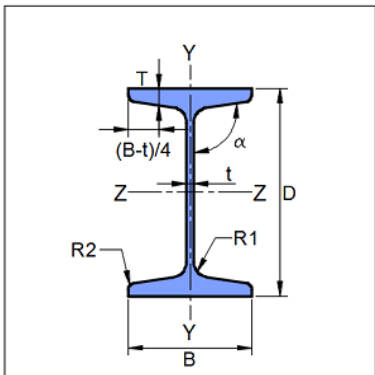
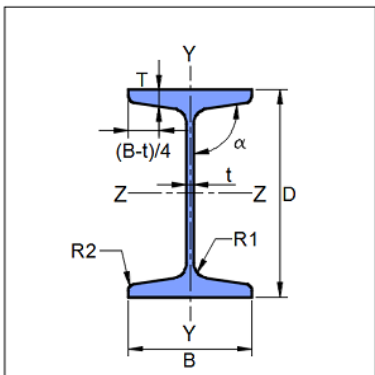




Company Name	IIT Bombay	Project Title	Shear Connection
Group/Team Name	Osdag	Subtitle	End Plate
Designer	Engineer#1	Job Number	1.1.2.2.2
Date	04 /02 /2021	Client	Prof. S R Satish Kumar, IIT Madras

1 Input Parameters

Main Module		Shear Connection		
Module		End Plate Connection		
Connectivity		Column Web-Beam Web		
Shear Force (kN)		275.0		
Axial Force (kN)		0.0		
Supporting Section - Mechanical Properties				
	Supporting Section		HB 350	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		300	
	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		MB 400	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		300	
	Mass, m (kg/m)	61.55	I_z (cm ⁴)	20400.0
	Area, A (cm ²)	78.4	I_y (cm ⁴)	622.0
	D (mm)	400.0	r_z (cm)	16.1
	B (mm)	140.0	r_y (cm)	2.81
	t (mm)	8.9	Z_z (cm ³)	1020.0
	T (mm)	16.0	Z_y (cm ³)	88.8
	Flange Slope	98	Z_{pz} (cm ³)	1170.0
	R_1 (mm)	14.0	Z_{py} (cm ³)	149.0
	R_2 (mm)	7.0		



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Bolt Details - Input and Design Preference	
Diameter (mm)	[20]
Property Class	[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)	[20]
Material	E 250 (Fe 410 W)A
Ultimate Strength, F_u (MPa)	410
Yield Strength, F_y (MPa)	240
Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, F_u (MPa)	410.0



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)	275.0	$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{400.0 \times 8.9 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 560554.6249950185$ [Ref. IS 800:2007, Cl.10.4.3]	Pass
Tension Capacity (kN)	0.0	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 400.0 \times 8.9$ $= \frac{3560.0 \times 300}{1.1 \times 10^3}$ $= 970909.09$ [Ref. IS 800:2007, Cl.6.2]	

2.2 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)		20	
Property Class		9.8	
Plate Thickness (mm)		20	
No. of Bolt Columns	2	2	Pass
No. of Bolt Rows		3	Pass
Min. Pitch Distance (mm)	$p_{min} = 2.5d$ $= 2.5 \times 20$ $= 50.0$ [Ref. IS 800:2007, Cl.10.2.2]	70	Pass



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Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p/g_{\max} = \min(32t, 300)$ $= \min(32 \times 8.9, 300)$ $= \min(284.8, 300)$ $= 284.8$ <p>Where, $t = \min(20.0, 8.9)$</p> <p>[Ref. IS 800:2007, Cl.10.2.3]</p>	70	Pass
Min. End Distance (mm)	$e_{\min} = 1.5d_0$ $= 1.5 \times 22.0$ $= 33.0$ <p>[Ref. IS 800:2007, Cl.10.2.4.2]</p>	35	Pass
Max. End Distance (mm)	$e_{\max} = 12t\varepsilon; \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 20 \times \sqrt{\frac{250}{240}} = 244.95$ $e_2 = 12 \times 8.3 \times \sqrt{\frac{250}{300}} = 90.92$ $e_{\max} = \min(e_1, e_2) = 90.92$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	35	Pass
Min. Edge Distance (mm)	$e'_{\min} = 1.5d_0$ $= 1.5 \times 22.0$ $= 33.0$ <p>[Ref. IS 800:2007, Cl.10.2.4.2]</p>	35	Pass



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Designer	Engineer#1	Job Number	1.1.2.2.2
Date	04 /02 /2021	Client	Prof. S R Satish Kumar, IIT Madras

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{\max} = 12t\epsilon; \epsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 20 \times \sqrt{\frac{250}{240}} = 244.95$ $e_2 = 12 \times 8.3 \times \sqrt{\frac{250}{300}} = 90.92$ $e'_{\max} = \min(e_1, e_2) = 90.92$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	35	Pass
Min. Gauge Distance (mm)	$g_{\min} = 2(e'_{\min} + s) + t_w$ $= 2(33.0 + 6) + 8.9$ $= 86.9$	92	Pass
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3} \gamma_{mb}}$ $= \frac{900.0 \times 1 \times 245}{1000 \times \sqrt{3} \times 1.25}$ $= 101.84$ <p>[Ref. IS 800:2007, Cl.10.3.3]</p>	
Kb		$k_b = \min \left(\frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0 \right)$ $= \min \left(\frac{35}{3 \times 22.0}, \frac{70}{3 \times 22.0} - 0.25, \frac{900.0}{440}, 1.0 \right)$ $= \min(0.53, 0.81, 2.05, 1.0)$ $= 0.53$ <p>[Ref. IS 800:2007, Cl.10.3.4]</p>	
Bearing Capacity (kN)		$V_{dpp} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.53 \times 20 \times 8.3 \times 440}{1000 \times 1.25}$ $= 77.42$ <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	1.1.2.2.2
Date	04 /02 /2021	Client	Prof. S R Satish Kumar, IIT Madras

Check	Required	Provided	Remarks
Capacity (kN)	$V_{bv} = \frac{V}{n}$ $= \frac{275.0}{6}$ $= 45.83$	$V_{db} = \min (V_{dsb}, V_{dpsb})$ $= \min (101.84, 77.42)$ $= 77.42$ [Ref. IS 800:2007, Cl.10.3.2]	
Long Joint Reduction Factor		$l_j = (n_r - 1) \times p$ $= (3 - 1) \times 70 = 140$ $l = 140$ $15 \times d = 15 \times 20 = 300$ 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		$l_g = \Sigma (t_p + t_{member})$ $= 38.3$ $5d = 100$ $8d = 160$ 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)	45.83	$V_{rd} = \beta_{lj} \beta_{lg} \beta_{pk} V_{db}$ $= 1.0 \times 1.0 \times 0.875 \times 77.42$ $= 67.74$ [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)	$T_{ba} = \frac{P}{n}$ $= \frac{0.0}{6}$ $= 0.0$		



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Check	Required	Provided	Remarks
Bolt Prying Force (kN)	$Q = \frac{l_v}{2l_e} \left[T_e - \frac{\beta \eta f_o b_e t^4}{27 l_e l_v^2} \right]$ $l_v = e - \frac{R_1}{2}$ $= 35 - \frac{14.0}{2} = 35.55 \text{ mm}$ $f_o = 0.7 f_{ub}$ $= 0.7 \times 900.0$ $= 630.0 \text{ N/mm}^2$ $l_e = \min \left(e, 1.1 t \sqrt{\frac{\beta f_o}{f_y}} \right)$ $= \min \left(35, 1.1 \times 20 \times \sqrt{\frac{2 \times 630.0}{240}} \right)$ $= \min(35, 50.41) = 35 \text{ mm}$ $\beta = 2 \text{ (non pre-tensioned bolt)}$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{140.0}{2} = 70 \text{ mm}$ $Q = \frac{35.55}{2 \times 35} \times \left[0.0 - \left(\frac{2 \times 1.5 \times 630.0 \times 70 \times 20^4}{27 \times 35 \times 35.55^2} \right) \times 10^{-3} \right]$ $Q = 0.0$ <p><i>Note : The end plate is sufficiently thick to prevent yielding of the plate. Thus, Q = 0</i></p> <p>[Ref. IS 800:2007, Cl.10.4.7]</p>		



Company Name	IIT Bombay	Project Title	Shear Connection
Group/Team Name	Osdag	Subtitle	End Plate
Designer	Engineer#1	Job Number	1.1.2.2.2
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Check	Required	Provided	Remarks
Bolt Tension Force (kN)	$T_f = T_1 + Q$ $= 0.0 + 0.0$ $= 0.0$	$T_{db} = 0.90 f_{ub} A_n / \gamma_{mb}$ $< f_{yb} A_{sb} (\gamma_{mb} / \gamma_{m0})$ $= \min \left(0.90 \times 900.0 \times 245 / 1.25, \right.$ $\left. 900.0 \times 314 \times (1.25/1.1) \right)$ $= \min(158.76, 321.14)$ $= 158.76$ [Ref. IS 800:2007, Cl.10.3.5]	
Interaction Ratio	≤ 1	$\left(\frac{V_{sb}}{V_{db}} \right)^2 + \left(\frac{T_b}{T_{db}} \right)^2 \leq 1.0$ $\left(\frac{45.83}{67.74} \right)^2 + \left(\frac{0.0}{158.76} \right)^2 = 0.46$ [Ref. IS 800:2007, Cl.10.3.6]	Pass

2.3 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (400.0 - 2 \times 16.0 - 2 \times 14.0)$ $= 204.0$ [Ref. INSDAG, Ch.5, sec.5.2.3]	210	Pass
Max. Plate Height (mm)	$d_b - 2(t_{bf} + r_{b1} + \text{gap})$ $= 400.0 - 2 \times (16.0 + 14.0 + 10)$ $= 340.0$	210	Pass
Min. Plate Thickness (mm)	$t_w = 8.9$	20	Pass
Min. Plate Width (mm)	$w_{p_{\min}} = g^i + e^i_{\min} 2$ $= 92 + 33.0 \times 2$ $= 158.0$	162	Pass
Max. Plate Width (mm)	$w_{p_{\max}} = D - 2T_f - 2R_r$ $= 350.0 - 2 \times 250.0 - 2 \times 12.0$ $= 302.8$	162	Pass



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Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{210 \times 20 \times 240}{\sqrt{3} \times 1.1 \times 1000}$ $= 529.06$ [Ref. IS 800:2007, Cl.10.4.3]	
Block Shear Capacity in Shear (kN)		$V_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{db} = \min(V_{db1}, V_{db2}) = 714.5$ [Ref. IS 800:2007, Cl.6.4]	
Shear Capacity (kN)	275.0	$V_d = \min(S_c, V_{db})$ $= \min(529.06, 714.5)$ $= 529.06$ [Ref. IS 800:2007, Cl.6.1]	Pass
Moment Capacity (kNm)	$M = T_e \times ecc$ $ecc = \frac{g}{2} - \frac{t_w}{2} - s = 35.55$ $M = 0.0 \times 35.55 \times 10^{-3} = 0.0$	$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 21000.0 \times 240}{1.1 \times 10^6}$ $= 1.527$ [Ref. IS 800:2007, Cl.8.2.1.2]	



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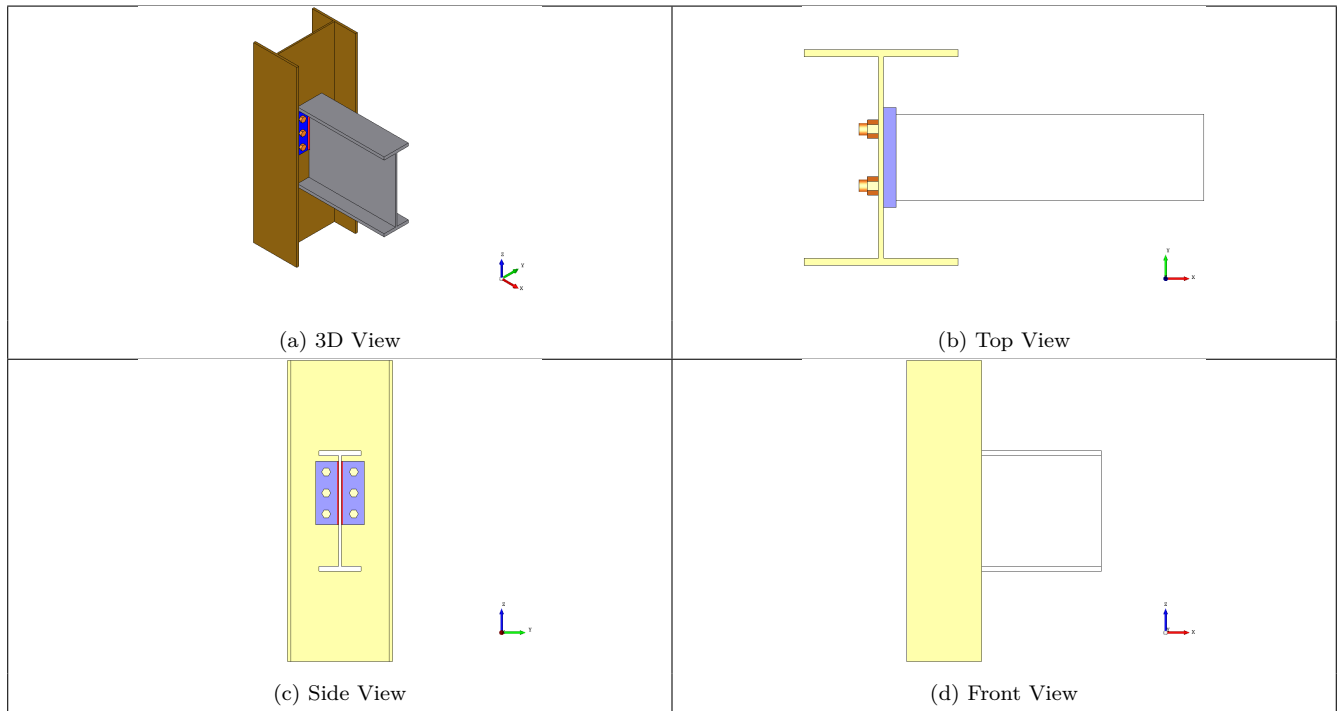
2.4 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= \max(8, 8)$ s_{min} based on thicker part = 5 [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	6	Pass
Max. Weld Size (mm)	Thickness of thinner part $= \min(20, 8.9) = 8.9$ $s_{max} = 10$ [Ref. IS 800:2007, Cl.10.5.3.1]	6	Pass
Weld Strength (N/mm)	$R_w = \sqrt{(A_{wh})^2 + (V_{wv})^2}$ $V_{wv} = \frac{V}{l_w} = \frac{275000.0}{386.0}$ $A_{wh} = \frac{A}{l_w} = \frac{0.0}{386.0}$ $R_w = \sqrt{(0.0)^2 + (712.44)^2}$ $= 712.44$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{4.2 \times 410}{\sqrt{3} \times 1.25}$ $= 795.36$ [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]	$l_w = h$ $= 210$ $150t_t = 150 \times 4.2 = 630.0$ since, $l < 150t_t$ then $f_{wrd} = f_w$ $f_{wrd} = 795.36$ [Ref. IS 800:2007, Cl.10.5.7.3.]	
Weld Strength (N/mm)	712.44	795.36	Pass



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3 3D Views



4 Design Log

2021-02-04 12:14:39 - Osdag - INFO - End plate is designed with minimum possible plate thickness.
2021-02-04 12:14:39 - Osdag - INFO - Bolt columns are limited to two (one on each side) in shear end plate.
2021-02-04 12:14:39 - Osdag - INFO - === End Of Design ===