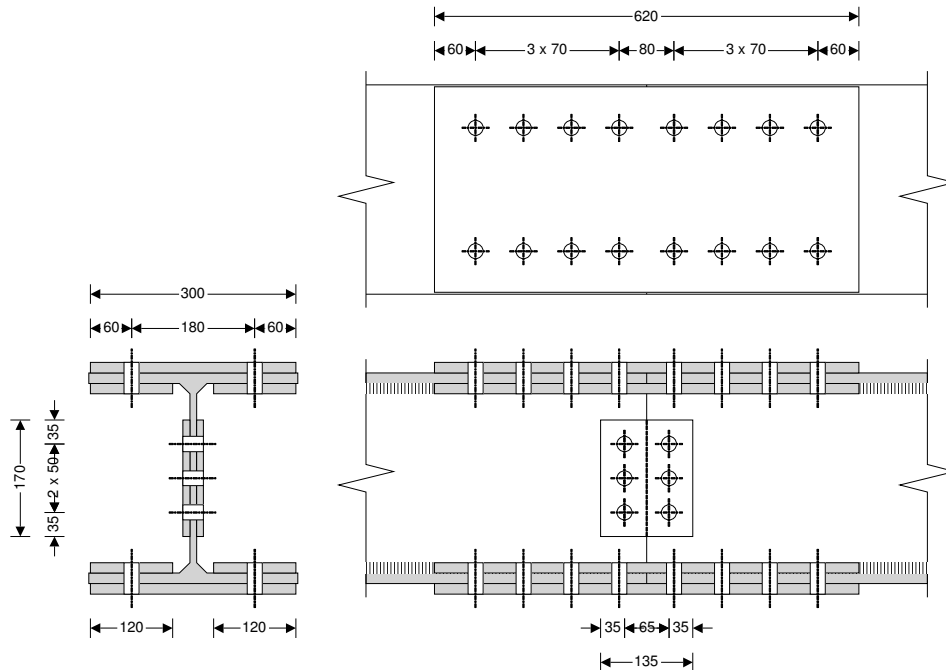


BOLTED COVER PLATE SPLICE CONNECTION TO BS5950-1:2000

TEDDS calculation version 1.0.06



Connection loads

Design moment

$M = 148 \text{ kNm}$

Axial force in the member (compression +ve)

$N = 80 \text{ kN}$

Shear force in the member

$V = 84 \text{ kN}$

Steel beam details

Beam section classification

UC 305x305x97

Grade of steel section

S275

Section bearing strength

$p_{bs_s} = 460 \text{ N/mm}^2$

General connection details

Grade of steel plate

S275

Plate bearing strength

$p_{bs_p} = 460 \text{ N/mm}^2$

Bolt classification

M20 (Torqued General Grade HSFG)

Hole diameter

$D_h = 22 \text{ mm}$

Bolt slip factor

$\mu = 0.50$

Hole type factor

$K_s = 1.0$

Flange plate details – plates bolted to both sides of each flange

Thickness of flange plates

$t_{fp} = 15 \text{ mm}$

Width of outer flange plates

$b_{fp} = 300 \text{ mm}$

Width of inner flange plates

$b_{fp_i} = 120 \text{ mm}$

Length of flange plates

$l_{fp} = 620 \text{ mm}$

Flange bolting details

Rows of flange bolts on each side of joint

$n_{fb_r} = 4$

Bolts per row

$n_{fb_p} = 2$

Total number of flange bolts each side of joint

$n_{fb} = n_{fb_r} \times n_{fb_p} = 8$

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Spacing between rows of bolts	$S_f = 70$ mm
Spacing between rows of bolts across joint	$S_{fc} = 80$ mm
Spacing at end of flange plates	$S_{fe} = 60$ mm
Lateral spacing between central bolts	$S_{flc} = 180$ mm
Lateral spacing at edge of flange plates	$S_{fle} = 60$ mm

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

Thickness of web plates	$t_{wp} = 10$ mm
Width of web plates	$b_{wp} = 135$ mm
Length of web plates	$l_{wp} = 170$ mm

Web bolting details

Rows of web bolts	$n_{wb_r} = 3$
Bolts per row each side of joint	$n_{wb_p} = 1$
Total number of web bolts each side of joint	$n_{wb} = n_{wb_r} \times n_{wb_p} = 3$
Spacing between rows of bolts	$S_w = 50$ mm
Spacing at end of web plates	$S_{we} = 35$ mm
Lateral spacing between central bolts	$S_{wlc} = 65$ mm
Lateral spacing at edge of web plates	$S_{wle} = 35$ mm

Step 1 - Distribution of forces in member flanges

Forces in member tension flange	$T = [M / (D_b - T_b)] - N / 2 = 466$ kN
Forces in member compression flange	$C = [M / (D_b - T_b)] + N / 2 = 546$ kN
Force in the flange	$F_f = \max(T, C) = 546$ 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	$F_f / p_{ys} = 1985$ mm ²
Effective net area coefficient	$K_e = 1.2$
Effective flange area	$A_{ef} = \min(K_e \times [B_b - (n_{fb_p} \times D_h)] \times T_b, B_b \times T_b) = 4702$ 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	$F_f / p_{yp} = 1985$ mm ²
Effective flange plate area	$A_{ep} = \min(K_e \times [b_{fp} + 2 \times (b_{fp_i} - (n_{fb_p} \times D_h))] \times t_{fp}, (b_{fp} + 2 \times b_{fp_i}) \times t_{fp})$
	$A_{ep} = 8100$ mm ²

PASS - Effective flange plate area is adequate

Step 3 - Design of flange bolts

Slip resistance of the bolt per interface	$S_{fb} = 1.1 \times K_s \times \mu \times P_p = 79.2$ kN
Bearing capacity of the bolt in the flange	$P_{bg_s} = 1.5 \times d \times T_b \times p_{bs_s} = 212.5$ kN
Bearing capacity of the bolt in the plate	$P_{bg_p} = 3 \times d \times t_{fp} \times p_{bs_p} = 414.0$ kN
Average flange bolt end distance	$S_{fe_ave} = S_{fe} + (n_{fb_r} - 1) \times S_f / 2 = 165$ mm
Bearing capacity limit of the bolt in the plate	$P_{bg_p_lim} = S_{fe_ave} \times t_{fp} \times p_{bs_p} = 1138.5$ kN
Bolt capacity	$P_s = \min(2 \times S_{fb}, P_{bg_s}, P_{bg_p}, P_{bg_p_lim}) = 158.4$ kN
Number of bolts required	$n_{fb_req} = F_f / P_s = 3.4$
Number of bolts provided	$n_{fb} = 8$

PASS - Flange plate bolting is adequate

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Step 4 - Design of web plates and bolts

Check web plate in shear

Shear force in web plates

$$V = 84 \text{ kN}$$

Gross shear area

$$A_v = n_{wp} \times l_{wp} \times t_{wp} = 3400 \text{ mm}^2$$

Net shear area (allowing for bolt holes)

$$A_{v_net} = n_{wp} \times (l_{wp} - n_{wb_r} \times D_h) \times t_{wp} = 2080 \text{ mm}^2$$

Net shear area limit

$$0.85 \times A_v / K_e = 2408 \text{ mm}^2$$

Net shear capacity of web plates

$$p_{v_net} = 0.7 \times K_e \times A_{v_net} \times p_{yp} = 480 \text{ kN}$$

Gross shear capacity of web plates

$$p_{v_gross} = 0.6 \times A_v \times p_{yp} = 561 \text{ kN}$$

Length of block shear face

$$L_v = S_{we} + (n_{wb_r} - 1) \times S_w = 135 \text{ mm}$$

Length of block tension face

$$L_t = S_{wl} + (n_{wb_p} - 1) \times S_w = 35 \text{ mm}$$

Block shear coefficient

$$k = \text{if}(n_{wb_p} > 1, 2.5, 0.5) = 0.5$$

Block shear capacity of web plates

$$p_{v_block} = 0.6 \times p_{yp} \times t_{wp} \times n_{wp} \times [L_v + K_e \times (L_t - k \times D_h)] = 541 \text{ kN}$$

Shear capacity of web plates

$$p_v = \min(p_{v_net}, p_{v_gross}, p_{v_block}) = 480 \text{ kN}$$

PASS - Effective web plate area is adequate in shear

Check web plate in bending

Second moment of area of web plate

$$I = (t_{wp} \times l_{wp}^3 / 12) - (n_{wb_r} \times t_{wp} \times D_h^3 / 12) - (t_{wp} \times D_h \times K \times S_w^2)$$

$$I = 2967547 \text{ mm}^4$$

Distance from joint to centroid of bolt group

$$a = [((n_{wb_p} - 1) \times S_{wl}) + S_{wl}] / 2 = 33 \text{ mm}$$

Moment in web plate

$$M_{wp} = V \times a = 2.7 \text{ kNm}$$

Moment capacity of web plates

$$M_{cap} = p_{yp} \times n_{wp} \times I / (l_{wp} / 2) = 19.2 \text{ kNm}$$

PASS - Effective web plate area is adequate in bending

Check web plate bolts

Elastic section modulus of bolt group

$$Z_b = n_{wb_r} \times (n_{wb_r} + 1) \times S_w / 6 = 100 \text{ mm}$$

Force on bolt due to moment

$$F_m = V \times a / Z_b = 27.3 \text{ kN}$$

Force on bolt due to direct shear

$$F_v = V / n_{wb_r} = 28.0 \text{ kN}$$

Resultant bolt load

$$F_r = \sqrt{(F_m^2 + F_v^2)} = 39.1 \text{ kN}$$

Angle of the resultant bolt load

$$\theta = \text{atan}(F_m / F_v) = 44.3 \text{ deg}$$

Minimum edge distance

$$e_r = \min(S_{we} / \cos(\theta), S_{wl} / \cos(90 - \theta)) = 49 \text{ mm}$$

Edge distance factor for web plate bearing

$$K_{edge} = \min(e_r / (3 \times d), 1) = 0.8$$

Slip resistance of the bolt per interface

$$S_{fb} = 1.1 \times K_s \times \mu \times P_p = 79.2 \text{ kN}$$

Bearing capacity of the bolt in the web

$$P_{bg_s} = 1.5 \times d \times t_b \times p_{bs_s} = 136.6 \text{ kN}$$

Bearing capacity of the bolt in the plate

$$P_{bg_p} = 1.5 \times K_{edge} \times d \times t_{wp} \times n_{wp} \times p_{bs_p} = 224.9 \text{ kN}$$

Bolt capacity

$$P_s = \min(n_{wp} \times S_{fb}, P_{bg_s}, P_{bg_p}) = 136.6 \text{ kN}$$

PASS - Web plate bolting is adequate

Connection summary

Beam classification

UC 305x305x97

Bolt classification

M20 (Torqued General Grade HSFG)

Flange plates

620 mm x 300 mm x 15 mm to the outside of each flange

2 No. 620 mm x 120 mm x 15 mm to the inside of each flange

Flange bolting

16 No. total per flange - 4 No. rows of 2 No. bolts on each side of the joint

Web plates

170 mm x 135 mm x 10 mm on each side of the web

Web bolting

6 No. total - 3 No. rows of 1 No. bolts on each side of the joint