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Project				Job no.	
BEAM A - Plate Connection - Restraining in centre on mid wall				2023-7459	
Calcs for				Start page no./Revision	
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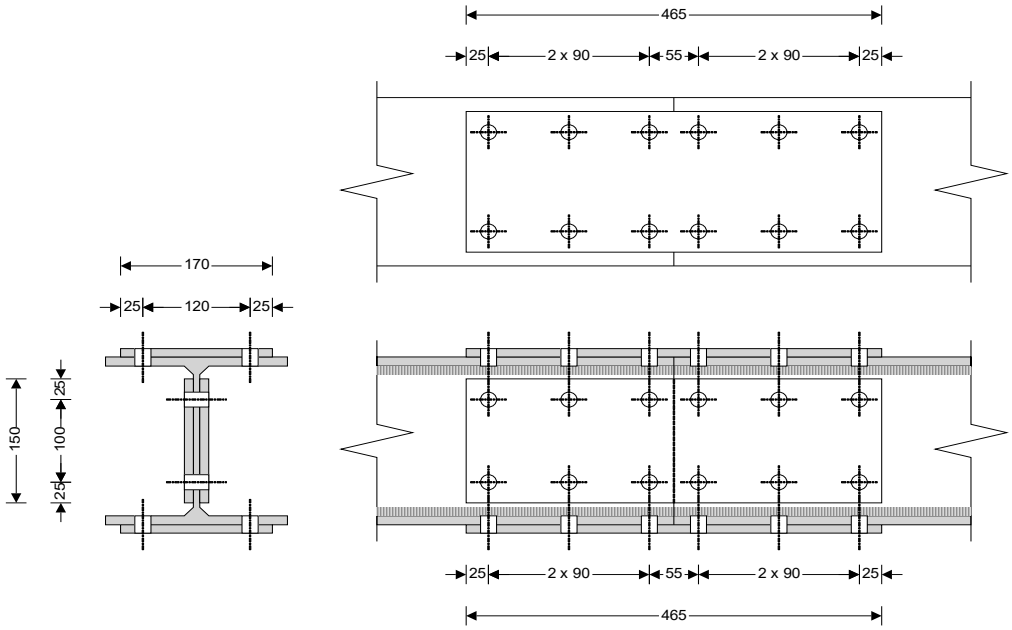
BOLTED COVER PLATE SPLICE CONNECTION TO BS5950-1:2000

TEDDS calculation version 1.0.08



Connection loads

Design moment	M = **50** kNm
Axial force in the member (compression +ve)	N = **50** kN
Shear force in the member	V = **50** kN

Steel beam details

Beam section classification	**UC 203x203x46**
Grade of steel section	**S275**
Section bearing strength	p_{bs_s} = **460** N/mm^2

General connection details

Grade of steel plate	**S275**
Plate bearing strength	p_{bs_p} = **460** N/mm^2
Bolt classification	**M16 (Torqued General Grade HSFG)**
Hole diameter	D_h = **18** mm
Bolt slip factor	μ = **0.50**
Hole type factor	K_s = 1.0

Flange plate details – plates bolted to one side of each flange

Thickness of flange plates	t_{fp} = **10** mm
Width of flange plates	b_{fp} = **170** mm
Length of flange plates	l_{fp} = **465** mm

Flange bolting details

Rows of flange bolts on each side of joint	n_{fb_r} = **3**
Bolts per row	n_{fb_p} = **2**
Total number of flange bolts each side of joint	n_{fb} = $n_{fb\_r} \times n_{fb\_p}$ = **6**
Spacing between rows of bolts	S_f = **90** mm

Spacing between rows of bolts across joint	S_{fc} = **55** mm
Spacing at end of flange plates	S_{fe} = **25** mm
Lateral spacing between central bolts	S_{flc} = **120** mm
Lateral spacing at edge of flange plates	S_{fle} = **25** mm

Web plate details - plates bolted to both sides of the web

Thickness of web plates	t_{wp} = **10** mm
Width of web plates	b_{wp} = **465** mm
Length of web plates	l_{wp} = **150** mm

Web bolting details

Rows of web bolts	n_{wb_r} = **2**
Bolts per row each side of joint	n_{wb_p} = **3**
Total number of web bolts each side of joint	$n_{wb} = n_{wb\_r} \times n_{wb\_p}$ = **6**
Spacing between rows of bolts	S_w = **100** mm
Spacing at end of web plates	S_{we} = **25** mm
Lateral spacing between bolts	S_{wl} = **90** mm
Lateral spacing between central bolts	S_{wlc} = **55** mm
Lateral spacing at edge of web plates	S_{wle} = **25** mm

Step 1 - Distribution of forces in member flanges

Forces in member tension flange	$T = [M / (D_b - T_b)] – N / 2$ = **235** kN
Forces in member compression flange	$C = [M / (D_b - T_b)] + N / 2$ = **285** kN
Force in the flange	$F_f = \max(T, C)$ = **285** kN

Step 2 - Calculate distribution of forces in member flanges

Check area of flange

Design strength of section	p_{ys} = **275** N/mm^2
Minimum required effective flange area	F_f / p_{ys} = **1037** mm^2
Effective net area coefficient	K_e = **1.2**
Effective flange area	$A_{ef} = \min(K_e \times [B_b – (n_{fb\_p} \times D_h)] \times T_b, B_b \times T_b)$ = **2212** mm^2

PASS - Effective flange area is adequate

Check area of flange plates

Design strength of plates	p_{yp} = **275** N/mm^2
Minimum required effective flange plate area	F_f / p_{yp} = **1037** mm^2
Effective flange plate area	$A_{ep} = \min(K_e \times [b_{fp} – (n_{fb\_p} \times D_h)] \times t_{fp}, b_{fp} \times t_{fp})$ = **1608** mm^2

PASS - Effective flange plate area is adequate

Step 3 - Design of flange bolts

Slip resistance of the bolt per interface	$S_{fb} = 1.1 \times K_s \times \mu \times P_p$ = **50.7** kN
Bearing capacity of the bolt in the flange	$P_{bg\_s} = 1.5 \times d \times T_b \times p_{bs\_s}$ = **121.4** kN
Bearing capacity of the bolt in the plate	$P_{bg\_p} = 1.5 \times d \times t_{fp} \times p_{bs\_p}$ = **110.4** kN
Average flange bolt end distance	$S_{fe\_ave} = S_{fe} + (n_{fb\_r} - 1) \times S_f / 2$ = **115** mm
Bearing capacity limit of the bolt in the plate	$P_{bg\_p\_lim} = 0.5 \times S_{fe\_ave} \times t_{fp} \times p_{bs\_p}$ = **264.5** kN
Bolt capacity	$P_s = \min(S_{fb}, P_{bg\_s}, P_{bg\_p}, P_{bg\_p\_lim})$ = **50.7** kN
Number of bolts required	$n_{fb\_req} = F_f / P_s$ = **5.6**
Number of bolts provided	n_{fb} = **6**

PASS - Flange plate bolting is adequate

Step 4 - Design of web plates and bolts

Check web plate in shear

Shear force in web plates	V = **50** kN
Gross shear area	$A_v = n_{wp} \times l_{wp} \times t_{wp}$ = **3000** mm^2
Net shear area (allowing for bolt holes)	$A_{v\_net} = n_{wp} \times (l_{wp} - n_{wb\_r} \times D_h) \times t_{wp}$ = **2280** mm^2
Net shear area limit	$0.85 \times A_v / K_e$ = **2125** mm^2
	$A_{v\_net} >= 0.85 \times A_v / K_e$ - Bolt holes may be ignored in the shear area
Gross shear capacity of web plates	$p_{v\_gross} = 0.6 \times A_v \times p_{yp}$ = **495** kN
Length of block shear face	$L_v = S_{we} + (n_{wb\_r} - 1) \times S_w$ = **125** mm
Length of block tension face	$L_t = S_{wle} + (n_{wb\_p} - 1) \times S_{wl}$ = **205** mm
Block shear coefficient	$k = if(n_{wb\_p} > 1, 2.5, 0.5)$ = **2.5**
Block shear capacity of web plates	$p_{v\_block} = 0.6 \times p_{yp} \times t_{wp} \times n_{wp} \times [L_v + K_e \times (L_t - k \times D_h)]$ = **1046** kN
Shear capacity of web plates	$p_v = min(p_{v\_gross}, p_{v\_block})$ = **495** kN
	PASS - Effective web plate area is adequate in shear

Check web plate in bending

Second moment of area of web plate	$I = (t_{wp} \times l_{wp}^3 / 12) - (n_{wb\_r} \times t_{wp} \times D_h^3 / 12) - (t_{wp} \times D_h \times K \times S_w^2)$
	I = **1902780** mm^4
Distance from joint to centroid of bolt group	$a = [((n_{wb\_p} - 1) \times S_{wl}) + S_{wlc}] / 2$ = **117** mm
Moment in web plate	$M_{wp} = V \times a$ = **5.9** kNm
Moment capacity of web plates	$M_{cap} = p_{yp} \times n_{wp} \times I / (l_{wp} / 2)$ = **14.0** kNm
	PASS - Effective web plate area is adequate in bending

Check web plate bolts

Moment of inertia of bolt group	I_{bg} = **47400** mm^2
Force on bolt due to direct shear	$F_v = V / n_{wb}$ = **8.3** kN
Vertical force on bolt due to moment	$F_{mv} = M_{wp} \times x / I_{bg}$ = **11.2** kN
Horizontal force on bolt due to moment	$F_{mh} = M_{wp} \times y / I_{bg}$ = **6.2** kN
Resultant bolt load	$F_r = \sqrt{((F_v + F_{mv})^2 + F_{mh}^2)}$ = **20.5** kN
Angle of the resultant bolt load	$\theta = atan(F_{mh} / (F_v + F_{mv}))$ = **17.6** deg
Minimum edge distance	$e_r = min(S_{we} / cos(\theta), S_{wle} / cos(90 - \theta))$ = **26** mm
Edge distance factor for web plate bearing	$K_{edge} = min(e_r / (3 \times d), 1)$ = **0.5**
Slip resistance of the bolt per interface	$S_{fb} = 1.1 \times K_s \times \mu \times P_p$ = **50.7** kN
Bearing capacity of the bolt in the web	$P_{bg\_s} = 1.5 \times d \times t_b \times p_{bs\_s}$ = **79.5** kN
Bearing capacity of the bolt in the plate	$P_{bg\_p} = 1.5 \times K_{edge} \times d \times t_{wp} \times n_{wp} \times p_{bs\_p}$ = **120.7** kN
Bolt capacity	$P_s = min(n_{wp} \times S_{fb}, P_{bg\_s}, P_{bg\_p})$ = **79.5** kN
	PASS - Web plate bolting is adequate

Connection summary

Beam classification	**UC 203x203x46**
Bolt classification	**M16 (Torqued General Grade HSFG)**
Flange plates	**465 mm x 170 mm x 10 mm to the outside of each flange**
Flange bolting	**12 No. total per flange - 3 No. rows of 2 No. bolts on each side of the joint**
Web plates	**150 mm x 465 mm x 10 mm on each side of the web**
Web bolting	**12 No. total - 2 No. rows of 3 No. bolts on each side of the joint**