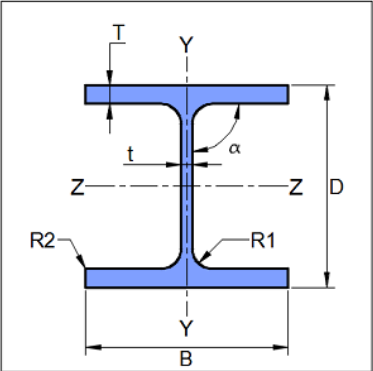
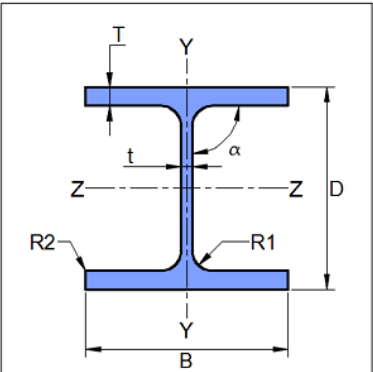




Company Name	IIT Bombay	Project Title	Shear Connection
Group/Team Name	Osdag	Subtitle	End Plate
Designer	Engineer#1	Job Number	1.1.2.1.2
Date	04 /02 /2021	Client	Dr. Harshvardhan Subbarao, Mumbai

1 Input Parameters

Main Module		Shear Connection		
Module		End Plate Connection		
Connectivity		Column Flange-Beam Web		
Shear Force (kN)		250.0		
Axial Force (kN)		80.0		
Supporting Section - Mechanical Properties				
	Supporting Section		UC 254 x 254 x 89	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		300	
	Mass, m (kg/m)	88.9	I_z (cm ⁴)	14268.0
	Area, A (cm ²)	113.3	I_y (cm ⁴)	4857.0
	D (mm)	260.3	r_z (cm)	11.2
	B (mm)	256.3	r_y (cm)	6.55
	t (mm)	10.3	Z_z (cm ³)	1096.0
	T (mm)	17.3	Z_y (cm ³)	379.0
	Flange Slope	90	Z_{pz} (cm ³)	1224.0
	R_1 (mm)	12.7	Z_{py} (cm ³)	575.0
	R_2 (mm)	0.0		
	Supported Section - Mechanical Properties			
	Supported Section		UB 356 x 127 x 39	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		300	
	Mass, m (kg/m)	39.1	I_z (cm ⁴)	10172.0
	Area, A (cm ²)	49.8	I_y (cm ⁴)	358.0
	D (mm)	353.0	r_z (cm)	14.3
	B (mm)	126.0	r_y (cm)	2.7
	t (mm)	6.6	Z_z (cm ³)	576.0
	T (mm)	10.7	Z_y (cm ³)	57.0
	Flange Slope	90	Z_{pz} (cm ³)	659.0
	R_1 (mm)	10.2	Z_{py} (cm ³)	89.1
	R_2 (mm)	0.0		



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Bolt Details - Input and Design Preference	
Diameter (mm)	[24]
Property Class	[8.8]
Type	Friction Grip Bolt
Hole Type	Standard
Bolt Tension	Pretensioned
Slip Factor, (μ_f)	0.25
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)	[18]
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)	440.0



Company Name	IIT Bombay	Project Title	Shear Connection
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Designer	Engineer#1	Job Number	1.1.2.1.2
Date	04 /02 /2021	Client	Dr. Harshvardhan Subbarao, Mumbai

2 Design Checks

Design Status	Pass
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2.1 Section Design Check

Check	Required	Provided	Remarks
Shear Capacity (kN)	250.0	$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{353.0 \times 6.6 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 366848.36104308814$ [Ref. IS 800:2007, Cl.10.4.3]	Pass
Tension Capacity (kN)	80.0	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 353.0 \times 6.6$ $= \frac{2329.8 \times 300}{1.1 \times 10^3}$ $= 635400.0$ [Ref. IS 800:2007, Cl.6.2]	Pass

2.2 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)		24	
Property Class		8.8	
Plate Thickness (mm)		18	
No. of Bolt Columns	2	2	Pass
No. of Bolt Rows		4	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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Designer	Engineer#1	Job Number	1.1.2.1.2
Date	04 /02 /2021	Client	Dr. Harshvardhan Subbarao, Mumbai

Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p/g_{\max} = \min(32t, 300)$ $= \min(32 \times 6.6, 300)$ $= \min(211.2, 300)$ $= 211.2$ <p>Where, $t = \min(18.0, 6.6)$</p> <p>[Ref. IS 800:2007, Cl.10.2.3]</p>	60	Pass
Min. End Distance (mm)	$e_{\min} = 1.7d_0$ $= 1.7 \times 26.0$ $= 44.2$ <p>[Ref. IS 800:2007, Cl.10.2.4.2]</p>	45	Pass
Max. End Distance (mm)	$e_{\max} = 12t\varepsilon; \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 18 \times \sqrt{\frac{250}{250}} = 216.0$ $e_2 = 12 \times 17.3 \times \sqrt{\frac{250}{300}} = 189.51$ $e_{\max} = \min(e_1, e_2) = 189.51$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	45	Pass
Min. Edge Distance (mm)	$e'_{\min} = 1.7d_0$ $= 1.7 \times 26.0$ $= 44.2$ <p>[Ref. IS 800:2007, Cl.10.2.4.2]</p>	45	Pass



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Designer	Engineer#1	Job Number	1.1.2.1.2
Date	04 /02 /2021	Client	Dr. Harshvardhan Subbarao, Mumbai

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{\max} = 12t\epsilon; \epsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 18 \times \sqrt{\frac{250}{250}} = 216.0$ $e_2 = 12 \times 17.3 \times \sqrt{\frac{250}{300}} = 189.51$ $e'_{\max} = \min(e_1, e_2) = 189.51$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	45	Pass
Min. Gauge Distance (mm)	$g_1 = 2(e'_{\min} + s) + t_w$ $= 2(44.2 + 5) + 6.6$ $= 105.0$ $g_2 = 2(e'_{\min} + R_r) + T_w$ $= 2(44.2 + 12.7) + 10.3$ $= 124.1$ $g_{\min} = \max(g_1, g_2)$ $= 124.1$	126	Pass
Slip Resistance (kN)		$V_{dsf} = \frac{\mu_f n_e K_h F_o}{\gamma_{mf}}$ <p>Where, $F_o = 0.7 f_{ub} A_{nb}$</p> $V_{dsf} = \frac{0.25 \times 1 \times 1.0 \times 0.7 \times 830.0 \times 353}{1.25 \times 10^3}$ $= 41018.6$ <p>[Ref. IS 800:2007, Cl.10.4.3]</p>	
Capacity (kN)	$V_{bv} = \frac{V}{n}$ $= \frac{250.0}{8}$ $= 31.25$	41018.6	



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Designer	Engineer#1	Job Number	1.1.2.1.2
Date	04 /02 /2021	Client	Dr. Harshvardhan Subbarao, Mumbai

Check	Required	Provided	Remarks
Long Joint Reduction Factor		$l_j = (n_r - 1) \times p$ $= (4 - 1) \times 60 = 180$ $l = 180$ $15 \times d = 15 \times 24 = 360$ <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		$l_g = \Sigma (t_p + t_{\text{member}})$ $= 45.3$ $5d = 120$ $8d = 192$ <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		$t_{pk} = \text{gap}$ $= 10.0\text{mm}$ <p>since, $t_{pk} \geq 6\text{mm}$, 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>	
Bolt Capacity (post reduction factor) (kN)	31.25	$V_{rd} = \beta_{lj} \beta_{lg} \beta_{pk} V_{db}$ $= 1.0 \times 1.0 \times 1.0 \times 41.02$ $= 41.02$ <p>[Ref. IS 800:2007, Cl.10.3.3]</p>	
Bolt Tension Force (kN)	$T_{ba} = \frac{P}{n}$ $= \frac{80.0}{8}$ $= 10.0$		



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Check	Required	Provided	Remarks
Bolt Prying Force (kN)	$Q = \frac{l_v}{2l_e} \left[T_e - \frac{\beta \eta f_o b_e t^4}{27 l_e l_v^2} \right]$ $l_v = e - \frac{R_1}{2}$ $= 45 - \frac{10.2}{2} = 54.7 \text{ mm}$ $f_o = 0.7 f_{ub}$ $= 0.7 \times 830.0$ $= 581.0 \text{ N/mm}^2$ $l_e = \min \left(e, 1.1 t \sqrt{\frac{\beta f_o}{f_y}} \right)$ $= \min \left(45, 1.1 \times 18 \times \sqrt{\frac{1 \times 581.0}{250}} \right)$ $= \min(45, 30.18) = 30.18 \text{ mm}$ $\beta = 1 \text{ (pre-tensioned bolt)}$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{126.0}{2} = 60 \text{ mm}$ $Q = \frac{54.7}{2 \times 30.18} \times \left[10.0 - \left(\frac{1 \times 1.5 \times 581.0 \times 60 \times 18^4}{27 \times 30.18 \times 54.7^2} \right) \times 10^{-3} \right]$ $Q = 4.34$ <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	1.1.2.1.2
Date	04 /02 /2021	Client	Dr. Harshvardhan Subbarao, Mumbai

Check	Required	Provided	Remarks
Bolt Tension Force (kN)	$T_f = T_1 + Q$ $= 10.0 + 4.34$ $= 14.34$	$T_{db} = 0.90 f_{ub} A_n / \gamma_{mb}$ $< f_{yb} A_{sb} (\gamma_{mb} / \gamma_{m0})$ $= \min \left(0.90 \times 830.0 \times 353 / 1.25, \right.$ $\left. 830.0 \times 452 \times (1.25 / 1.1) \right)$ $= \min(210.95, 426.32)$ $= 210.95$ [Ref. IS 800:2007, Cl.10.3.5]	Pass
Interaction Ratio	≤ 1	$\left(\frac{V_{sb}}{V_{db}} \right)^2 + \left(\frac{T_b}{T_{db}} \right)^2 \leq 1.0$ $\left(\frac{31.25}{41.02} \right)^2 + \left(\frac{14.34}{210.95} \right)^2 = 0.58$ [Ref. IS 800:2007, Cl.10.3.6]	Pass

2.3 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (353.0 - 2 \times 10.7 - 2 \times 10.2)$ $= 186.72$ [Ref. INSDAG, Ch.5, sec.5.2.3]	270	Pass
Max. Plate Height (mm)	$d_b - 2(t_{bf} + r_{b1} + \text{gap})$ $= 353.0 - 2 \times (10.7 + 10.2 + 10)$ $= 311.2$	270	Pass
Min. Plate Thickness (mm)	$t_w = 6.6$	18	Pass
Min. Plate Width (mm)	$w_{p_{\min}} = g^i + e^i_{\min} 2$ $= 126 + 44.2 \times 2$ $= 214.4$	216	Pass
Max. Plate Width (mm)	$w_{p_{\max}} = T_f$ $= 256.3$	216	Pass



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Designer	Engineer#1	Job Number	1.1.2.1.2
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Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{270 \times 18 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 637.71$ [Ref. IS 800:2007, Cl.10.4.3]	
Block Shear Capacity in Shear (kN)		$V_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{db} = \min(V_{db1}, V_{db2}) = 779.27$ [Ref. IS 800:2007, Cl.6.4]	
Shear Capacity (kN)	250.0	$V_d = \min(S_c, V_{db})$ $= \min(637.71, 779.27)$ $= 637.71$ [Ref. IS 800:2007, Cl.6.1]	Pass
Moment Capacity (kNm)	$M = T_e \times ecc$ $ecc_1 = \frac{g}{2} - \frac{t_w}{2} - s = 54.7$ $ecc_2 = \frac{g}{2} - \frac{T_w}{2} - R_r = 45.15$ $\max(ecc_1, ecc_2) = 54.7$ $M = 10.0 \times 54.7 \times 10^{-3} = 0.545$	$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 21870.0 \times 250}{1.1 \times 10^6}$ $= 1.105$ [Ref. IS 800:2007, Cl.8.2.1.2]	Pass



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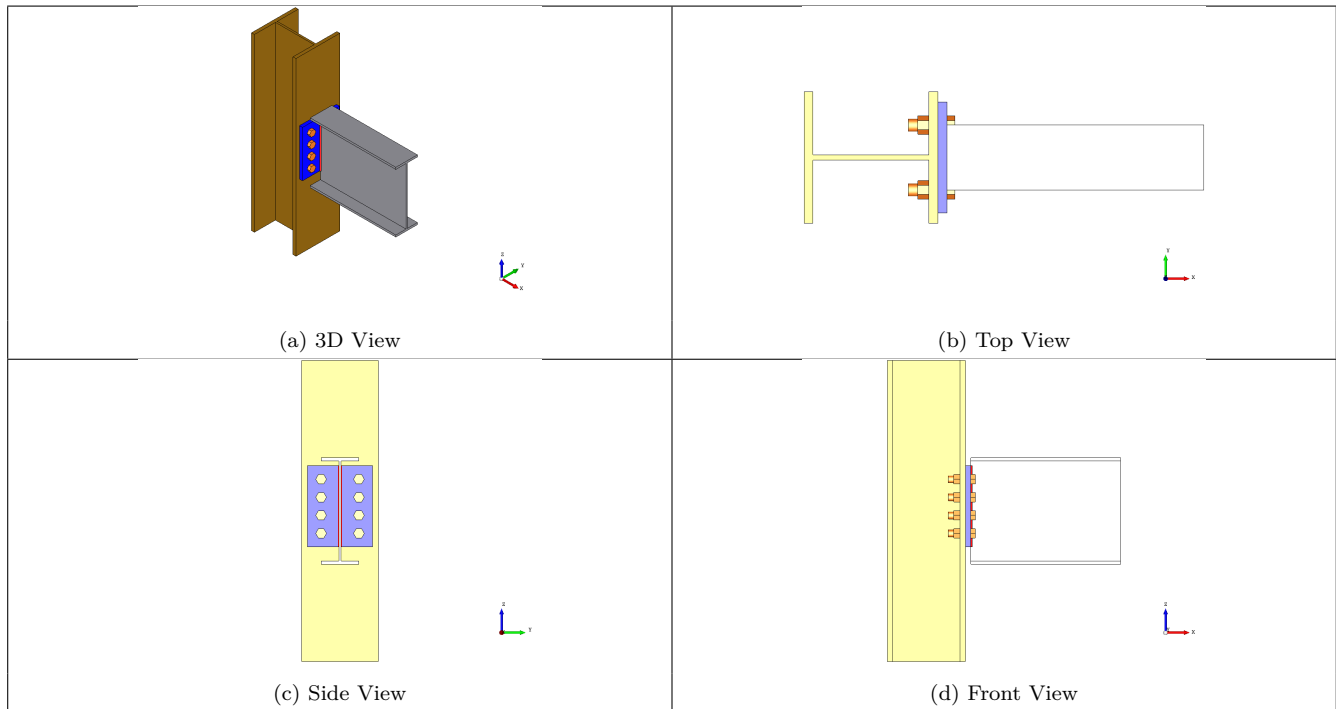
2.4 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= \max(6, 6)$ 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 $= \min(18, 6.6) = 6.6$ $s_{max} = 8$ [Ref. IS 800:2007, Cl.10.5.3.1]	5	Pass
Weld Strength (N/mm)	$R_w = \sqrt{(A_{wh})^2 + (V_{wv})^2}$ $V_{wv} = \frac{V}{l_w} = \frac{250000.0}{520.0}$ $A_{wh} = \frac{A}{l_w} = \frac{80000.0}{520.0}$ $R_w = \sqrt{(153.85)^2 + (480.77)^2}$ $= 504.78$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{3.5 \times 410}{\sqrt{3} \times 1.25}$ $= 662.8$ [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]	$l_w = h$ $= 270$ $150t_t = 150 \times 3.5 = 525.0$ 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)	504.78	662.8	Pass



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3 3D Views



4 Design Log

2021-02-04 12:09:16 - Osdag - INFO - End plate is designed with minimum possible plate thickness.
2021-02-04 12:09:16 - Osdag - INFO - Bolt columns are limited to two (one on each side) in shear end plate.
2021-02-04 12:09:16 - Osdag - INFO - === End Of Design ===