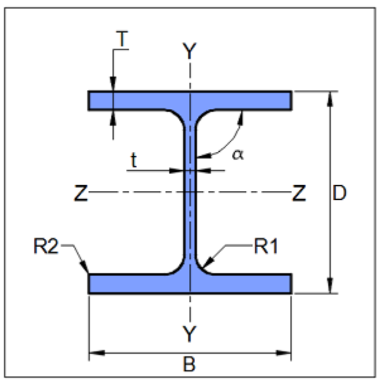
		Created with Osdag®	
Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Fin Plate
Designer	Engineer #1	Job Number	1.1.1.3.2
Date	17 /12 /2020	Client	Manas M. Ghosh, INSDAG, Kolkata

1 Input Parameters

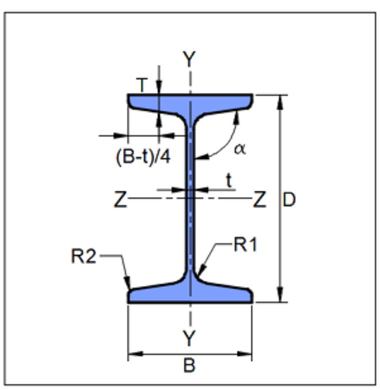
Main Module	Shear Connection
Module	Fin Plate
Connectivity	Beam-Beam
Shear Force (kN)	100.0
Axial Force (kN)	0.0

Supporting Section - Mechanical Properties



Supporting Section		UB 305 x 102 x 33	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (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, Fu (MPa)		410	
Yield Strength, Fy (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, (mu_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	$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{260.0 \times 7.7 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 262.69$ $[Ref. IS\ 800 : 2007, Cl. 10.4.3]$	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	$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = l \times t = 260.0 \times 7.7$ $= \frac{2002.0 \times 250}{1.1 \times 10^3}$ $= 455.0$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 6.2]$	

2.2 Load Consideration

Check	Required	Provided	Remarks

Check	Required	Provided	Remarks
Applied Shear Force (kN)	100.0	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 262.69, 40.0)$ $= 40$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(100.0, 40)$ $= 100.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.7]$	
Applied Axial Force (kN)	0.0	0.0	

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)	$p_{min} = 2.5\ d$ $= 2.5 \times 16.0$ $= 40.0$ $[Ref\ IS\ 800:2007,\ Cl.\ 10.2.2]$	75	**Pass**
Max. Pitch Distance (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 \times 7.7,\ 300\ mm)$ $= \min(246.4,\ 300\ mm)$ $= 246.4$ $Where,\ t = min(14.0, 7.7)$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.2.3]$	75	**Pass**

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

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

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

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

2.4 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$0.6{\times}(d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (300.0 - 2 \times 13.1 - 2 \times 14.0)$ $= 147.48$ $[Ref.\ INSDAG - Chpt.5,\ Sect.5.2.3]$	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)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{220 \times 14.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 404.15$ $[Ref.IS\ 800:2007, Cl.10.4.3]$	
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)		$V_{dn} = \frac{0.75\ A_{vn}\ f_u}{\sqrt{3}\ \gamma_{m1}}$ $= 1 \times \frac{(220 - (3 \times 20.0)) \times 14.0 \times 410}{\sqrt{3} \times 1.25}$ $= 688.8$ $[Ref.AISC\ \ Sect.J4]$	

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

Check	Required	Provided	Remarks
Block Shear Capacity in Tension (kN)		$T_{dbl1} = \frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{dbl2} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 692.02$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.4]$	
Tension Capacity (kN)	0.0	$T_d = min(T_{dg}, T_{dn}, T_{db})$ $= min(700.0, 743.9, 692.02)$ $= 692.02$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.1]$	
Moment Capacity (kNm)	6.5	$M_{dzz} = \frac{\beta_b \times Z_p \times fy}{\gamma_{mo} \times 10^6}$ $= \frac{1.0 \times 169400.0 \times 250}{1.1 \times 10^6}$ $= 38.5$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	**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)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{260.0 \times 7.7 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 262.69$ $[Ref. IS\ 800:2007, Cl.10.4.3]$	

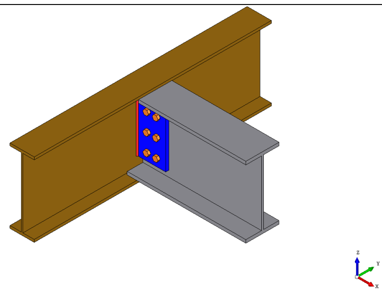
Check	Required	Provided	Remarks
Allowable Shear Capacity (kN)	$V = 100.0$	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 262.69$ $= 157.62$ [*Limited to low shear*]	**Pass**
Shear Rupture Capacity (kN)		$V_{dn} = \frac{0.75\ A_{vn}\ f_u}{\sqrt{3}\ \gamma_{m1}}$ $= 1 \times \frac{(260.0-(3\times 20.0))\times 7.7\times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

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

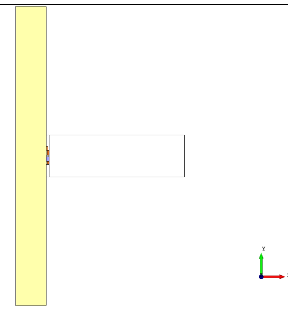
2.6 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{min}}$ *based on thinner part* $= 6 \ or \ 6$ 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)	$R_w = \sqrt{(T_{wh} + A_{wh})^2 + (T_{wv} + V_{wv})^2}$ $T_{wh} = \frac{M \times y_{max}}{Ipw} = \frac{6500000.0 \times 105.0}{1543500.0}$ $T_{wv} = \frac{M \times x_{max}}{Ipw} = \frac{6500000.0 \times 0.0}{1543500.0}$ $V_{wv} = \frac{V}{l_w} = \frac{100000.0}{420}$ $A_{wh} = \frac{A}{l_w} = \frac{0.0}{420}$ $R_w = \sqrt{(442.18 + 0.0)^2 + (0.0 + 238.1)^2}$ $= 502.2$	$f_w = \frac{t_t \ f_u}{\sqrt{3} \ \gamma_{mw}}$ $= \frac{3.5 \times 410}{\sqrt{3} \times 1.25}$ $= 662.8$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1]$	**Pass**

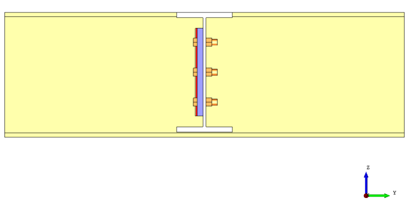
3 3D Views



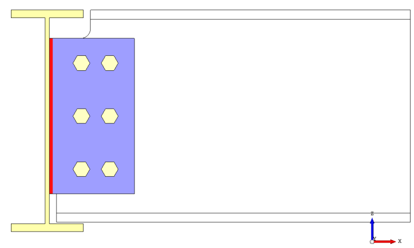
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log