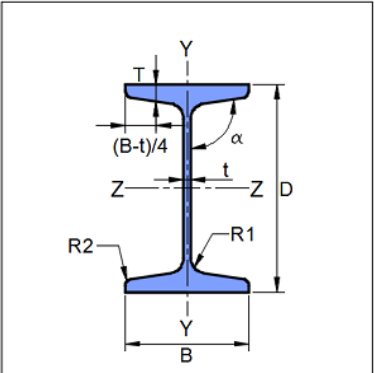
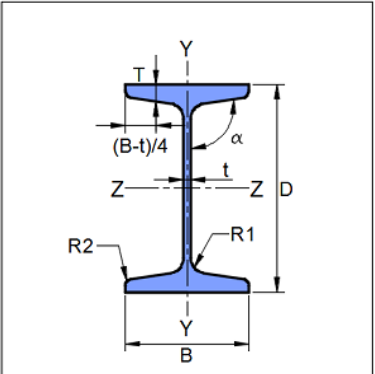




Company Name	IIT Bombay	Project Title	Shear Connection
Group/Team Name	Osdag	Subtitle	End Plate
Designer	Engineer#1	Job Number	1.1.2.2.1
Date	04 /02 /2021	Client	Prof. V Kalyanaraman, IIT Madras

1 Input Parameters

Main Module		Shear Connection		
Module		End Plate Connection		
Connectivity		Column Web-Beam Web		
Shear Force (kN)		220.0		
Axial Force (kN)		30.0		
Supporting Section - Mechanical Properties				
	Supporting Section		HB 350	
	Material		E 250 (Fe 410 W)A	
	Ultimate Strength, F_u (MPa)		410	
	Yield Strength, F_y (MPa)		250	
	Mass, m (kg/m)	67.42	I_z (cm ⁴)	19100.0
	Area, A (cm ²)	85.9	I_y (cm ⁴)	2450.0
	D (mm)	350.0	r_z (cm)	14.9
	B (mm)	250.0	r_y (cm)	5.34
	t (mm)	8.3	Z_z (cm ³)	1090.0
	T (mm)	11.6	Z_y (cm ³)	196.0
	Flange Slope	94	Z_{pz} (cm ³)	1210.0
	R_1 (mm)	12.0	Z_{py} (cm ³)	324.0
	R_2 (mm)	6.0		
	Supported Section - Mechanical Properties			
	Supported Section		WB 300	
	Material		E 250 (Fe 410 W)A	
	Ultimate Strength, F_u (MPa)		410	
	Yield Strength, F_y (MPa)		250	
	Mass, m (kg/m)	48.12	I_z (cm ⁴)	9820.0
	Area, A (cm ²)	61.3	I_y (cm ⁴)	990.0
	D (mm)	300.0	r_z (cm)	12.6
	B (mm)	200.0	r_y (cm)	4.01
	t (mm)	7.4	Z_z (cm ³)	654.0
	T (mm)	10.0	Z_y (cm ³)	99.0
	Flange Slope	96	Z_{pz} (cm ³)	731.0
	R_1 (mm)	11.0	Z_{py} (cm ³)	171.0
	R_2 (mm)	5.5		



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Bolt Details - Input and Design Preference	
Diameter (mm)	[16, 20, 24]
Property Class	[4.6, 4.8, 5.6, 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	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, 20]
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)	500.0



Company Name	IIT Bombay	Project Title	Shear Connection
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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)	220.0	$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{300.0 \times 7.4 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 291299.4540002203$ [Ref. IS 800:2007, Cl.10.4.3]	Pass
Tension Capacity (kN)	30.0	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 300.0 \times 7.4$ $= \frac{2220.0 \times 250}{1.1 \times 10^3}$ $= 504545.45$ [Ref. IS 800:2007, Cl.6.2]	Pass

2.2 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)		24	
Property Class		4.6	
Plate Thickness (mm)		14	
No. of Bolt Columns	2	2	Pass
No. of Bolt Rows		3	Pass
Min. Pitch Distance (mm)	$p_{min} = 2.5d$ $= 2.5 \times 24$ $= 60.0$ [Ref. IS 800:2007, Cl.10.2.2]	60	Pass



Company Name	IIT Bombay	Project Title	Shear Connection
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Date	04 /02 /2021	Client	Prof. V Kalyanaraman, IIT Madras

Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p/g_{\max} = \min(32t, 300)$ $= \min(32 \times 7.4, 300)$ $= \min(236.8, 300)$ $= 236.8$ <p>Where, $t = \min(20.0, 7.4)$</p> <p>[Ref. IS 800:2007, Cl.10.2.3]</p>	60	Pass
Min. End Distance (mm)	$e_{\min} = 1.5d_0$ $= 1.5 \times 30.0$ $= 45.0$ <p>[Ref. IS 800:2007, Cl.10.2.4.2]</p>	45	Pass
Max. End Distance (mm)	$e_{\max} = 12t\varepsilon; \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14 \times \sqrt{\frac{250}{240}} = 171.46$ $e_2 = 12 \times 8.3 \times \sqrt{\frac{250}{250}} = 99.6$ $e_{\max} = \min(e_1, e_2) = 99.6$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	45	Pass
Min. Edge Distance (mm)	$e'_{\min} = 1.5d_0$ $= 1.5 \times 30.0$ $= 45.0$ <p>[Ref. IS 800:2007, Cl.10.2.4.2]</p>	45	Pass



Company Name	IIT Bombay	Project Title	Shear Connection
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Designer	Engineer#1	Job Number	1.1.2.2.1
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Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{\max} = 12t\epsilon; \epsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14 \times \sqrt{\frac{250}{240}} = 171.46$ $e_2 = 12 \times 8.3 \times \sqrt{\frac{250}{250}} = 99.6$ $e'_{\max} = \min(e_1, e_2) = 99.6$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	45	Pass
Min. Gauge Distance (mm)	$g_{\min} = 2(e'_{\min} + s) + t_w$ $= 2(45.0 + 5) + 7.4$ $= 107.4$	108	Pass
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3} \gamma_{mb}}$ $= \frac{400.0 \times 1 \times 353}{1000 \times \sqrt{3} \times 1.25}$ $= 65.22$ <p>[Ref. IS 800:2007, Cl.10.3.3]</p>	
Kb		$k_b = \min \left(\frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0 \right)$ $= \min \left(\frac{45}{3 \times 30.0}, \frac{60}{3 \times 30.0} - 0.25, \frac{400.0}{410}, 1.0 \right)$ $= \min(0.5, 0.42, 0.98, 1.0)$ $= 0.42$ <p>[Ref. IS 800:2007, Cl.10.3.4]</p>	
Bearing Capacity (kN)		$V_{dpp} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.42 \times 24 \times 8.3 \times 410}{1000 \times 1.25}$ $= 48.02$ <p>[Ref. IS 800:2007, Cl.10.3.4]</p>	



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Group/Team Name	Osdag	Subtitle	End Plate
Designer	Engineer#1	Job Number	1.1.2.2.1
Date	04 /02 /2021	Client	Prof. V Kalyanaraman, IIT Madras

Check	Required	Provided	Remarks
Capacity (kN)	$V_{bv} = \frac{V}{n}$ $= \frac{220.0}{6}$ $= 36.67$	$V_{db} = \min (V_{dsb}, V_{dpsb})$ $= \min (65.22, 48.02)$ $= 48023.136000000006$ [Ref. IS 800:2007, Cl.10.3.2]	
Long Joint Reduction Factor		$l_j = (n_r - 1) \times p$ $= (3 - 1) \times 60 = 120$ $l = 120$ $15 \times d = 15 \times 24 = 360$ since, $l_j < 15 \times d$ then $\beta_{lj} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.1]	
Large Grip Length Reduction Factor		$l_g = \Sigma (t_p + t_{member})$ $= 32.3$ $5d = 120$ $8d = 192$ since, $l_g < 5d$; $\beta_{lg} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.2]	
Packing Plate Reduction Factor		$t_{pk} = \text{gap}$ $= 10.0\text{mm}$ since, $t_{pk} \geq 6\text{mm}$, then $V_{rd} = \beta_{pk} V_{db}$ $\beta_{pk} = 1.0 - 0.0125 \times 10.0 = 0.875$ [Ref. IS 800:2007, Cl.10.3.3.3]	
Bolt Capacity (post reduction factor) (kN)	36.67	$V_{rd} = \beta_{lj} \beta_{lg} \beta_{pk} V_{db}$ $= 1.0 \times 1.0 \times 0.875 \times 48.02$ $= 42.02$ [Ref. IS 800:2007, Cl.10.3.3]	



Company Name	IIT Bombay	Project Title	Shear Connection
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Check	Required	Provided	Remarks
Bolt Tension Force (kN)	$T_{ba} = \frac{P}{n}$ $= \frac{30.0}{6}$ $= 5.0$		



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Check	Required	Provided	Remarks
Bolt Prying Force (kN)	$Q = \frac{l_v}{2l_e} \left[T_e - \frac{\beta \eta f_o b_e t^4}{27 l_e l_v^2} \right]$ $l_v = e - \frac{R_1}{2}$ $= 45 - \frac{11.0}{2} = 45.3 \text{ mm}$ $f_o = 0.7 f_{ub}$ $= 0.7 \times 400.0$ $= 280.0 \text{ N/mm}^2$ $l_e = \min \left(e, 1.1 t \sqrt{\frac{\beta f_o}{f_y}} \right)$ $= \min \left(45, 1.1 \times 14 \times \sqrt{\frac{2 \times 280.0}{250}} \right)$ $= \min(45, 23.05) = 23.05 \text{ mm}$ $\beta = 2 \text{ (non pre-tensioned bolt)}$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{200.0}{2} = 60 \text{ mm}$ $Q = \frac{45.3}{2 \times 23.05} \times \left[5.0 - \left(\frac{2 \times 1.5 \times 280.0 \times 60 \times 14^4}{27 \times 23.05 \times 45.3^2} \right) \times 10^{-3} \right]$ $Q = 4.4$ <p>[Ref. IS 800:2007, Cl.10.4.7]</p>		



Company Name	IIT Bombay	Project Title	Shear Connection
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Designer	Engineer#1	Job Number	1.1.2.2.1
Date	04 /02 /2021	Client	Prof. V Kalyanaraman, IIT Madras

Check	Required	Provided	Remarks
Bolt Tension Force (kN)	$T_f = T_1 + Q$ $= 5.0 + 4.4$ $= 9.4$	$T_{db} = 0.90 f_{ub} A_n / \gamma_{mb}$ $< f_{yb} A_{sb} (\gamma_{mb} / \gamma_{m0})$ $= \min \left(0.90 \times 400.0 \times 353 / 1.25, \right.$ $\left. 400.0 \times 452 \times (1.25/1.1) \right)$ $= \min(101.66, 205.45)$ $= 98.62$ [Ref. IS 800:2007, Cl.10.3.5]	Pass
Interaction Ratio	≤ 1	$\left(\frac{V_{sb}}{V_{db}} \right)^2 + \left(\frac{T_b}{T_{db}} \right)^2 \leq 1.0$ $\left(\frac{36.67}{42.02} \right)^2 + \left(\frac{9.4}{98.62} \right)^2 = 0.77$ [Ref. IS 800:2007, Cl.10.3.6]	Pass

2.3 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (300.0 - 2 \times 10.0 - 2 \times 11.0)$ $= 154.8$ [Ref. INSDAG, Ch.5, sec.5.2.3]	210	Pass
Max. Plate Height (mm)	$d_b - 2(t_{bf} + r_{b1} + \text{gap})$ $= 300.0 - 2 \times (10.0 + 11.0 + 10)$ $= 258.0$	210	Pass
Min. Plate Thickness (mm)	$t_w = 7.4$	14	Pass
Min. Plate Width (mm)	$w_{p_{\min}} = g^i + e^i_{\min} 2$ $= 108 + 45.0 \times 2$ $= 198.0$	198	Pass
Max. Plate Width (mm)	$w_{p_{\max}} = D - 2T_f - 2R_r$ $= 350.0 - 2 \times 250.0 - 2 \times 12.0$ $= 302.8$	198	Pass



Company Name	IIT Bombay	Project Title	Shear Connection
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Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{210 \times 14 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 385.77$ [Ref. IS 800:2007, Cl.10.4.3]	
Block Shear Capacity in Shear (kN)		$V_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{db} = \min(V_{db1}, V_{db2}) = 501.11$ [Ref. IS 800:2007, Cl.6.4]	
Shear Capacity (kN)	220.0	$V_d = \min(S_c, V_{db})$ $= \min(385.77, 501.11)$ $= 385.77$ [Ref. IS 800:2007, Cl.6.1]	Pass
Moment Capacity (kNm)	$M = T_e \times ecc$ $ecc = \frac{g}{2} - \frac{t_w}{2} - s = 45.3$ $M = 5.0 \times 45.3 \times 10^{-3} = 0.225$	$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 10290.0 \times 250}{1.1 \times 10^6}$ $= 0.668$ [Ref. IS 800:2007, Cl.8.2.1.2]	Pass



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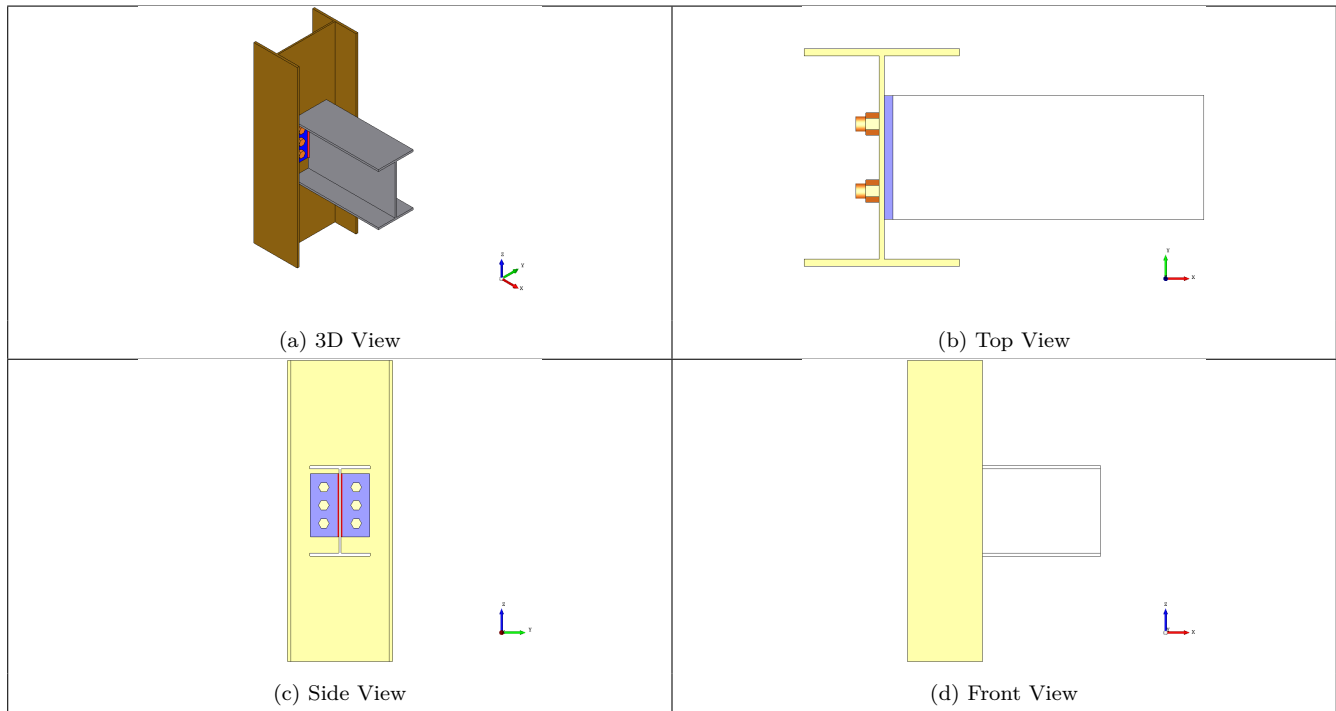
2.4 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= \max(7, 7)$ 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 $= \min(14, 7.4) = 7.4$ $s_{max} = 8$ [Ref. IS 800:2007, Cl.10.5.3.1]	5	Pass
Weld Strength (N/mm)	$R_w = \sqrt{(A_{wh})^2 + (V_{wv})^2}$ $V_{wv} = \frac{V}{l_w} = \frac{220000.0}{420.0}$ $A_{wh} = \frac{A}{l_w} = \frac{30000.0}{420.0}$ $R_w = \sqrt{(71.43)^2 + (523.81)^2}$ $= 555.09$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{3.5 \times 410}{\sqrt{3} \times 1.25}$ $= 662.8$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	
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 = plate length or 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]	$l_w = h$ $= 210$ $150t_t = 150 \times 3.5 = 525.0$ 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)	555.09	662.8	Pass



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3 3D Views



4 Design Log

2021-02-04 12:13:00 - Osdag - INFO - End plate is designed with minimum possible plate thickness.
2021-02-04 12:13:00 - Osdag - INFO - Bolt columns are limited to two (one on each side) in shear end plate.
2021-02-04 12:13:00 - Osdag - INFO - === End Of Design ===