Capital
Consulting Engineers Limited

Structural Calculations
(Rev B)

20/07/18

(Project Ref: CCEL/386)

Internal Alterations of
5 Storey Victorian Town House

at

87 Gower Street
London
WC1E 6AB

The Institution of Structural Engineers

Capital Consulting Engineers Limited
Nicon House, 45 Silver Street
Enfield EN1 3EF
Tel: 020 3653 0950

Project 87 Gower Street, London WC1E 6AB			**Job Ref.** CCEL/386	
Part of Structure Internal Alterations			**Sheet No.** 1/B	
Drawing Ref.	**Made by** Ian R	**Date** 20/07/18	**Checked by**	**Date**

Ref	Date	Details	Prepared by	Checked by
	22/02/18	Calculations for BC submission and Construction	Ian Robinson	Steve Davis
				
A	26/02/18	Revised calculations for BC submission and Construction. (Floor plans updated)	Ian Robinson	Steve Davis
				
B	20/07/18	Revised calculations for BC submission and Construction. (Basement opening revised)	Ian Robinson	Steve Davis
				

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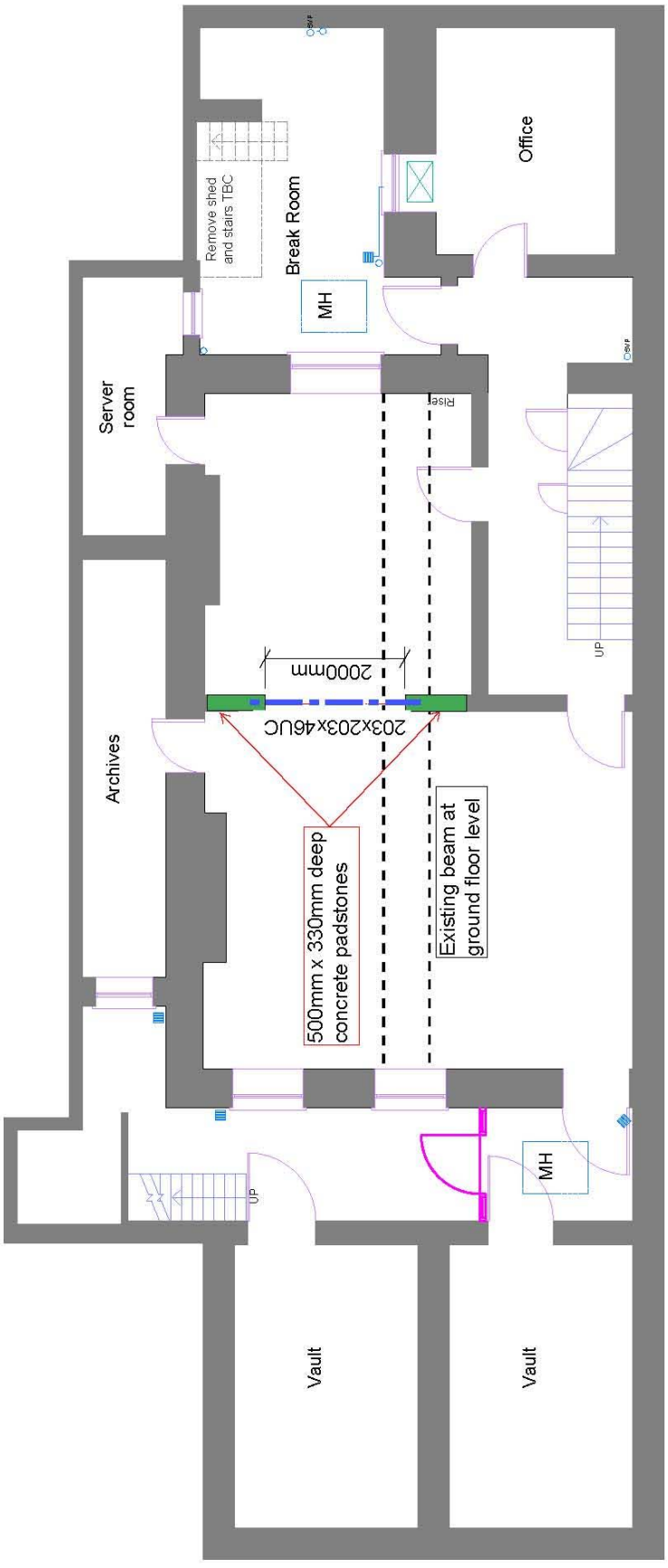
Project			Job Ref.
87 Gower Street, London WC1E 6AB			CCEL/386
Part of Structure			**Sheet No.**
Internal Alterations			2/B
Drawing Ref.	**Made by**	**Date**	**Checked by** / **Date**
	Ian R	20/07/18	



Proposed Structural Arrangement - Basement Plan

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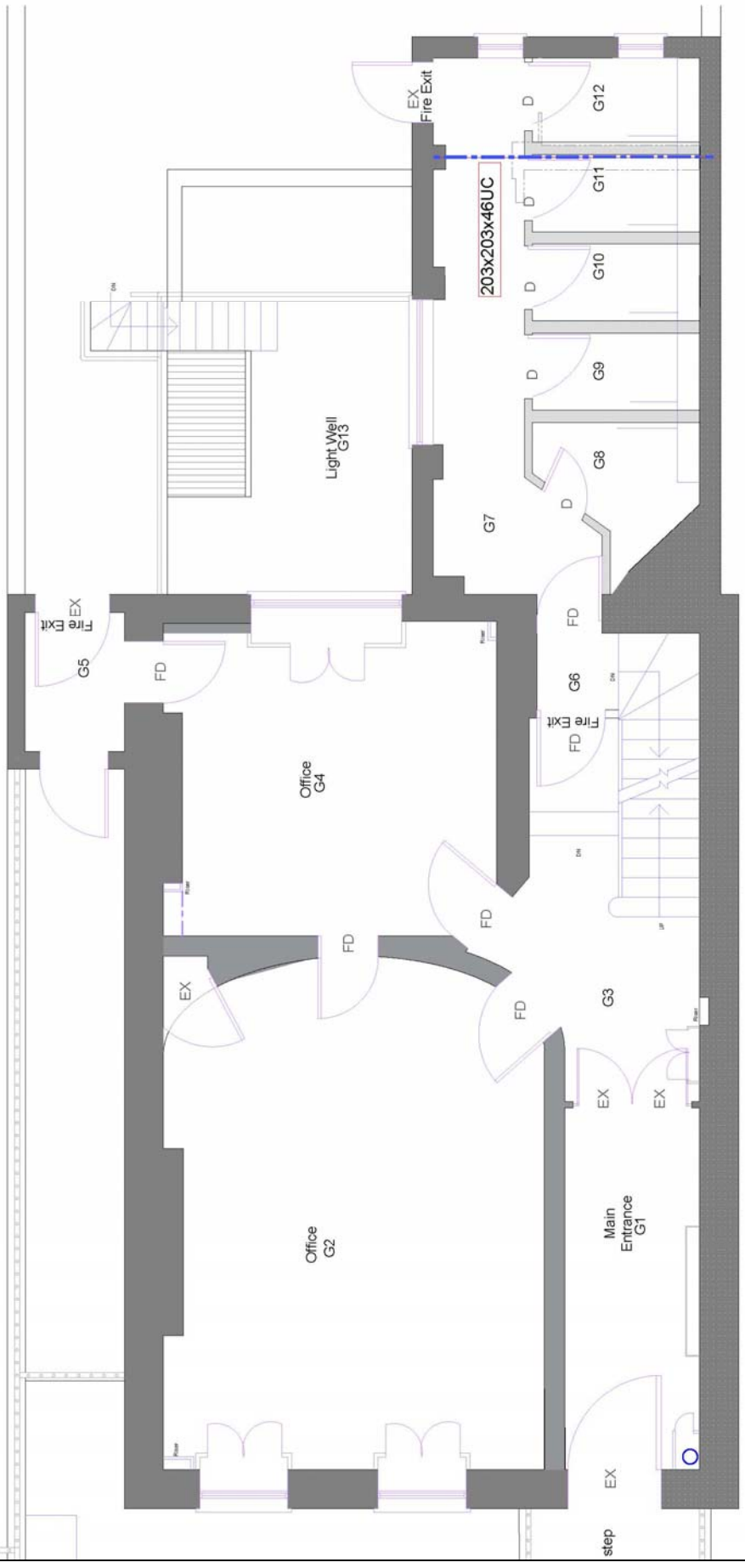
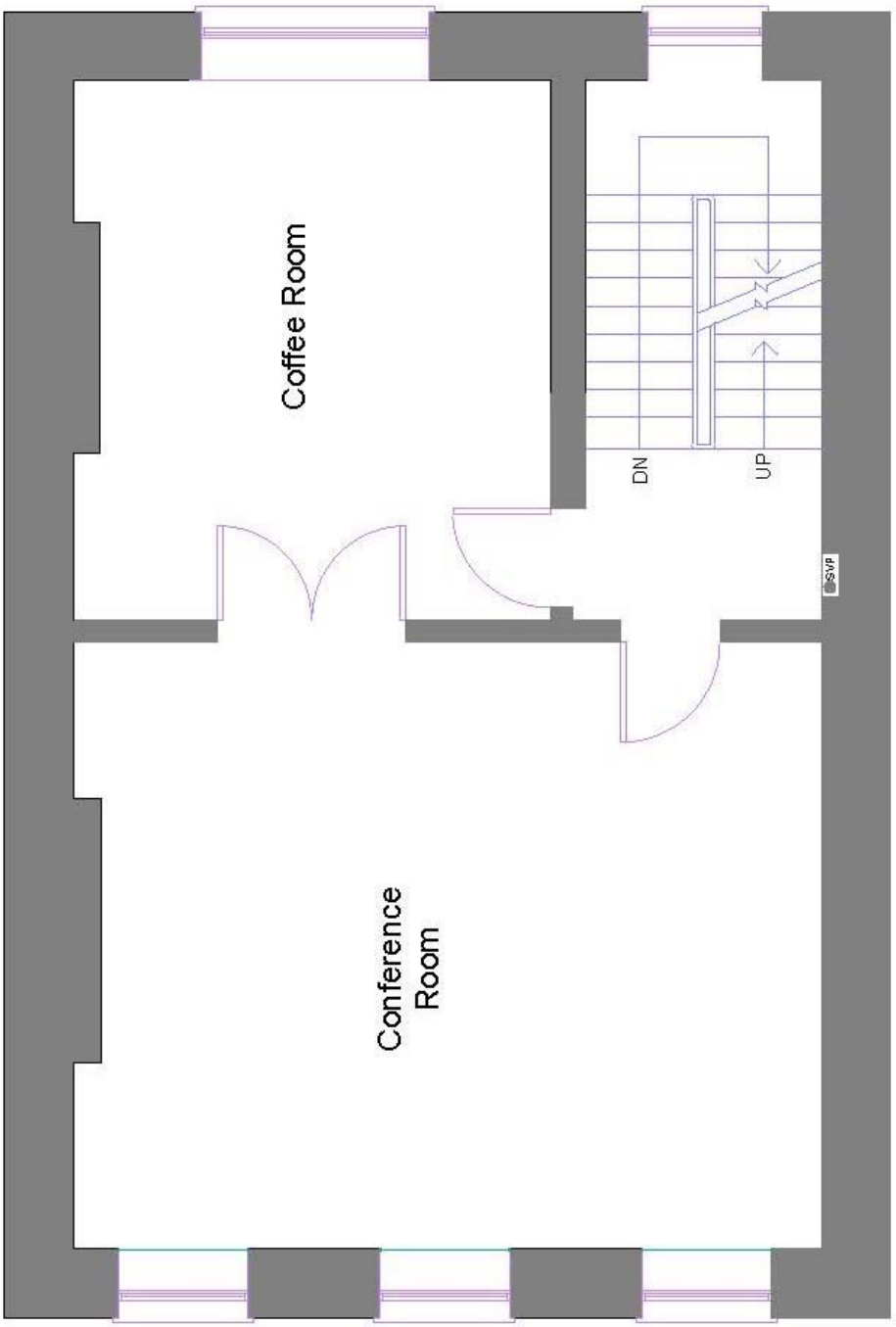
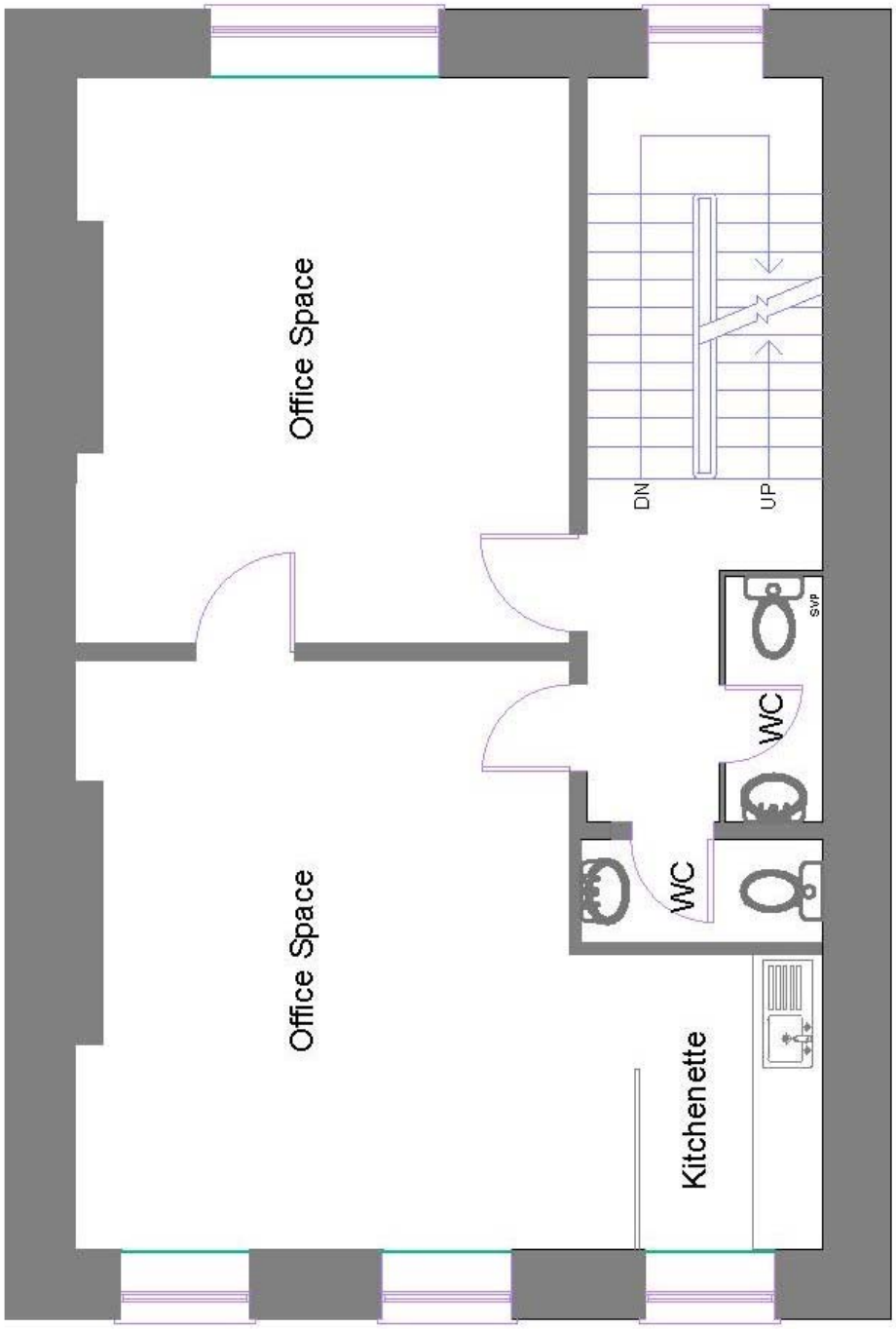
Project			Job Ref.
87 Gower Street, London WC1E 6AB			CCEL/386
Part of Structure			**Sheet No.**
Internal Alterations			3/B
Drawing Ref.	**Made by**	**Date**	**Checked by** / **Date**
	Ian R	20/07/18	



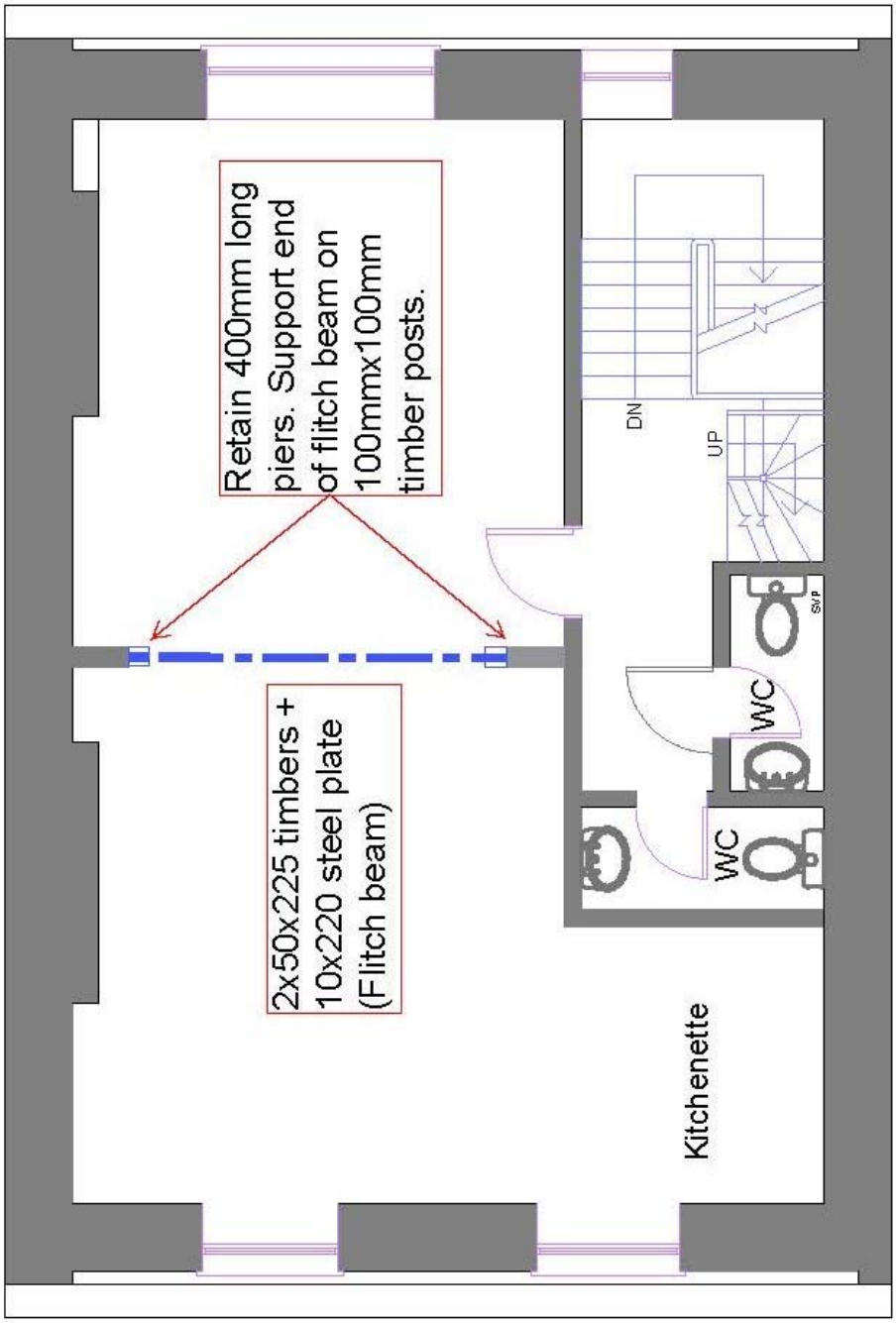
Proposed Structural Arrangement - Ground Floor Plan



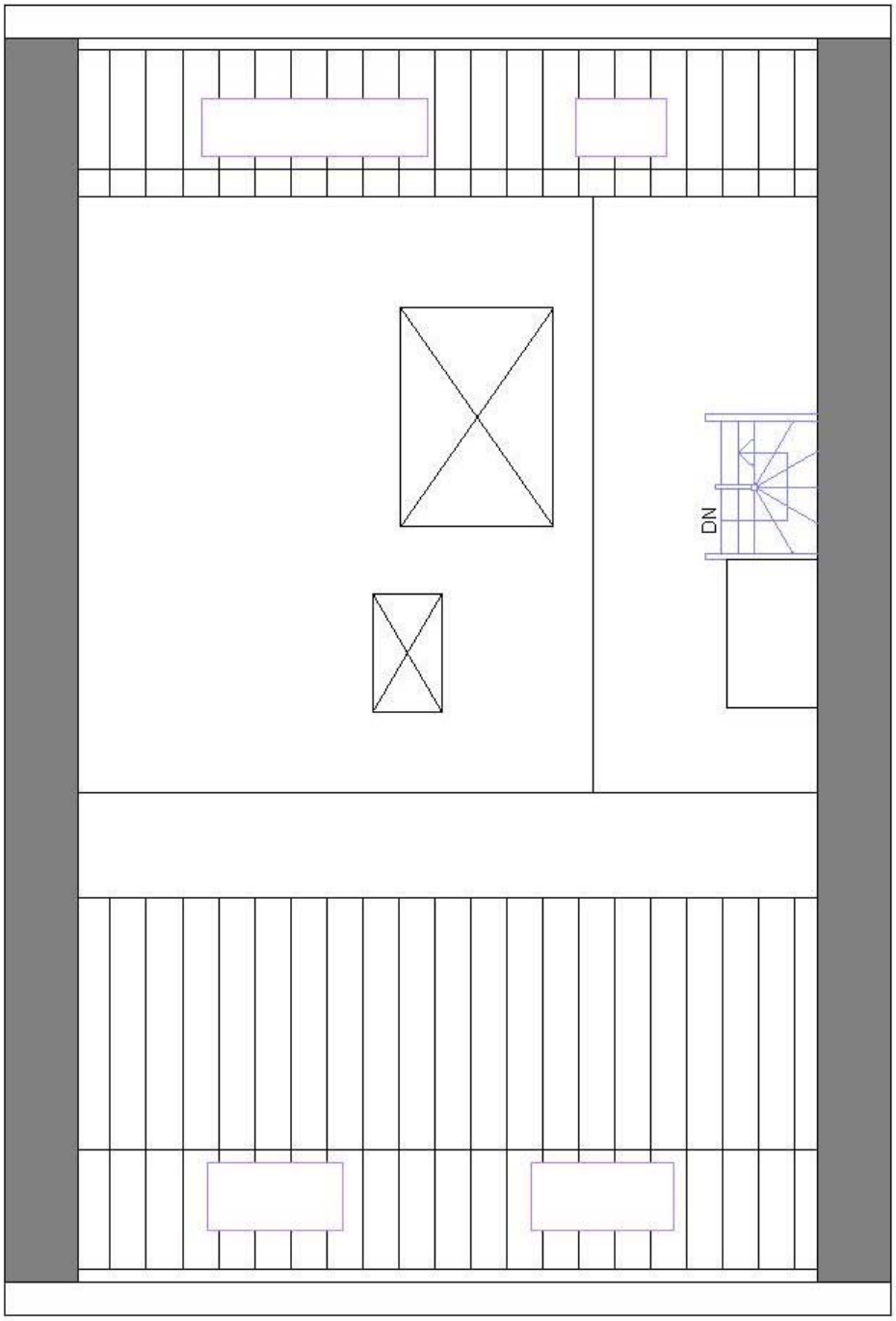
Proposed Structural Arrangement - First Floor Plan



Proposed Structural Arrangement - Second Plan



Proposed Structural Arrangement - Third Floor Plan



Proposed Structural Arrangement - Loft Plan

Loading

Floors

Existing Timber floors

T & G Boards	= 0.12 kN/m^2
Timber Joists	= 0.20 kN/m^2
Lathe & Plaster Ceiling	= 0.25 kN/m^2
Services	= 0.03 kN/m^2
Dead Load	= 0.60 kN/m^2
Imposed Load (Office)	= 2.50 kN/m^2

Roofs

Flat Roof

Felt covering	= 0.10 kN/m^2
Joists and Insulation	= 0.20 kN/m^2
Plasterboard Ceiling	= 0.10 kN/m^2
Services	= 0.05 kN/m^2
Dead Load	= 0.45 kN/m^2
Imposed Load	= 0.75 kN/m^2

Timber Mansard Roof

Slates, Timber Battens and Felt	= 0.50 kN/m^2
Rafters	= 0.15 kN/m^2
Dead Load	= 0.65 kN/m^2
Imposed Load	= 0.60 kN/m^2

Roof Space

Joists and Insulation	= 0.15 kN/m^2
Lathe & Plaster Ceiling	= 0.25 kN/m^2
Services	= 0.05 kN/m^2
Dead Load	= 0.45 kN/m^2
Imposed Load	= 0.25 kN/m^2

Water Tank (within roof space) = 0.5m x 1.0m x 10 = 5 kN/m

Walls

215mm Solid Brick Wall

215mm Brickwork	= 4.30 kN/m^2
Plaster & skim (x2)	= 0.50 kN/m^2
Dead Load	= 4.80 kN/m^2

103mm Timber Stud with Brick Infill

103mm Brickwork	= 2.00 kN/m^2
Lathe and plaster (both sides)	= 0.50 kN/m^2
Dead Load	= 2.50 kN/m^2

Timber Stud Partition

Lathe and plaster	= 0.75 kN/m^2

Member Loads

Existing Ground Floor Beam (2No. beams, total span = 10m)

Dead Load

Ground Floor	= 0.60 x 6.5/2	= 1.95 kN/m
Beam S/W		= 0.50 kN/m

Imposed Load

Ground Floor	= 2.50 x 6.5/2	= 8.13 kN/m

Beam B/1 (span = 2.0m)

Dead Load

Roof Space	= 0.45 x 5.0/2	= 1.13 kN/m
Water tank		= 5.00 kN/m
Third Floor	= 0.60 x 10/2	= 3.00 kN/m
Second Floor	= 0.60 x 10/2	= 3.00 kN/m
First Floor	= 0.60 x 10/2	= 3.00 kN/m
215mm Brick	= 4.80 x 3.0	= 14.4 kN/m
103mm Stud/Brick	= 2.5 x 2.5 x 2.0	= 12.5 kN/m
Beam S/W		= 0.70 kN/m
Grnd Flr Beam	= 2.45 x 10/2	= 12.25 kN (@ 0.3m)

Imposed Load

Roof Space	= 0.25 x 5.0/2	= 0.63 kN/m
Third Floor	= 2.50 x 10/2	= 12.5 kN/m
Second Floor	= 2.50 x 10/2	= 12.5 kN/m
First Floor	= 2.50 x 10/2	= 12.5 kN/m
Grnd Flr Beam	= 8.13 x 10/2	= 40.7 kN (@ 0.3m)

Beam G/1 (span = 3.2m)

Dead Load

Pitch Roof	= 0.65 x 1.0/2 x 6.0/2	= 0.98 kN (@ 1.0m)
Flat Roof	= 0.45 x 2.5/2 x 6.0/2	= 1.69 kN (@ 1.0m)
215mm brick	= 4.80 x 0.75	= 3.60 kN/m
Beam S/W		= 0.40 kN

Imposed Load

Pitch Roof	= 0.60 x 1.0/2 x 6.0/2	= 0.90 kN (@ 1.0m)
Flat Roof	= 0.75 x 2.5/2 x 6.0/2	= 2.81 kN (@ 1.0m)

Beam 3/1 (span = 3.5m)

Dead Load

Roof Space	= 0.45 x 5.0/2	= 1.13 kN/m
Water tank		= 5.00 kN/m
103mm Stud/Brick	= 2.5 x 0.50	= 1.25 kN/m
Beam S/W		= 0.30 kN/m

Imposed Load

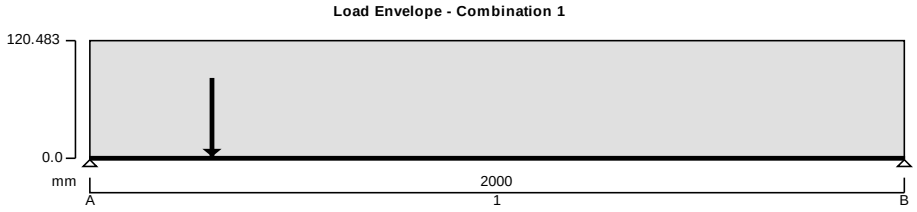
Roof Space	= 0.25 x 5.0/2	= 0.63 kN/m

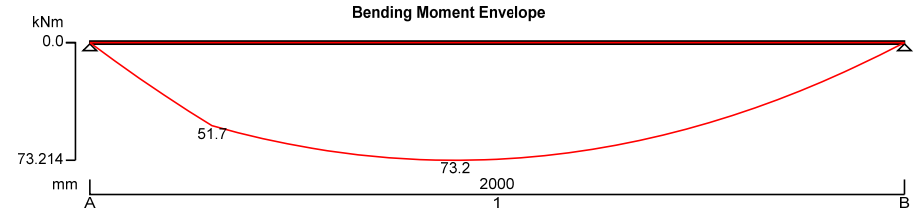
BEAM B/1

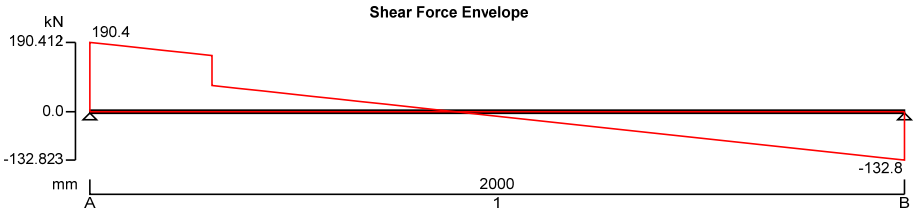
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.05







Support conditions

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

Applied loading

Beam loads	Roof space - Dead full UDL 1.13 kN/m
	Roof space - Imposed full UDL 0.63 kN/m
	Water tank - Dead full UDL 5 kN/m
	Third Floor - Dead full UDL 3 kN/m
	Third Floor - Imposed full UDL 12.5 kN/m
	Second Floor - Dead full UDL 3 kN/m
	Second Floor - Imposed full UDL 12.5 kN/m
	First Floor - Dead full UDL 3 kN/m
	First Floor - Imposed full UDL 12.5 kN/m
	215mm Bwk - Dead full UDL 14.4 kN/m
	103mm Bwk - Dead full UDL 12.5 kN/m

Beam S/W - Dead self weight of beam × 1

Grnd Flr Beam - Dead point load 12.25 kN at 300 mm

Grnd Flr Beam - Imposed point load 40.7 kN at 300 mm

Load combinations

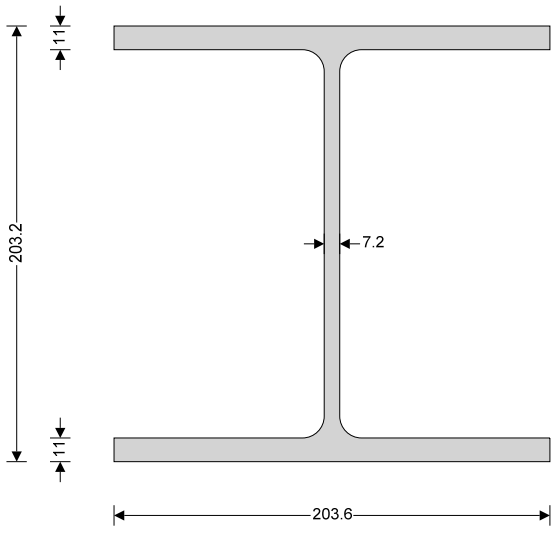
Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
	Span 1	Dead × 1.40
		Imposed × 1.60
	Support B	Dead × 1.40
		Imposed × 1.60

Analysis results

Maximum moment	M_{max} = **73.2** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **190.4** kN	V_{min} = **-132.8** kN
Deflection	δ_{max} = **2.2** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **190.4** kN	R_{A_min} = **190.4** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **52.9** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **72.7** kN	
Maximum reaction at support B	R_{B_max} = **132.8** kN	R_{B_min} = **132.8** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **44.3** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **44.2** kN	

Section details

Section type **UC 203x203x46 (BS4-1)** Steel grade **S275**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **1.00** Section classification **Compact**

Shear capacity - Section 4.2.3

Design shear force F_v = **190.4** kN Design shear resistance P_v = **241.4** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment M = **73.2** kNm Moment capacity high shear M_c = **130** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment M_b = **127.9** kNm M_b / m_{LT} = **137.4** kNm

PASS - Moment capacity exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

Limiting deflection δ_{lim} = **5.556** mm Maximum deflection δ = **2.207** mm

PASS - Maximum deflection does not exceed deflection limit

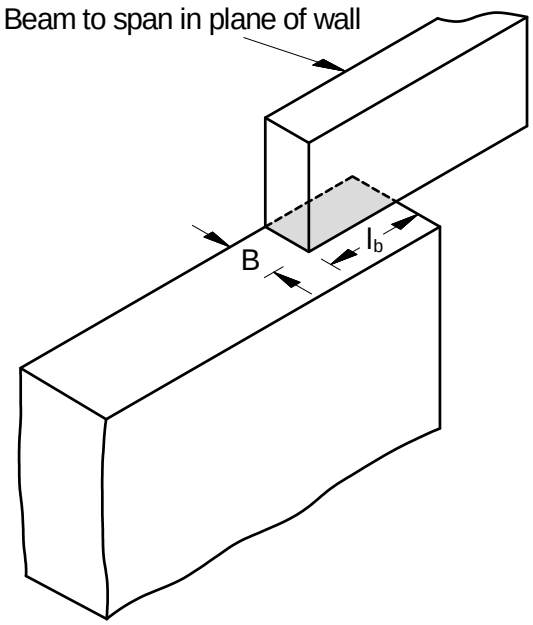
BEAM B/1 BEARING

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.05

Masonry details

Masonry type	**Clay or calcium silicate bricks**		
Compressive strength	p_{unit} = **20.0** N/mm^2	Mortar designation	**iii**
Masonry units	**Category II**	Construction control	**Normal**
Partial safety factor	γ_m = **3.5**	Characteristic strength	f_k = **5.0** N/mm^2
Leaf thickness	t = **215** mm	Effective wall thickness	t_{ef} = **215** mm
Wall height	h = **2400** mm	Effective height of wall	h_{ef} = **2400** mm



Bearing details

Beam spanning in plane of wall

Width of bearing	B = **215** mm	Length of bearing	l_b = **500** mm

Loading details

Concentrated dead load	G_k = **53** kN	Concentrated imposed load	Q_k = **73** kN
Design concentrated load	F = **191.0** kN		
Distributed dead load	g_k = **0.0** kN/m	Distributed imposed load	q_k = **0.0** kN/m
Design distributed load	f = **0.0** kN/m		

Masonry bearing type

Bearing type	**Type 1**	Bearing safety factor	γ_{bear} = **1.25**

Check design bearing without a spreader

Design bearing stress	f_{ca} = **1.777** N/mm^2	Allowable bearing stress	f_{cp} = **1.786** N/mm^2

PASS - Allowable bearing stress exceeds design bearing stress

Check design bearing at 0.4 × h below the bearing level

Design bearing stress f_{ca} = **0.608** N/mm^2 Allowable bearing stress f_{cp} = **1.414** N/mm^2

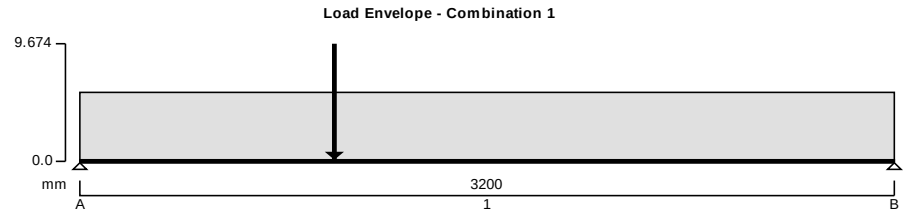
PASS - Allowable bearing stress at 0.4 × h below bearing level exceeds design bearing stress

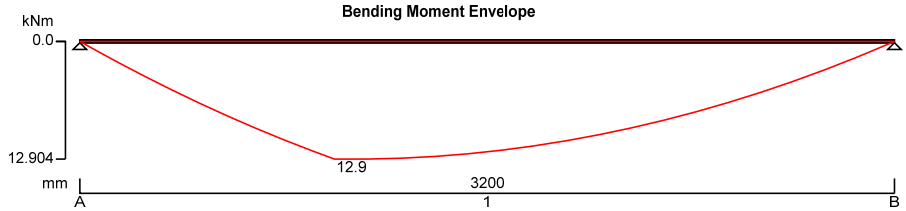
BEAM G/1

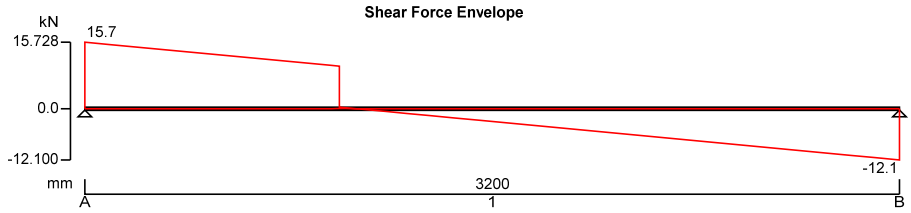
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.05







Support conditions

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

Applied loading

Beam loads

Pitch Roof - Dead point load 0.98 kN at 1000 mm
Pitch Roof - Imposed point load 0.9 kN at 1000 mm
Flat Roof - Dead point load 1.69 kN at 1000 mm
Flat Roof - Imposed point load 2.81 kN at 1000 mm
215mm Brick - Dead full UDL 3.6 kN/m
Beam S/W - Dead self weight of beam × 1

Load combinations

Load combination 1	Support A	Dead × 1.40 Imposed × 1.60
	Span 1	Dead × 1.40 Imposed × 1.60
	Support B	Dead × 1.40 Imposed × 1.60

Analysis results

Maximum moment	M_{max} = **12.9** kNm	M_{min} = **0** kNm

Maximum shear	V_{max} = **15.7** kN	V_{min} = **-12.1** kN
Deflection	δ_{max} = **1** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **15.7** kN	R_{A_min} = **15.7** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **8.3** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **2.6** kN	
Maximum reaction at support B	R_{B_max} = **12.1** kN	R_{B_min} = **12.1** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **7.3** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **1.2** kN	

Section details

Section type	**UC 203x203x46 (BS4-1)**	Steel grade	**S275**

Classification of cross sections - Section 3.5

Tensile strain coefficient	ε = **1.00**	Section classification	**Compact**

Shear capacity - Section 4.2.3

Design shear force	F_v = **15.7** kN	Design shear resistance	P_v = **241.4** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment	M = **12.9** kNm	Moment capacity low shear	M_c = **136.8** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment	M_b = **108.3** kNm	M_b / m_{LT} = **122.3** kNm	

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

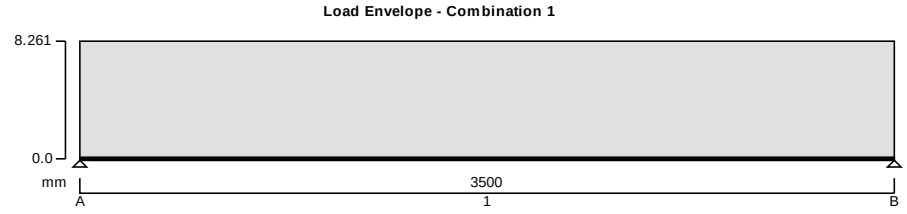
Limiting deflection	δ_{lim} = **8.889** mm	Maximum deflection	δ = **0.973** mm

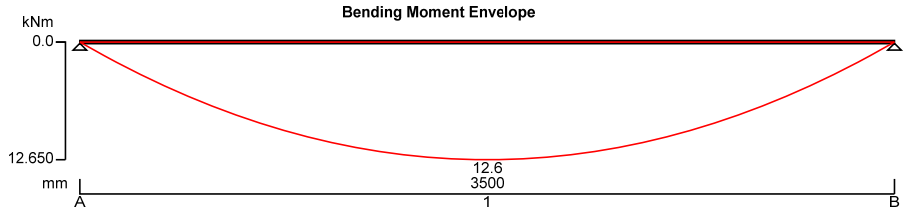
PASS - Maximum deflection does not exceed deflection limit

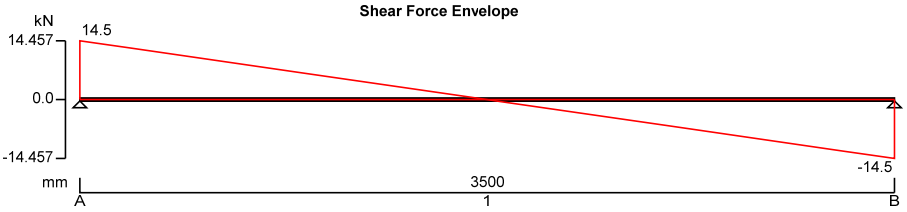
BEAM 3/1

FLITCH BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.5.07







Applied loading

Beam loads

Roof Space	Dead full UDL 1.130 kN/m
Roof Space	Imposed full UDL 0.630 kN/m
Water tank	Dead full UDL 5.000 kN/m
103mm Brick	Dead full UDL 1.250 kN/m
Beam S/W	Dead self weight of beam × 1

Load combinations

Load combination 1	Support A	Dead × 1.00
		Imposed × 1.00
	Span 1	Dead × 1.00
		Imposed × 1.00
	Support B	Dead × 1.00
		Imposed × 1.00

Analysis results

Design moment	M = **12.650** kNm	Design shear	F = **14.457** kN
Total load on beam	W_{tot} = **28.914** kN		
Reactions at support A	R_{A_max} = **14.457** kN	R_{A_min} = **14.457** kN	
Unfactored dead load reaction at support A	R_{A_Dead} = **13.354** kN		
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **1.103** kN		
Reactions at support B	R_{B_max} = **14.457** kN	R_{B_min} = **14.457** kN	
Unfactored dead load reaction at support B	R_{B_Dead} = **13.354** kN		
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **1.103** kN		

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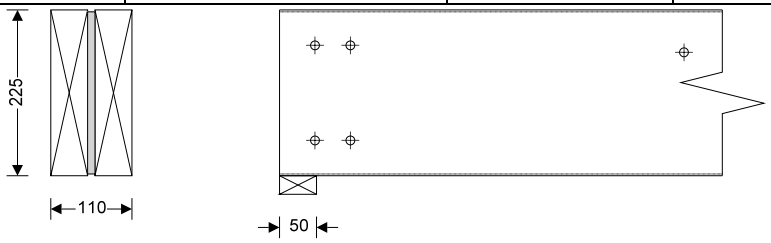
Internal Alterations			18/B
Drawing Ref.	**Made by** Ian R	**Date** 20/07/18	**Checked by** / **Date**



Timber section details

Breadth of section	b = **50** mm	Depth of section	h = **225** mm
Number of sections	N = **2**		
Timber strength class	**C16**		

Steel section details

Breadth of steel plate	b_s = **10** mm	Depth of steel plate	h_s = **220** mm
Number of steel plates in beam	N_s = **1**	Steel stress	p_y = **165** N/mm^2
Bolt diameter	ϕ_b = **12** mm	Maximum bolt spacing	S_{max} = **500** mm

Member details

Service class of timber	**1**	Load duration	**Medium term**
Length of bearing	L_b = **50** mm		

Lateral support - cl.2.10.8

Permiss.depth-to-breadth ratio **3.00** Actual depth-to-breadth ratio **2.05**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress σ_{c_adm} = **3.025** N/mm^2 Applied bearing stress σ_{c_a} = **2.891** N/mm^2

PASS - Applied compressive stress is less than permissible compressive stress at bearing

Bending parallel to grain

Permiss. timber bending stress σ_{m_adm} = **7.522** N/mm^2 Applied timber bending stress σ_{m_a} = **4.718** N/mm^2

PASS - Timber bending stress is less than permissible timber bending stress

Permiss. steel bending stress p_y = **165.000** N/mm^2 Applied steel bending stress $\sigma_{m\_a\_s}$ = **144.586** N/mm^2

PASS - Steel bending stress is less than permissible steel bending stress

Shear parallel to grain

Permissible shear stress τ_{adm} = **0.921** N/mm^2 Applied shear stress τ_a = **0.303** N/mm^2

PASS - Applied shear stress is less than permissible shear stress

Deflection

Permissible deflection δ_{adm} = **10.500** mm Total deflection δ_a = **7.308** mm

PASS - Total deflection is less than permissible deflection

Flitch plate bolting requirements

Bolts required at beam end N_{be} = **3.163** Bolts required to beam length N_{bl} = **6.327**

- Provide a minimum of 4 No.12 mm diameter bolts at each support
- Provide a minimum of 7 No.12 mm diameter bolts along the length of the beam

Minimum bolt spacings

Minimum end spacing	S_{end} = **48** 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 = **3.0** mm