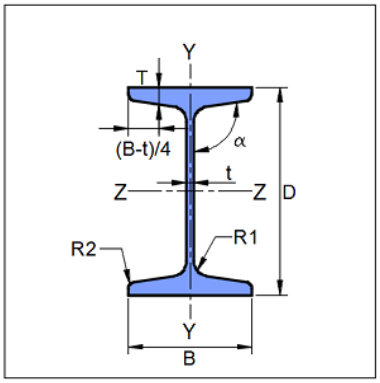
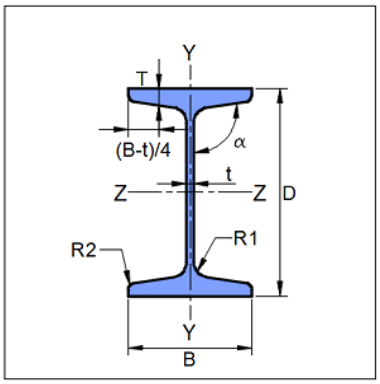
Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Seated Angle
Designer	Engineer #1	Job Number	1.1.4.2.1
Date	17 /12 /2020	Client	Pradyumna M, Independent Consultant, Bengaluru

1 Input Parameters

Module		Seated Angle	
Main Module		Shear Connection	
Connectivity		Column Web-Beam Web	
Shear Force (kN)		230.0	
Supporting Section - Mechanical Properties			
	Supporting Section	HB 450	
	Material	E 250 (Fe 410 W)A	
	Ultimate Strength, Fu (MPa)	410	
	Yield Strength, Fy (MPa)	250	
	Mass, m (kg/m) 87.22	I_z (cm^4)	39200.0
	Area, A (cm^2) 111.0	I_y(cm^4)	2980.0
	D (mm) 450.0	r_z (cm)	18.7
	B (mm) 250.0	r_y (cm)	5.18
	t (mm) 9.8	Z_z (cm^3)	1740.0
	T (mm) 13.7	Z_y (cm^3)	238.0
	Flange Slope 94	Z_{pz} (cm^3)	1950.0
	R_1 (mm) 15.0	Z_{py} (cm^3)	394.0
	R_2 (mm) 7.5		
Supported Section - Mechanical Properties			
	Supported Section	MB 400	
	Material	E 250 (Fe 410 W)A	
	Ultimate Strength, Fu (MPa)	410	
	Yield Strength, Fy (MPa)	250	
	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		
Bolt Details - Input and Design Preference			

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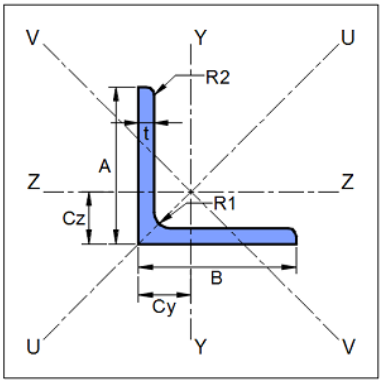
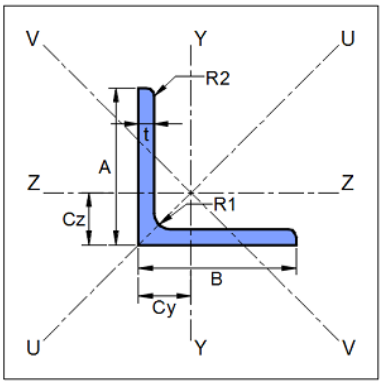
Diameter (mm)	[20, 24, 30]
Property Class	[4.6, 4.8, 5.6, 5.8, 6.8, 8.8, 9.8]
Type	Bearing Bolt
Hole Type	Standard
Slip Factor, (mu_f)	0.3
Detailing - Design Preference	
Edge Preparation Method	Rolled, machine-flame cut, sawn and planed
Gap Between Members (mm)	10.0
Are the Members Exposed to Corrosive Influences?	False
Seated and Top Angle Details	



Section Size*		50 x 50 x 3	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (MPa)		250	
Mass, m (kg/m)	2.34	I_u (cm^4)	11.4
Area, A (cm^2)	2.99	I_v(cm^4)	3.01
A (mm)	50.0	r_z (cm)	1.55
B (mm)	50.0	r_y (cm)	1.55
t (mm)	3.0	r_u (cm)	1.96
R_1 (mm)	6.0	r_v (cm)	1.0
R_2 (mm)	0.0	Z_z (cm^3)	1.97
C_y (mm)	13.4	Z_y (cm^3)	1.97
C_z (mm)	13.4	Z_{pz} (cm^3)	3.53
I_z (cm^4)	7.21	Z_{py} (cm^3)	1.97
I_y(cm^4)	7.21		



Section Size*		50 x 50 x 3	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (MPa)		250	
Mass, m (kg/m)	2.34	I_u (cm^4)	11.4
Area, A (cm^2)	2.99	I_v(cm^4)	3.01
A (mm)	50.0	r_z (cm)	1.55
B (mm)	50.0	r_y (cm)	1.55
t (mm)	3.0	r_u (cm)	1.96

R_1 (mm)	6.0	r_v (cm)	1.0
R_2 (mm)	0.0	Z_z (cm^3)	1.97
C_y (mm)	13.4	Z_y (cm^3)	1.97
C_z (mm)	13.4	Z_{pz} (cm^3)	3.53
I_z (cm^4)	7.21	Z_{py} (cm^3)	1.97
I_y(cm^4)	7.21		

1.1 List of Input Section

Seated Angle List	'50 x 50 x 3', '50 x 50 x 4', '50 x 50 x 5', '50 x 50 x 6', '55 x 55 x 4', '55 x 55 x 5', '55 x 55 x 6', '55 x 55 x 8', '60 x 60 x 4', '60 x 60 x 5', '60 x 60 x 6', '60 x 60 x 8', '65 x 65 x 4', '65 x 65 x 5', '65 x 65 x 6', '65 x 65 x 8', '70 x 70 x 5', '70 x 70 x 6', '70 x 70 x 8', '70 x 70 x 10', '75 x 75 x 5', '75 x 75 x 6', '75 x 75 x 8', '75 x 75 x 10', '80 x 80 x 6', '80 x 80 x 8', '80 x 80 x 10', '80 x 80 x 12', '90 x 90 x 6', '90 x 90 x 8', '90 x 90 x 10', '90 x 90 x 12', '100 x 100 x 6', '100 x 100 x 8', '100 x 100 x 10', '100 x 100 x 12', '110 x 110 x 8', '110 x 110 x 10', '110 x 110 x 12', '110 x 110 x 16', '130 x 130 x 8', '130 x130 x 10', '130 x130 x 12', '130 x130 x 16', '150 x 150 x 10', '150 x 150 x 12', '150 x 150 x 16', '150 x 150 x 20', '200 x 200 x 12', '200 x 200 x 16', '200 x 200 x 20', '200 x 200 x 25', '50 x 50 x 7', '50 x 50 x 8', '55 x 55 x 10', '60 x 60 x 10', '65 x 65 x 10', '70 x 70 x 7', '100 x 100 x 7', '100 x 100 x 15', '120 x 120 x 8', '120 x 120 x 10', '120 x 120 x 12', '120 x 120 x 15', '130 x 130 x 9', '150 x 150 x 15', '150 x 150 x 18', '180 x 180 x 15', '180 x 180 x 18', '180 x 180 x 20', '200 x 200 x 24'

1.2 List of Input Section

Top Angle List	'50 x 50 x 3', '50 x 50 x 4', '50 x 50 x 5', '50 x 50 x 6', '55 x 55 x 4', '55 x 55 x 5', '55 x 55 x 6', '55 x 55 x 8', '60 x 60 x 4', '60 x 60 x 5', '60 x 60 x 6', '60 x 60 x 8', '65 x 65 x 4', '65 x 65 x 5', '65 x 65 x 6', '65 x 65 x 8', '70 x 70 x 5', '70 x 70 x 6', '70 x 70 x 8', '70 x 70 x 10', '75 x 75 x 5', '75 x 75 x 6', '75 x 75 x 8', '75 x 75 x 10', '80 x 80 x 6', '80 x 80 x 8', '80 x 80 x 10', '80 x 80 x 12', '90 x 90 x 6', '90 x 90 x 8', '90 x 90 x 10', '90 x 90 x 12', '100 x 100 x 6', '100 x 100 x 8', '100 x 100 x 10', '100 x 100 x 12', '110 x 110 x 8', '110 x 110 x 10', '110 x 110 x 12', '110 x 110 x 16', '130 x 130 x 8', '130 x130 x 10', '130 x130 x 12', '130 x130 x 16', '150 x 150 x 10', '150 x 150 x 12', '150 x 150 x 16', '150 x 150 x 20', '200 x 200 x 12', '200 x 200 x 16', '200 x 200 x 20', '200 x 200 x 25', '50 x 50 x 7', '50 x 50 x 8', '55 x 55 x 10', '60 x 60 x 10', '65 x 65 x 10', '70 x 70 x 7', '100 x 100 x 7', '100 x 100 x 15', '120 x 120 x 8', '120 x 120 x 10', '120 x 120 x 12', '120 x 120 x 15', '130 x 130 x 9', '150 x 150 x 15', '150 x 150 x 18', '180 x 180 x 15', '180 x 180 x 18', '180 x 180 x 20', '200 x 200 x 24'

2 Design Checks

Design Status	Fail

2.1 Section Design

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{400.0 \times 8.9 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 778548.09$ [$Ref. IS\ 800 : 2007, Cl. 10.4.3$]	
Allowable Shear Capacity (kN)	230.0	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 778548.09$ $= 467128.8541625154$ [*Limited to low shear*]	**Pass**

2.2 Load Consideration

Check	Required	Provided	Remarks
Applied Shear Force (kN)	230.0	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 778548.09, 40.0)$ $= 40$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(230.0, 40)$ $= 230.0$ [$Ref.\ IS\ 800 : 2007,\ Cl.\ 10.7$]	

2.3 Bolt Design Checks on Column

Check	Required	Provided	Remarks
Diameter (mm)		20.0	
Property Class		9.8	
Plate Thickness (mm)		25.0	
Large Grip Length Reduction Factor	$if\ l_g \geq 5\ d\ then\ V_{rd} = \beta_{lg}\ V_{db}$ $if\ l_g < 5d\ then\ V_{rd} = V_{db}$ $l_g \leq 8d$ $where,$ $l_g = \Sigma(t_{ep} + t_{member})$ $\beta_{lg} = 8d/(3d + l_g)$ $but\ \beta_{lg} \leq \beta_{lj}$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3.2]$	$l_g = \Sigma\ (t_p + t_{member})$ $= 41.0$ $5d = 100.0$ $8d = 160.0$ $since,\ l_g < 5d\ ;\ \beta_{lg} = 1.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3.2]$	**Pass**
Min. Edge Distance (mm)	$e'_{min} = 1.5\ d_0$ $= 1.5 \times 22.0$ $= 33.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.2]$		
Minimum Width (mm)On Column	$4 \times e' + 2 \times R_1 + t = 179.8$	$B = 250.0$	**Pass**
Minimum Width (mm)On Beam	$4 \times e' + 2 \times R_1 + t = 176.9$	$B = 140.0$	**Fail**

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2.4 Seated Angle Checks

Check	Required	Provided	Remarks
Designation		200 x 200 x 24	
Shear Capacity (kN)	230.0	$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{160.0 \times 25.0 \times 240}{\sqrt{3} \times 1.1 \times 1000}$ $= 483.715$ [$Ref. IS\ 800:2007, Cl.10.4.3$]	
Allowable Shear Capacity (kN)	230.0	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 483.715$ $= 290.23$ [*Limited to low shear*]	**Pass**
Bearing Length		$b_{lreq} = \frac{V \times \gamma_m 0}{t_w \times f_y} - t_f - r_r$ $= \frac{230.0 \times 1.1}{8.9 \times 250} - 16.0 - 14.0$ $= 83.71$ $k = t_f + r_r$ $k = 16.0 + 14.0 = 30.0$ $b_1 = max(b_{1req}, k) = 83.71$ $b_2 = b_1 + gap - t - r_{ra}$ $b_2 = 83.71 + 10.0 - 24.0 - 18.0$ $b_2 = max(b_2, 0) = 51.71$	
Minimum Leg Length (mm)	$b_1 + gap = 93.71$	200.0	**Pass**

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Check	Required	Provided	Remarks
Moment Capacity (kNm)	$M = V \times ecc$ $if\ b_2 \leq b_1, ecc = \frac{b_2}{b_1} \times \frac{b_2}{2}$ $ecc = \frac{51.71}{83.71} \times \frac{51.71}{2}$ $= 15.97$ $M = 230.0 \times 15.97 \times 10^{-3}$ $= 3.673$	$M_{dzz} = \frac{\beta_b \times Z_p \times fy}{\gamma_{mo} \times 10^6}$ $= \frac{1.0 \times 23040.0 \times 240}{1.1 \times 10^6}$ $= 5.03$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 8.2.1.2]$	**Pass**

3 Design Log

2020-12-17 23:23:45 - Osdag - INFO - The required seated angle thickness is available. Fetching angle leg size.

2020-12-17 23:23:45 - Osdag - ERROR - sufficient leg size / flange width is not available for selected bolt, please select lower bolt diameter

2020-12-17 23:23:45 - Osdag - ERROR - It fails in detailing check