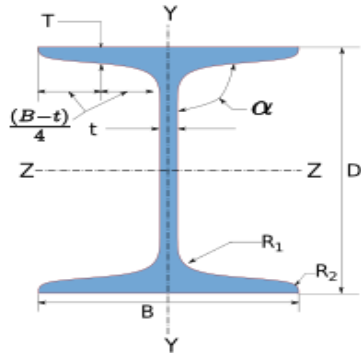




Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

1 Input Parameters

Module		Column-to-Column End Plate Connection		
Main Module		Moment Connection		
Bending Moment (kNm)		0.0		
Shear Force (kN)		0.0		
Axial Force (kN)		350.0		
Column Section - Mechanical Properties				
	Beam Section *		HB 250	
	Material		E 250 (Fe 410 W)A	
	Ultimate Strength, F_u (MPa)		410	
	Yield Strength, F_y (MPa)		250	
	Mass, m (kg/m)	50.98	I_z (cm ⁴)	7730.0
	Area, A (cm ²)	64.9	I_y (cm ⁴)	1960.0
	D (mm)	250.0	r_z (cm)	10.9
	B (mm)	250.0	r_y (cm)	5.49
	t (mm)	6.9	Z_z (cm ³)	619.0
	T (mm)	9.7	Z_y (cm ³)	156.0
	Flange Slope	94	Z_{pz} (cm ³)	678.0
	R_1 (mm)	10.0	Z_{py} (cm ³)	262.0
	R_2 (mm)	5.0		
Bolt Details - Input and Design Preference				
Diameter (mm)		[24, 30]		
Property Class		[8.8, 9.8, 10.9, 12.9]		
Type		Bearing Bolt		
Bolt Tension		Non pre-tensioned		
Hole Type		Standard		
Slip Factor, (μ_f)		0.3		
Detailing - Design Preference				
Edge Preparation Method		Rolled, machine-flame cut, sawn and planed		
Are the Members Exposed to Corrosive Influences?		False		



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

2 Design Checks

Design Status	Pass
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2.1 Member Capacity

Check	Required	Provided	Remarks
Section Classification		Semi-Compact [Ref: Table 2, Cl.3.7.2 and 3.7.4, IS 800:2007]	
Axial Capacity Member (kN)	350	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $= \frac{6490.0 \times 250}{1.1 \times 10^3}$ $= 1475.0$ [Ref. IS 800:2007, Cl.6.2]	Pass
Shear Capacity Member (kN)	0	$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{230.6 \times 6.9 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 208.78$ [Ref. IS 800:2007, Cl.10.4.3]	
Plastic Moment Capacity (kNm)		$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{0.91 \times 678000.0 \times 250}{1.1 \times 10^6}$ $= 140.68$ [Ref. IS 800:2007, Cl.8.2.1.2]	
Moment Deformation Criteria (kNm)		$M_{dc} = \frac{1.5 Z_e f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.5 \times 619000.0 \times 250}{1.1 \times 10^6}$ $= 211.02$ [Ref. IS 800:2007, Cl.8.2.1.2]	



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

Check	Required	Provided	Remarks
Moment Capacity Member (kNm)	0	$M_{dz} = \min(M_{dz}, M_{dc})$ $= \min(140.68, 211.02)$ $= 140.68$ [Ref. IS 800:2007, Cl.8.2]	

2.2 Load Consideration

Check	Required	Provided	Remarks
Interaction Ratio		<p>I.R. axial $= P_x/T_{dg}$ $= 350.0/1475.0$ $= 0.24$</p> <p>I.R. moment $= M_z/M_{dz}$ $= 0.0/140.68$ $= 0.0$</p> <p>I.R. sum $= \text{I.R. axial} + \text{I.R. moment}$ $= 0.24 + 0.0$ $= 0.24$</p>	



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

Check	Required	Provided	Remarks
Minimum Required Load	<p>if I.R. axial < 0.3 and I.R. moment < 0.5</p> $P_{x\min} = 0.3T_{dg}$ $M_{z\min} = 0.5M_{dz}$ <p>elif sum I.R. ≤ 1.0 and I.R. moment < 0.5</p> <p>if $(0.5 - \text{I.R. moment}) < (1 - \text{sum I.R.})$</p> $M_{z\min} = 0.5 \times M_{dz}$ <p>else</p> $M_{z\min} = M_z + ((1 - \text{sum I.R.}) \times M_{dz})$ $P_{x\min} = P_x$ <p>elif sum I.R. ≤ 1.0 and I.R. axial < 0.3</p> <p>if $(0.3 - \text{I.R. axial}) < (1 - \text{sum I.R.})$</p> $P_{x\min} = 0.3T_{dg}$ <p>else</p> $P_{x\min} = P_x + ((1 - \text{sum I.R.}) \times T_{dg})$ $M_{z\min} = M_z$ <p>else</p> $P_{x\min} = P_x$ $M_{z\min} = M_z$ <p>Note: AL is the user input for load</p>	$M_{z\min} = 70.34$ $P_{x\min} = 442.5$ <p>[Ref. IS 800:2007, Cl.10.7]</p>	
Applied Axial Force (kN)	350.0	$P_u = \max(P_x, P_{x\min})$ $= \max(350.0, 442.5)$ $= 442.5$	



Company Name	IIT Bombay	Project Title	Moment Connection
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Designer	Engineer#1	Job Number	1.2.3.3.2.1
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Check	Required	Provided	Remarks
Applied Shear Force (kN)	0.0	$V_{y\min} = \min(0.15V_{dy}, 40.0)$ $= \min(0.15 \times 347.97, 40.0)$ $= 40.0$ $V_u = \max(V_y, V_{y\min})$ $= \max(0.0, 40.0)$ $= 40.0$ [Ref. IS 800:2007, Cl.10.7]	
Applied Moment (kNm)	0.0	$M_u = \max(M_z, M_{z\min})$ $= \max(0.0, 70.34)$ $= 70.34$ [Ref. IS 800:2007, Cl.8.2.1.2]	

2.3 Bolt Check

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Quantity Optimization	$d = 30.0$	
Property Class	Bolt Grade Optimization	8.8	
Hole Diameter (mm)		$d_0 = 33.0$	
No. of Bolts (along one side of the web) (n)	$n_{bw} = 2 \times \left(\frac{D - (2 \times T_f) - (2 \times e)}{p} + 1 \right)$ $= 2 \times \left(\frac{250.0 - (2 \times 9.7) - (2 \times 50)}{75.0} + 1 \right)$ $= 4$	4	Pass
No. of Bolts (along one side of the flange overhang) (n)	$n_{bf} = 2 \times \left(\frac{b/2 - (T_w/2) - (2 \times e)}{p} + 1 \right)$ $= 2 \times \left(\frac{250.0/2 - (0.5 \times 6.9) - (2 \times 50)}{75.0} + 1 \right)$ $= 2$	2	Pass
Total No. of Bolts		8	



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3} \gamma_{mb}}$ $= \frac{830.0 \times 1 \times 561}{1000 \times \sqrt{3} \times 1.25}$ $= 215.07$ <p>[Ref. IS 800:2007, Cl.10.3.3]</p>	
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.51 \times 30.0 \times 45.0 \times 410}{1000 \times 1.25}$ $= 564.57$ <p>[Ref. IS 800:2007, Cl.10.3.4]</p>	
Capacity (kN)	$V_{sb} = \frac{V}{n_{wb}}$ $= \frac{40.0}{4}$ $= 5.0$	$V_{db} = \min (V_{dsb}, V_{dpb})$ $= \min (215.07, 564.57)$ $= 215.07$ <p>[Ref. IS 800:2007, Cl.10.3.2]</p>	Pass
Tension due to Moment and Axial Force (kN)	$T_1 = \frac{P}{n} + \frac{M \times y_{max}}{y_{sqr}}$ $= \frac{442.5 \times 10^3}{8} + \frac{70340.91 \times 10^6 \times 295.15}{249027.49}$ $= 138.68$		



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

Check	Required	Provided	Remarks
Prying force (kN)	$Q = \frac{l_v}{2l_e} \left[T_e - \frac{\beta \eta f_o b_e t^4}{27 l_e l_v^2} \right]$ $l_v = e - t_w$ $= 50 - 0 = 50 \text{ mm}$ $f_o = 0.7 f_{ub}$ $= 0.7 \times 830.0$ $= 581.0 \text{ N/mm}^2$ $l_e = \min \left(e, 1.1 t \sqrt{\frac{\beta f_o}{f_y}} \right)$ $= \min \left(50, 1.1 \times 45.0 \times \sqrt{\frac{2 \times 581.0}{250}} \right)$ $= \min(50, 75.46) = 50 \text{ mm}$ $\beta = 2 \text{ (non pre-tensioned bolt)}$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{250.0}{2} = 125.0 \text{ mm}$ $Q = \frac{50}{2 \times 50} \times \left[138.68 - \left(\frac{2 \times 1.5 \times 581.0 \times 125.0 \times 45.0^4}{27 \times 50 \times 50^2} \right) \right] \times 10^{-3}$ $Q = 6.55$ <p>[Ref. IS 800:2007, Cl.10.4.7]</p>		OK



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

Check	Required	Provided	Remarks
Tension demand (kN)	$T_b = T_1 + Q$ $= 139 + 6.55$ $= 145.23$	$T_{db} = 0.90 f_{ub} A_n / \gamma_{mb}$ $< f_{yb} A_{sb} (\gamma_{mb} / \gamma_{m0})$ $= \min \left(0.90 \times 830.0 \times 561 / 1.25, \right.$ $\left. 660.0 \times 707.0 \times (1.25/1.1) \right)$ $= \min(335.25, 530.25)$ $= 335.25$ [Ref. IS 800:2007, Cl.10.3.5]	Pass
Min. Pitch Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 30.0$ $= 75.0$ [Ref. IS 800:2007, Cl.10.2.2]	75.0	Pass
Max. Pitch Distance (mm)	$p/g_{\max} = \min(32t, 300)$ $= \min(32 \times 45.0, 300)$ $= \min(1440.0, 300)$ $= 300$ Where, $t = \min(45.0, 45.0)$ [Ref. IS 800:2007, Cl.10.2.3]	75.0	Pass
Min. End Distance (mm)	$e_{\min} = 1.5d_0$ $= 1.5 \times 33.0$ $= 49.5$ [Ref. IS 800:2007, Cl.10.2.4.2]	50	Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

Check	Required	Provided	Remarks
Max. End Distance (mm)	$e_{\max} = 12t\epsilon; \epsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 45.0 \times \sqrt{\frac{250}{250}} = 540.0$ $e_2 = 12 \times 45.0 \times \sqrt{\frac{250}{250}} = 540.0$ $e_{\max} = \min(e_1, e_2) = 540.0$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	50	Pass

2.4 End Plate Checks

Check	Required	Provided	Remarks
Min. Plate Length (mm)	$D + 4e$ $= 250.0 + 4 \times 50$ $= 450.0$	450.0	Pass
Min. Plate Height (mm)	250.0	250.0	Pass
Min. Plate Thickness (mm)	$t_p = \max \left(\sqrt{\frac{4M_{cr}}{b_{eff}(f_y/\gamma_{m0})}}, \right.$ $\left. \sqrt[4]{\left(T_1 - \frac{2Ql_e}{l_v}\right) \times \left(\frac{27l_e l_v^2}{\beta \eta f_o b_e}\right)} \right)$ $= \max \left(\sqrt{\frac{4 \times 6.93 \times 10^6}{75 \times (250/1.1)}}, \right.$ $\left. \sqrt[4]{\left(138681.28 - \frac{2 \times 6.55 \times 50}{50}\right) \times \left(\frac{27 \times 50 \times 50^2}{2 \times 1.5 \times 581.0 \times 125.0}\right)} \right)$ $= 45.0$	45.0	
Moment Capacity (kNm)	$M_{ep} = \text{Tension in bolt X end distance}$ $= T_b \times e$ $= 138681.28 \times 50$ $= 6.93$	$M_{dp} = \frac{b_{eff} t_p^2 f_y}{4 \gamma_{m0}}$ $= \frac{75.0 \times 45.0^2 \times 250}{4 \times 1.1}$ $= 8.63$	Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

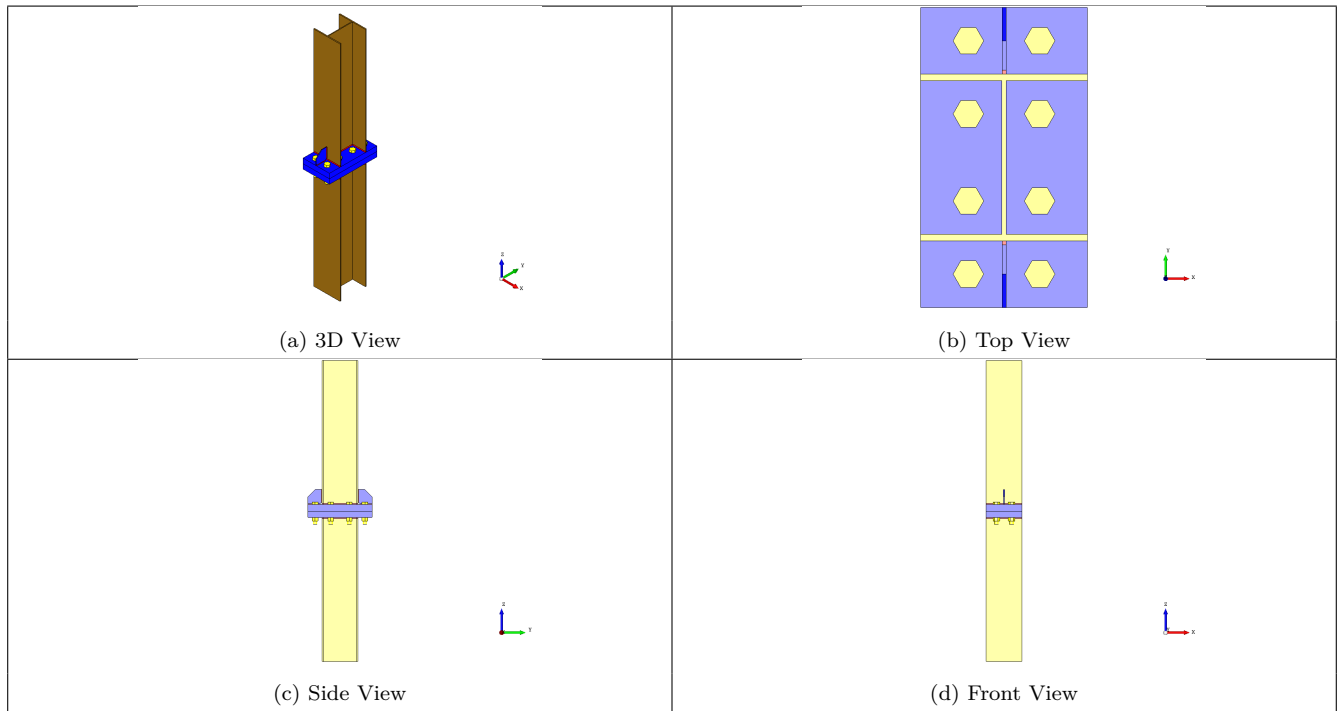
2.5 Stiffener Details

Check	Required	Provided	Remarks
Height (mm)	$h_s = 14 t_s$ = 100	100	
Width (mm)	$w_s = 2 e$ = 2×50 = 100	100	
Thickness (mm)		6	
Type		Groove Weld	
Weld Between Stiffener and End plate		Groove Weld	



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.3.3.2.1
Date	04 /02 /2021	Client	Mr. Manas M Ghosh, Kolkata

3 3D Views



4 Design Log

2021-02-04 15:09:55 - Osdag - INFO - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].

2021-02-04 15:09:55 - Osdag - INFO - The value of load(s) is/are set at minimum recommended value as per IS 800:2007, Cl.10.7.

2021-02-04 15:09:55 - Osdag - INFO - : Overall Column End Plate connection design is SAFE

2021-02-04 15:09:55 - Osdag - INFO - :=====End Of design=====