FIELD SPLICE CONNECTION

(Design Procedure + Solved Example)

Design Procedure

GIVEN SECTION DIMENSIONS For Flange b_f & t_f & For Web h_w & t_w

1- GET SPLICE PLATES DIMENSIONS

For Plate (1) (b_1 & t_1)

$$b_1 t_1 = 0.5\, b_f t_f$$

where $b_1 = b_f$ & $t_1 = 0.5\, t_f$

For Plate (2) (b_2 & t_2)

$$b_f t_f = b_1 t_1 + 2(b_2 t_2)$$

where $b_2 = 0.5x(b_f - t_w - 2(S_W) - 1cm)$

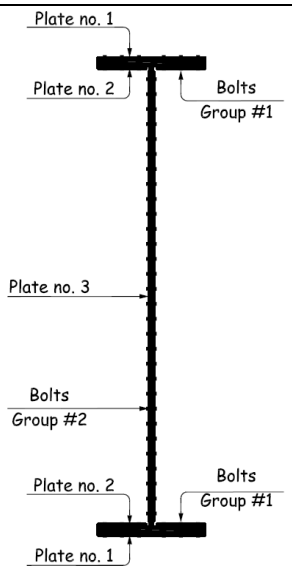
& get t_2

For Plate (3) (b_3 & t_3)

$$h_w t_w = 2(b_3 t_3)$$

where $b_3 = h_w - 2(t_2) - (1cm)$

& get t_3



2- GET REQUIRED NO. OF BOLTS

A. SPLICE OF FLANGE PLATE

- **Max Capacity** C = T = Area of flange x 0.8 F_y
- **Resistance of bolt**

1 – $F_{s,Rd} = \emptyset_{s,Rd}\, k_s n\, \mu\, F_{p.c}$

where $\emptyset_{s,Rd} = 0.9$ & $k_s = 1$ & $n = 2$ & $\mu = 0.4$ & $F_{p.c} = 0.7F_{ub}(0.78)A_b$

$$F_{s,Rd} = 0.4\, F_{ub} A_b \text{ ----------[1]}$$

2 – $F_{b,Rd} = \emptyset_{b,Rd}\, k_1 \propto_b F_u\, d\, t_{min}$

NOTE - It is recommended to assume Edge distance= 2d ----- $K_1 = 2.5$ & $\propto_b = 0.67$

$$F_{b,Rd} = \emptyset_{b,Rd}\,(1.675)\, F_u\, d\, t_{min}$$

where $\emptyset_{b,Rd} = 0.8$ & $t_{min} = from\,(t_1 + t_2\ OR\ t_f)$

$$F_{b,Rd} = 1.34\, F_u\, d\, t_{min} \text{ ----------[2]}$$

FROM [1] & [2] --------- Get R_{Least}

$$n_1(no.of\ rows)x\,(no.of\ bolts\ per\ row) = \frac{C = T}{R_{least}}$$

$$L_1 = 2(nx3x\emptyset) + 2cm$$

CHECK NET SCTION FRACTURE (Tension flange):- $\dfrac{T}{A_{gross\ flange}} \le 0.84\left(\dfrac{A_{net\ flange}}{A_{gross\ flange}}\right) F_u$

B. SPLICE OF WEB PLATE

$$GET\ n_2 = \frac{b_3}{4x\emptyset} \approx Get\ n_2\ ,,,Then\ Get\ Actual\ Pitch = \frac{b_3}{n_2}$$

Resistance of bolt

$$1-\ F_{s,Rd} = \emptyset_{s,Rd}\, k_s n\, \mu\, F_{p.c}$$

$$where\ \emptyset_{s,Rd} = 0.9\ \&\ k_s = 1\ \&\ n = 2\ \&\ \mu = 0.4\ \&\ F_{p.c} = 0.7F_{ub}(0.78)A_b$$

$$F_{s,Rd} = 0.4\, F_{ub}A_b \text{ ----------[1]}$$

$$2-\ F_{b,Rd} = \emptyset_{b,Rd}\, k_1 \propto_b\ F_u\ d\ t_{min}$$

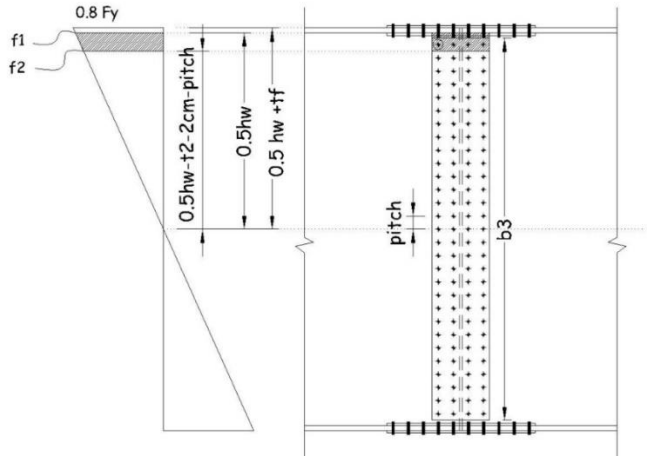
NOTE - It is recommended to assume Edge distance= 2d ----- $K_1 = 2.5$ & $\propto_b = 0.67$

$$F_{b,Rd} = \emptyset_{b,Rd}\,(1.675)\, F_u\, d\ t_{min}$$

$$where\ \emptyset_{b,Rd} = 0.8\ \&\ t_{min} = from\ (t_1 + t_2\ OR\ t_f)$$

$$F_{b,Rd} = 1.34\, F_u\, d\ t_{min} \text{ ----------[2]}$$

FROM [1] & [2] --------- Get R_{Least}



$$F_1 = \frac{0.5(h_w)}{0.5(h_w) + t_f}(0.8xF_y) \quad \&\ F_2 = \frac{0.5(h_w) - t_2 - 0.5cm - \frac{P}{2} - e}{0.5(h_w) + t_f}(0.8xF_y)$$

CHECK ON CRITICAL BOLT (assuming 2 rows)

$$H = \frac{1}{2}\left[\frac{F_1 + F_2}{2} * \left(\frac{Pitch}{2} + t_2 + 0.5cm + e\right) * t_w\right] \quad \&\quad V = \frac{Q}{2xn_2}$$

$$R = \sqrt{H^2 + V^2} \ < \ R_{least}$$

Design a bolted field splice for the main girder section at 2.40m from its midspan. Consider that the shear force at this location is 110 t.
Use bolts M27 grade (10.9) Category C.
Where Main Girder dimensions ST(52) (h_w = 400 cm& t_w=1.8 cm) , **(**b_f = 80 cm& t_f=4.0 cm)
SOLUTION

1- GET SPLICE PLATES DIMENSIONS

For Plate (1) (b_1 & t_1)

$$b_1 t_1 = 0.5\, b_f t_f$$

where b_1 = 80 cm & t_1 = 0.5 t_f =0.5(4)=2.0 cm

For Plate (2) (b_2 & t_2)

$$b_f t_f = b_1 t_1 + 2(b_2 t_2)$$

$$b_2 = 0.5x(b_f - t_w - 2(S_W) - 1cm\ (clearance))$$

where $b_2 = 0.5x(80 - 1.8 - 2(0.8cm) - 1) = 37\ cm$

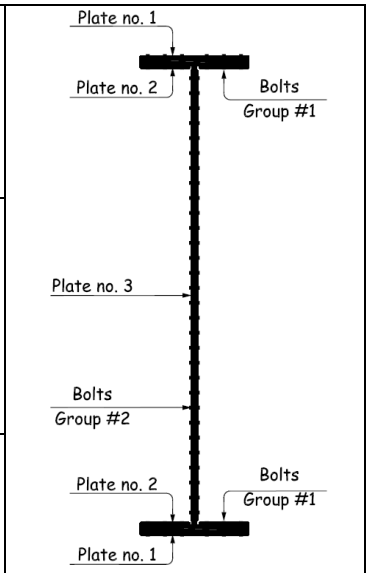
& get t_2 = 2.2 cm

For Plate (3) (b_3 & t_3)

$$h_w t_w = 2(b_3 t_3)$$

where $b_3 = 400 - 2(2.20) - 1cm = 395\ cm$

& get t_3=1 cm



2- GET REQUIRED NO. OF BOLTS

A. FOR FLANGE

- **Max Capacity** C =T = Area of flange x 0.8 F_y = 80*4.0*0.8*3.6 =921.6 t
- **Resistance of bolt**

1 – $F_{s,Rd} = 0.4\, F_{ub} A_b$ = 0.4x10x0.25x3.14x2.7^2=22.9 t ---------[1]

2 – $F_{b,Rd} = 1.34 F_u\ d\ t_{min}$ = 1.34x5.2x2.7x4.0=75.25 t ------[2]

Get R_{Least} = 22.9 t

$$n_1 = \frac{921.6}{22.9} = 41\ bolt = (6\ bolt\ per\ row x\ 7\ rows\ of\ bolts)$$

- **CHECK NET SECTION FRACTURE (Tension flange):-**

$$F_t = \frac{9216}{80*4.0} = 2.88\ \frac{t}{cm^2} \le 0.84\left(\frac{A_{net\ flange}}{A_{gross\ flange}}\right) F_u = 0.84\left(\frac{(80x4.0)-6(2.7+0.3)(4)}{80x4.0}\right) x5.2 = 3.38\ t/cm^2$$

B. FOR WEB

$$GET\ n_2 = \frac{395}{4x2.7} \approx 38\ Get\ n_2\ ,,,Then\ Get\ Actual\ Pitch = \frac{395}{38} = 10.39\ cm$$

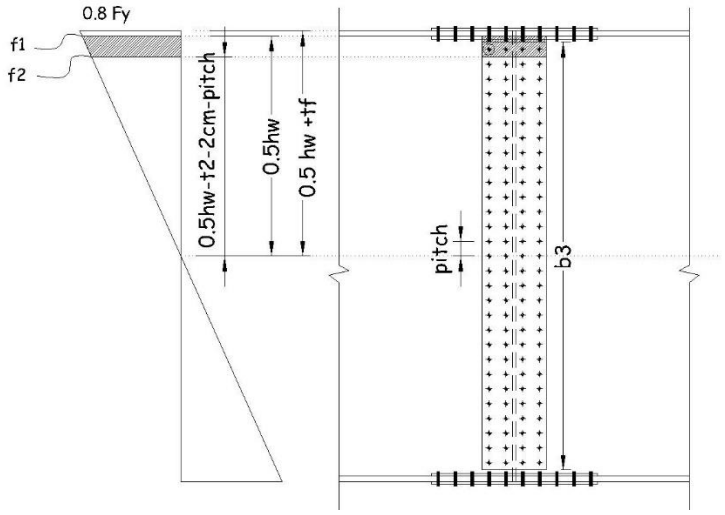
$$THEN\ P = 10.3\ cm\ and\ edge\ e = \frac{395 - 37 * 10.3}{2} = 6.95\ cm > (2d) = 5.4\ cm$$

Resistance of bolt

1 – $F_{s,Rd} = 0.4\ F_{ub}A_b$ = 0.4x10x0.25x3.14x2.7^2=22.9 t ---------[1]

2 – $F_{b,Rd} = 1.34F_u\ d\ t_{min}$ = 1.34x5.2x2.7x1.8=33.86 t ---------[2]

Get R_{Least} = 22.90 t



$$F_1 = \frac{0.5(400)}{0.5(400) + 4}(0.8x3.6) = 2.81\ t/cm^2$$

$$F_2 = \frac{0.5(400) - 2.2 - 0.5cm - 6.95 - \frac{10.3}{2}}{0.5(400) + 4.0}(0.8x3.6) = 2.61\ t/cm^2$$

CHECK ON CRITICAL BOLT (assuming 2 rows x 38 bolt)

$$H = \frac{1}{2}\left[\frac{2.81 + 2.61}{2} * \left(\frac{10.3}{2} + 6.95 + 2.20 + 0.5cm\right) * 1.8\right] = 36\ t$$

$$V = \frac{110}{2x38} = 1.44\ t$$

$$R = \sqrt{36^2 + 1.44^2} = 36.03\ t > R_{least} = 22.90\ t\ (UNSAFE)$$

INCREASE ANOTHER 2 ROW (4rowsx38 bolt)

$$R = 36.03 * \frac{2}{4} = 18.00\ t < R_{least} = 22.90\ t\ (SAFE)$$