

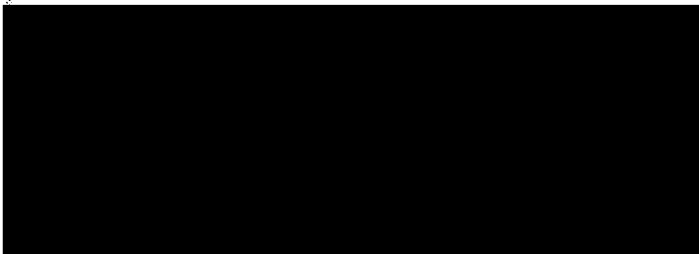


20 GLAMIS STREET, BOGNOR REGIS, WEST SUSSEX, PO21 1DQ

Structural calculations for internal alterations



Calculations produced by Karl Page MEng, CEng, MICE



FEBRUARY 1, 2021

	Project: 20 Glamis Street, Bognor Regis, West Sussex, PO21 1DQ	By: KP	Page No. 1
	Structural calculations for a second story extension	Date: Jan-21	Project No. KPSC1738

1.0 Introduction

The following calculations have been carried out for Your home plans on behalf of the property owner to remove two internal walls within their property.

The internal walls to be removed are in the basement and extend throughout the property on the ground and first floor. The internal walls are used to support the floor joists and flat roof.

The new steel beams will form a T arrangement to support the intersecting walls and the main beam will be supported by steel columns at either end. New foundations are required as the loading from the wall is large. Additionally it is believed that the internal wall provides buttressing to the external walls and therefore a steel frame will maintain the restraint.

All design has been carried out in accordance with:

The Building Regulations 2010, Approved document A (Structural)

BS EN 1990: Basis of structural design + associated National Annex

BS EN 1991: Actions on structures + associated National Annex

BS EN 1993: Design of steel structures + associated National Annex

BS 59771: Lintels – Method for assessing load

BS 5268-2: Structural use of timber

All calculations in this report have been undertaken by Karl Page MEng CEng MICE, Chartered Civil Engineer on behalf of KP Structural Consultants Ltd.

	Project: 20 Glamis Street, Bognor Regis, West Sussex, PO21 1DQ	By: KP	Page No. 2
	Structural calculations for a second story extension	Date: Jan-21	Project No. KPSC1738

2.0 Specification

The following recommendations summarise the findings from the calculations in this report. The calculations are based on all work undertaken by a suitably experienced and competent builder who will inspect the site to verify that information provided to KP Structural Consultants is correct. Where there are any discrepancies in this information, KP Structural Consultants should be informed.

Specification for steel beam: Steel beam to support internal wall - Beam 1

- 1 No. 203 x 102 x 23 UB
- Length to be confirmed by the builder
- Minimum grade 355 steel
- One end of beam to have a partial depth end plate 150 x 150 x 8mm to be welded to end of the web of the beam.
- Connection into web of supporting beam to be using 4No M16 grade 8.8 bolts in 18mm holes
- End of beam to be notched 25mm deep (top and bottom) by 120mm long to accommodate connection into supporting beam (refer to figure 2 & 3)
- Bolt gauge (horizontal spacing) to be 90mm, pitch (vertical spacing) to be 70mm
- Other end of beam to have a minimum bearing of 150mm onto concrete padstone 440 x 100 x 215 placed on internal wall.
- The builder is to check the condition of the remaining masonry to ensure that it is in a sound condition and suitable to support the existing beam.

Specification for steel beam: Steel beam to support internal wall - Beam 2

Note: The builder is to ensure that adequate cross propping (horizontal propping) to the side walls to the basement is provided prior to removing the cross wall which is to be replaced by beam 2. The internal cross wall is believed to provide buttressing to the external walls in the basement.

- 1 No. 203 x 203 x 52 UC
- Length to be confirmed by the builder
- Minimum grade 355 steel
- Beam 1 to be bolted into endplate of column C01 through bottom flange of beam using 4No M20 grade 8.8 bolts in 22mm holes.
- Bolt gauge to be 90mm, pitch to be 80mm
- Steel plate (top plate) used to support full width of cavity wall above the beam. Top plate to be positioned centrally over steel beam and overhang top flange laterally. Top plate to be 8mm thick, width of plate sized to suit cavity (no greater than 300mm wide).
- Top plate to be welded to either side of top flange of beam, weld to be 50mm long at 250mm centres along length of beam

 KP Structural Consultants Chartered Engineers	Project: 20 Glamis Street, Bognor Regis, West Sussex, PO21 1DQ Structural calculations for a second story extension	By: KP	Page No. 3
		Date: Jan-21	Project No. KPSC1738

Specification for steel column: Steel column to support beam 2 – C01

- 2 No. 203 x 203 x 46 UC
- Length to be confirmed by the builder
- Minimum grade 355 steel
- Top of column to have a full depth end plate 200 x 200 x 12mm to be welded to the web and flanges at the end of the beam - Refer to figure 4.
- The column should be centrally placed on a new pad foundation 1.2m x 1.0m – depth to the satisfaction of the BCO
- Base plate welded to bottom of column to be 350mm x 350mm x 15mm thick. 4No 22mm holes drilled in each corner min edge distance to be 50mm.
- Column to be drilled and fixed into the foundation using 4No. M20 anchor bolts embedded by a minimum of 170mm and resin fixed using Hilti HIT-RE 500 mortar or similar approved in accordance with manufactures installation guidance – refer to figure 5.
- Blockwork to be tied to steel columns using wall ties shot fired into the steelwork @ 225 vertical c/c

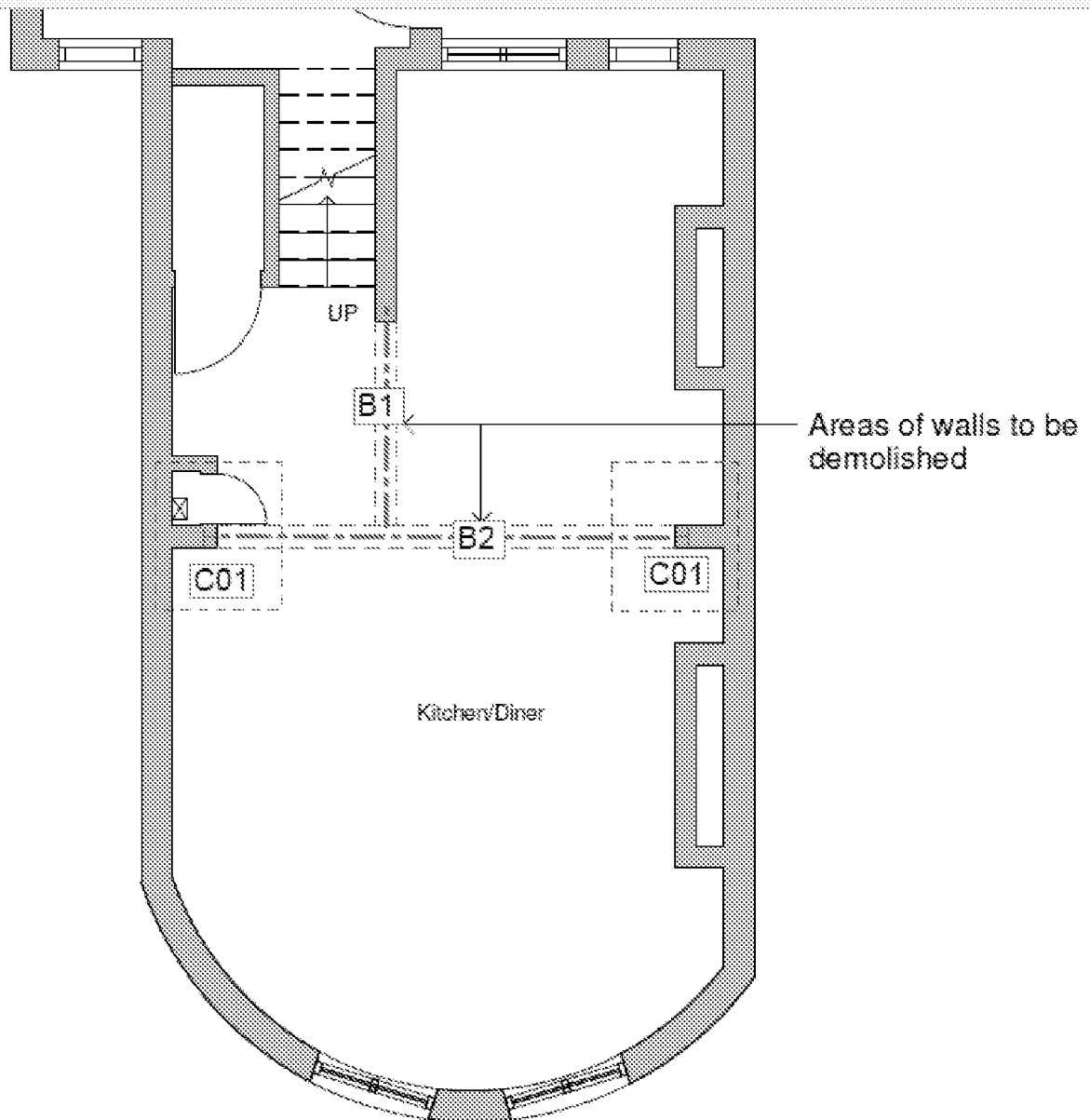


Figure 1: Plan view of basement floor showing proposed beam arrangement

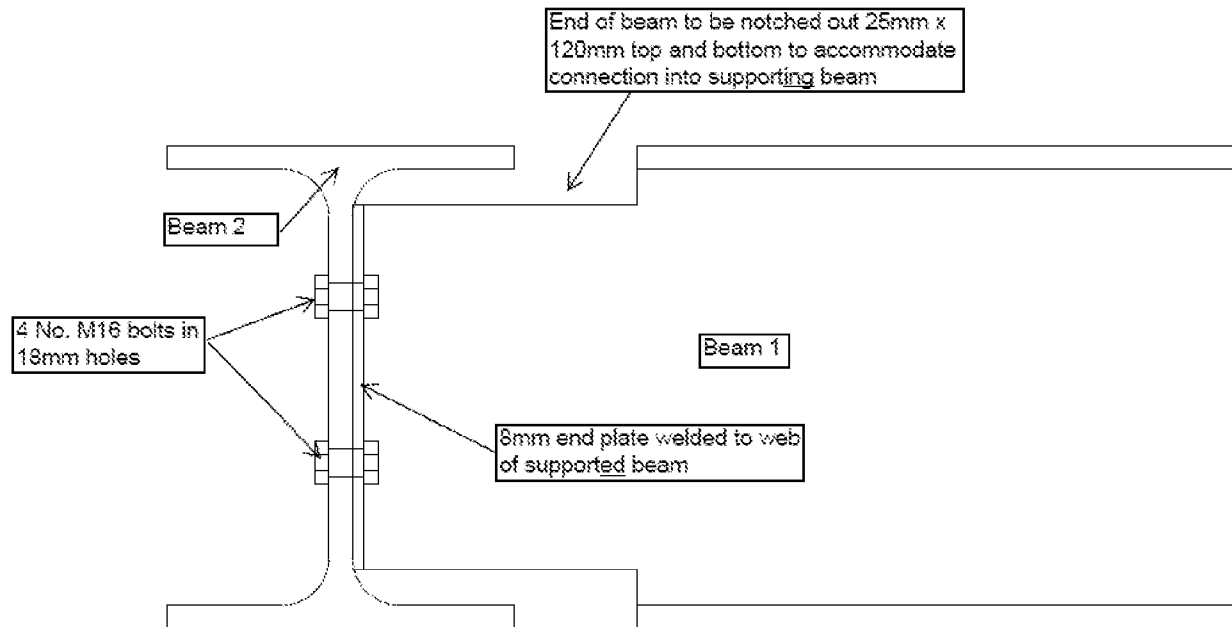


Figure 2: Elevation showing beam 2 connection with beam 1

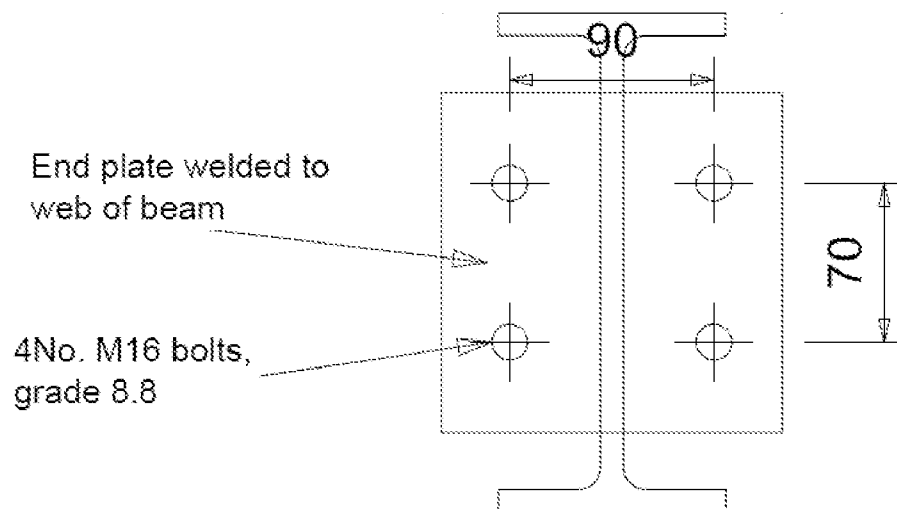


Figure 3: Section through beam 1 showing connection with beam 2

 KP Structural Consultants Chartered Engineers	Project: 20 Glamis Street, Bognor Regis, West Sussex, PO21 1DQ	By: KP	Page No. 6
	Structural calculations for a second story extension	Date: Jan-21	Project No. KPSC1738

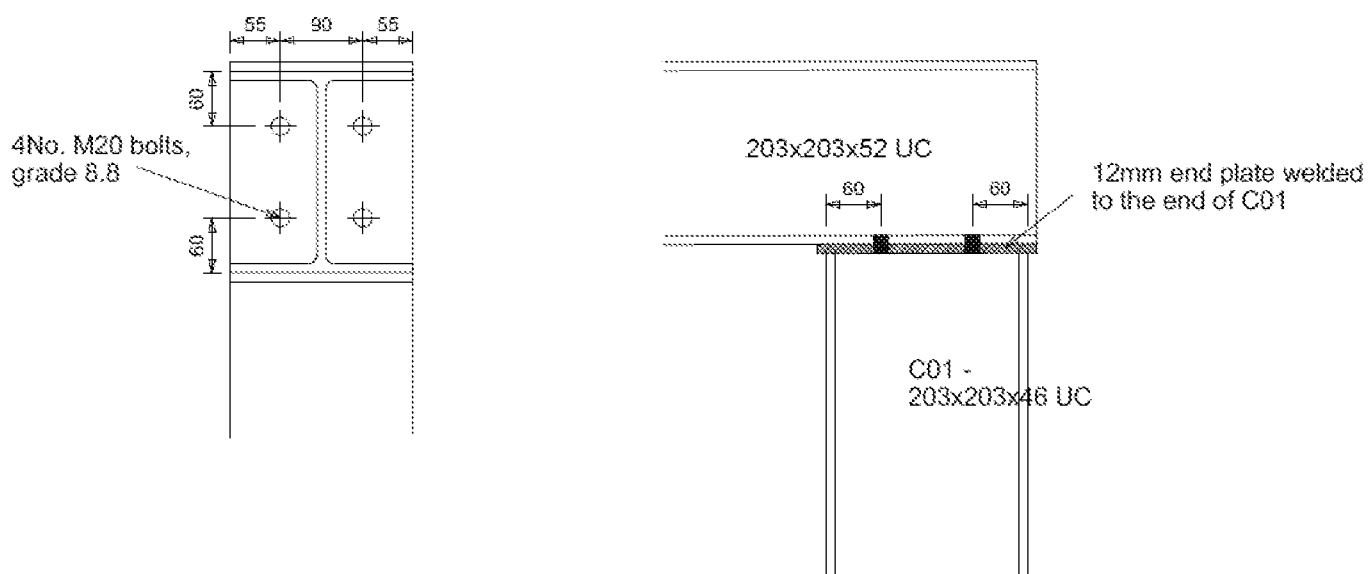


Figure 4: Section and elevation showing beam 1 connection with C01

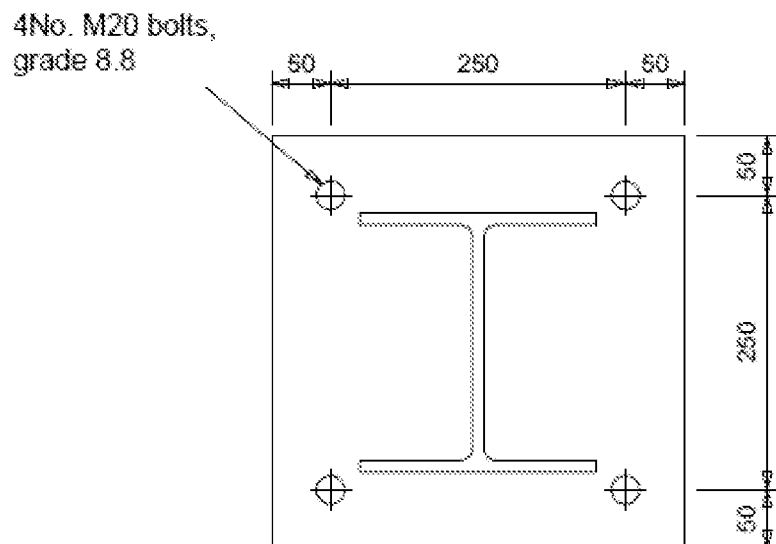


Figure 5: Section through C01 showing base plate arrangement

	Project: 20 Glamis Street, Bognor Regis, West Sussex, PO21 1DQ	By: KP	Page No. 7
	Structural calculations for a second story extension	Date: Jan-21	Project No. KPSC1738

3.0 Basis for calculations

The calculations in this report have been carried out based on the information provided by the client and listed in section 3 and on the assumptions listed below.

- The design has been carried out based on the existing property being built from a standard construction in the usual method. i.e. Concrete strip foundations, brick/blockwork cavity walls, timber floor and roof. The builder should inspect the property to ensure that this is the case. Where it is not KP structural Consultants should be informed
- Existing masonry walls are built from clay bricks (minimum compressive strength – 15N/mm²), concrete blocks (minimum compressive strength – 7.3N/mm²), and mortar is at least M4 (iii) (minimum compressive strength - 4N/mm²)
- Foundations will be exposed to ensure that they are in sound condition to the satisfaction of the building control officer and no less than 600mm wide and 1.0m deep unless otherwise specified
- Ground conditions assumed to be no worse than a stiff clay, stiff sandy clay, gravel or sand i.e. can be indented slightly by thumb.
- New foundations in shrinkable cohesive clays shall be taken to a depth below the influence any existing or proposed trees, hedges or shrubs near the building.
- New foundation to have a depth of 1.0m unless otherwise specified
- The integrity of all of the existing timber and masonry walls are in a sound condition
- All steelwork to be a minimum grade 355 steel
- All bolts used for steelwork connections should be grade 8.8
- All welded connection to be full strength unless otherwise specified
- Steel beams should not be supported by a chimney and should not be supported within 50mm of a flue.
- Existing steel beams and lintels are in a good condition and proposed building work will not apply any additional loading unless an assessment has been specifically detailed in this report.
- Supporting elements of existing beams are not to be disturbed or removed unless an alternative load path is adequately provided and detailed in the report.
- All notching to timbers are to be no greater than 0.5 x member thickness
- All drawings and sketches within this report are illustrative and intended to show arrangements and layouts of structural elements only.
- The Client is responsible for all temporary works required for the project
- The builder shall check all proposed structural details prior to commencing work to ensure; that the proposed design suits the method of construction, that all assumptions outlined in the report are correct and any other practical considerations are taken into account.
- The builder shall remove plaster/cladding or other superficial decoration to ensure that the assumed structural arrangement is correct prior to starting the work and ordering any materials. Any existing beams or other structural elements not shown on the engineering drawings should be notified to KP Structural Consultants.
- No variation to the arrangements detailed in this report are permitted without the consent of KP Structural Engineer

 KP Structural Consultants Chartered Engineers	Project: 20 Glamis Street, Bognor Regis, West Sussex, PO21 1DQ	By: KP	Page No. 8
	Structural calculations for a second story extension	Date: Jan-21	Project No. KPSC1738

4.0 Design calculations

Geometry of beam 1

Beam span 1.7 m

Loading on steel beam

	Nominal Load (kN/m ²)	Partial Factor	Factored load (kN/m ²)	Characteristic Beam Loading (kN/m)	Persistent Beam Loading (kN/m)
Beam Selfweight					
Dead load	NA	1.2	NA	0.231	0.28
Cavity Wall					
Total Load	2.25	1.35	3.04	12.83	17.31
Flat Roof					
Total Load	0.85	1.35	1.15	1.91	2.58
Imposed	0.60	1.50	0.90	1.35	2.03
Total applied load				16.3kN/m	22.2kN/m

Selfweight of building materials			Notes: On roofs imposed loads need not be applied in combination with either snow or wind action (BS EN 1991-1-1-2002). Characteristic load combination $E_d = E\{G_{k,j}; P; Q_{k,i}; \psi_{0,i} Q_{k,i}\} \quad j \geq 1; i > 1$
Chipboard 0.25 kN/m ² Plasterboard 0.15 kN/m ² Joists 0.10 kN/m ² Insulation 0.03 kN/m ² Tiles 0.60 kN/m ² Felt, Battens 0.07 kN/m ² Rafter 0.08 kN/m ² Brickwork 2.20 kN/m ² Blockwork 2.00 kN/m ² Plaster 0.25 kN/m ² Asphalt 0.5 kN/m ²			
			Persistent load combination $\sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_P P + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}$

Beam Capacity

Steel Beam 1No. 203x102x23

Applied Loading on the Beam

$$\text{Max applied moment} = \frac{22.2 \times 1.7^2}{8} = 8.02 \text{ kNm}$$

$$\text{Max applied shear} = \frac{22.2 \times 1.7}{2} = 18.87 \text{ kN}$$

Moment Capacity From TATA Blue Book

$$M_b = 53.5 \text{ kNm} > 8.02 \text{ kNm}$$

Therefore moment capacity is OK

Shear Capacity

$$V_{pl,Rd} = \frac{A_v (f_y / \sqrt{3})}{\gamma_{M0}}$$

$$V_{pl,Rd} = 197 \text{ kNm} > 18.87 \text{ kN}$$

Therefore shear capacity is OK

Shear Buckling

Shear Buckling check required where:

$$\frac{h_w}{t_w} > 72 \frac{\epsilon}{\eta}$$

$$\frac{h_w}{t_w} = 34.19$$

$$\frac{72 \times \epsilon}{\eta} = 66.56$$

Shear Buckling check is not required

Web Shear

$$\text{Design resistance } F_{Rd} = 267 \text{ kN}$$

$$267 \text{ kN} > 18.87 \text{ kN} \quad \text{Web bearing is OK}$$

Check Deflection

$$\text{Youngs Modulus } E = 210000 \text{ N/mm}^2$$

$$\text{Second moment of area } I = 21 \times 10^6 \text{ mm}^4$$

$$\text{Deflection } \delta = 0.40 \text{ mm}$$

Allowable deflection

$$= 0.003 \times \text{span} = 5.1 \text{ mm}$$

$$0.40 \text{ mm} < 5.1 \text{ mm}$$

Therefore deflection is OK

Geometry of beam 2

Beam span 3.7 m

Loading on steel beam

	Nominal Load (kN/m ²)	Partial Factor	Factored load (kN/m ²)	Characteristic Beam Loading (kN/m)	Persistent Beam Loading (kN/m)
Beam Selfweight					
Dead load	NA	1.2	NA	0.52	0.62
Floor					
Total Dead load	0.50	1.35	0.68	4.00	5.40
Imposed	1.50	1.50	2.25	12.00	18.00
Cavity Wall					
Total Load	4.45	1.35	6.01	25.37	34.24
Loading from Beam B1					19.00
Total applied load				41.9kN/m	58.3kN/m

Beam Capacity

Steel Beam 203x203x52

Applied Loading on the Beam

Moment from beam 1 = 3.2 kNm

Moment from beam 2 = $\frac{58.3 \times 3.7^2}{8}$ = 99.71 kNm

Total moment = 3.21 + 99.71 = **102.91 kNm**

Beam 2 shear = $\frac{58.3 \times 3.7}{2}$ = 107.79 kN

Total shear = 11.3 + 107.79 = **119.1 kN**

Moment Capacity

From TATA Blue Book

$$M_b = 137 \text{ kNm} > 102.91 \text{ kNm}$$

Therefore moment capacity is OK

Shear Capacity

$$V_{pl,Rd} = \frac{A_v f_y}{\gamma_{M2}}$$

$$V_{pl,Rd} = 298 \text{ kNm} > 119.09 \text{ kN}$$

Therefore shear capacity is OK

Shear Buckling

Shear Buckling check required where:

$$\frac{h_w}{t_w} > 72 \frac{\epsilon}{\eta}$$

$$\frac{h_w}{t_w} = 22.94$$

$$\frac{72 \times \epsilon}{\eta} = 66.56$$

Shear Buckling check is not required

Web Shear

Design resistance

$$F_{Rd} = 464 \text{ kN}$$

$$464 \text{ kN} > 119.09 \text{ kN}$$

Web bearing is OK

Check Deflection

Deflection	δ	=	9.25 mm
Deflection due to point load		=	1.26 mm
Total deflection		=	10.51 mm
Allowable deflection =	$0.003 \times \text{span}$	=	11.1 mm
	10.51 mm	<	11.1 mm

Therefore deflection is OK