



andrew hannett limited
civil | structural | architectural
Mobile 07761 346542 e-mail ah.ltd@gmx.com



71 Acton Gate, Wrexham

Internal Alterations

STRUCTURAL CALCULATIONS

January 2024

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		Initials Date
Prepared by	AH	01/24
Checked by		

71 Acton Gate, Wrexham

Preamble to Calculations

Scope of Calculations

These calculations have been prepared at the request of the owner of the above property. The calculations cover the structural design of beams to carry roof, floor and wall construction over expanded kitchen and dining area.

No warranty is given by the issue of the calculations to the structural integrity of any other part of the proposed building for which calculations or structural advice has not been specifically requested or given

Building Regulations Approval

The owners of the property are advised that the approval of the Local Planning and/or Building Control should be obtained prior to any ordering of materials or fabrication. No responsibility is accepted for any changes that may be required as a result of work having proceeded before such approvals have been obtained.

Measurements and Dimensions

Dimensions and details for the purpose of the calculations have been taken from pdf drawings provided by the Architect for the scheme. Where necessary, the drawings have been scaled.

The person responsible for carrying out the Works should ensure that all assumptions and dimensions used in the calculations are checked on site before ordering of materials or fabrication. Any discrepancies or dimensions found to be significantly different from that assumed should be brought to the attention of the undersigned, so that such discrepancy can be checked, and if necessary, the calculations amended.

Design References

Structural design has been based on any or all of the following:

- Building Regulations – Approved Document A
- EN1990 – Basis of Structural Design.
- EN1991 – Actions on Structures.
- EN1992 – Design of Concrete Structures.
- EN1993 – Design of Steel Structures.
- EN1994 – Design of Composite Steel and Concrete Structures.
- EN1995 – Design of Timber Structures.
- EN1996 – Design of Masonry Structures.
- EN1997 – Geotechnical Design

Liability

Nothing in the Contract confers nor purports to confer on any third party any benefit nor any right to enforce any terms of this Contract pursuant to the Contracts (Rights of Third Parties) Act 1999.

Copyright

The design report including any calculations, sketches, drawings and schedules are the copyright of Andrew Hannett Limited who will retain ownership until the account has been settled in full. The information contained herein shall not be shared with or issued to third parties for construction, approvals or any other purposes until the account has been settled in full. Andrew Hannett Limited reserve the right to withdraw the design report at any point until the account has been settled in full.

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Preamble to Calculations

CONSTRUCTION (DESIGN & MANAGEMENT) REGULATIONS CDM2015

The design reflected in this design report has been developed for Building Regulations and Construction purposes. Our appointment as Principal Designer stops after issue of this design package.

The Domestic Client duties under CDM2015 must be undertaken by the Contractor, or where there is more than one contractor, the Principal Contractor. Contractors in Domestic Projects must be aware of their Client duties under the Construction (Design and Management) Regulations 2015. Should this not be the case, then further guidance must be sought. Additional guidance in relation to the duties of the various parties is available on the HSE website.

In accordance with the Construction (Design & Management) Regulations 2015 it is our policy to 'Design Out' as many identifiable risks as possible for the construction, maintenance and demolition of the project. A Competent Contractor should be aware of 'normal' risks involved with the construction process. Unusual and/or significant residual risks that cannot be eliminated as part of the design process are listed below:

- 1. None Identified.

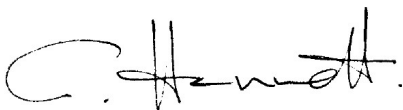
Safe methods and systems of work remain the responsibility of the Principal Contractor and must be identified in the Construction Phase Plan. A Construction Phase Plan must be drawn up for every project by the Contractor or Principal Contractor.

If any party using this design package considers or identifies any 'Abnormal' or 'Unusual' risks that have not been identified above they should share this with the project team immediately.

Health and Safety File – when our appointment as Principal Designer ends we will pass the Health and Safety File to the Principal Contractor. The Principal Contractor will be responsible for developing this and handing it to the Client on completion. The CITB has developed an app for iOS and Android platforms to aid in the compilation of Health and Safety Files.

Calculation Pages, Sketches and Drawings contained herein:

Calculation pages 1 to 12 inclusive.
Sketches SK01 – 03 including notes.

Signed: 

Date: 29 Jan. 24

Andrew Hannett. B.Eng(Hons), C.Eng, MICE

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Internal Alterations

INTERNAL ALTERATIONS

Provide calculations in support of structural design of beams to carry roof, floor and wall construction over expanded kitchen and dining area.

Loadings

Roof	Slates/Tiles	0.55		
	Battens	0.05		Snow Load = $(60-48) \times 0.75/30$ = <u>0.30 kN/m²</u>
	Felt	0.03		
	Trusses	0.15		
		<u>0.78 kN/m²</u> (slope)	=	<u>0.78</u> cos 48 = <u>1.17 kN/m² (plan)</u>
Ceiling	Ties	0.10		
	Insulation	0.05		Imposed = <u>0.25 kN/m²</u>
	P'board & skim	0.18		
		<u>0.33 kN/m²</u>		
Floor	Boards	0.15		
	Joists	0.15		Imposed = <u>1.5 kN/m²</u>
	Ceiling	0.18		
	Partitions	0.25		
		<u>0.73 kN/m²</u>		
Walls	Brick	<u>2.1 kN/m²</u>		
	Brick & plaster	<u>2.3 kN/m²</u>		
	Brick & 2 plaster	<u>2.5 kN/m²</u>		
	Brick & render	<u>2.5 kN/m²</u>		

Assumptions:

- Roof construction to main part of property comprises traditional purlin and rafter construction spanning between the elevations and internal load bearing walls.
- First floor construction over kitchen spans parallel to rear elevation.

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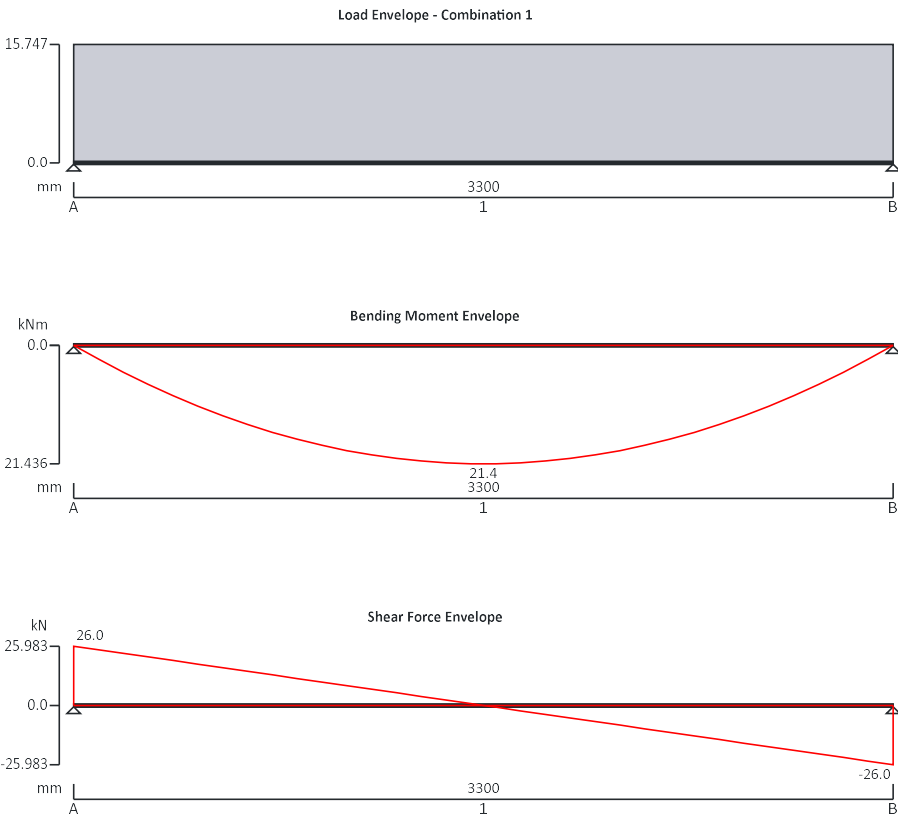
Job No. 2024/026

FLOOR BEAM FB1

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
	UDL gk - Permanent full UDL 8.7 kN/m
	UDL qk - Variable full UDL 2.5 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

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Internal Alterations

Variable × 1.50

Analysis results

Maximum moment

$M_{max} = 21.4 \text{ kNm}$

$M_{min} = 0 \text{ kNm}$

Maximum shear

$V_{max} = 26 \text{ kN}$

$V_{min} = -26 \text{ kN}$

Deflection

$\delta_{max} = 6.2 \text{ mm}$

$\delta_{min} = 0 \text{ mm}$

Maximum reaction at support A

$R_{A_max} = 26 \text{ kN}$

$R_{A_min} = 26 \text{ kN}$

Unfactored permanent load reaction at support A

$R_{A_Permanent} = 14.7 \text{ kN}$

Unfactored variable load reaction at support A

$R_{A_Variable} = 4.1 \text{ kN}$

Maximum reaction at support B

$R_{B_max} = 26 \text{ kN}$

$R_{B_min} = 26 \text{ kN}$

Unfactored permanent load reaction at support B

$R_{B_Permanent} = 14.7 \text{ kN}$

Unfactored variable load reaction at support B

$R_{B_Variable} = 4.1 \text{ kN}$

Section details

Section type

$UKB\ 178 \times 102 \times 19 \text{ (Tata Steel Advance)}$

Steel grade

$S275$

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element

$t = \max(t_f, t_w) = 7.9 \text{ mm}$

Nominal yield strength

$f_y = 275 \text{ N/mm}^2$

Nominal ultimate tensile strength

$f_u = 410 \text{ N/mm}^2$

Modulus of elasticity

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

Partial factors - Section 6.1

Resistance of cross-sections

$\gamma_{M0} = 1.00$

Resistance of members to instability

$\gamma_{M1} = 1.00$

Resistance of tensile members to fracture

$\gamma_{M2} = 1.10$

Lateral restraint

Span 1 has lateral restraint at supports only

Effective length factors

Effective length factor in major axis

$K_y = 1.000$

Effective length factor in minor axis

$K_z = 1.000$

Effective length factor for torsion

$K_{LT,A} = 1.000$
 $K_{LT,B} = 1.000$

Classification of cross sections - Section 5.5

$\epsilon = \sqrt{[235 \text{ N/mm}^2 / f_y]} = 0.92$

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section

$c = d = 146.8 \text{ mm}$

$c / t_w = 33.1 \times \epsilon \leq 72 \times \epsilon$ Class 1

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section

$c = (b - t_w - 2 \times r) / 2 = 40.6 \text{ mm}$

$c / t_f = 5.6 \times \epsilon \leq 9 \times \epsilon$ Class 1

Section is class 1

Check shear - Section 6.2.6

Height of web

$h_w = h - 2 \times t_f = 162 \text{ mm}$

Shear area factor

$\eta = 1.000$
 $h_w / t_w < 72 \times \epsilon / \eta$

Shear buckling resistance can be ignored

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Design shear force	$V_{Ed} = \max(\text{abs}(V_{\max}), \text{abs}(V_{\min})) = 26 \text{ kN}$
Shear area - cl 6.2.6(3)	$A_v = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 985 \text{ mm}^2$
Design shear resistance - cl 6.2.6(2)	$V_{c,Rd} = V_{pl,Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{M0} = 156.4 \text{ kN}$
PASS - Design shear resistance exceeds design shear force	
Check bending moment major (y-y) axis - Section 6.2.5	
Design bending moment	$M_{Ed} = \max(\text{abs}(M_{s1_max}), \text{abs}(M_{s1_min})) = 21.4 \text{ kNm}$
Design bending resistance moment - eq 6.13	$M_{c,Rd} = M_{pl,Rd} = W_{pl,y} \times f_y / \gamma_{M0} = 47.1 \text{ kNm}$
Slenderness ratio for lateral torsional buckling	
Correction factor - Table 6.6	$k_c = 0.94$
	$C_1 = 1 / k_c^2 = 1.132$
Curvature factor	$g = \sqrt{1 - (I_z / I_y)} = 0.948$
Poissons ratio	$\nu = 0.3$
Shear modulus	$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$
Unrestrained length	$L = 1.0 \times L_{s1} = 3300 \text{ mm}$
Elastic critical buckling moment	$M_{cr} = C_1 \times \pi^2 \times E \times I_z / (L^2 \times g) \times \sqrt{[I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z)]} = 44.9 \text{ kNm}$
Slenderness ratio for lateral torsional buckling	$\bar{\lambda}_{LT} = \sqrt{(W_{pl,y} \times f_y / M_{cr})} = 1.024$
Limiting slenderness ratio	$\bar{\lambda}_{LT,0} = 0.4$
$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored	
Design resistance for buckling - Section 6.3.2.1	
Buckling curve - Table 6.5	b
Imperfection factor - Table 6.3	$\alpha_{LT} = 0.34$
Correction factor for rolled sections	$\beta = 0.75$
LTB reduction determination factor	$\phi_{LT} = 0.5 \times [1 + \alpha_{LT} \times (\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta \times \bar{\lambda}_{LT}^2] = 1.000$
LTB reduction factor - eq 6.57	$\chi_{LT} = \min(1 / [\phi_{LT} + \sqrt{(\phi_{LT}^2 - \beta \times \bar{\lambda}_{LT}^2)}], 1, 1 / \bar{\lambda}_{LT}^2) = 0.685$
Modification factor	$f = \min(1 - 0.5 \times (1 - k_c) \times [1 - 2 \times (\bar{\lambda}_{LT} - 0.8)^2], 1) = 0.973$
Modified LTB reduction factor - eq 6.58	$\chi_{LT,mod} = \min(\chi_{LT} / f, 1) = 0.704$
Design buckling resistance moment - eq 6.55	$M_{b,Rd} = \chi_{LT,mod} \times W_{pl,y} \times f_y / \gamma_{M1} = 33.1 \text{ kNm}$
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	$\delta_{lim} = L_{s1} / 360 = 9.2 \text{ mm}$
Maximum deflection span 1	$\delta = \max(\text{abs}(\delta_{\max}), \text{abs}(\delta_{\min})) = 6.175 \text{ mm}$
PASS - Maximum deflection does not exceed deflection limit	

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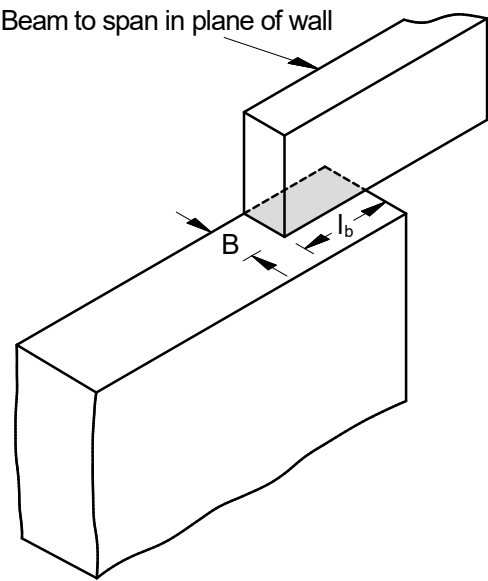
FLOOR BEAM FB1 - BEARING

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.08

Masonry details

Masonry type	Clay or calcium silicate bricks
Compressive strength of unit	$p_{unit} = 20.0 \text{ N/mm}^2$
Mortar designation	iii
Category of masonry units	Category II
Category of construction control	Normal
Partial safety factor for material strength	$\gamma_m = 3.5$
Thickness of load bearing leaf	$t = 100 \text{ mm}$
Effective thickness of masonry wall	$t_{ef} = 135 \text{ mm}$
Height of masonry wall	$h = 2400 \text{ mm}$
Effective height of masonry wall	$h_{ef} = 2400 \text{ mm}$



Bearing details

Beam spanning in plane of wall	
Width of bearing	$B = 100 \text{ mm}$
Length of bearing	$l_b = 150 \text{ mm}$

Compressive strength from Table 2 BS5628:Part 1 - Clay or calcium silicate bricks

Mortar designation	Mortar = "iii"
Brick compressive strength	$p_{unit} = 20.0 \text{ N/mm}^2$
Characteristic compressive strength	$f_k = 5.00 \text{ N/mm}^2$

Loading details

Characteristic concentrated dead load	$G_k = 15 \text{ kN}$
Characteristic concentrated imposed load	$Q_k = 4 \text{ kN}$
Design concentrated load	$F = (G_k \times 1.4) + (Q_k \times 1.6) = 27.1 \text{ kN}$

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Characteristic distributed dead load $g_k = 0.0 \text{ kN/m}$
Characteristic distributed imposed load $q_k = 0.0 \text{ kN/m}$
Design distributed load $f = (g_k \times 1.4) + (q_k \times 1.6) = 0.0 \text{ kN/m}$

Masonry bearing type
Bearing type **Type 2**
Bearing safety factor $\gamma_{\text{bear}} = 1.50$

Check design bearing without a spreader
Design bearing stress $f_{ca} = F / (B \times l_b) + f / t = 1.809 \text{ N/mm}^2$
Allowable bearing stress $f_{cp} = \gamma_{\text{bear}} \times f_k / \gamma_m = 2.143 \text{ N/mm}^2$
PASS - Allowable bearing stress exceeds design bearing stress

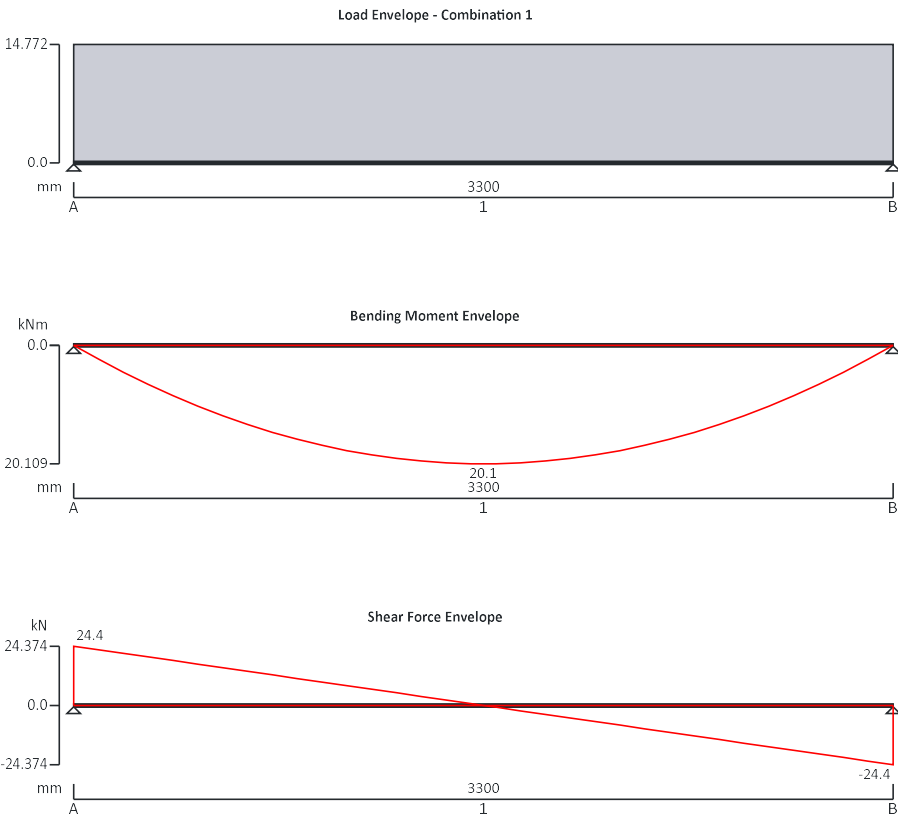
Check design bearing at $0.4 \times h$ below the bearing level
Slenderness ratio $h_{ef} / t_{ef} = 17.78$
Eccentricity at top of wall $e_x = 0.0 \text{ mm}$
From BS5628:1 Table 7
Capacity reduction factor $\beta = 0.84$
Length of bearing distributed at $0.4 \times h$ $l_d = 1110 \text{ mm}$
Maximum bearing stress $f_{ca} = F / (l_d \times t) + f / t = 0.245 \text{ N/mm}^2$
Allowable bearing stress $f_{cp} = \beta \times f_k / \gamma_m = 1.205 \text{ N/mm}^2$
PASS - Allowable bearing stress at $0.4 \times h$ below bearing level exceeds design bearing stress

FLOOR BEAM FB2

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 $\times 1$
	UDL gk - Permanent full UDL 9.2 kN/m
	UDL qk - Variable full UDL 1.4 kN/m

Load combinations

Load combination 1	Support A	Permanent $\times 1.35$
		Variable $\times 1.50$
		Permanent $\times 1.35$
		Variable $\times 1.50$
	Support B	Permanent $\times 1.35$

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Internal Alterations

Variable × 1.50

Analysis results

Maximum moment

$M_{max} = 20.1$ kNm

$M_{min} = 0$ kNm

Maximum shear

$V_{max} = 24.4$ kN

$V_{min} = -24.4$ kN

Deflection

$\delta_{max} = 5.8$ mm

$\delta_{min} = 0$ mm

Maximum reaction at support A

$R_{A_max} = 24.4$ kN

$R_{A_min} = 24.4$ kN

Unfactored permanent load reaction at support A

$R_{A_Permanent} = 15.5$ kN

Unfactored variable load reaction at support A

$R_{A_Variable} = 2.3$ kN

Maximum reaction at support B

$R_{B_max} = 24.4$ kN

$R_{B_min} = 24.4$ kN

Unfactored permanent load reaction at support B

$R_{B_Permanent} = 15.5$ kN

Unfactored variable load reaction at support B

$R_{B_Variable} = 2.3$ kN

Section details

Section type

UKB 178x102x19 (Tata Steel Advance)

Steel grade

S275

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element

$t = \max(t_r, t_w) = 7.9$ mm

Nominal yield strength

$f_y = 275$ N/mm²

Nominal ultimate tensile strength

$f_u = 410$ N/mm²

Modulus of elasticity

$E = 210000$ N/mm²

Partial factors - Section 6.1

Resistance of cross-sections

$\gamma_{M0} = 1.00$

Resistance of members to instability

$\gamma_{M1} = 1.00$

Resistance of tensile members to fracture

$\gamma_{M2} = 1.10$

Lateral restraint

Span 1 has lateral restraint at supports only

Effective length factors

Effective length factor in major axis

$K_y = 1.000$

Effective length factor in minor axis

$K_z = 1.000$

Effective length factor for torsion

$K_{LT,A} = 1.000$

$K_{LT,B} = 1.000$

Classification of cross sections - Section 5.5

$\epsilon = \sqrt{[235 \text{ N/mm}^2 / f_y]} = 0.92$

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section

$c = d = 146.8$ mm

$c / t_w = 33.1 \times \epsilon \leq 72 \times \epsilon$ Class 1

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section

$c = (b - t_w - 2 \times r) / 2 = 40.6$ mm

$c / t_f = 5.6 \times \epsilon \leq 9 \times \epsilon$ Class 1

Section is class 1

Check shear - Section 6.2.6

Height of web

$h_w = h - 2 \times t_f = 162$ mm

Shear area factor

$\eta = 1.000$

$h_w / t_w < 72 \times \epsilon / \eta$

Shear buckling resistance can be ignored

Job No. 2024/026

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Internal Alterations

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Design shear force	$V_{Ed} = \max(\text{abs}(V_{\max}), \text{abs}(V_{\min})) = 24.4 \text{ kN}$
Shear area - cl 6.2.6(3)	$A_v = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 985 \text{ mm}^2$
Design shear resistance - cl 6.2.6(2)	$V_{c,Rd} = V_{pl,Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{M0} = 156.4 \text{ kN}$
PASS - Design shear resistance exceeds design shear force	
Check bending moment major (y-y) axis - Section 6.2.5	
Design bending moment	$M_{Ed} = \max(\text{abs}(M_{s1_max}), \text{abs}(M_{s1_min})) = 20.1 \text{ kNm}$
Design bending resistance moment - eq 6.13	$M_{c,Rd} = M_{pl,Rd} = W_{pl,y} \times f_y / \gamma_{M0} = 47.1 \text{ kNm}$
Slenderness ratio for lateral torsional buckling	
Correction factor - Table 6.6	$k_c = 0.94$
	$C_1 = 1 / k_c^2 = 1.132$
Curvature factor	$g = \sqrt{[1 - (I_z / I_y)]} = 0.948$
Poissons ratio	$\nu = 0.3$
Shear modulus	$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$
Unrestrained length	$L = 1.0 \times L_{s1} = 3300 \text{ mm}$
Elastic critical buckling moment	$M_{cr} = C_1 \times \pi^2 \times E \times I_z / (L^2 \times g) \times \sqrt{[I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z)]} = 44.9 \text{ kNm}$
Slenderness ratio for lateral torsional buckling	$\bar{\lambda}_{LT} = \sqrt{(W_{pl,y} \times f_y / M_{cr})} = 1.024$
Limiting slenderness ratio	$\bar{\lambda}_{LT,0} = 0.4$
$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored	
Design resistance for buckling - Section 6.3.2.1	
Buckling curve - Table 6.5	b
Imperfection factor - Table 6.3	$\alpha_{LT} = 0.34$
Correction factor for rolled sections	$\beta = 0.75$
LTB reduction determination factor	$\phi_{LT} = 0.5 \times [1 + \alpha_{LT} \times (\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta \times \bar{\lambda}_{LT}^2] = 1.000$
LTB reduction factor - eq 6.57	$\chi_{LT} = \min(1 / [\phi_{LT} + \sqrt{(\phi_{LT}^2 - \beta \times \bar{\lambda}_{LT}^2)}], 1, 1 / \bar{\lambda}_{LT}^2) = 0.685$
Modification factor	$f = \min(1 - 0.5 \times (1 - k_c) \times [1 - 2 \times (\bar{\lambda}_{LT} - 0.8)^2], 1) = 0.973$
Modified LTB reduction factor - eq 6.58	$\chi_{LT,mod} = \min(\chi_{LT} / f, 1) = 0.704$
Design buckling resistance moment - eq 6.55	$M_{b,Rd} = \chi_{LT,mod} \times W_{pl,y} \times f_y / \gamma_{M1} = 33.1 \text{ kNm}$
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	$\delta_{lim} = L_{s1} / 360 = 9.2 \text{ mm}$
Maximum deflection span 1	$\delta = \max(\text{abs}(\delta_{\max}), \text{abs}(\delta_{\min})) = 5.849 \text{ mm}$
PASS - Maximum deflection does not exceed deflection limit	