM	Date 18/11/24	Chk'd by JL

Beams

Carry out design check on existing beams. Limit deflection to 14mm and calculation allowable line load for both deflection and strength.

		Beam Size				
Room		Depth (mm)	Wide (mm)	Loading Width (m)	Span (m)	Timber Grade
4	F	-	-	-	-	C24
1	F	180	290	2.205	5	C24
2	F	180	305	2.46	5.18	C24
3	F	185	290	1.765	4.57	C24
1	G	200	310	2.1	4.7	C24
2	G	250	275	2.4	4.7	C24
3	G	210	370	1.6	4.33	C24
3	G	-	-	-	-	C24
4	G	220	290	2.3	4.35	C24

Note: Beam in 4G has splice joint in vault that is supported off brick vault

		Beams - Max Loading			
		Deflection limited to 14mm		Strength limited	
Room		Capacity (kN/m)	Capacity (kN/m^2)	Capacity (kN/m)	Capacity (kN/m^2)
4	F	-	-	-	-
1	F	1.4	0.63	6.2	2.81
2	F	1.3	0.53	6.1	2.48
3	F	2.3	1.30	8	4.53
1	G	2.8	1.33	9.4	4.48
2	G	4.9	2.04	13.1	5.46
3	G	5.5	3.44	14.7	9.19
3	G	-	-	-	-
4	G	4.8	2.09	12.5	5.43

mason navarro pledge	Project 32 The Green, Richmond, London	Job No. 224260	Sheet / Rev. 33
		Design Element Floor Structure	
Calc. Title Loading		Calc. by CM	Date 18/11/24	Chk'd by JL

Loading				
		Dead		
		Existing Loads		(kN/m^2)
		18mm Plywood		0.01
		Joists		0.29
			Sum	**0.3**
		Additional Historic Loads		(kN/m^2)
		Lath + Plaster		**0.31**
		Additional Future		(kN/m^2)
		Services		0.05
		Insulation		0.05
		Lath + Plaster		0.31
			Sum	**0.41**
		Live		(kN/m^2)
		Domestic Loading		**1.5**

		Beams - Max Loading				
		Deflection limited to 14mm				
		Capacity	Capacity	Capacity	Capacity	
		Existing	Historically	Future Dead	Future D+L	Check
Room		(kN/m^2)	(kN/m^2)	(kN/m^2)	(kN/m^2)	
4	F	-	-	-	-	-
1	F	0.33	0.02	-0.08	-1.58	FAIL
2	F	0.23	-0.08	-0.18	-1.68	FAIL
3	F	1.00	0.69	0.59	-0.91	FAIL
1	G	1.03	0.72	0.62	-0.88	FAIL
2	G	1.74	1.43	1.33	-0.17	FAIL
3	G	3.14	2.83	2.73	1.23	PASS
3	G	-	-	-	-	-
4	G	1.79	1.48	1.38	-0.12	FAIL
		Strength limited				
		Capacity	Capacity	Capacity	Capacity	
		Existing	Historically	Future Dead	Future D+L	Check
Room		(kN/m^2)	(kN/m^2)	(kN/m^2)	(kN/m^2)	
4	F	-	-	-	-	-
1	F	2.51	2.20	2.10	0.60	PASS
2	F	2.18	1.87	1.77	0.27	PASS
3	F	4.23	3.92	3.82	2.32	PASS
1	G	4.18	3.87	3.77	2.27	PASS
2	G	5.16	4.85	4.75	3.25	PASS
3	G	8.89	8.58	8.48	6.98	PASS
3	G	-	-	-	-	-
4	G	5.13	4.82	4.72	3.22	PASS

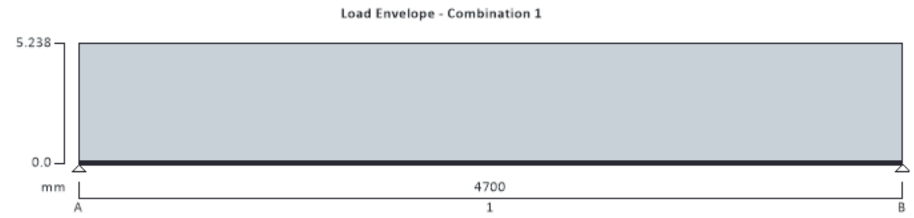
Summary

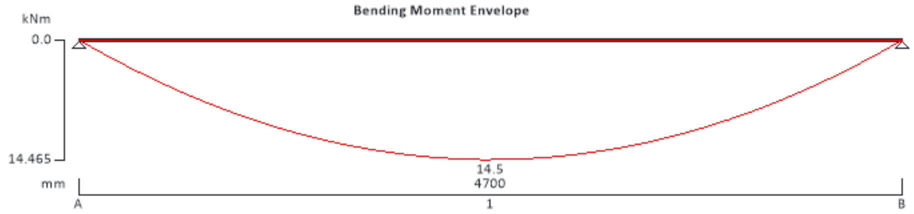
All beams pass in bending but many fail in deflection and will require strengthening. See typical flitch plate design over page.

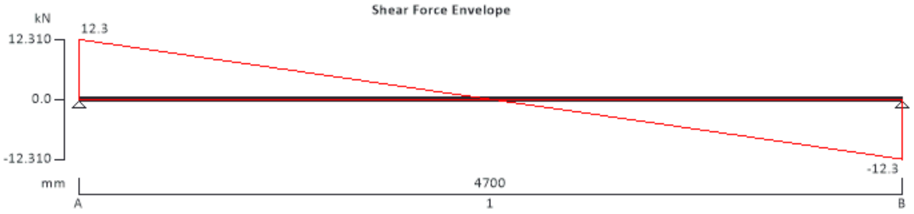
FLITCH BEAM ANALYSIS & DESIGN TO EN1995-1-1:2004

In accordance with EN1995-1-1:2004 + A2:2014 and Corrigendum No.1 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 1.7.05







Applied loading

Beam loads

Permanent self weight of beam × 1

Permanent full UDL 4.700 kN/m

Load combinations

Load combination 1	Support A	Permanent × 1.00
		Variable × 1.00
	Span 1	Permanent × 1.00
		Variable × 1.00
	Support B	Permanent × 1.00
		Variable × 1.00

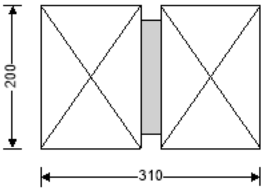
Analysis results

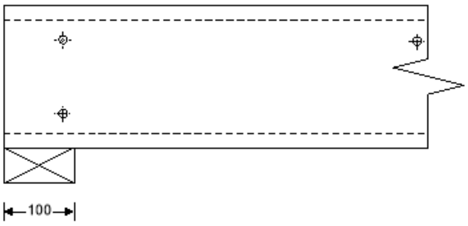
Design moment	M = **14.465** kN	Design shear	F = **12.310** kN
Total load on member	W_{tot} = **24.621** kN		
Reactions at support A	R_{A_max} = **12.310** kN	R_{A_min} = **12.310** kN	

Unfactored permanent load reaction at support A $R_{A\_Permanent}$ = **12.310** kN

Reactions at support B R_{B_max} = **12.310** kN R_{B_min} = **12.310** kN

Unfactored permanent load reaction at support B $R_{B\_Permanent}$ = **12.310** kN





Timber section details

Breadth of section b = **141** mm Depth of section h = **200** mm

Number of sections N = **2**

Timber strength class **C24**

Steel section details

Breadth of steel plate b_s = **28** mm Depth of steel plate h_s = **160** mm

Number of steel plates in beam N_s = **1** nominal yield stress f_y = **355** N/mm^2

Bolt diameter ϕ_b = **12** mm

Member details

Service class of timber **1** Load duration **Long-term**

Length of span L_{s1} = **4700** mm

Length of bearing L_b = **100** mm

Compression perpendicular to grain - cl.6.1.4

Design compressive stress $\sigma_{c.90.d}$ = **0.437** N/mm^2 Design compressive strength $f_{c.90.d}$ = **1.346** N/mm^2

PASS - Design compressive strength exceeds design compressive stress at bearing

Bending - cl 6.1.6

Design timber bending stress $\sigma_{m.t.d}$ = **3.905** N/mm^2 Design timber bending strength $f_{m.d}$ = **12.923** N/mm^2

PASS - Design timber bending strength exceeds design timber bending stress

Design steel bending stress $\sigma_{m.s.d}$ = **92.927** N/mm^2 Design steel bending strength $f_{y.d}$ = **355.000** N/mm^2

PASS - Design steel bending strength exceeds design steel bending stress

Shear - cl.6.1.7

Applied shear stress τ_d = **0.248** N/mm^2 Permissible shear stress $f_{v.d}$ = **2.154** N/mm^2

PASS - Design shear strength exceeds design shear stress

Deflection - cl.7.2

Deflection limit δ_{lim} = **14.000** mm Total final deflection δ_{fin} = **13.937** mm

PASS - Total final deflection is less than the deflection limit

Steel-to-timber connections - cl.8.2.3

Characteristic yield moment - exp.8.30 $M_{y.R.k} = 0.3\ \mathrm{mm}^{0.4} \times f_{u.k} \times \phi_b^{2.6}$ = **76745** Nmm

Char.embed.strength par.to grain - exp.8.32 $f_{h.0.k} = 0.082\mathrm{e}9\ \mathrm{m/sec}^2 \times (1\ \mathrm{mm} - 0.01 \times \phi_b) \times \rho_k$ = **25.256** N/mm^2

$k_{90} = 1.35 + 0.015 \times \phi_b / 1\ \mathrm{mm}$ = **1.530**

Char.embed.strength perp.to grain - exp.8.31 $f_{h.90.k} = f_{h.0.k} / k_{90}$ = **16.507** N/mm^2

Thickness limit for thin steel plates $b_{s.thn} = \phi_b / 2$ = **6** mm

Thickness limit for thick steel plates $b_{s.thk} = \phi_b$ = **12** mm

Characteristic load-carrying capacity for a plate of any thickness as the central member in double shear - exp.8.11

$F_{v.Rk.f} = f_{h.k} \times b \times \phi_b = \mathbf{27.930}$ kN

$F_{v.Rk.g} = f_{h.k} \times b \times \phi_b \times (\sqrt{[2 + 4 \times M_{y.Rk} / (f_{h.k} \times \phi_b \times b^2)]} - 1) = \mathbf{12.331}$ kN

$F_{v.Rk.h} = 2.3 \times \sqrt{[M_{y.Rk} \times f_{h.k} \times \phi_b]} = \mathbf{8.968}$ kN

$F_{v.Rk} = \mathrm{Min}(F_{v.Rk.f}, F_{v.Rk.g}, F_{v.Rk.h}) = \mathbf{8.968}$ kN

Flitch plate bolting requirements

Total load on member	W_{tot} = **24.621** kN	Total load taken by steel	W_s = **18.896** kN
Characteristic bolt capacity	$F_{v.Rk}$ = **8.968** kN	Number of interfaces	N_{int} = **2**
Bolts required at supports	N_{be} = **2**	Bolts required to beam length	N_{bl} = **1.054**
Limiting bolt spacing	S_{limit} = **500** mm	Maximum bolt spacing	S_{max} = **500** mm

Provide a minimum of 2 No.12 mm diameter bolts at each support

Provide 12 mm diameter bolts at maximum 500 mm centres staggered 50 mm alternately above and below the centre line

Minimum bolt spacings - cl.8.5

Minimum end spacing	S_{end} = **84** mm	Minimum edge spacing	S_{edge} = **48** mm
Minimum bolt spacing	S_{bolt} = **48** mm		
Minimum washer diameter	ϕ_w = **36** mm	Minimum washer thickness	t_w = **3.6** mm

mnp mason navarro pledge	Project 32 The Green, Richmond	Job No. 224260	Sheet / Rev. 38
		Design Element Floor structure	
Calc. Title Design of beam in G4		Calc. by CM	Date 18/11/24	Chk'd by JL

Design of strengthening to beam in G4.

The beam has a splice connection at midspan that cannot carry bending forces ∴ the beam has been propped off the vaulting below. The beam is to be strengthened and the prop removed.

Design 2No. steel channel sections to strengthen the beam. New steelwork is to carry the total load.

- Span of beam = 4.35m
- Loading width = 2.3 m
- Size of beam = 220mm (d) × 290mm (w)

Loading - Full UDL

- Dead = 0.71 kN/m² × 2.3m = 1.63 kN/m
- Live = 1.5kN/m² × 2.3m = 3.45 kN/m
- S.W. beam = 4.2kN/m³ × 0.22m × 0.29m = 0.27kN/m

Results

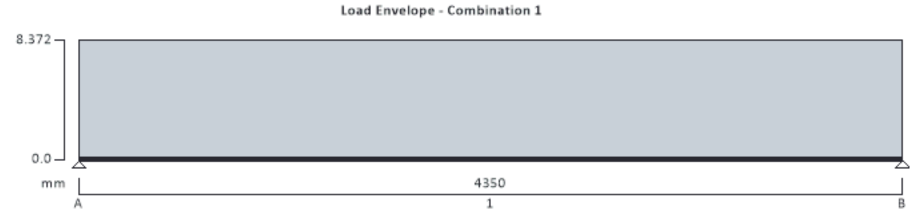
Use 2No. 150×90 PFCs fixed

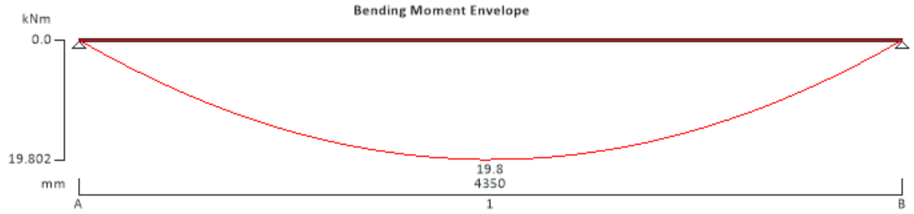
See Tedds calculations over page

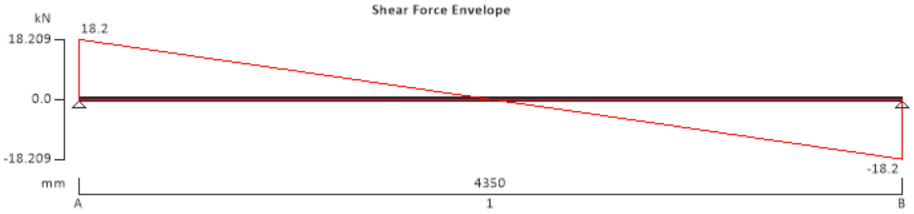
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14







Support conditions

Support A	Vertically restrained Rotationally free
Support B	Vertically restrained Rotationally free

Applied loading

Beam loads	Permanent self weight of beam × 1 Permanent full UDL 1.63 kN/m Permanent full UDL 0.27 kN/m Variable full UDL 3.45 kN/m

Load combinations

Load combination 1	Support A	Permanent × 1.35 Variable × 1.50
		Permanent × 1.35 Variable × 1.50
	Support B	Permanent × 1.35

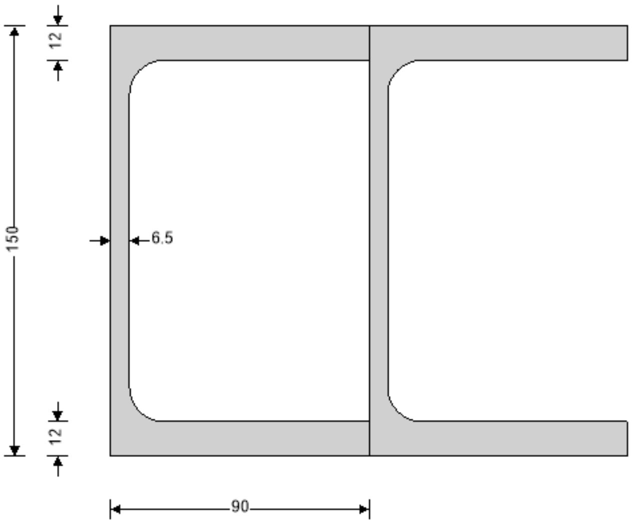
Variable × 1.50

Analysis results

Maximum moment	M_{max} = **19.8** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **18.2** kN	V_{min} = **-18.2** kN
Deflection	δ_{max} = **5.6** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **18.2** kN	R_{A_min} = **18.2** kN
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **5.2** kN	
Unfactored variable load reaction at support A	$R_{A\_Variable}$ = **7.5** kN	
Maximum reaction at support B	R_{B_max} = **18.2** kN	R_{B_min} = **18.2** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **5.2** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **7.5** kN	

Section details

Section type **2 x PFC 150x90x24 (British Steel Section Range 2022 (BS4-1))** Steel grade **S355**



Section classification **Class 1**

Check shear - Section 6.2.6

Design shear force V_{Ed} = **18** kN Design shear resistance $V_{c,Rd}$ = **452.1** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment M_{Ed} = **19.8** kNm Des.bending resist.moment $M_{c,Rd}$ = **126.8** kNm

Slenderness ratio for lateral torsional buckling

LTB slenderness ratio $\bar{\lambda}_{LT}$ = **1.091** Limiting slenderness ratio $\bar{\lambda}_{LT,0}$ = **0.400**

$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored

Design resistance for buckling - Section 6.3.2.1

Des.buckling resist.moment $M_{b,Rd}$ = **66.2** kNm

PASS - Design buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to permanent and variable loads

Limiting deflection δ_{lim} = **12.1** mm Maximum deflection δ = **5.559** mm

PASS - Maximum deflection does not exceed deflection limit

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