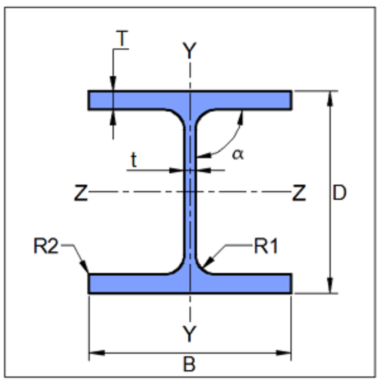
	Created with Osdag®		
Company Name	IIT Bombay	Project Title	Shear Connection
Group/Team Name	Osdag	Subtitle	Seated Angle
Designer	Engineer#1	Job Number	1.1.4.2.2
Date	04 /02 /2021	Client	Dr. Pradyumna M, Bengaluru

1 Input Parameters

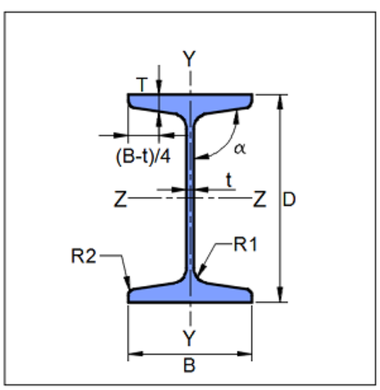
Module	Seated Angle Connection
Main Module	Shear Connection
Connectivity	Column Web-Beam Web
Shear Force (kN)	90.0

Supporting Section - Mechanical Properties



Supporting Section		UC 203 x 203 x 60	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, F_u (MPa)		410	
Yield Strength, F_y (MPa)		250	
Mass, m (kg/m)	60.0	I_z (cm^4)	6125.0
Area, A (cm^2)	76.4	I_y(cm^4)	2064.0
D (mm)	209.6	r_z (cm)	8.95
B (mm)	205.8	r_y (cm)	5.2
t (mm)	9.4	Z_z (cm^3)	584.0
T (mm)	14.2	Z_y (cm^3)	201.0
Flange Slope	90	Z_{pz} (cm^3)	656.0
R_1 (mm)	10.2	Z_{py} (cm^3)	305.0
R_2 (mm)	0.0		

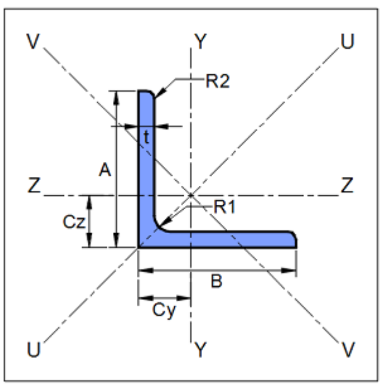
Supported Section - Mechanical Properties



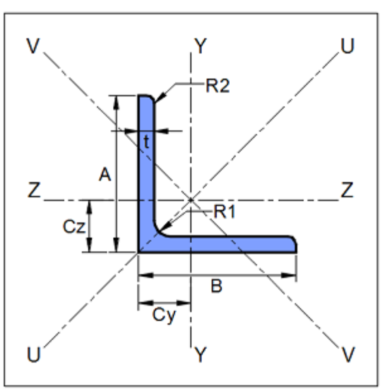
Supported Section		LB 325	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, F_u (MPa)		410	
Yield Strength, F_y (MPa)		250	
Mass, m (kg/m)	43.07	I_z (cm^4)	9880.0
Area, A (cm^2)	54.8	I_y(cm^4)	510.0
D (mm)	325.0	r_z (cm)	13.4
B (mm)	165.0	r_y (cm)	3.05
t (mm)	7.0	Z_z (cm^3)	608.0
T (mm)	9.8	Z_y (cm^3)	61.9
Flange Slope	98	Z_{pz} (cm^3)	688.0
R_1 (mm)	16.0	Z_{py} (cm^3)	111.0
R_2 (mm)	8.0		

Bolt Details - Input and Design Preference

Diameter (mm)	[16]
Property Class	[8.8]
Type	Bearing Bolt
Hole Type	Standard
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
Seated and Top Angle Details	



Section Size*	90 x 90 x 10		
Material	E 250 (Fe 410 W)A		
Ultimate Strength, F_u (MPa)	410		
Yield Strength, F_y (MPa)	250		
Mass, m (kg/m)	13.47	I_u (cm^4)	205.0
Area, A (cm^2)	17.1	I_v(cm^4)	53.6
A (mm)	90.0	r_z (cm)	2.75
B (mm)	90.0	r_y (cm)	2.75
t (mm)	10.0	r_u (cm)	3.46
R_1 (mm)	8.5	r_v (cm)	1.77
R_2 (mm)	0.0	Z_z (cm^3)	20.2
C_y (mm)	26.0	Z_y (cm^3)	20.2
C_z (mm)	26.0	Z_{pz} (cm^3)	36.4
I_z (cm^4)	129.0	Z_{py} (cm^3)	20.2
I_y(cm^4)	129.0		



Section Size*	80 x 80 x 10		
Material	E 250 (Fe 410 W)A		
Ultimate Strength, F_u (MPa)	410		
Yield Strength, F_y (MPa)	250		
Mass, m (kg/m)	11.88	I_u (cm^4)	141.0
Area, A (cm^2)	15.1	I_v(cm^4)	37.1
A (mm)	80.0	r_z (cm)	2.43
B (mm)	80.0	r_y (cm)	2.43
t (mm)	10.0	r_u (cm)	3.05

R_1 (mm)	8.0	r_v (cm)	1.57
R_2 (mm)	0.0	Z_z (cm^3)	15.8
C_y (mm)	23.6	Z_y (cm^3)	15.8
C_z (mm)	23.6	Z_{pz} (cm^3)	28.4
I_z (cm^4)	89.2	Z_{py} (cm^3)	15.8
I_y(cm^4)	89.2		

1.1 List of Input Section

Seated Angle List	'90 x 90 x 10'

1.2 List of Input Section

Top Angle List	'80 x 80 x 10'

2 Design Checks

Design Status	Pass

2.1 Section Design

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{325.0 \times 7.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 497.53$ [Ref. IS 800:2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	90.0	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 497.53$ $= 298.516$ [Limited to low shear]	Pass

2.2 Load Consideration

Check	Required	Provided	Remarks
Applied Shear Force (kN)	90.0	$V_{y_{\min}} = \min(0.15 V_{d_y},\ 40.0)$ $= \min(0.15 \times 497.53,\ 40.0)$ $= 40$ $V_u = \max(V_y,\ V_{y_{\min}})$ $= \max(90.0, 40)$ $= 90.0$ [Ref. IS 800:2007, Cl.10.7]	

2.3 Bolt Design Checks on Column

Check	Required	Provided	Remarks
Diameter (mm)		16	
Property Class		8.8	
Plate Thickness (mm)		10.0	
Large Grip Length Reduction Factor	if $l_g \geq 5d,$ then $V_{\text{rd}} = \beta_{lg} V_{\text{db}}$ if $l_g < 5d$ then $V_{\text{rd}} = V_{\text{db}}$ $l_g \leq 8d$ where, $l_g = \Sigma(t_{\text{ep}} + t_{\text{member}})$ $\beta_{lg} = 8d/(3d + l_g)$ but $\beta_{lg} \leq \beta_{lj}$ [Ref. IS 800:2007, Cl.10.3.3.2]	$l_g = \Sigma\ (t_p + t_{\text{member}})$ $= 24.2$ $5d = 80$ $8d = 128$ since, $l_g < 5d$; $\beta_{lg} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.2]	Pass
No. of Bolt Columns		2	
No. of Bolt Rows	$1 \leq n_r \leq 2$	1	Pass
Min. Pitch Distance (mm)	$p_{\text{min}} = 2.5d$ $= 2.5 \times 16$ $= 40.0$ [Ref. IS 800:2007, Cl.10.2.2]	40	Pass
Max. Pitch Distance (mm)	$p_{\text{max}} = \min(32t,\ 300)$ $= \min(32 \times 10.0,\ 300)$ $= \min(320.0,\ 300)$ $= 300$ Where, $t = \min(10.0, 14.2)$ [Ref. IS 800:2007, Cl.10.2.3]	40	Pass

Check	Required	Provided	Remarks
Min. End Distance (mm)	$e_{\text{min}} = 1.5d_0$ $= 1.5 \times 18.0$ $= 27.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	42	Pass
Max. End Distance (mm)	$e_{\text{max}} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 10.0 \times \sqrt{\frac{250}{250}} = 120.0$ $e_2 = 12 \times 9.4 \times \sqrt{\frac{250}{250}} = 112.8$ $e_{\text{max}} = \min(e_1,\ e_2) = 112.8$ [Ref. IS 800:2007, Cl.10.2.4.3]	42	Pass
Min. Edge Distance (mm)	$e'_{\text{min}} = 1.5d_0$ $= 1.5 \times 18.0$ $= 27.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	30	Pass
Max. Edge Distance (mm)	$e'_{\text{max}} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 10.0 \times \sqrt{\frac{250}{250}} = 120.0$ $e_2 = 12 \times 9.4 \times \sqrt{\frac{250}{250}} = 112.8$ $e'_{\text{max}} = min(e_1,\ e_2) = 112.8$ [Ref. IS 800:2007, Cl.10.2.4.3]	30	Pass
Shear Capacity (kN)		$V_{\text{dsb}} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}}$ $= \frac{800.0 \times 1 \times 157}{1000 \times \sqrt{3}\ \times\ 1.25}$ $= 58.01$ [Ref. IS 800:2007, Cl.10.3.3]	

Check	Required	Provided	Remarks
Kb		$k_b = \min\left(\frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0\right)$ $= \min\left(\frac{30}{3 \times 18.0}, \frac{40}{3 \times 18.0} - 0.25, \frac{800.0}{410}, 1.0\right)$ $= \min(0.56, 0.49, 1.95, 1.0)$ $= 0.49$ [Ref. IS 800:2007, Cl.10.3.4]	
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.49 \times 16 \times 9.4 \times 410}{1000 \times 1.25}$ $= 60.43$ [Ref. IS 800:2007, Cl.10.3.4]	
Capacity (kN)	$V_{bv} = \frac{V}{n}$ $= \frac{90.0}{2}$ $= 45.0$	$V_{\text{db}} = \min\ (V_{\text{dsb}},\ V_{\text{dpb}})$ $= \min\ (58.01,\ 60.43)$ $= 58.01$ [Ref. IS 800:2007, Cl.10.3.2]	
Capacity (kN)	45.0	58.01	Pass

2.4 Detailing Check

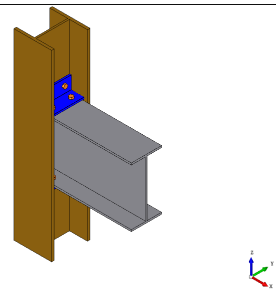
Check	Required	Provided	Remarks
Minimum Width (mm) (on beam)	$4 \times e' + t_w + 2 \times r_r$ $= 4 \times 30 + 9.4 + 2 \times 10.2$ $= 159.0$	165.0	Pass
Min. Leg Length (mm) (on column)	$2 \times e' + t + r_{ra} + (n_r - 1) \times p$ $= 2 \times 30 + 10.0 + 8.5 + (1 - 1) \times 40$ $= 78.5$	90.0	Pass

2.5 Seated Angle Checks

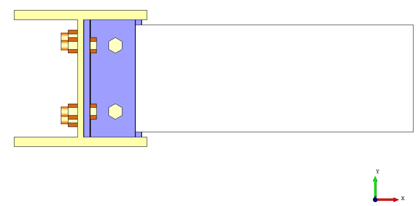
Check	Required	Provided	Remarks
Designation		90 x 90 x 10	
Shear Capacity (kN)	90.0	$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{185.0 \times 10.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 242.75$ [Ref. IS 800:2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	90.0	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 242.75$ $= 145.65$ [Limited to low shear]	Pass
Bearing Length		$b_{l_{\text{req}}} = \frac{V\gamma_m 0}{t_w f_y} - t_f - r_r$ $= \frac{90.0 \times 1.1}{7.0 \times 250} - 9.8 - 16.0$ $= 30.77$ $k = t_f + r_r$ $k = 9.8 + 16.0 = 25.8$ $b_1 = \max(b_{1_{\text{req}}},\ k) = 30.77$ $b_2 = b_1 + \text{gap} - t - r_{r_a}$ $b_2 = 30.77 + 10.0 - 10.0 - 8.5$ $b_2 = \max(b_2,\ 0) = 22.27$	
Minimum Leg Length (mm)	$b_1 + \text{gap} = 40.77$	90.0	Pass

Check	Required	Provided	Remarks
Moment Capacity (kNm)	$M = V \times ecc$ if $b_2 \leq b_1,\ ecc = \frac{b_2}{b_1} \times \frac{b_2}{2}$ $ecc = \frac{22.27}{30.77} \times \frac{22.27}{2}$ $= 8.06$ $M = 90.0 \times 8.06 \times 10^{-3}$ $= 0.725$	$M_{dz} = \frac{\beta_b Z_p fy}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 4625.0 \times 250}{1.1 \times 10^6}$ $= 1.05$ [Ref. IS 800:2007, Cl.8.2.1.2]	**Pass**

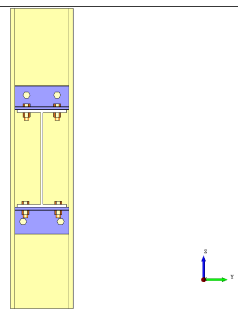
3 3D Views



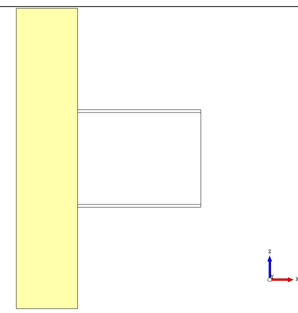
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log

2021-02-04 13:03:08 - Osdag - INFO - Based on the thumb rules, a minimum top angle leg size of 78.0 mm and a thickness of 8 mm is required to provide stability to LB 325.

2021-02-04 13:03:08 - Osdag - INFO - === End Of Design ===