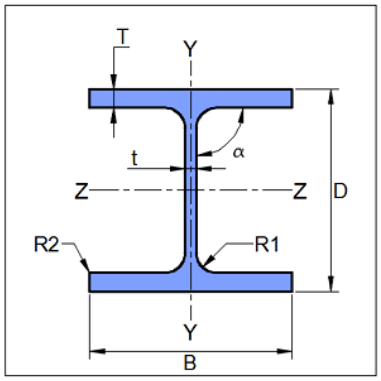
Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Seated Angle
Designer	Engineer #1	Job Number	1.1.4.2.2
Date	17 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

1 Input Parameters

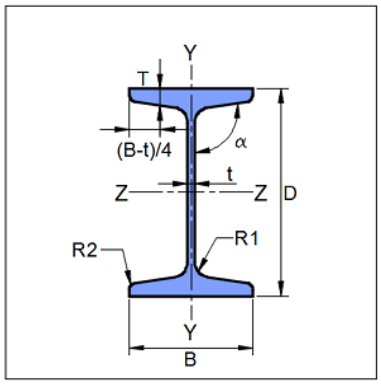
Module	Seated Angle
Main Module	Shear Connection
Connectivity	Column Web-Beam Web
Shear Force (kN)	90.0

Supporting Section - Mechanical Properties



Supporting Section		UC 203 x 203 x 52	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (MPa)		250	
Mass, m (kg/m)	52.0	I_z (cm^4)	5259.0
Area, A (cm^2)	66.3	I_y(cm^4)	1777.0
D (mm)	206.2	r_z (cm)	8.91
B (mm)	204.3	r_y (cm)	5.18
t (mm)	7.9	Z_z (cm^3)	510.0
T (mm)	12.5	Z_y (cm^3)	174.0
Flange Slope	90	Z_{pz} (cm^3)	567.0
R_1 (mm)	10.2	Z_{py} (cm^3)	264.0
R_2 (mm)	0.0		

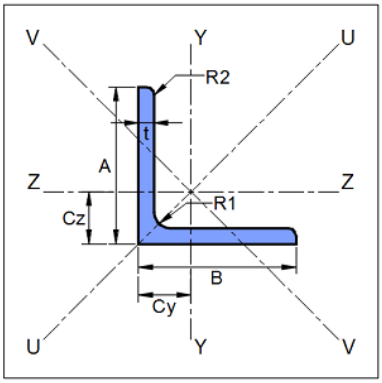
Supported Section - Mechanical Properties



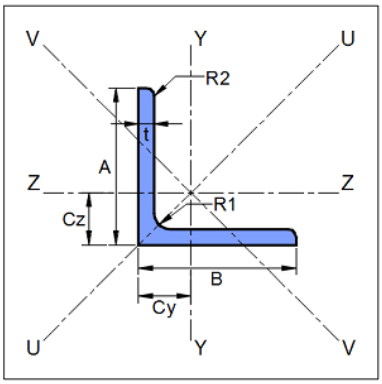
Supported Section		LB 325	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (MPa)		250	
Mass, m (kg/m)	43.07	I_z (cm^4)	9880.0
Area, A (cm^2)	54.8	I_y(cm^4)	510.0
D (mm)	325.0	r_z (cm)	13.4
B (mm)	165.0	r_y (cm)	3.05
t (mm)	7.0	Z_z (cm^3)	608.0
T (mm)	9.8	Z_y (cm^3)	61.9
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, (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*		90 x 90 x 10	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (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, Fu (MPa)		410	
Yield Strength, Fy (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)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{325.0 \times 7.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 497527.22$ [$Ref. IS\ 800:2007, Cl.10.4.3$]	
Allowable Shear Capacity (kN)	90.0	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 497527.22$ $= 298516.3323650906$ [*Limited to low shear*]	**Pass**

2.2 Load Consideration

Check	Required	Provided	Remarks
Applied Shear Force (kN)	90.0	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 497527.22, 40.0)$ $= 40$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(90.0, 40)$ $= 90.0$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.7$]	

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	$if\ l_g \geq 5\ d\ then\ V_{rd} = \beta_{lg}\ V_{db}$ $if\ l_g < 5d\ then\ V_{rd} = V_{db}$ $l_g \leq 8d$ $where,$ $l_g = \Sigma(t_{ep} + t_{member})$ $\beta_{lg} = 8d/(3d + l_g)$ $but\ \beta_{lg} \leq \beta_{lj}$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3.2]$	$l_g = \Sigma\ (t_p + t_{member})$ $= 22.5$ $5d = 80$ $8d = 128$ $since,\ l_g < 5d\ ;\ \beta_{lg} = 1.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3.2]$	**Pass**
No. of Bolt Columns		2	
No. of Bolt Rows	$1 \leq n_r \leq 2$	1	**Pass**
Min. Pitch Distance (mm)	$p_{min} = 2.5\ d$ $= 2.5 \times 16$ $= 40.0$ $[Ref\ IS\ 800:2007,\ Cl.\ 10.2.2]$	40	**Pass**
Max. Pitch Distance (mm)	$p_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 \times 10.0,\ 300\ mm)$ $= \min(320.0,\ 300\ mm)$ $= 300$ $Where,\ t = min(10.0, 12.5)$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.2.3]$	40	**Pass**

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Seated Angle
Designer	Engineer #1	Job Number	1.1.4.2.2
Date	17 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

Check	Required	Provided	Remarks
Min. End Distance (mm)	$e_{min} = 1.5\ d_0$ $= 1.5 \times 18.0$ $= 27.0$ [*Ref. IS* 800 : 2007, *Cl.* 10.2.4.2]	42	**Pass**
Max. End Distance (mm)	$e_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 10.0 \times \sqrt{\frac{250}{250}} = 120.0$ $e_2 = 12 \times 7.9 \times \sqrt{\frac{250}{250}} = 94.8$ $e_{max} = min(e_1, e_2) = 94.8$ [*Ref. IS* 800 : 2007, *Cl.* 10.2.4.3]	42	**Pass**
Min. Edge Distance (mm)	$e'_{min} = 1.5\ d_0$ $= 1.5 \times 18.0$ $= 27.0$ [*Ref. IS* 800 : 2007, *Cl.* 10.2.4.2]	30.0	**Pass**
Max. Edge Distance (mm)	$e'_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 10.0 \times \sqrt{\frac{250}{250}} = 120.0$ $e_2 = 12 \times 7.9 \times \sqrt{\frac{250}{250}} = 94.8$ $e'_{max} = min(e_1, e_2) = 94.8$ [*Ref. IS* 800 : 2007, *Cl.* 10.2.4.3]	30.0	**Pass**
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub}\ n_n\ A_{nb}}{\sqrt{3}\ \gamma_{mb}}$ $= \frac{800.0 \times 1 \times 157}{1000 \times \sqrt{3}\ \times\ 1.25}$ $= 58.01$ [*Ref. IS* 800 : 2007, *Cl.* 10.3.3]	

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Seated Angle
Designer	Engineer #1	Job Number	1.1.4.2.2
Date	17 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

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)		$V_{dpb} = \frac{2.5\ k_b\ d\ t\ f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.49 \times 16 \times 7.9 \times 410}{1000 \times 1.25}$ $= 50.79$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.4]$	
Capacity (kN)	$V_{bv} = \frac{V}{n}$ $= \frac{90.0}{2}$ $= 45.0$	$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (58.01, 50.79)$ $= 50.79$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.2]$	
Capacity (kN)	45.0	50.79	**Pass**

2.4 Detailing Check

Check	Required	Provided	Remarks
Minimum Width (mm)On Column	148.3	204.3	**Pass**
Minimum Width (mm)On Beam	159.0	165.0	**Pass**
Min. Leg Length (mm)On Column	78.5	90.0	**Pass**

2.5 Seated Angle Checks

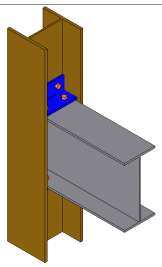
Check	Required	Provided	Remarks
Designation		90 x 90 x 10	
Shear Capacity (kN)	90.0	$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{185.0 \times 10.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 242.75$ $[Ref. IS\ 800:2007, Cl.10.4.3]$	
Allowable Shear Capacity (kN)	90.0	$V_d = 0.6\ V_{dy}$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

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Seated Angle
Designer	Engineer #1	Job Number	1.1.4.2.2
Date	17 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

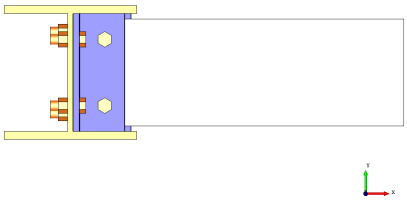
Check	Required	Provided	Remarks
Moment Capacity (kNm)	$M = V \times ecc$ $if\ b_2 \leq b_1, ecc = \frac{b_2}{b_1} \times \frac{b_2}{2}$ $ecc = \frac{22.27}{30.77} \times \frac{22.27}{2}$ $= 8.06$ $M = 90.0 \times 8.06 \times 10^{-3}$ $= 0.725$	$M_{dzz} = \frac{\beta_b \times Z_p \times fy}{\gamma_{mo}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

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Seated Angle
Designer	Engineer #1	Job Number	1.1.4.2.2
Date	17 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

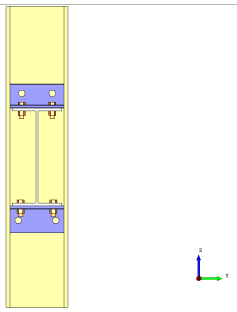
3 3D Views



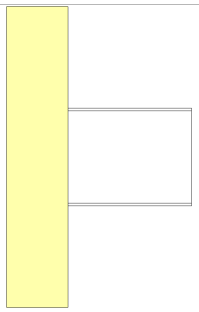
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log

2020-12-17 23:25:55 - Osdag - INFO - The required seated angle thickness is available. Fetching angle leg size.
2020-12-17 23:25:55 - 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.