IKT CONSULTING
STRUCTURAL ENGINEERS LIMITED

Structural Design Calculations

Site Address:

**** Mews Lane**

*******, Nottingham**

NG **W**

Prepared for:

Mr & Mrs ***

Date: 16 August 2022

Introduction

The following calculations have been produced for the proposed structural alteration referred to as ** Mews Lane, *******.

The existing property appeared to be a traditional brick cavity wall construction, with traditional timber cut roof.

Scope of Design /work

IKT Consulting Limited design was limited to 2No. steel beams, and masonry to support the walls, floor joists and roof loadings.

General Notes

The Engineer has carried out the design in accordance with the information provided in drawings by the client.

However, unless and until the structural fabric of the building is fully exposed, these should be treated as assumptions and not certainties and should be confirmed or otherwise by the contractor on site. Should the contractor's site discoveries indicate that these assumptions are incorrect he should advise the Engineer immediately and await the Engineers advice on how to proceed.

Sketches are to demonstrate certain features of the design and are not intended as working drawings. Where shown, details are intended to identify the main structural features. It is assumed that the work will be carried out by experienced and competent personnel, therefore exhaustive detailing is not required.

The fabricator/supplier will normally bear responsibility for the structural members up to the point where they are off-loaded onto the site: thereupon they become the responsibility of the contractor.

The delivery should be checked to ensure that it complies with the specification and that the quantities and dimensions are correct. Any discrepancies must immediately be brought to the attention of the supplier.

Contractor/builder appointed to carry out the construction work must carefully assess our proposed layouts, proposed structural specifications and existing site before undertaking construction work.

If the contractor is unsure about the length or size of any design structural element, he must contact the structural engineer for clarification before undertaking construction work.

The contractor must demonstrate a full understanding of the project before starting deconstruction/construction work, and if unclear about any part of the design the contractor must contact us before undertaking the work.

If needed client or contractor must get the local authority approval, i.e. submit the proposed design and layout for approval before undertaking any construction work.

The contractor must provide the client with details of the construction process and risks involve (i.e. damage to existing decoration, existing features and fixtures etc.) before carrying out the construction work.

Fire protection to be in accordance with relevant Building Regulations and Architect's details. New steel beams to be fire protected using British Gypsum Gyproc Fireline Pink plasterboard or 2 layers of plasterboard and skim to achieve minimum 30 minutes to 1-hour fire protection.

All dimensions are to be confirmed by the contractor on-site prior to construction.

All bolts to be minimum M16, Grade 8.8 u.n.o.

All internal steelwork to be shot blast to SA2.5 Standard and painted with 2 coats zinc phosphate min 120 microns or Red Oxide Primer except as noted on drawings.

All external steelwork to be galvanised to suit exposure condition.

All temporary works to the contractor's design and details.

Amendments to the design

Before placing an order or commencing work on site the contractor should be satisfied that the design brief is correct and that he has sufficient information to perform the works safely. IKT Consulting Ltd cannot be held responsible for any incorrect or incomplete design brief.

Codes of Practice

This project was generally designed using the following standards:

The Building Regs. – Approved Document A (2010)

BS EN 1990 - Basis of structural design

BS EN 1991 - Actions on structures

BS EN 1993 - Design of steel structures

BS EN 1996 – Design of Masonry Structures

Calculation Method

Tekla Structural designer 2020 design software will be used to assist with these calculations (print outs are included) to Eurocodes / British Standards.

Structural Consideration

All internal walls are assumed to be solid blockwork wall and to be confirmed on site.

Foundation trial pits to be inspected by the Local Authority building inspector to ascertain and to give advice on foundation underpinning requirements.

Build 330 (L) x 330 (W) Solid brick or 7.3N/mm2 blocks piers and tied to existing masonry to support Beam B2.

Design Notes

1. This design/sketch to be read in conjunction with all specifications and all relevant architects, engineers, services and specialist drawings.
2. **All dimensions are to be confirmed by the contractor on-site prior to construction.**
3. Steelwork to be grade S355, execution class 2and CE marked, unless otherwise noted.
4. To minimise deflections of the existing structure, new beams must be pinned uptight to existing construction with slate or dry-pack mortar, and all mortar allowed to cure prior to de-propping.
5. All work to be undertaken in accordance with the current Building Regulations Part A, British Standards and good building practice.
6. Beams and lintels to have a minimum bearing length of 100mm when perpendicular to the wall, and 200mm when parallel to the wall unless noted otherwise.
7. Due to significant structural works, minor post-construction deflection of brittle finishes may be expected in the existing building.
8. All load-bearing inner skin walls to be minimum 100mm thick medium density (3.6N) concrete blockwork wall unless noted otherwise.
9. All steels that support timber work are to have the flanges pre-drilled @ 500mm centres to accept timber plates.
10. Drawings are not to scale.

Design Summary - Member Sizes

All dimensions to be confirmed by builder prior to construction

Beam B1: 1No UB ***x***x** to suit the masonry above. Grade S355; Span 3.55m (Dimension TBC by builder).

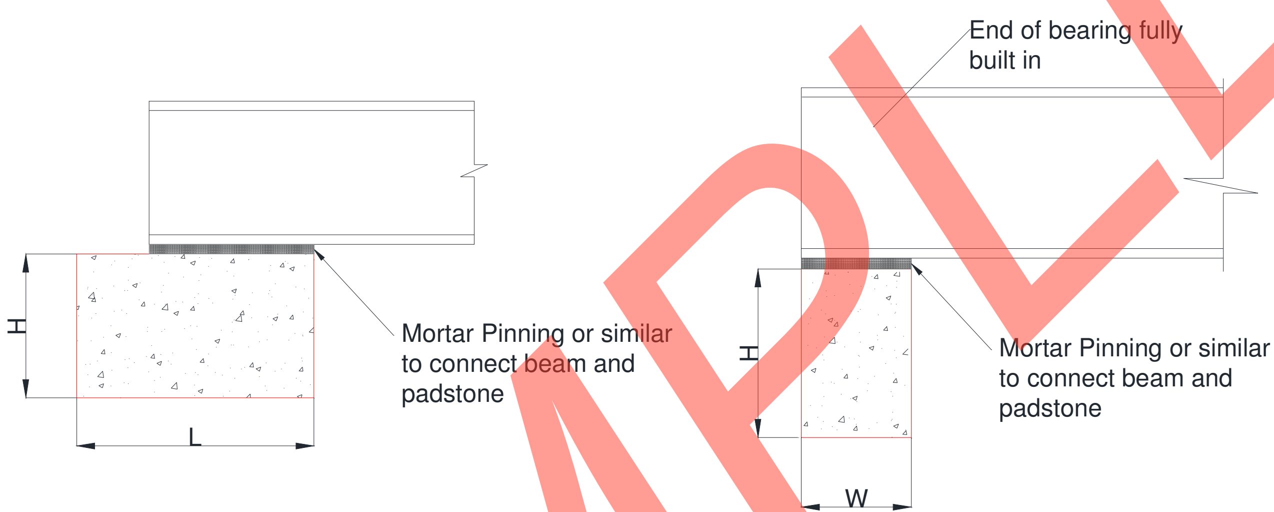
Beam B2: 1No UC ***x***x**. Grade S355; Span 5.75m (Dimension TBC by builder).

Padstones

PS 1: 3No Padstone 330L x 100W x 215H. C35 Mass Concrete padstones. Build 330 (L) x 330 (W) Solid brick or 7.3N/mm2 blocks piers and tied to existing masonry to support Beam B2.

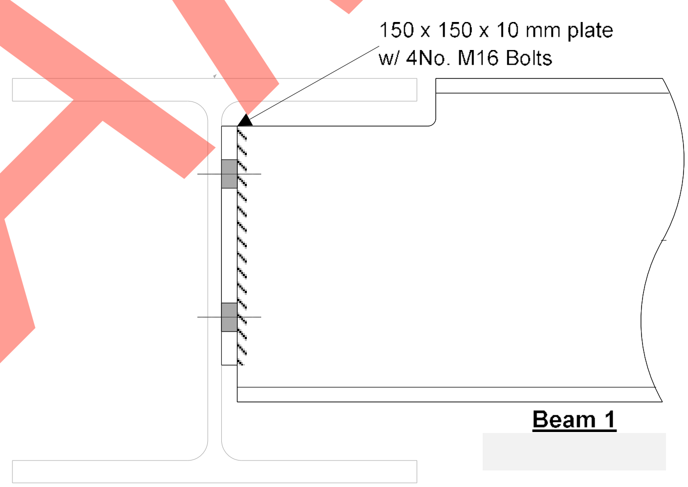
PS 2: 1No. 440x 100 x 215 high required, C35 Mass Concrete padstones.

Our Structural calculations are based on drawings supplied by the Client and the contractor/builder appointed to carry out the construction work must carefully assess our proposed layouts, proposed structural specifications against the existing site by removing the building covering and plasterboards to expose the structure before ordering materials or commencing work on-site and undertaking construction work. If unclear about any part of the design the contractor must contact IKT Consulting before ordering materials and allow a sufficient time scale of no less than 48 hours to resolve any discrepancy.



Minimum bearing length of 100mm when perpendicular to the wall, and 200mm when parallel to the wall unless noted otherwise.

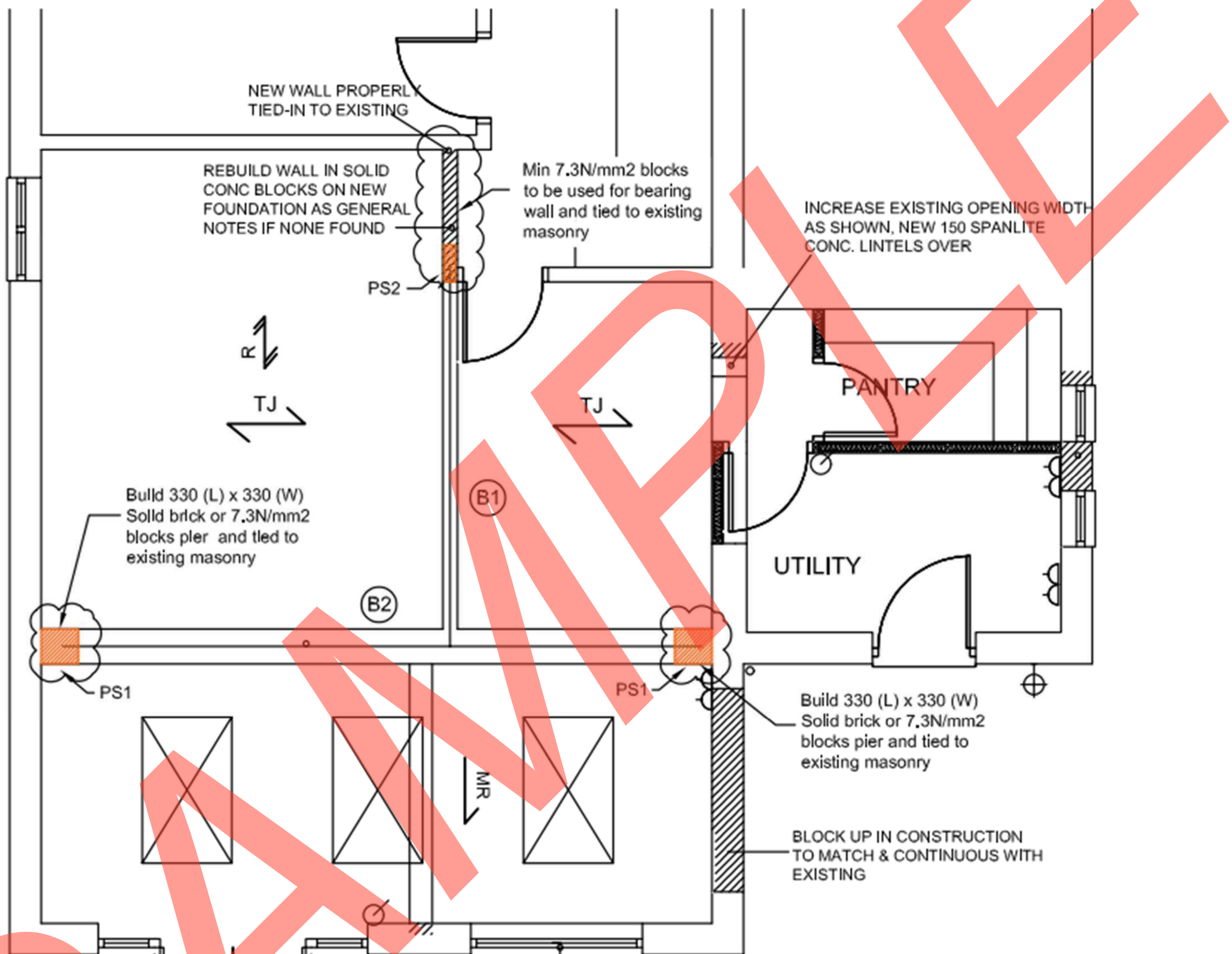
Detail 1 - Typical Padstone



Detail 2 - Typical Connection

KEY PLAN

Top of beams to be confirmed on site.



NOTE:
Do not scale from this drawing.
Existing structures must be adequately propped during beam installation.

All site works shall be in accordance with the health & safety Act & associated regulations issued by the Health & Safety Executive & the Construction Regulations.

Materials in excess of 20kg must be 2 man lift or machine lift

All dimensions are to be confirmed by the contractor on site prior to placing an order or commencing work on site.

Indicates floor span @ first floor

LOADING SCHEDULE

Imposed Load

	kN/m²
Domestic Load	2.000
Roof load	0.750

Dead Load

Roof:	Depth/ thickness	Width	Length	Mat. Weight	Centres	Load
	m	m	m	kN/m³	m	kN/m²
Tiles						0.50
Battens+felt						0.05
Rafters						0.20
Insulation						0.05
Plasterboard + Skim	0.010			15.780		0.20
					TOTAL	**1.00**
Slope	**20**				Tot/cos α	**1.06**
Slope	**40**				Tot/cos α	**1.31**

Floor (Timber Joist):	Depth/ thickness	Width	Length	Mat. Weight	Centres	Load
	m	m	m	kN/m³	m	kN/m²
Board	0.022	~~~	~~~	7.000	~~~	0.15
Joist						0.20
ceiling and service						0.20
					TOTAL	**0.55**

Cavity wall (1Blk+cav+1blk)	Depth/ thickness	Width	Length	Mat. Weight	Centres	Load
	m	m	m	kN/m³	m	kN/m²
Mortar	0.020	~~~	~~~	20.000	~~~	0.40
Brick	0.102	~~~	~~~	20.000	~~~	2.04
Block	0.100	~~~	~~~	17.000	~~~	1.70
					TOTAL	**4.14**

Solid wall (100thk):	Depth/ thickness	Width	Length	Mat. Weight	Centres	Load
Stud wall	m	m	m	kN/m³	m	kN/m²
Render	0.015	~~~	~~~	20.000	~~~	0.30
Brick	0.102	~~~	~~~	20.000	~~~	2.04
					TOTAL	**2.34**

STEEL DESIGN

BEAM 01

Total Length= 3.5 m

Carrying:

1) Floor joist
2) Masonry

Summary of Applied Loads:

	Dead		Imposed	
100thk Masonry	2.34	kN/m²	0.00	kN/m²
First floor	0.55	kN/m²	2.00	kN/m²

UDLs

Masonry

height	2.700	m		
	Dead		*Imposed*	
	6.318	kN/m	0.000	kN/m

Floor Joists

Floor span	5.890	m		
Loaded Width	2.945	m		
	Dead		*Imposed*	
	1.63	kN/m	5.89	kN/m

Loads to beam

UDLs (uf)	*Dead load*		*Imposed load*	
TOT	**7.950**	**kN/m**	**5.890**	**kN/m**

Beam reactions (unfactored)

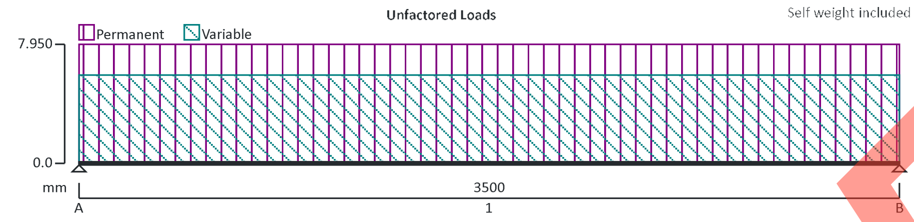
Dead Reaction	13.12	kN
Imposed Reaction	9.72	kN
Max Reaction (unfactored)	22.84	kN
Max Reaction (factored)	32.29	kN

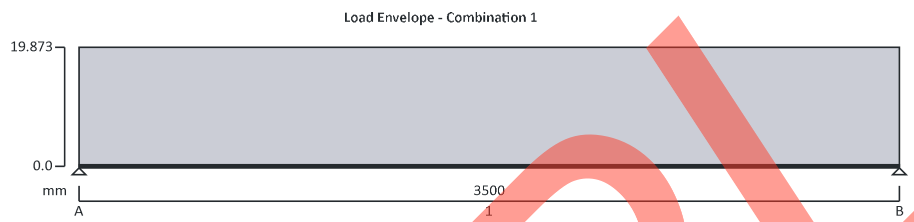
ADOPT 1 UB ***x*x****

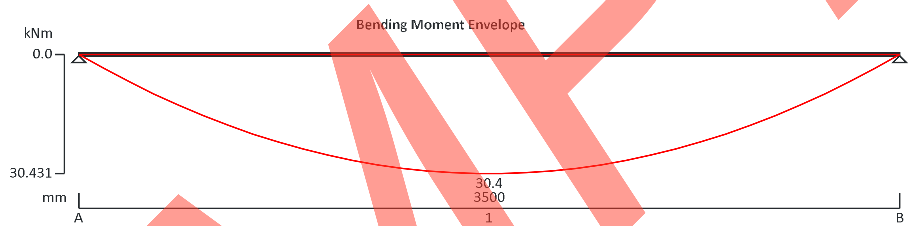
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

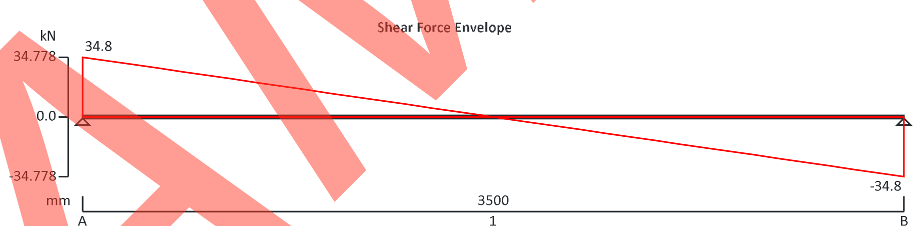
In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

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 7.95 kN/m
	Variable full UDL 5.89 kN/m

Load combinations

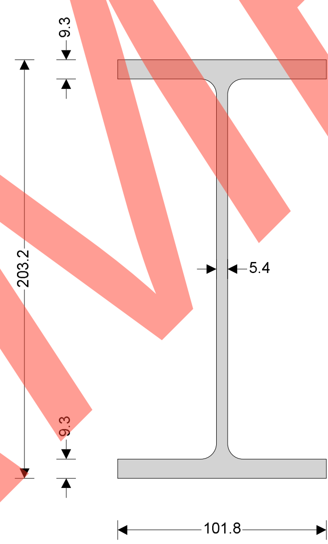
Load combination 1	Support A	Permanent × 1.35
		Variable × 1.50
		Permanent × 1.35
		Variable × 1.50
	Support B	Permanent × 1.35
		Variable × 1.50

Analysis results

Maximum moment;	M_{max} = **30.4** kNm;	M_{min} = **0** kNm
Maximum shear;	V_{max} = **34.8** kN;	V_{min} = **-34.8** kN
Deflection;	δ_{max} = **6.2** mm;	δ_{min} = **0** mm
Maximum reaction at support A;	R_{A_max} = **34.8** kN;	R_{A_min} = **34.8** kN
Unfactored permanent load reaction at support A;	$R_{A\_Permanent}$ = **14.3** kN	
Unfactored variable load reaction at support A;	$R_{A\_Variable}$ = **10.3** kN	
Maximum reaction at support B;	R_{B_max} = **34.8** kN;	R_{B_min} = **34.8** kN
Unfactored permanent load reaction at support B;	$R_{B\_Permanent}$ = **14.3** kN	
Unfactored variable load reaction at support B;	$R_{B\_Variable}$ = **10.3** kN	

Section details

Section type; **UKB ***x***x** (Tata Steel Advance)**; Steel grade; **S355**



Section classification; **Class 1**

Check shear - Section 6.2.6

Design shear force; V_{Ed} = **35** kN; Design shear resistance; $V_{c,Rd}$ = **253.7** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment; M_{Ed} = **30.4** kNm; Des.bending resist.moment; $M_{c,Rd}$ = **83.1** kNm

Slenderness ratio for lateral torsional buckling

LTB slenderness ratio; $\bar{\lambda}_{LT}$ = **1.549**; Limiting slenderness ratio; $\bar{\lambda}_{LT,0}$ = **0.400**

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$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ ***- 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 compression - Section 6.2.4

Design compression force; N_{Ed} = **0** kN; Design resistance of section; $N_{c,Rd}$ = **1043.7** kN

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance; $N_{b,y,Rd}$ = **950.7** kN

PASS - Design buckling resistance exceeds design compression force

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance; $N_{b,z,Rd}$ = **230.7** kN

PASS - Design buckling resistance exceeds design compression force

Check torsional and torsional-flexural buckling

Torsional buckling force; $N_{cr,T}$ = **1072.4** kN; Torsional-flexural buckling; $N_{cr,TF}$ = **1072.4** kN

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance; $N_{b,T,Rd}$ = **632** kN

PASS - Design buckling resistance exceeds design compression force

Combined bending and axial force - Section 6.2.9

Bending and axial force check; $N_{Ed} <= \min(0.25 \times N_{pl,Rd}, 0.5 \times h_w \times t_w \times f_y / \gamma_{M0})$

No allowance on the plastic moment need to be accounted for due to the effect of axial force

Interaction factors k_{ij} for members not susceptible to torsional deformations - Table B.1

Interaction formulae; $N_{Ed} / (\chi_y \times N_{Rk} / \gamma_{M1}) + k_{yy} \times M_{Ed} / (\chi_{LT} \times M_{Rk} / \gamma_{M1})$ = **0.855**

$N_{Ed} / (\chi_z \times N_{Rk} / \gamma_{M1}) + k_{zy} \times M_{Ed} / (\chi_{LT} \times M_{Rk} / \gamma_{M1})$ = **0.513**

PASS - Combined bending and compression checks are satisfied

Check vertical deflection - Section 7.2.1

Consider deflection due to permanent and variable loads

Limiting deflection δ_{lim} = **9.7** mm; Maximum deflection; δ = **6.218** mm

PASS - Maximum deflection does not exceed deflection limit

<u>MASONRY BEARING DESIGN</u>

In accordance with EN1996-1-1:2005 + A1:2012, incorporating Corrigenda February 2006 and July 2009 and the UK National Annex.

Tedds calculation version 1.0.14

Summary table

Load	Local concentration		Spreader		Utilisation	
	Design force	Resistance	Design stress	Resistance		
1	35.3 kN	48.7 kN	2.07 N/mm^2	2.39 N/mm^2	0.869	Pass

Masonry panel details

Panel length; L = **1200** mm; Panel height; h = **2400** mm
Load bearing leaf thickness; t = **102** mm; Effective height; h_{ef} = **1662** mm
Effective thickness; t_{ef} = **127** mm

Masonry material details

Unit type; **Aggregate concrete - Group 1**
Mean masonry strength; f_b = **10.1** N/mm^2; Specific weight of units; γ = **16** kN/m^3
Mortar type; **M4 - General Purpose;** Mortar strength; f_m = **4.0** N/mm^2
Characteristic strength; f_k = **5.73** N/mm^2

Design compressive strength of masonry for inner (loaded) leaf

Category of manufacturing; **Category II;** Class of execution control; **Class 2**
Partial factor for material; γ_M = **3.00**; Design strength of masonry; f_d = **1.91** N/mm^2

Partial safety factors for design loads

Permanent partial factor; γ_{fG} = **1.35**; Variable partial factor; γ_{fQ} = **1.50**

Superimposed vertical loading details

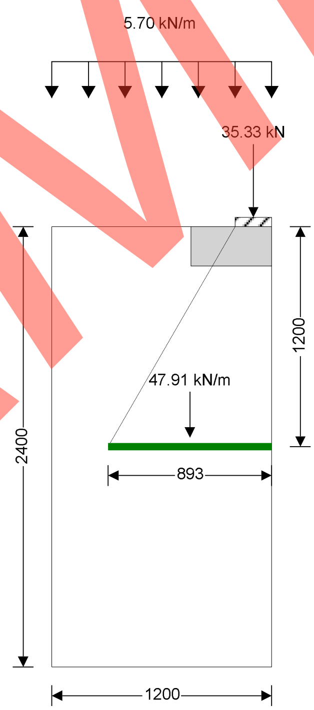
Permanent UDL at top of wall; g_k = **2.00** kN/m; Variable UDL at top of wall; q_k = **2.00** kN/m
Eccent. of permanent UDL; e_{gu} = **0** mm; Eccent. of variable UDL; e_{qu} = **0** mm

Slenderness ratio of masonry wall - Section 5.5.1.4

Slenderness ratio limit; λ_{lim} = **27**; Slenderness ratio; λ = **13.1**

PASS - Slenderness ratio is less than slenderness limit

Concentrated Load 1 details - P1



Permanent load; G_{kc1} = **14.50** kN; Variable load; Q_{kc1} = **10.50** kN
Eccentricity of load; e_{c1} = **0** mm; Length of load; L_{c1} = **200** mm

Width of load; w_{c1} = **102** mm; Height of load; h_{c1} = **2400** mm

Distance to right edge; r_{11} = **0** mm; Distance to nearest edge; a_{11} = **0** mm

Walls subjected to concentrated loads - Section 6.1.3

Design concentrated load; N_{Edc1} = **35.33** kN; Design resistance; N_{Rdc1} = **48.68** kN

PASS - Design resistance exceeds applied concentrated load

Design of spreader beam

Type of spreader; **Concrete padstone;** Type of load; **Point load**

Length of spreader; L_{sp1} = **440** mm; Width of spreader; w_{sp1} = **102** mm

Height of spreader; h_{sp1} = **215** mm; Eccentricity of load; e_{sp1} = **0** mm

Modulus of elasticity; E_{sp1} = **28608** N/mm^2; Maximum moment; M_{Edsp1} = **0.96** kNm

Maximum shear; V_{Edsp1} = **18.18** kN; Allowable stress; σ_{Rdsp1} = **2.39** N/mm^2

Design stress; σ_{Edsp1} = **2.07** N/mm^2

PASS - Design stress under spreader is less than the allowable bearing stress

Walls subjected to mainly vertical loading - Section 6.1.2

Vertical load at mid-height; N_{Ed1} = **47.91** kN/m; Design resistance; N_{Rd1} = **153.00** kN/m

PASS - Design value of vertical resistance exceeds applied vertical load

BEAM 02

Total Length= 5.75 m

Carrying:

1) Extension roof
2) Main roof
3) Masonry
4) Beam 1

Summary of Applied Loads:

	Dead		*Imposed*	
Masonry	4.14	kN/m^2	0.00	kN/m^2
Main roof	1.31	kN/m^2	0.75	kN/m^2
Extension roof	1.06	kN/m^2	0.75	kN/m^2

UDLs

Masonry

height 2.700 m

Dead		*Imposed*	
11.178	kN/m	0.000	kN/m

Inner leaf

Roof

span 4.350 m

Loaded Width	2.175	m		
	Dead		*Imposed*	
	2.84	kN/m	1.63	kN/m

Outer leaf

Extension roof

Roof span	2.400	m		
Loaded Width	1.200	m		
	Dead		*Imposed*	
	1.28	kN/m	0.90	kN/m

Distributed loads

UDLs (uf)	*Dead load*		*Imposed load*	
Inner leaf	8.428	kN/m	1.631	kN/m
outer leaf	6.866	kN/m	0.900	kN/m
TOT	**15.294**	**kN/m**	**2.531**	**kN/m**

Point load - B1 at inner leaf

	Dead		*Imposed*	
	14.5	kN/m	10.5	kN/m
Tot point load	**14.5**	**kN**	**10.5**	**kN**

Beam reactions (unfactored)

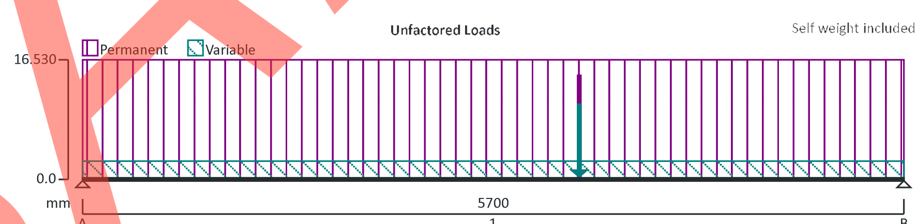
Refer to Tedds results

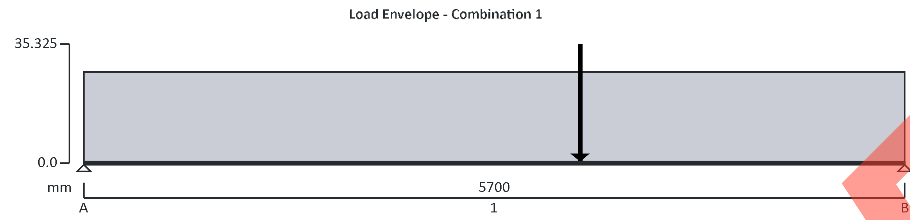
1No UC ***x*x** to support the external wall**

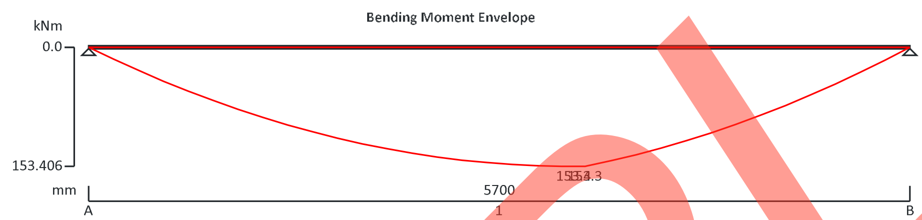
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

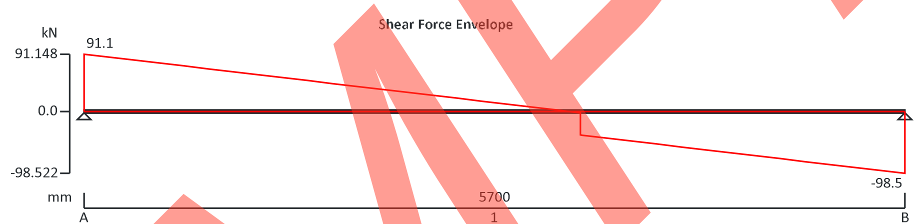
In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

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 16.53 kN/m
	Variable full UDL 2.53 kN/m
	Permanent point load 14.5 kN at 3445 mm
	Variable point load 10.5 kN at 3445 mm

Load combinations

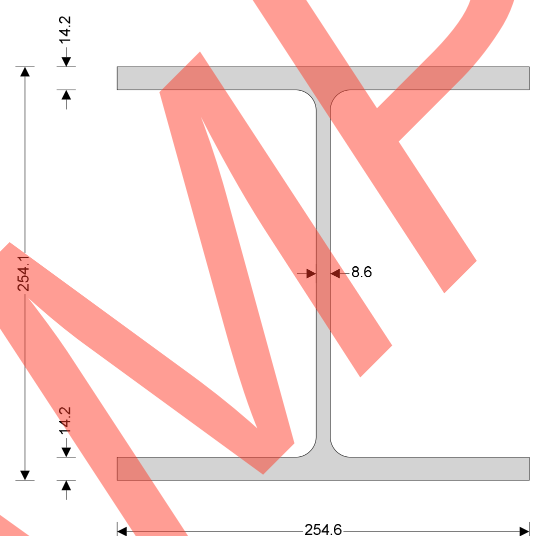
Load combination 1	Support A	Permanent × 1.35
		Variable × 1.50
		Permanent × 1.35
		Variable × 1.50
	Support B	Permanent × 1.35
		Variable × 1.50

Analysis results

Maximum moment;	M_{max} = **153.4** kNm;	M_{min} = **0** kNm
Maximum moment span 1 segment 1;	$M_{s1\_seg1\_max}$ = **149.8** kNm;	$M_{s1\_seg1\_min}$ = **0** kNm
Maximum moment span 1 segment 2;	$M_{s1\_seg2\_max}$ = **153.4** kNm;	$M_{s1\_seg2\_min}$ = **0** kNm
Maximum shear;	V_{max} = **91.1** kN;	V_{min} = **-98.5** kN
Maximum shear span 1 segment 1;	$V_{s1\_seg1\_max}$ = **91.1** kN;	$V_{s1\_seg1\_min}$ = **0** kN
Maximum shear span 1 segment 2;	$V_{s1\_seg2\_max}$ = **14** kN;	$V_{s1\_seg2\_min}$ = **-98.5** kN
Deflection segment 3;	δ_{max} = **15.1** mm;	δ_{min} = **0** mm
Maximum reaction at support A;	R_{A_max} = **91.1** kN;	R_{A_min} = **91.1** kN
Unfactored permanent load reaction at support A;	$R_{A\_Permanent}$ = **54.9** kN	
Unfactored variable load reaction at support A;	$R_{A\_Variable}$ = **11.4** kN	
Maximum reaction at support B;	R_{B_max} = **98.5** kN;	R_{B_min} = **98.5** kN
Unfactored permanent load reaction at support B;	$R_{B\_Permanent}$ = **57.9** kN	
Unfactored variable load reaction at support B;	$R_{B\_Variable}$ = **13.6** kN	

Section details

Section type; **UKC ***x***x** (Tata Steel Advance);** Steel grade; **S355**



Section classification; **Class 2**

Check shear - Section 6.2.6

Design shear force; V_{Ed} = **99** kN; Design shear resistance; $V_{c,Rd}$ = **525.2** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment; M_{Ed} = **153.4** kNm; Des.bending resist.moment; $M_{c,Rd}$ = **352.2** kNm

Slenderness ratio for lateral torsional buckling

LTB slenderness ratio; $\bar{\lambda}_{LT}$ = **0.570**; 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; $M_{b,Rd}$ = **327.6** kNm

PASS - Design buckling resistance moment exceeds design bending moment

Check compression - Section 6.2.4

Design compression force; N_{Ed} = **0** kN; Design resistance of section; $N_{c,Rd}$ = **3305.1** kN

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance; $N_{b,y,Rd}$ = **2638.2** kN

PASS - Design buckling resistance exceeds design compression force

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance; $N_{b,z,Rd}$ = **2643** kN

PASS - Design buckling resistance exceeds design compression force

Check torsional and torsional-flexural buckling

Torsional buckling force; $N_{cr,T}$ = **5009.8** kN; Torsional-flexural buckling; $N_{cr,TF}$ = **5009.8** kN

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance; $N_{b,T,Rd}$ = **2163.1** kN

PASS - Design buckling resistance exceeds design compression force

Combined bending and axial force - Section 6.2.9

Bending and axial force check; $N_{Ed} <= \min(0.25 \times N_{pl,Rd}, 0.5 \times h_w \times t_w \times f_y / \gamma_{M0})$

No allowance on the plastic moment need to be accounted for due to the effect of axial force

Interaction factors k_{ij} for members not susceptible to torsional deformations - Table B.1

Interaction formulae; $N_{Ed} / (\chi_y \times N_{Rk} / \gamma_{M1}) + k_{yy} \times M_{Ed} / (\chi_{LT} \times M_{Rk} / \gamma_{M1})$ = **0.445**

$N_{Ed} / (\chi_z \times N_{Rk} / \gamma_{M1}) + k_{zy} \times M_{Ed} / (\chi_{LT} \times M_{Rk} / \gamma_{M1})$ = **0.267**

PASS - Combined bending and compression checks are satisfied

Check vertical deflection - Section 7.2.1

Consider deflection due to permanent and variable loads

Limiting deflection δ_{lim} = **22.8** mm; Maximum deflection; δ = **15.135** mm

PASS - Maximum deflection does not exceed deflection limit

<u>MASONRY BEARING DESIGN</u>

In accordance with EN1996-1-1:2005 + A1:2012, incorporating Corrigenda February 2006 and July 2009 and the UK National Annex.

Tedds calculation version 1.0.14

Summary table

Load	Local concentration		Spreader		Utilisation	
	Design force	Resistance	Design stress	Resistance		
1	99.3 kN	121.2 kN	2.34 N/mm^2	2.39 N/mm^2	0.981	Pass

Masonry panel details

Panel length; L = **2000** mm; Panel height; h = **2400** mm

Load bearing leaf thickness; t = **280** mm; Effective height; h_{ef} = **2069** mm

Effective thickness; t_{ef} = **280** mm

Masonry material details

Unit type; **Aggregate concrete - Group 1**

Mean masonry strength; f_b = **10.1** N/mm^2; Specific weight of units; γ = **16** kN/m^3

Mortar type; **M4 - General Purpose;** Mortar strength; f_m = **4.0** N/mm^2

Characteristic strength; f_k = **5.73** N/mm^2

Design compressive strength of masonry

Category of manufacturing; **Category II;** Class of execution control; **Class 2**

Partial factor for material; γ_M = **3.00**; Design strength of masonry; f_d = **1.91** N/mm^2

Partial safety factors for design loads

Permanent partial factor; γ_{fG} = **1.35**; Variable partial factor; γ_{fQ} = **1.50**

Superimposed vertical loading details

Permanent UDL at top of wall; g_k = **2.00** kN/m; Variable UDL at top of wall; q_k = **2.00** kN/m

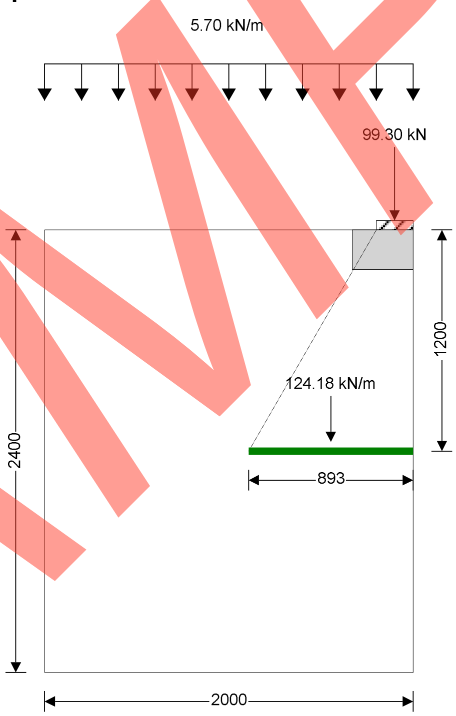
Eccent. of permanent UDL; e_{gu} = **0** mm; Eccent. of variable UDL; e_{qu} = **0** mm

Slenderness ratio of masonry wall - Section 5.5.1.4

Slenderness ratio limit; λ_{lim} = **27**; Slenderness ratio; λ = **7.4**

PASS - Slenderness ratio is less than slenderness limit

Concentrated Load 1 details - P1



Permanent load; G_{kc1} = **58.00** kN; Variable load; Q_{kc1} = **14.00** kN

Eccentricity of load; e_{c1} = **0** mm; Length of load; L_{c1} = **200** mm

Width of load; w_{c1} = **254** mm; Height of load; h_{c1} = **2400** mm

Distance to right edge; r_{11} = **0** mm; Distance to nearest edge; a_{11} = **0** mm

Connection details

Connection type;	**Partial depth end plate**
Number of supported beams;	**1 supported beam**

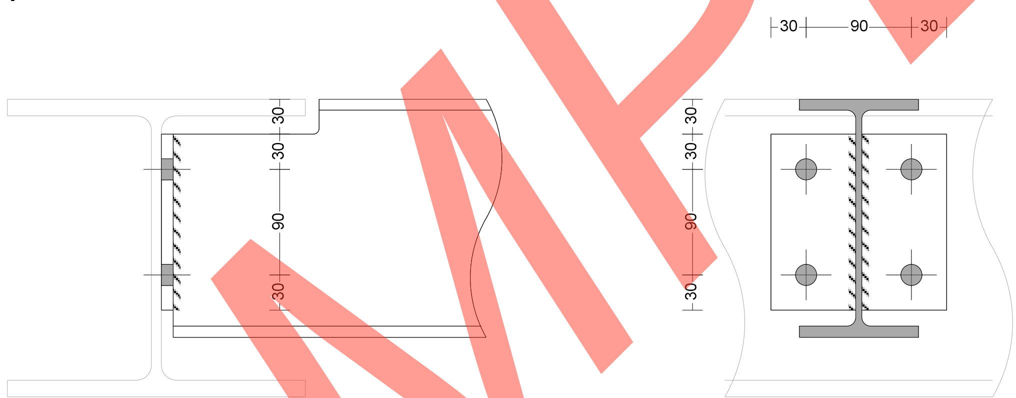
Partial factors

Resistance of cross-section;	γ_{M0} = **1.00**
Resistance of members to instability;	γ_{M1} = **1.00**
Cross-sections in tension to fracture;	$\gamma_{M2,c}$ = **1.10**
Resistance of bolts;	$\gamma_{M2,b}$ = **1.25**
Structural integrity;	$\gamma_{M,u}$ = **1.10**

Supporting beam details

Section name;	**UC 254x254x73**
Steel grade;	**S355**
Yield strength;	f_y = **355** N/mm^2
Ultimate strength;	f_u =**470** N/mm^2

Beam 1



Summary Results

Check	Description	Units	Design Force	Design Resistance	Utilisation	
1	Recommended detailing practices					PASS
2	Supported beam - Welds	kN	53	159.5	0.333	PASS
4	Supported beam - Web in shear	kN	75	149.4	0.502	PASS
5	Supported beam - Resistance at notch	kNm	10.1	15.2	0.667	PASS
6	Supported beam - Local stability notch					PASS
8	Connection - Bolt group	kN	75	192.9	0.389	PASS
9	Connection - End plate in shear	kN	75	375.1	0.200	PASS
10	Supporting beam - Shear	kN	37.5	337.3	0.111	PASS
11	Tying resistance - Plate and bolts	kN	75	174.9	0.429	PASS

Check	Description	Units	Design Force	Design Resistance	Utilisation	
12	Tying resistance - Supported beam web	kN	75	346.1	0.217	PASS

Design forces

Design shear; V_{Ed1} = **75** kN

Design tying force; F_{Ed1} = **75** kN

Supported beam details

Section name; **UB 203x102x23**

Steel grade; **S355**

Yield strength; $f_{y,b}$ = **355** N/mm^2

Ultimate strength; $f_{u,b}$ = **470** N/mm^2

Correlation factor; $\beta_{w,b}$ = **0.9**

End plate details

Plate height; h_p = **150** mm

Plate width; b_p = **150** mm

Plate thickness; t_p = **10** mm

Plate grade; **S275**

Yield strength; $f_{y,p}$ = **275** N/mm^2

Ultimate strength; $f_{u,p}$ = **410** N/mm^2

Correlation factor; $\beta_{w,p}$ = **0.85**

Bolt details

Number of bolt rows; $n_{1,1}$ = **2**

Total number of bolts; n_b = **4**

End distance; e_1 = **30** mm

Edge distance; e_2 = **30** mm

Pitch; p_1 = **90** mm

Gauge; p_3 = **90** mm

Bolt hole; d_0 = **18** mm

Bolt size; **M16**

Bolt grade; **8.8**

Yield strength; $f_{y,bolt}$ = **640** N/mm^2

Ultimate strength; $f_{u,bolt}$ = **800** N/mm^2

Check 1: Recommended detailing practice

Minimum plate height; $0.6 \times h_b$ = **121.9** mm

Actual plate height; h_p = **150** mm

Maximum depth to plate; **50 mm**

Actual depth to plate; d_p = **30** mm

Maximum plate thickness; **10 mm**

Actual plate thickness; t_p = **10** mm

Minimum bolt gauge; **90 mm**

Actual bolt gauge; p_3 = **90** mm

Top Notch

Depth of notch; d_{nt} = **30** mm

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Length of notch; l_n = **125** mm
Minimum vertical clearance; $Max(t_{f,b} + r_b, t_f + r)$ = **26.9** mm
Actual vertical clearance; d_{nt} = **30** mm
Minimum horizontal clearance; **10 mm**
Actual horizontal clearance; $l_n - (b - t_w) / 2 + t_p$ = **12** mm

PASS - Recommended detailing practices are met

Check 2: Supported beam - Welds

Weld leg size; s_w = **6.0** mm
Minimum weld throat thickness; $0.48 \times t_{w,b}$ = **2.6** mm
Effective weld throat thickness; $a_w = 0.7 \times s_w$ = **4.2** mm
Correlation factor; $\beta_w = Min(\beta_{w,b}, \beta_{w,p})$ = **0.85**
Design shear strength; $f_{vw,d} = Min(f_{u,b},f_{u,p}) / \sqrt{(3)} / (\beta_w \times \gamma_{M2,c})$ = **253.17** N/mm^2
Design resistance; $F_{w,Rd} = f_{vw,d} \times a_w \times h_p$ = **159.5** kN
Design weld force; $F_{w,Ed} = \sqrt{(V_{Ed1}{}^2 + F_{Ed1}{}^2)} / 2$ = **53.03** kN
Utilisation; $F_{w,Ed} / F_{w,Rd}$ = **0.333**

PASS - Weld throat thickness greater than required

Check 4: Supported beam - Web in shear

Shear area; $A_v = 0.9 \times h_p \times t_{w,b}$ = **729** mm^2
Plastic shear resistance of beam web; $V_{pl,Rd} = A_v \times (f_{y,b} / \sqrt{(3)}) / \gamma_{M0}$ = **149.42** kN
Design shear resistance; $V_{c,Rd} = V_{pl,Rd}$ = **149.42** kN
Utilisation; $V_{Ed1} / V_{c,Rd}$ = **0.502**

PASS - Web shear resistance greater than design shear

Check 5: Supported beam - Resistance at notch

Single Notch (low shear, $V_{Ed} <= 0.5V_{pl,N,Rd}$)

Area of Tee section at notch; A_{Tee} = **1832** mm^2
Elastic modulus of Tee section; $W_{el,N,y}$ = **42765** mm^3
Shear area at notch; $A_{v,N} = A_{Tee} - b_b \times t_{f,b} + (t_{w,b} + 2 \times r_b) \times t_{f,b} / 2$ = **981** mm^2
Shear resistance at notch; $V_{pl,N,Rd} = (A_{v,N} \times f_{y,b}) / (\sqrt{(3)} \times \gamma_{M0})$ = **201.03** kN
Moment resistance at notch; $M_{v,N,Rd} = f_{y,b} \times W_{el,N,y} / \gamma_{M0}$ = **15.18** kNm
Design moment at notch; $M_{v,Ed} = V_{Ed1} \times (t_p + l_n)$ = **10.13** kNm
Utlilisation; $M_{v,Ed} / M_{v,N,Rd}$ = 0.667

PASS - Notch resistance is greater than design force

Check 6: Supported beam - Local stability of notched beam

Single notch

Maximum notch depth; $h_b / 2$ = **101.6** mm
Actual notch depth; d_{nt} = **30** mm
Maximum notch length ($h_b/t_{w,b} <= 48.0$); h_b = **203.2** mm
Actual notch length; l_n = **125** mm

PASS - Local stability is accounted for

Check 8: Connection - Bolt group

Bolt tensile stress area; A_s = **157** mm^2
Bolt shear stress factor; α_v = **0.6**
Bolt shear resistance; $F_{v,Rd} = \alpha_v \times f_{u,bolt} \times A_s / \gamma_{M2,b}$ = **60.29** kN
For the end plate; $\alpha_{b,p} = Min(e_1 / (3 \times d_0), p_1 / (3 \times d_0) - 1/4, f_{u,bolt} / f_{u,p}, 1)$ = **0.56**

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$k_{1,p} = Min(2.8 \times e_2 / d_0 - 1.7, 1.4 \times p_3 / d_0 - 1.7, 2.5) =$ **2.5**

For the supporting member; $\alpha_{b,2} = Min(p_1 / (3 \times d_0) - 1/4, f_{u,bolt} / f_u, 1) =$ **1**

$k_{1,2} = Min(1.4 \times p_3 / d_0 - 1.7, 2.5) =$ **2.5**

Bearing on the end plate; $F_{b,Rd,p} = k_{1,p} \times \alpha_{b,p} \times f_{u,p} \times d_b \times t_p / \gamma_{M2,b} =$ **72.89** kN

Bearing on the supporting member; $F_{b,Rd,2} = k_{1,2} \times \alpha_{b,2} \times f_u \times d_b \times t_w / \gamma_{M2,b} =$ **129.34** kN

Minimum bearing resistance; $F_{b,Rd1} = Min(F_{b,Rd,p}, F_{b,Rd,2}) =$ **72.89** kN

Resistance of the bolt group; $F_{Rd} = 0.8 \times n_b \times F_{v,Rd} =$ **192.92** kN

Utilisation; $V_{Ed1} / F_{Rd} =$ **0.389**

PASS - Bolt group resistance is greater than design force

Check 9: Connection - End plate in shear

Net shear area; $A_{v,net} = t_p \times (h_p - n_{1,1} \times d_0) =$ **1140** mm^2

Edge shear area; $A_{nt} = t_p \times (e_2 - d_0 / 2) =$ **210** mm^2

Shear area from end bolt; $A_{nv} = t_p \times (h_p - e_1 - (n_{1,1} - 0.5) \times d_0) =$ **930** mm^2

Gross section shear resistance; $V_{Rd,g} = (2 \times h_p \times t_p) / 1.27 \times f_{y,p} / (\sqrt{(3)} \times \gamma_{M0}) =$ **375.05** kN

Net section shear resistance; $V_{Rd,n} = 2 \times A_{v,net,A\_c1} \times f_{u,plate,A\_c1} / (\sqrt{(3)} \times \gamma_{M2,c}) =$ **490.64** kN

Block tearing resistance; $V_{Rd,b} = 2 \times (f_{u,p} \times A_{nt} / \gamma_{M2,c} + f_{y,p} \times A_{nv} / (\sqrt{(3)} \times \gamma_{M0})) =$ **451.86** kN

End plate in-plane bending resistance; $h_p < 1.36 p_3$ - No additional requirements

End plate shear resistance; $V_{Rd,pl,min} = Min(V_{Rd,g}, V_{Rd,n}, V_{Rd,b}) =$ **375.05** kN

Utilisation; _PlateShearUtilisationA_c1 = **0.2**

PASS - Shear resistance of end plate greater than design force

Check 10: Supporting beam - Shear

Distance from top bolt to flange; $e_{1,t} =$ **60** mm

Distance from bottom bolt to flange; $e_{1,b} =$ **104** mm

Minimum top distance; $e_t = Min(e_{1,t}, 5 \times d_b) =$ **60** mm

Minimum bottom distance; $e_b = Min(e_{1,b}, p_3 / 2, 5 \times d_b) =$ **45** mm

Shear area of supporting member; $A_v = t_w \times (e_t + (n_{1,1} - 1) \times p_1 + e_b) =$ **1677** mm^2

Net shear area of supporting member; $A_{v,net} = A_v - n_{1,1} \times d_0 \times t_w =$ **1367** mm^2

Local shear resistance; $V_{Rd,min} = Min(A_v \times f_y / (\sqrt{(3)} \times \gamma_{M0}), A_{v,net} \times f_u / (\sqrt{(3)} \times \gamma_{M2,c})) =$ **337.32** kN

Utilisation; $V_{Ed1}/2 / V_{Rd,min} =$ **0.111**

PASS - Beam shear resistance is greater than design force

Check 11: Tying resistance - Plate and bolts

Effective end distance; $e_{1A} = Min(e_1, 0.5 \times (p_3 - t_{w,b} - 2 \times a_w \times \sqrt{(2)}) + d_0/2) =$ **30** mm

Effective bolt pitch; $p_{1A} = Min(p_1, p_3 - t_{w,b} - 2 \times a_w \times \sqrt{(2)} + d_0) =$ **90** mm

Minimum end distance; $e_{min} = e_2 =$ **30** mm

Bolt factor; $k_2 =$ **0.9**

Distance from weld throat to bolt; $m_w = (p_3 - t_{w,b} - 2 \times 0.8 \times a_w \times \sqrt{(2)}) / 2 =$ **37.5** mm

$n_w = Min(e_{min}, 1.25 \times m_w) =$ **30** mm

Width across bolt head points; $d_w =$ **26** mm

$e_w = d_w / 4 =$ **6.5** mm

Effective length of equivalent T-stub; $\Sigma l_{eff} = 2 \times e_{1A} + (n_{1,1} - 1) \times p_{1A} =$ **150.0** mm

Moment resistance of plate; $M_{pl,1,Rd,u} = (0.25 \times \Sigma l_{eff} \times t_p^2 \times f_{u,p}) / \gamma_{M,u} =$ **1.4** kNm

$M_{pl,2,Rd,u} = M_{pl,1,Rd,u} =$ **1.4** kNm

Mode 1 plate failure;	$F_{Rd,u,1} = (8 \times n_w - 2 \times e_w) \times M_{pl,1,Rd,u} / (2 \times m_w \times n_w - e_w \times (m_w + n_w))$ = **174.92** kN
Individual bolt resistance;	$F_{t,Rd,u} = k_2 \times f_{u,bolt} \times A_s / \gamma_{M,u}$ = **102.76** kN
Group bolt resistance;	$\Sigma F_{t,Rd,u} = n_b \times F_{t,Rd,u}$ = **411.05** kN
Mode 2 bolt and plate failure;	$F_{Rd,u,2} = (2 \times M_{pl,2,Rd,u} + n_w \times \Sigma F_{t,Rd,u}) / (m_w + n_w)$ = **223.94** kN
Mode 3 bolt failure;	$F_{Rd,u,3} = \Sigma F_{t,Rd,u}$ = **411.05** kN
Minimum resistance;	$F_{Rd,u,min} = \mathrm{Min}(F_{Rd,u,1}, F_{Rd,u,2}, F_{Rd,u,3})$ = **174.92** kN
Utilisation;	$F_{Ed1} / F_{Rd,u,min}$ = **0.429**

PASS - Tying resistance of plate and bolts is greater than design force

Check 12: Tying resistance - Supported beam web

Web resistance;	$F_{Rd,u} = (t_{w,b} \times h_p \times f_{u,b}) / \gamma_{M,u}$ = **346.09** kN
Utilisation;	$F_{Ed1} / F_{Rd,u}$ = **0.217**

PASS - Supported beam web tying resistance is greater than design force

;

Revision	Date	Engineer	Checked By
-	August 22	A.N	IKT

IKT
GF - Plan view
16/08/22
not to scale

Note:

1. All beam to have minimum 150mm bearing length and 2 course of Class A engineering brick as padstone (unless noted otherwise).
2. New brick piers to be adequately tooth jointed into existing walls

TJ — Denotes assumed floor span direction of timber joist @ 1st floor

R — Denotes assumed floor span direction of attic trusses for the roof (30 degrees)

MR — Denotes assumed floor span direction of mono pitch roof

Beam Size:

B1 - 1No UB x x to suit the masonry above. Grade S355; (Dimension TBC by others).

B2 - 1No UC x x to suit the masonry above. Grade S355; (Dimension TBC by others) - End bearing at solid wall to be min 200mm

Padstone Size:

- PS1 - 3No Padstone 330L x 100W x 215H
- PS2 - 1No Padstone 440L x 100W x 215H