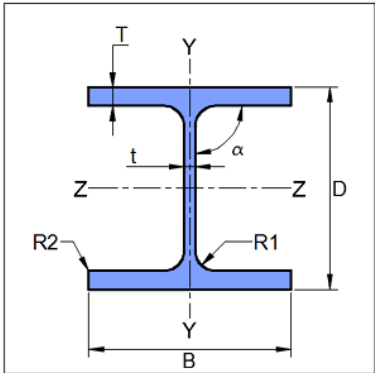
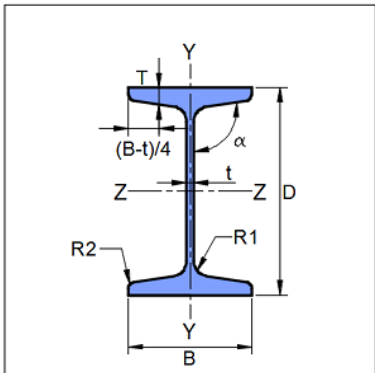




Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	End Plate
Designer	Engineer #1	Job Number	1.1.2.1.1
Date	17 /12 /2020	Client	Harshavardhan Subbarao, Construma Consultancy, Mumbai

1 Input Parameters

Main Module		Shear Connection		
Module		End Plate		
Connectivity		Column Flange-Beam Web		
Shear Force (kN)		240.0		
Axial Force (kN)		125.0		
Supporting Section - Mechanical Properties				
	Supporting Section		PBP 300 X 109.54	
	Material		E 350 (Fe 490)	
	Ultimate Strength, Fu (MPa)		490	
	Yield Strength, Fy (MPa)		350	
	Mass, m (kg/m)	109.54	Iz (cm4)	23400.0
	Area, A (cm2)	139.0	Iy(cm4)	7680.0
	D (mm)	308.0	rz (cm)	12.9
	B (mm)	311.0	ry (cm)	7.42
	t (mm)	15.3	Zz (cm3)	1520.0
	T (mm)	15.3	Zy (cm3)	494.0
	Flange Slope	90	Zpz (cm3)	1710.0
	R1 (mm)	15.0	Zpy (cm3)	758.0
	R2 (mm)	0.0		
	Supported Section - Mechanical Properties			
	Supported Section		LB 400	
	Material		E 250 (Fe 410 W)A	
	Ultimate Strength, Fu (MPa)		410	
	Yield Strength, Fy (MPa)		250	
	Mass, m (kg/m)	56.82	Iz (cm4)	19300.0
	Area, A (cm2)	72.4	Iy(cm4)	716.0
	D (mm)	400.0	rz (cm)	16.3
	B (mm)	165.0	ry (cm)	3.14
	t (mm)	8.0	Zz (cm3)	965.0
	T (mm)	12.5	Zy (cm3)	86.8
	Flange Slope	98	Zpz (cm3)	1090.0
	R1 (mm)	16.0	Zpy (cm3)	151.0
	R2 (mm)	8.0		



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Bolt Details - Input and Design Preference	
Diameter (mm)	[16, 20, 24, 30]
Property Class	[4.8, 5.6, 6.8, 9.8]
Type	Bearing Bolt
Hole Type	Standard
Bolt Tension	Non pre-tensioned
Slip Factor, (μ_f)	0.3
Detailing - Design Preference	
Edge Preparation Method	Rolled, machine-flame cut, sawn and planed
Gap Between Members (mm)	10.0
Are the Members Exposed to Corrosive Influences?	False
Plate Details - Input and Design Preference	
Thickness (mm)	[14, 16, 18, 20, 22, 25, 28]
Material	E 250 (Fe 410 W)A
Ultimate Strength, F_u (MPa)	410
Yield Strength, F_y (MPa)	250
Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, F_u (MPa)	490.0



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2 Design Checks

Design Status	Pass
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2.1 Section Design Check

Check	Required	Provided	Remarks
Shear Capacity (kN)	240.0	$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{mo}}$ $= \frac{400.0 \times 8.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 419891.10486518237$ [Ref. IS 800 : 2007, Cl.10.4.3]	Pass
Tension Capacity (kN)	125.0	$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = l \times t = 400.0 \times 8.0$ $= \frac{3200.0 \times 250}{1.1 \times 10^3}$ $= 727272.73$ [Ref. IS 800 : 2007, Cl. 6.2]	Pass

2.2 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)		16	
Property Class		6.8	
Plate Thickness (mm)		14	
No. of Bolt Columns	2	2	Pass
No. of Bolt Rows		5	Pass
Min. Pitch Distance (mm)	$p_{min} = 2.5 d$ $= 2.5 \times 16$ $= 40.0$ [Ref IS 800 : 2007, Cl. 10.2.2]	50	Pass



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Designer	Engineer #1	Job Number	1.1.2.1.1
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Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p/g_{max} = \min(32 t, 300 \text{ mm})$ $= \min(32 \times 8.0, 300 \text{ mm})$ $= \min(256.0, 300 \text{ mm})$ $= 256.0$ $\text{Where, } t = \min(28.0, 8.0)$ $[\text{Ref. IS 800 : 2007, Cl. 10.2.3}]$	50	Pass
Min. End Distance (mm)	$e_{min} = 1.5 d_0$ $= 1.5 \times 18.0$ $= 27.0$ $[\text{Ref. IS 800 : 2007, Cl. 10.2.4.2}]$	30	Pass
Max. End Distance (mm)	$e_{max} = 12 t \varepsilon; \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14 \times \sqrt{\frac{250}{240}} = 171.46$ $e_2 = 12 \times 15.3 \times \sqrt{\frac{250}{350}} = 155.17$ $e_{max} = \min(e_1, e_2) = 155.17$ $[\text{Ref. IS 800 : 2007, Cl. 10.2.4.3}]$	30	Pass
Min. Edge Distance (mm)	$e'_{min} = 1.5 d_0$ $= 1.5 \times 18.0$ $= 27.0$ $[\text{Ref. IS 800 : 2007, Cl. 10.2.4.2}]$	30	Pass



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Date	17 /12 /2020	Client	Harshavardhan Subbarao, Construma Consultancy, Mumbai

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{max} = 12 t \varepsilon; \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14 \times \sqrt{\frac{250}{240}} = 171.46$ $e_2 = 12 \times 15.3 \times \sqrt{\frac{250}{350}} = 155.17$ $e'_{max} = \min(e_1, e_2) = 155.17$ <p>[Ref. IS 800 : 2007, Cl. 10.2.4.3]</p>	30	Pass
Min. Gauge Distance (mm)	$g_1 = 2(e'_{min} + s) + t_w$ $= 2(27.0 + 5) + 8.0$ $= 72.0$ $g_2 = 2(e'_{min} + R_r) + T_w$ $= 2(27.0 + 15.0) + 15.3$ $= 99.3$ $g_{min} = \max(g_1, g_2)$ $= 99.3$	106	Pass
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3} \gamma_{mb}}$ $= \frac{600.0 \times 1 \times 157}{1000 \times \sqrt{3} \times 1.25}$ $= 43.51$ <p>[Ref. IS 800 : 2007, Cl. 10.3.3]</p>	
Kb		$k_b = \min\left(\frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0\right)$ $= \min\left(\frac{30}{3 \times 18.0}, \frac{50}{3 \times 18.0} - 0.25, \frac{600.0}{410}, 1.0\right)$ $= \min(0.56, 0.68, 1.46, 1.0)$ $= 0.56$ <p>[Ref. IS 800 : 2007, Cl. 10.3.4]</p>	



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Designer	Engineer #1	Job Number	1.1.2.1.1
Date	17 /12 /2020	Client	Harshavardhan Subbarao, Construma Consultancy, Mumbai

Check	Required	Provided	Remarks
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.56 \times 16 \times 14 \times 410}{1000 \times 1.25}$ $= 102.86$ <p>[Ref. IS 800 : 2007, Cl. 10.3.4]</p>	
Capacity (kN)	$V_{bv} = \frac{V}{n}$ $= \frac{240.0}{10}$ $= 24.0$	$V_{db} = \min (V_{dsb}, V_{dpb})$ $= \min (43.51, 102.86)$ $= 43509.1162861302$ <p>[Ref. IS 800 : 2007, Cl. 10.3.2]</p>	
Long Joint Reduction Factor		$l_j = (n_r - 1) \times p$ $= (5 - 1) \times 50 = 200$ $l = 200$ $15 \times d = 15 \times 16 = 240$ <p>since, $l_j < 15 \times d$ then $\beta_{lj} = 1.0$</p> <p>[Ref. IS 800 : 2007, Cl. 10.3.3.1]</p>	
Large Grip Length Reduction Factor		$l_g = \Sigma (t_p + t_{member})$ $= 39.3$ $5d = 80$ $8d = 128$ <p>since, $l_g < 5d$; $\beta_{lg} = 1.0$</p> <p>[Ref. IS 800 : 2007, Cl. 10.3.3.2]</p>	
Packing Plate Reduction Factor		$t_{pk} = gap$ $= 10.0mm$ <p>since, $t_{pk} \geq 6mm$ then $V_{rd} = \beta_{pk} V_{db}$</p> $\beta_{pk} = 1.0 - 0.0125 \times 10.0 = 0.875$ <p>[Ref. IS 800 : 2007, Cl. 10.3.3.3]</p>	



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Designer	Engineer #1	Job Number	1.1.2.1.1
Date	17 /12 /2020	Client	Harshavardhan Subbarao, Construma Consultancy, Mumbai

Check	Required	Provided	Remarks
Bolt Capacity (post reduction factor) (kN)	24.0	$V_{rd} = \beta_{lj} \beta_{lg} \beta_{pk} \times V_{db}$ $= 1.0 \times 1.0 \times 0.875 \times 43.51$ $= 38.07$ [Ref. IS 800 : 2007, Cl. 10.3.3]	
Bolt Tension Force (kN)	$T_{ba} = \frac{P}{n}$ $= \frac{125.0}{10}$ $= 12.5$		



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Check	Required	Provided	Remarks
Bolt Prying Force (kN)	$Q = \frac{l_v}{2 \times l_e} \left[T_e - \frac{\beta \times \eta \times f_o \times b_e \times t^4}{27 \times l_e \times l_v^2} \right]$ $l_v = e - \frac{R_1}{2}$ $= 30 - \frac{16.0}{2} = 44.0 \text{ mm}$ $f_o = 0.7 \times f_{ub}$ $= 0.7 \times 600.0$ $= 420.0 \text{ N/mm}^2$ $l_e = \min \left(e, 1.1 t \sqrt{\frac{\beta f_o}{f_y}} \right)$ $= \min \left(30, 1.1 \times 14 \times \sqrt{\frac{2 \times 420.0}{250}} \right)$ $= \min(30, 28.23) = 28.23 \text{ mm}$ $\beta = 2 \text{ (non pre-tensioned bolt)}$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{165.0}{2} = 50 \text{ mm}$ $Q = \frac{44.0}{2 \times 28.23} \times \left[12.5 - \left(\frac{2 \times 1.5 \times 420.0 \times 50 \times 14^4}{27 \times 28.23 \times 44.0^2} \right) \right] \times 10^{-3}$ $Q = 8.38$ <p>[Ref. IS 800 : 2007, Cl. 10.4.7]</p>		



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Check	Required	Provided	Remarks
Bolt Tension Force (kN)	$T_f = T_1 + Q$ $= 12.5 + 8.38$ $= 20.88$	$T_{db} = 0.90 f_{ub} A_n / \gamma_{mb}$ $< f_{yb} A_{sb} (\gamma_{mb} / \gamma_{m0})$ $= \min \left(0.90 \times 600.0 \times 157 / 1.25, \right.$ $\left. 600.0 \times 201 \times (1.25/1.1) \right)$ $= \min(67.82, 137.05)$ $= 67.82$ [Ref. IS 800 : 2007, Cl. 10.3.5]	Pass
Interaction Ratio	≤ 1	$\left(\frac{V_{sb}}{V_{db}} \right)^2 + \left(\frac{T_b}{T_{db}} \right)^2 \leq 1.0$ $\left(\frac{24.0}{38.07} \right)^2 + \left(\frac{20.88}{67.82} \right)^2 = 0.49$ [Ref. IS 800 : 2007, Cl. 10.3.6]	Pass

2.3 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (400.0 - 2 \times 12.5 - 2 \times 16.0)$ $= 205.8$ [Ref. INSDAG – Chpt.5, Sect.5.2.3]	260	Pass
Max. Plate Height (mm)	$d_b - 2(t_{bf} + r_{b1} + gap)$ $= 400.0 - 2 \times (12.5 + 16.0 + 10)$ $= 343.0$	260	Pass
Min. Plate Thickness (mm)	$t_w = 8.0$	14	Pass
Min. Plate Width (mm)	$w_{p_{min}} = g^i + e^i_{min} \ 2$ $= 106 + 27.0 \times 2$ $= 160.0$	166	Pass
Max. Plate Width (mm)	$w_{p_{max}} = T_f$ $= 311.0$	166	Pass



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Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{mo}}$ $= \frac{260 \times 14 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 477.63$ [Ref. IS 800 : 2007, Cl.10.4.3]	
Block Shear Capacity in Shear (kN)		$V_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{db} = \min(V_{db1}, V_{db2}) = 546.43$ [Ref. IS 800 : 2007, Cl. 6.4]	
Shear Capacity (kN)	240.0	$V_d = \min(S_e, V_{db})$ $= \min(477.63, 546.43)$ $= 477.63$ [Ref. IS 800 : 2007, Cl. 6.1]	Pass
Moment Capacity (kNm)	$M = T_e \times ecc$ $ecc_1 = \frac{g}{2} - \frac{t_w}{2} - s = 44.0$ $ecc_2 = \frac{g}{2} - \frac{T_w}{2} - R_r = 30.35$ $\max(ecc_1, ecc_2) = 44.0$ $M = 12.5 \times 44.0 \times 10^{-3} = 0.546$	$M_{dzz} = \frac{\beta_b \times Z_p \times f_y}{\gamma_{mo} \times 10^6}$ $= \frac{1.0 \times 12740.0 \times 250}{1.1 \times 10^6}$ $= 0.557$ [Ref. IS 800 : 2007, Cl. 8.2.1.2]	Pass



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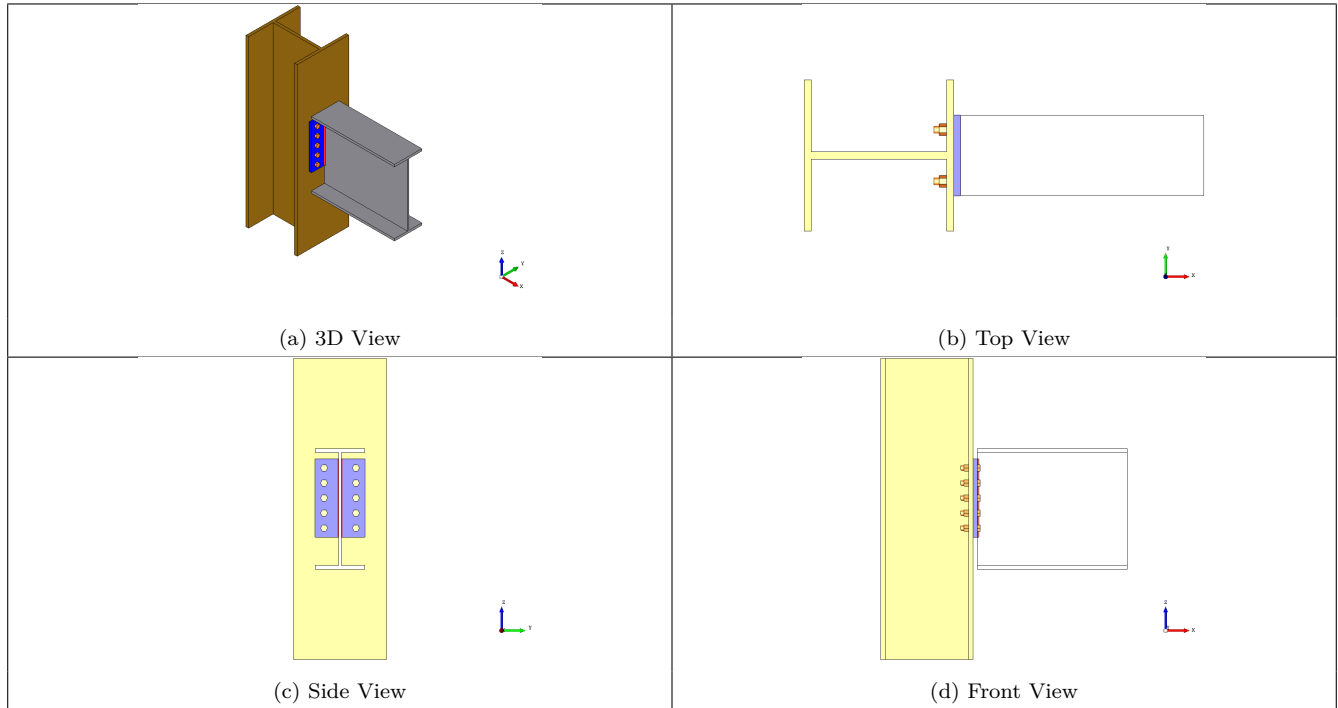
2.4 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= 8$ or 8 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 $= \min(14, 8.0) = 8.0$ $s_{max} = 8$ [Ref. IS 800 : 2007, Cl. 10.5.3.1]	5	Pass
Weld Strength (N/mm)	$R_w = \sqrt{(A_{wh})^2 + (V_{wv})^2}$ $V_{wv} = \frac{V}{l_w} = \frac{240000.0}{416.0}$ $A_{wh} = \frac{A}{l_w} = \frac{125000.0}{416.0}$ $R_w = \sqrt{(300.48)^2 + (576.92)^2}$ $= 541.2$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{4.2 \times 410}{\sqrt{3} \times 1.25}$ $= 662.8$ [Ref. IS 800 : 2007, Cl. 10.5.7.1.1]	
Weld Strength (post long joint) (N/mm)	if $l \geq 150t_t$ then $V_{rd} = \beta_{lw} V_{db}$ if $l < 150t_t$ then $V_{rd} = V_{db}$ where, $l = pt.length \text{ or } pt.height$ $\beta_{lw} = 1.2 - \frac{(0.2l)}{(150t_t)}$ but $0.6 \leq \beta_{lw} \leq 1.0$ [Ref. IS 800 : 2007, Cl. 10.5.7.3]	$l_w = h$ $= 260$ $150t_t = 150 \times 4.2 = 630.0$ since, $l < 150t_t$ then $f_{wrd} = f_w$ $f_{wrd} = 662.8$ [Ref. IS 800 : 2007, Cl. 10.5.7.3]	
Weld Strength (N/mm)	541.2	662.8	Pass



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3 3D Views



4 Design Log