Tekla.Tedds Les Gooding Design Limited 10 St. Chad's Avenue Chatburn Clitheroe BB7 4AN	Project Alterations to an Outbuilding at Highcliffe Cottage, Grindleton	Job no.
	Calcs for New Steel Beam to Support Concrete Beam and Block Roof	Start page no./Revision 2

Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
LG	06/07/2023				

STEEL MEMBER DESIGN (BS5950)

STEEL MEMBER DESIGN (BS5950)

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

TEDDS calculation version 3.0.07

Section details

Section type — UC 203x203x46 (British Steel Section Range 2022 (BS4-1))

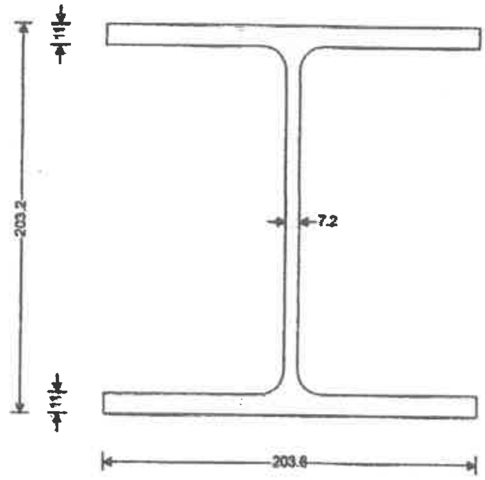
Steel grade — S355

From table 9: Design strength p_y

Thickness of element — max(T, t) = 11.0 mm

Design strength — p_y = 355 N/mm^2

Modulus of elasticity — E = 205000 N/mm^2



Lateral restraint

Distance between major axis restraints — L_x = 2500 mm

Distance between minor axis restraints — L_y = 2500 mm

Effective length factors

Effective length factor in major axis — K_x = 1.00

Effective length factor in minor axis — K_y = 1.00

Effective length factor for lateral-torsional buckling — K_{LT} = 1.20 + 2 × D

Classification of cross sections - Section 3.5

$\varepsilon = \sqrt{[275 \text{ N/mm}^2 / p_y]} = 0.88$

Internal compression parts - Table 11

Depth of section — d = 155.8 mm

$d / t = 24.6 \times \varepsilon <= 80 \times \varepsilon$ — Class 1 plastic

Outstand flanges - Table 11

Width of section — b = B / 2 = 101.8 mm

$b / T = 10.5 \times \varepsilon <= 15 \times \varepsilon$ — Class 3 semi-compact

Section is class 3 semi-compact

Shear capacity - Section 4.2.3

Design shear force — $F_{y,v}$ = 15.9 kN

$d / t < 70 \times \varepsilon$

Web does not need to be checked for shear buckling

Shear area — $A_v = t \times D = 1463$ mm^2

Design shear resistance — $P_{y,v} = 0.6 \times p_y \times A_v = 311.6$ kN

PASS - Design shear resistance exceeds design shear force

Shear capacity - Section 4.2.3

Design shear force — $F_{x,v} = 0$ kN

Moment capacity - Section 4.2.5

Design bending moment — $M = 9.9$ kNm

Effective plastic modulus - Section 3.5.6

Limiting value for class 2 compact flange — $\beta_{2f} = 10 \times \varepsilon = 8.801$

Limiting value for class 3 semi-compact flange — $\beta_{3f} = 15 \times \varepsilon = 13.202$

Limiting value for class 2 compact web — $\beta_{2w} = 100 \times \varepsilon = 88.014$

Limiting value for class 3 semi-compact web — $\beta_{3w} = 120 \times \varepsilon = 105.617$

Effective plastic modulus - cl.3.5.6.2

$S_{eff} = \min(Z_{xx} + (S_{xx} - Z_{xx}) \times \min([((\beta_{3w} / (d / t))^2 - 1) / ((\beta_{3w} / \beta_{2w})^2 - 1)], [(\beta_{3f} / (b / T) - 1) / (\beta_{3f} / \beta_{2f} - 1)]), S_{xx}) = 494583$ mm^3

Moment capacity low shear - cl.4.2.5.2 — $M_c = \min(p_y \times S_{eff}, 1.2 \times p_y \times Z_{xx}) = 175.6$ kNm

Effective length for lateral-torsional buckling - Section 4.3.5

Effective length for lateral torsional buckling — $L_E = 1.2 \times L_y + 2 \times D = 3406$ mm

Slenderness ratio — $\lambda = L_E / r_{yy} = 66.617$

Equivalent slenderness - Section 4.3.6.7

Buckling parameter — $u = 0.847$

Torsional index — $x = 17.327$

Slenderness factor — $v = 1 / [1 + 0.05 \times (\lambda / x)^2]^{0.25} = 0.871$

Ratio - cl.4.3.6.9 — $\beta_W = S_{eff} / S_{xx} = 0.986$

Equivalent slenderness - cl.4.3.6.7 — $\lambda_{LT} = u \times v \times \lambda \times \sqrt{[\beta_W]} = 48.810$

Limiting slenderness - Annex B.2.2 — $\lambda_{L0} = 0.4 \times (\pi^2 \times E / p_y)^{0.5} = 30.198$

$\lambda_{LT} > \lambda_{L0}$ - Allowance should be made for lateral-torsional buckling

Bending strength - Section 4.3.6.5

Robertson constant — $\alpha_{LT} = 7.0$

Perry factor — $\eta_{LT} = \max(\alpha_{LT} \times (\lambda_{LT} - \lambda_{L0}) / 1000, 0) = 0.130$

Euler stress — $p_E = \pi^2 \times E / \lambda_{LT}^2 = 849.2$ N/mm^2

$\phi_{LT} = (p_y + (\eta_{LT} + 1) \times p_E) / 2 = 657.4$ N/mm^2

Bending strength - Annex B.2.1 — $p_b = p_E \times p_y / (\phi_{LT} + (\phi_{LT}^2 - p_E \times p_y)^{0.5}) = 295.8$ N/mm^2

Equivalent uniform moment factor - Section 4.3.6.6

Equivalent uniform moment factor for LTB — $m_{LT} = 0.925$

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment — $M_b = p_b \times S_{eff} = 146.3$ kNm

$M_b / m_{LT} = 158.2$ kNm

PASS - Buckling resistance moment exceeds design bending moment

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

TEDDS calculation version 3.0.07

Section details

Section type — UC 152x152x23 (British Steel Section Range 2022 (BS4-1))

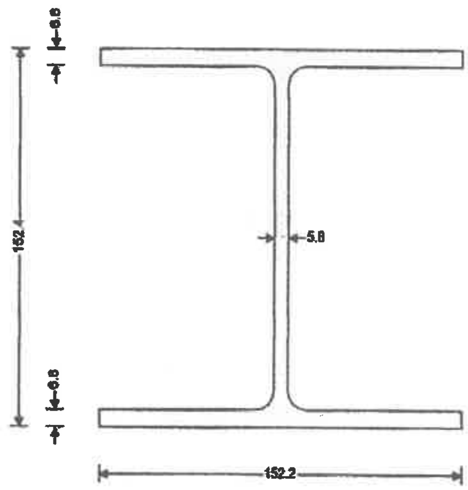
Steel grade — S355

From table 9: Design strength p_y

Thickness of element — $\max(T, t) = 6.8$ mm

Design strength — $p_y = 355$ N/mm^2

Modulus of elasticity — $E = 205000$ N/mm^2



Lateral restraint

Distance between major axis restraints — $L_x = 1500$ mm

Distance between minor axis restraints — $L_y = 1500$ mm

Effective length factors

Effective length factor in major axis — $K_x = 1.00$

Effective length factor in minor axis — $K_y = 1.00$

Effective length factor for lateral-torsional buckling — $K_{LT} = 1.20 + 2 \times D$

Classification of cross sections - Section 3.5

$\varepsilon = \sqrt{[275 \text{ N/mm}^2 / p_y]} = 0.88$

Internal compression parts - Table 11

Depth of section — $d = 123.6$ mm

$d / t = 24.2 \times \varepsilon <= 80 \times \varepsilon$ — Class 1 plastic

Outstand flanges - Table 11

Width of section — $b = B / 2 = 76.1$ mm

$b / T = 12.7 \times \varepsilon <= 15 \times \varepsilon$ — Class 3 semi-compact

Section is class 3 semi-compact

Shear capacity - Section 4.2.3

Design shear force — $F_{y,v} = 9.5$ kN

$d / t < 70 \times \varepsilon$

Web does not need to be checked for shear buckling

Shear area $A_v = t \times D = 884$ mm^2

Design shear resistance $P_{y,v} = 0.6 \times p_y \times A_v = 188.3$ kN

PASS - Design shear resistance exceeds design shear force

Shear capacity - Section 4.2.3

Design shear force $F_{x,v} = 0$ kN

Moment capacity - Section 4.2.5

Design bending moment $M = 3.6$ kNm

Effective plastic modulus - Section 3.5.6

Limiting value for class 2 compact flange $\beta_{2f} = 10 \times \varepsilon = 8.801$

Limiting value for class 3 semi-compact flange $\beta_{3f} = 15 \times \varepsilon = 13.202$

Limiting value for class 2 compact web $\beta_{2w} = 100 \times \varepsilon = 88.014$

Limiting value for class 3 semi-compact web $\beta_{3w} = 120 \times \varepsilon = 105.617$

Effective plastic modulus - cl.3.5.6.2

$S_{eff} = \min(Z_{xx} + (S_{xx} - Z_{xx}) \times \min([((\beta_{3w} / (d / t))^2 - 1) / ((\beta_{3w} / \beta_{2w})^2 - 1)], [(\beta_{3f} / (b / T) - 1) / (\beta_{3f} / \beta_{2f} - 1)]), S_{xx}) = 170473$ mm^3

Moment capacity low shear - cl.4.2.5.2 $M_c = \min(p_y \times S_{eff}, 1.2 \times p_y \times Z_{xx}) = 60.5$ kNm

Effective length for lateral-torsional buckling - Section 4.3.5

Effective length for lateral torsional buckling $L_E = 1.2 \times L_y + 2 \times D = 2105$ mm

Slenderness ratio $\lambda = L_E / r_{yy} = 56.919$

Equivalent slenderness - Section 4.3.6.7

Buckling parameter $u = 0.840$

Torsional index $x = 20.701$

Slenderness factor $v = 1 / [1 + 0.05 \times (\lambda / x)^2]^{0.25} = 0.923$

Ratio - cl.4.3.6.9 $\beta_W = S_{eff} / S_{xx} = 0.937$

Equivalent slenderness - cl.4.3.6.7 $\lambda_{LT} = u \times v \times \lambda \times \sqrt{[\beta_W]} = 42.688$

Limiting slenderness - Annex B.2.2 $\lambda_{L0} = 0.4 \times (\pi^2 \times E / p_y)^{0.5} = 30.198$

$\lambda_{LT} > \lambda_{L0}$ - Allowance should be made for lateral-torsional buckling

Bending strength - Section 4.3.6.5

Robertson constant $\alpha_{LT} = 7.0$

Perry factor $\eta_{LT} = \max(\alpha_{LT} \times (\lambda_{LT} - \lambda_{L0}) / 1000, 0) = 0.087$

Euler stress $p_E = \pi^2 \times E / \lambda_{LT}^2 = 1110.3$ N/mm^2

$\phi_{LT} = (p_y + (\eta_{LT} + 1) \times p_E) / 2 = 781.2$ N/mm^2

Bending strength - Annex B.2.1 $p_b = p_E \times p_y / (\phi_{LT} + (\phi_{LT}^2 - p_E \times p_y)^{0.5}) = 316.3$ N/mm^2

Equivalent uniform moment factor - Section 4.3.6.6

Equivalent uniform moment factor for LTB $m_{LT} = 0.925$

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment $M_b = p_b \times S_{eff} = 53.9$ kNm

$M_b / m_{LT} = 58.3$ kNm

PASS - Buckling resistance moment exceeds design bending moment