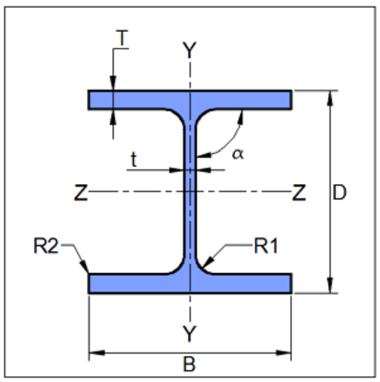
Created with Osdag®

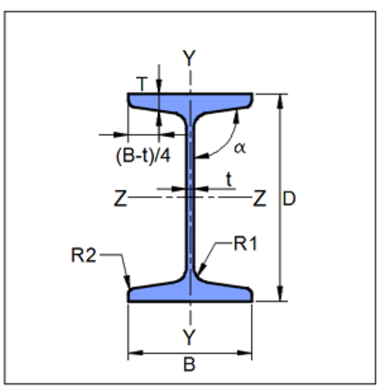
Company Name	IIT Bombay	Project Title	Shear Connection
Group/Team Name	Osdag	Subtitle	Fin Plate
Designer	Engineer#1	Job Number	1.1.1.3.2
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

1 Input Parameters

Main Module		Shear Connection	
Module		Fin Plate Connection	
Connectivity		Beam-Beam	
Shear Force (kN)		100.0	
Axial Force (kN)		0.0	
Supporting Section - Mechanical Properties			
Supporting Section		UB 305 x 102 x 33	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, F_u (MPa)		410	
Yield Strength, F_y (MPa)		250	
Mass, m (kg/m)	32.8	I_z (cm^4)	6501.0
Area, A (cm^2)	41.8	I_y(cm^4)	194.0
D (mm)	313.0	r_z (cm)	12.5
B (mm)	102.4	r_y (cm)	2.2
t (mm)	6.6	Z_z (cm^3)	416.0
T (mm)	10.8	Z_y (cm^3)	38.0
Flange Slope	90	Z_{pz} (cm^3)	481.0
R_1 (mm)	7.6	Z_{py} (cm^3)	60.0
R_2 (mm)	0.0		



Supported Section - Mechanical Properties			
Supported Section		MB 300	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, F_u (MPa)		410	
Yield Strength, F_y (MPa)		250	
Mass, m (kg/m)	46.02	I_z (cm^4)	8990.0
Area, A (cm^2)	58.6	I_y(cm^4)	486.0
D (mm)	300.0	r_z (cm)	12.3
B (mm)	140.0	r_y (cm)	2.87
t (mm)	7.7	Z_z (cm^3)	599.0
T (mm)	13.1	Z_y (cm^3)	69.4
Flange Slope	98	Z_{pz} (cm^3)	681.0
R_1 (mm)	14.0	Z_{py} (cm^3)	117.0
R_2 (mm)	7.0		



Bolt Details - Input and Design Preference	
Diameter (mm)	[16]
Property Class	[5.8]
Type	Bearing Bolt
Hole Type	Over-sized
Bolt Tension	Non pre-tensioned
Slip Factor, (μ_f)	0.3
Detailing - Design Preference	
Edge Preparation Method	Sheared or hand flame cut
Gap Between Members (mm)	10.0
Are the Members Exposed to Corrosive Influences?	False
Plate Details - Input and Design Preference	
Thickness (mm)	[14]
Material	E 250 (Fe 410 W)A
Ultimate Strength, Fu (MPa)	410
Yield Strength, Fy (MPa)	250
Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, Fu (MPa)	450.0

2 Design Checks

Design Status	Pass

2.1 Initial Section Check

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)	100.0	$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{260.0 \times 7.7 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 262.69$ [Ref. IS 800:2007, Cl.10.4.3]	Pass
Allowable Shear Capacity (kN)	100.0	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 262.69$ $= 157.62$ [Limited to low shear]	Pass
Tension Yielding Capacity (kN)	0.0	$T_{\mathrm{dg}} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 260.0 \times 7.7$ $= \frac{2002.0 \times 250}{1.1 \times 10^3}$ $= 455.0$ [Ref. IS 800:2007, Cl.6.2]	

2.2 Load Consideration

Check	Required	Provided	Remarks
Applied Axial Force (kN)	0.0	0.0	

Check	Required	Provided	Remarks
Applied Shear Force (kN)	100.0	$V_{y_{\min}} = \min(0.15V_{d_y},\ 40.0)$ $= \min(0.15 \times 262.69,\ 40.0)$ $= 40$ $V_u = \max(V_y,\ V_{y_{\min}})$ $= \max(100.0, 40)$ $= 100.0$ [Ref. IS 800:2007, Cl.10.7]	

2.3 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)		16.0	
Property Class		5.8	
Plate Thickness (mm)	$t_w = 7.7$	14.0	Pass
No. of Bolt Columns		2	Pass
No. of Bolt Rows		3	
Min. Pitch Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 16.0$ $= 40.0$ [Ref. IS 800:2007, Cl.10.2.2]	75	Pass
Max. Pitch Distance (mm)	$p/g_{\max} = \min(32t,\ 300)$ $= \min(32 \times 7.7,\ 300)$ $= \min(246.4,\ 300)$ $= 246.4$ Where, $t = \min(14.0, 7.7)$ [Ref. IS 800:2007, Cl.10.2.3]	75	Pass

Check	Required	Provided	Remarks
Min. Gauge Distance (mm)	$p_{\text{min}} = 2.5d$ $= 2.5 \times 16.0$ $= 40.0$ [Ref. IS 800:2007, Cl.10.2.2]	40	Pass
Max. Gauge Distance (mm)	$p/g_{\text{max}} = \min(32t,\ 300)$ $= \min(32 \times 7.7,\ 300)$ $= \min(246.4,\ 300)$ $= 246.4$ Where, $t = \min(14.0, 7.7)$ [Ref. IS 800:2007, Cl.10.2.3]	40	Pass
Min. End Distance (mm)	$e_{\text{min}} = 1.7d_0$ $= 1.7 \times 20.0$ $= 34.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	35	Pass
Max. End Distance (mm)	$e_{\text{max}} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14.0 \times \sqrt{\frac{250}{250}} = 168.0$ $e_2 = 12 \times 7.7 \times \sqrt{\frac{250}{250}} = 92.4$ $e_{\text{max}} = \min(e_1,\ e_2) = 92.4$ [Ref. IS 800:2007, Cl.10.2.4.3]	35	Pass
Min. Edge Distance (mm)	$e'_{\text{min}} = 1.7d_0$ $= 1.7 \times 20.0$ $= 34.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	35	Pass

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{\max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14.0 \times \sqrt{\frac{250}{250}} = 168.0$ $e_2 = 12 \times 7.7 \times \sqrt{\frac{250}{250}} = 92.4$ $e'_{\max} = min(e_1,\ e_2) = 92.4$ [Ref. IS 800:2007, Cl.10.2.4.3]	35	Pass
Moment Demand (kNm)		$M_d = (V_u \times \text{ecc} + M_w)$ $\text{ecc} = \text{eccentricity}$ $M_w = \text{external moment acting on web}$ $= \frac{(100.0 \times 10^3 \times 65.0 + 0.0 \times 10^6)}{10^6}$ $= 6.5$	
Bolt Force Parameter(s) (mm)	$l_n = \text{length available}$ $l_n = p\ (n_r - 1)$ $= 75 \times (3 - 1)$ $= 150$ $y_{\max} = l_n/2$ $= 150/2$ $= 75.0$ $x_{\max} = g(n_c - 1)/2$ $= 40 \times (2 - 1)/2$ $= 20.0$		

Check	Required	Provided	Remarks
Bolt Force (kN)	$vbv = V_u/(n_r \times n_c) = \frac{100.0}{(3 \times 2)} = 16.67$ $tmh = \frac{M_d \times y_{\max}}{\Sigma r_i^2} = \frac{6.5 \times 75.0}{24.9} = 19.58$ $tmv = \frac{M_d \times x_{\max}}{\Sigma r_i^2} = \frac{6.5 \times 20.0}{24.9} = 5.22$ $abh = \frac{A_u}{(n_r \times n_c)} = \frac{0.0}{(3 \times 2)} = 0.0$ $v_{\text{res}} = \sqrt{(vbv + tmv)^2 + (tmh + abh)^2} = \sqrt{(16.67 + 5.22)^2 + (19.58 + 0.0)^2} = 29.37$		
Shear Capacity (kN)		$V_{\text{dsb}} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}} = \frac{520.0 \times 1 \times 157}{1000 \times \sqrt{3} \times 1.25} = 37.71$ [Ref. IS 800:2007, Cl.10.3.3]	

Check	Required	Provided	Remarks
Kb		$k_b = \min\left(\frac{e}{3d_0},\ \frac{p}{3d_0} - 0.25,\ \frac{f_{ub}}{f_u},\ 1.0\right)$ $= \min\left(\frac{35}{3 \times 20.0},\ \frac{75}{3 \times 20.0} - 0.25,\ \frac{520.0}{410},\ 1.0\right)$ $= \min(0.58, 1.0, 1.27, 1.0)$ $= 0.58$ [Ref. IS 800:2007, Cl.10.3.4]	
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.58 \times 16.0 \times 7.7 \times 410}{1000 \times 1.25}$ $= 41.02$ [Ref. IS 800:2007, Cl.10.3.4]	
Capacity (kN)		$V_{\text{db}} = \min\ (V_{\text{dsb}},\ V_{\text{dpb}})$ $= \min\ (37.71,\ 41.02)$ $= 37.71$ [Ref. IS 800:2007, Cl.10.3.2]	
Long Joint Reduction Factor	if $l_j \geq 15d$ then $V_{\text{rd}} = \beta_{lj} V_{\text{db}}$ if $l_j < 15d$ then $V_{\text{rd}} = V_{\text{db}}$ where, $l_j = ((nc \text{ or } nr) - 1) \times (p \text{ or } g)$ $\beta_{lj} = 1.075 - l/(200d)$ but $0.75 \leq \beta_{lj} \leq 1.0$ [Ref. IS 800:2007, Cl.10.3.3.1]	$l_j = (n_r - 1) \times p$ $= (3 - 1) \times 75 = 150$ $l = 150$ $15 \times d = 15 \times 16.0 = 240.0$ since, $l_j < 15 \times d$ then $\beta_{lj} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.1]	
Capacity (kN)	29.37	37.71	**Pass**

2.4 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (300.0 - 2 \times 13.1 - 2 \times 14.0)$ $= 147.48$ [Ref. INSDAG, Ch.5, sec.5.2.3]	220	Pass
Max. Plate Height (mm)	$d_b - t_{bf} + r_{b1} - notch_h$ $= 300.0 - 13.1 + 14.0 - 40$ $= 222.9$	220	Pass
Min. Plate Width (mm)	$2e_{\min} + (n_c - 1)p_{\min})$ $= 2 \times 34.0 + (2 - 1) \times 40.0$ $= 118.0$	120.0	Pass
Min. Plate Thickness (mm)	$t_w = 7.7$	14.0	Pass
Shear Yielding Capacity (kN)		$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{220 \times 14.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 404.15$ [Ref. IS 800:2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	$V = 100.0$	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 404.15$ $= 242.49$ [Limited to low shear]	Pass
Shear Rupture Capacity (kN)		$V_{d_n} = \frac{0.75 A_{v_n} f_u}{\sqrt{3}\gamma_{m1}}$ $= 1 \times \frac{(220 - (3 \times 20.0)) \times 14.0 \times 410}{\sqrt{3} \times 1.25}$ $= 688.8$ [Ref. AISC, sect. J4]	

Check	Required	Provided	Remarks
Block Shear Capacity in Shear (kN)		$V_{\text{dbl1}} = \frac{A_{\text{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{\text{dbl2}} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{\text{db}} = \min(V_{db1},\ V_{db2}) = 525.83$ [Ref. IS 800:2007, Cl.6.4]	
Shear Capacity (kN)	100.0	$V_d = \min(S_c,\ V_{d_n},\ V_{d_b})$ $= \min(242.49,\ 688.8,\ 525.83)$ $= 242.49$ [Ref. IS 800:2007, Cl.6.1]	Pass
Tension Yielding Capacity (kN)		$T_{\text{dg}} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 220 \times 14.0$ $= \frac{3080.0 \times 250}{1.1 \times 10^3}$ $= 700.0$ [Ref. IS 800:2007, Cl.6.2]	
Tension Rupture Capacity (kN)		$T_{\text{dn}} = \frac{0.9 A_n f_u}{\gamma_{m1}}$ $= \frac{1 \times\ 0.9 \times (220 - 3 \times 20.0) \times 14.0 \times 410}{1.25}$ $= 743.9$ [Ref. IS 800:2007, Cl.6.3.1]	

Check	Required	Provided	Remarks
Block Shear Capacity in Tension (kN)		$T_{\text{dbl1}} = \frac{A_{\text{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{\text{dbl2}} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{\text{db}} = \min(T_{db1},\ T_{db2}) = 692.02$ [Ref. IS 800:2007, Cl.6.4]	
Tension Capacity (kN)	0.0	$T_{\text{d}} = \min(T_{\text{dg}},\ T_{\text{dn}},\ T_{\text{db}})$ $= \min(700.0, 743.9, 692.02)$ $= 692.02$ [Ref.IS 800:2007, Cl.6.1]	
Moment Capacity (kNm)	6.5	$M_{dz} = \frac{\beta_b Z_p f y}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 169400.0 \times 250}{1.1 \times 10^6}$ $= 38.5$ [Ref. IS 800:2007, Cl.8.2.1.2]	Pass
Interaction Ratio	≤ 1	$\frac{6.5}{38.5} + \frac{0.0}{692.02} = 0.17$ [Ref. IS 800:2007, Cl.10.7]	Pass

2.5 Section Design

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{260.0 \times 7.7 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 262.69$ [Ref. IS 800:2007, Cl.10.4.3]	

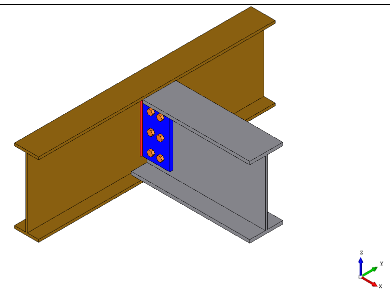
Check	Required	Provided	Remarks
Allowable Shear Capacity (kN)	$V = 100.0$	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 262.69$ $= 157.62$ [Limited to low shear]	Pass
Shear Rupture Capacity (kN)		$V_{d_n} = \dfrac{0.75 A_{v_n} f_u}{\sqrt{3}\gamma_{m1}}$ $= 1 \times \dfrac{(260.0 - (3 \times 20.0)) \times 7.7 \times 410}{\sqrt{3} \times 1.25}$ $= 473.55$ [Ref. AISC, sect. J4]	
Block Shear Capacity in Shear (kN)		$V_{\text{dbl1}} = \dfrac{A_{\text{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \dfrac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{\text{dbl2}} = \dfrac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \dfrac{A_{tg} f_y}{\gamma_{m0}}$ $V_{\text{db}} = \min(V_{db1},\ V_{db2}) = 289.2$ [Ref. IS 800:2007, Cl.6.4]	
Shear Capacity (kN)	100.0	$V_d = \min(S_c,\ V_{d_n},\ V_{d_b})$ $= \min(157.62,\ 473.55,\ 289.2)$ $= 157.62$ [Ref. IS 800:2007, Cl.6.1]	Pass
Tension Yielding Capacity (kN)		$T_{\text{dg}} = \dfrac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 260.0 \times 7.7$ $= \dfrac{2002.0 \times 250}{1.1 \times 10^3}$ $= 455.0$ [Ref. IS 800:2007, Cl.6.2]	

Check	Required	Provided	Remarks
Tension Rupture Capacity (kN)		$T_{\text{dn}} = \frac{0.9A_n f_u}{\gamma_{m1}}$ $= \frac{1 \times\ 0.9 \times (260.0 - 3 \times 20.0) \times 7.7 \times 410}{1.25}$ $= 454.61$ [Ref. IS 800:2007, Cl.6.3.1]	
Block Shear Capacity in Tension (kN)		$T_{\text{dbl1}} = \frac{A_{\text{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn} f_u}{\gamma_{m1}}$ $T_{\text{dbl2}} = \frac{0.9A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{\text{db}} = \min(T_{db1},\ T_{db2}) = 380.61$ [Ref. IS 800:2007, Cl.6.4]	
Tension Capacity (kN)	0.0	$T_{\text{d}} = \min(T_{\text{dg}},\ T_{\text{dn}},\ T_{\text{db}})$ $= \min(455.0, 454.61, 380.61)$ $= 380.61$ [Ref.IS 800:2007, Cl.6.1]	
Moment Capacity (kNm)	6.5	$M_{d_{\text{z}}} = \frac{\beta_b Z_p f y}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 681000.0 \times 250}{1.1 \times 10^6}$ $= 154.77$ [Ref. IS 800:2007, Cl.8.2.1.2]	**Pass**
Interaction Ratio	≤ 1	$\frac{6.5}{154.77} + \frac{0.0}{380.61} = 0.04$ [Ref. IS 800:2007, Cl.10.7]	**Pass**

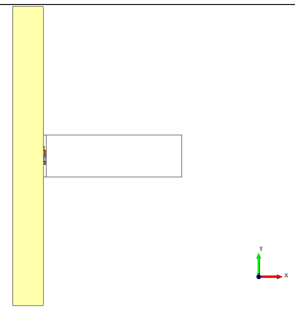
2.6 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{\min}}$ based on thinner part $= \max(6,\ 6)$ $s_{\min}$ based on thicker part $= 5$ [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	5	**Pass**
Max. Weld Size (mm)	Thickness of thinner part $= \min(6.6,\ 14.0) = 6.6$ $s_{\max} = 8$ [Ref. IS 800:2007, Cl.10.5.3.1]	5	**Pass**
Weld Strength (N/mm)	$R_{\rm w} = \sqrt{(T_{\rm wh} + A_{\rm wh})^2 + (T_{\rm wv} + V_{\rm wv})^2}$ $T_{\rm wh} = \frac{M \times y_{\max}}{I_{pw}} = \frac{6500000.0 \times 105.0}{1543500.0}$ $T_{\rm wv} = \frac{M \times x_{\max}}{I_{pw}} = \frac{6500000.0 \times 0.0}{1543500.0}$ $V_{\rm wv} = \frac{V}{l_w} = \frac{100000.0}{420}$ $A_{\rm wh} = \frac{A}{l_w} = \frac{0.0}{420}$ $R_{\rm w} = \sqrt{(442.18 + 0.0)^2 + (0.0 + 238.1)^2}$ $= 502.2$	$f_w = \frac{t_t f_u}{\sqrt{3}\gamma_{mw}}$ $= \frac{3.5 \times 410}{\sqrt{3} \times 1.25}$ $= 662.8$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	**Pass**

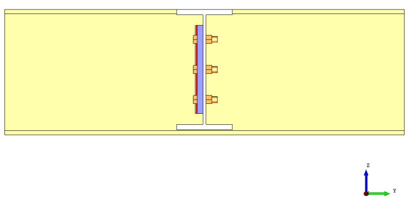
3 3D Views



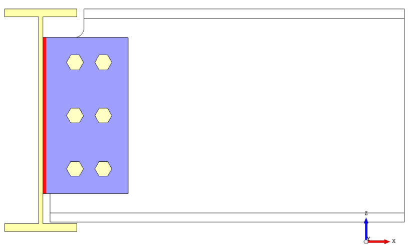
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log

2021-02-04 11:57:06 - Osdag - INFO - === End Of Design ===