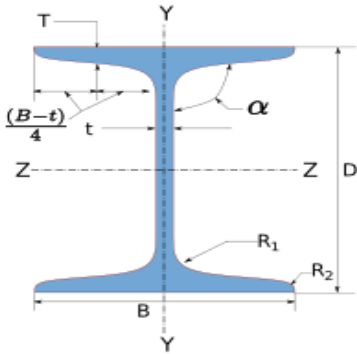
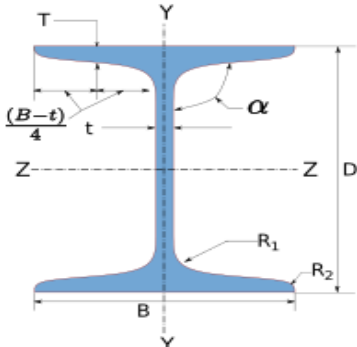




Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

## 1 Input Parameters

Main Module		Moment Connection		
Module		Beam-to-Column End Plate Connection		
Connectivity		Column Flange-Beam Web		
End Plate Type		Extended Both Ways - Reversible Moment		
Bending Moment (kNm)		180.0		
Shear Force (kN)		100.0		
Axial Force (kN)		0.0		
Column Section - Mechanical Properties				
	Column Section		PBP 400 X 158.1	
	Material		E 350 (Fe 490)	
	Ultimate Strength, Fu (MPa)		490	
	Yield Strength, Fy (MPa)		350	
	Mass, m (kg/m)	158.1	Iz (cm4)	45900.0
	Area, A (cm2)	201.0	Iy(cm4)	18300.0
	D (mm)	356.0	rz (cm)	15.1
	B (mm)	394.0	ry (cm)	9.6
	t (mm)	18.0	Zz (cm3)	2570.0
	T (mm)	18	Zy (cm3)	932.0
	Flange Slope	90	Zpz (cm3)	2880.0
	R1 (mm)	15.0	Zpy (cm3)	1420.0
	R2 (mm)	0.0		
Beam Section - Mechanical Properties				
	Beam Section		MB 500	
	Material		E 300 (Fe 440)	
	Ultimate Strength, Fu (MPa)		440	
	Yield Strength, Fy (MPa)		300	
	Mass, m (kg/m)	86.88	Iz (cm4)	45200.0
	Area, A (cm2)	110.0	Iy(cm4)	1360.0
	D (mm)	500.0	rz (cm)	20.2
	B (mm)	180.0	ry (cm)	3.51
	t (mm)	10.2	Zz (cm3)	1800.0
	T (mm)	17.2	Zy (cm3)	152.0
	Flange Slope	98	Zpz (cm3)	2070.0



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

	$R_1$ (mm)	17.0	$Z_{py}$ (cm <sup>3</sup> )	259.0
	$R_2$ (mm)	8.5		
Plate Details - Input and Design Preference				
Thickness (mm)			[16, 20, 22]	
Material			E 250 (Fe 410 W)A	
Ultimate Strength, $F_u$ (MPa)			410	
Yield Strength, $F_y$ (MPa)			240	
Bolt Details - Input and Design Preference				
Diameter (mm)			[20, 24, 30]	
Property Class			[6.8, 8.8, 9.8]	
Type			Bearing Bolt	
Bolt Tension			Non pre-tensioned	
Hole Type			Standard	
Slip Factor, ( $\mu_f$ )			0.3	
Weld Details - Input and Design Preference				
Type of Weld Fabrication			Shop Weld	
Material Grade Overwrite, $F_u$ (MPa)			590.0	
Beam Flange to End Plate			Groove Weld	
Beam Web to End Plate			Fillet Weld	
Stiffener			Fillet Weld	
Continuity Plate			Fillet Weld	
Detailing - Design Preference				
Edge Preparation Method			Sheared or hand flame cut	
Gap Between Members (mm)			0.0	
Are the Members Exposed to Corrosive Influences?			True	



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

## 2 Design Checks

Design Status	Pass
---------------	------

### 2.1 Beam to Column - Compatibility Check

Check	Required	Provided	Remarks
Beam Section Compatibility	$B_{req} = B_b + 25$ $= 180.0 + 25$ $= 205.0$	$B_{available} = B_c$ $= 394.0$	Compatible

### 2.2 Member Capacity - Supported Section

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{0.6 \times 465.6 \times 10.2 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 448.68$ <p>[Ref. IS 800:2007, Cl.10.4.3]</p>	Restricted to low shear
Plastic Moment Capacity (kNm)		$M_{dz} = \frac{\beta_b Z_{pz} f_y}{\gamma_{m0}}$ $= \frac{1.0 \times 2070000.0 \times 300}{1.1 \times 10^6}$ $= 564.55$ <p>[Ref. IS 800:2007, Cl.8.2.1.2]</p>	$V < 0.6 V_{dy}$



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

## 2.3 Member Capacity - Supporting Section

Check	Required	Provided	Remarks
Plastic Moment Capacity (kNm)		$M_{dz} = \frac{\beta_b Z_{pz} f_y}{\gamma_{m0}}$ $= \frac{0.89 \times 2880000.0 \times 350}{1.1 \times 10^6}$ $= 817.73$ <p>Note: The capacity of the section is not based on the beam-column or column design. The actual capacity might vary.</p> <p>[Ref. IS 800:2007, Cl.8.2.1.2]</p>	<b>Semi-compact</b>
Plastic Moment Capacity (kNm)		$M_{dy} = \frac{\beta_b Z_{py} f_y}{\gamma_{m0}}$ $= \frac{0.66 \times 1420000.0 \times 350}{1.1 \times 10^6}$ $= 296.55$ <p>Note: The capacity of the section is not based on the beam-column or column design. The actual capacity might vary.</p> <p>[Ref. IS 800:2007, Cl.8.2.1.2]</p>	<b>Semi-compact</b>

## 2.4 Load Consideration

Check	Required	Provided	Remarks
Axial Force (kN)		$P_x = 0.0$	<b>OK</b>



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Shear Force (kN)	$V_y = 100.0$	$V_{ymin} = \min(0.15V_{dy}, 40.0)$ $= \min(0.15 \times 448.68, 40.0)$ $= \min(67.3, 40.0)$ $= 40.0$ $V_u = \max(V_y, V_{ymin})$ $\text{but, } \leq V_{dy}$ $= \max(100.0, 40.0)$ $\text{but, } \leq 448.68$ $= 100.0$ [Ref. IS 800:2007, Cl.10.7]	Pass
Bending Moment (major axis) (kNm)	$M_z = 180.0$	$M_{zmin} = 0.5M_{dz}$ $= 0.5 \times 564.55$ $= 282.27$ $M_u = \max(M_z, M_{zmin})$ $\text{but, } \leq M_{dz} \text{ of the column section}$ $= \max(180.0, 282.27)$ $\leq 817.73$ $= 282.27$ [Ref. IS 800:2007, Cl.8.2.1.2]	Pass
Effective Bending Moment (major axis) (kNm)		$M_{ue} = M_u + P_x \times \left( \frac{D}{2} - \frac{T}{2} \right) \times 10^{-3}$ $= 282.27 +$ $0.0 \times \left( \frac{500.0}{2} - \frac{17.2}{2} \right) \times 10^{-3}$ $= 282.27$	OK



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

## 2.5 Bolt Optimization

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Diameter Optimization	$d = 20$	Pass
Property Class	Bolt Property Class Optimization	6.8	Pass
Hole Diameter (mm)		$d_0 = 22.0$	OK
No. of Bolt Columns		$n_c = 2$	Pass
No. of Bolt Rows		$n_r = 8$	Pass
Total No. of Bolts		$n = n_r X n_c = 16$	Pass

## 2.6 Detailing

Check	Required	Provided	Remarks
Min. Pitch Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 20.0$ $= 50.0$  [Ref. IS 800:2007, Cl.10.2.2]	70	Pass
Max. Pitch Distance (mm)	$p_{\max} = \min(32t, 300)$ $= \min(32 \times 20.0, 300)$ $= \min(640.0, 300)$ $= 300$  Where, $t = \min(20.0, 20.0)$  [Ref. IS 800:2007, Cl.10.2.3]	70	Pass
Min. End Distance (mm)	$e_{\min} = 1.7d_0$ $= 1.7 \times 22.0$ $= 37.4$  [Ref. IS 800:2007, Cl.10.2.4.2]	40	Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Max. End Distance (mm)	$e_{\max} = 40 + 4t$ <p>Where, <math>t = \min(20.0, 20.0)</math></p> $= 40 + (4 \times 20)$ $e_{\max} = 120.0$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	40	Pass
Min. Edge Distance (mm)	$e'_{\min} = 1.7d_0$ $= 1.7 \times 22.0$ $= 37.4$ <p>[Ref. IS 800:2007, Cl.10.2.4.2]</p>	40	Pass
Max. Edge Distance (mm)	$e'_{\max} = 40 + 4t$ <p>Where, <math>t = \min(20.0, 20.0)</math></p> $= 40 + (4 \times 20)$ $e'_{\max} = 120.0$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	40	Pass
Cross-centre Gauge Distance (mm)		114	Pass

## 2.7 Critical Bolt Design

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3} \gamma_{mb}}$ $= \frac{600.0 \times 1 \times 245}{1000 \times \sqrt{3} \times 1.25}$ $= 67.9$ <p>[Ref. IS 800:2007, Cl.10.3.3]</p>	OK



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Kb		$k_b = \min \left( \frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0 \right)$ $= \min \left( \frac{40}{3 \times 22.0}, \frac{70}{3 \times 22.0} - 0.25, \frac{600.0}{440}, 1.0 \right)$ $= \min(0.61, 0.81, 1.36, 1.0)$ $= 0.61$ <p>[Ref. IS 800:2007, Cl.10.3.4]</p>	OK
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.61 \times 20.0 \times 20.0 \times 410}{1000 \times 1.25}$ $= 200.08$ <p>[Ref. IS 800:2007, Cl.10.3.4]</p>	OK
Bolt Capacity (kN)		$V_{db} = \min (V_{dsb}, V_{dpb})$ $= \min (67.9, 200.08)$ $= 67.9$ <p>[Ref. IS 800:2007, Cl.10.3.2]</p>	
Large Grip Length Reduction Factor		$l_g = \sum (t_p + t_{member})$ $= \sum (20.0 + 18)$ $= 38.0 \text{ mm}$ $5d = 5 \times 20.0 = 100.0$ $8d = 8 \times 20.0 = 160.0$ <p>Since, <math>l_g &lt; 5d</math></p> $\beta_{tg} = 1.0$ <p>[Ref. IS 800 : 2007, Cl. 10.3.3.2]</p>	Pass





Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Bolt Capacity (post reduction factor) (kN)		$V_{db} = V_{db}\beta_{tg}$ $= 67.9 \times 1.0$ $= 67.9$ <i>[Ref. IS 800 : 2007, Cl. 10.3.3.2]</i>	OK
Shear Demand (per bolt) (kN)	$V_{sb} = \frac{V_u}{n}$ $= \frac{100.0}{16}$ $= 6.25$	$V_{db} = 67.9$	Pass
Lever Arm (mm)	$r = [482.8, 482.8, 0, 48.6, 482.8, 482.8, 0, 118.6]$  Note: $r_1$ and $r_2$ are the first rows outside and inside the tension/top flange. $r_3$ and $r_4$ are the first rows outside and inside the compression/bottom flange. $r_5$ is the second row outside tension/top flange, and, $r_6$ is the second row inside the tension/top flange. $r_7$ is the second row outside compression/bottom flange, and, $r_8$ is the second row inside the compression/bottom flange. row(s) $r_9$ and beyond are the rows inside the flange,] placed in a symmetrical manner.  Note: The lever arm is computed by considering the N.A at the centre of the bottom flange. Rows with identical lever arm values mean they are considered acting as bolt group near the tension or compression flange.		Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Tension Due to Moment (kN)	$T_1 = \frac{M_{ue}}{4 \times n_c \times \left( r_1 + \frac{r_1^2}{r_1} + \sum_{i=8}^{n_r} \frac{r_i^2}{r_1} \right)}$ $= \frac{282.27 \times 10^3}{4 \times 2 \times \left( 482.8 + \frac{48.6^2}{482.8} + \sum_{i=8}^8 \frac{r_i^2}{482.8} \right)}$ $= 68.27$ <p>Note: <math>T_1</math> is the tension in the critical bolt. The critical bolt is the bolt nearest to the tension flange.</p>		OK



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Prying Force (kN)	$Q = \frac{l_v}{2l_e} \left[ T_e - \frac{\beta \eta f_o b_e t^4}{27 l_e l_v^2} \right]$ $l_v = e - \frac{R_1}{2}$ $= 40 - \frac{17.0}{2} = 31.5 \text{ mm}$ $f_o = 0.7 f_{ub}$ $= 0.7 \times 600.0$ $= 420.0 \text{ N/mm}^2$ $l_e = \min \left( e, 1.1 t \sqrt{\frac{\beta f_o}{f_y}} \right)$ $= \min \left( 40, 1.1 \times 20 \times \sqrt{\frac{2 \times 420.0}{240}} \right)$ $= \min(40, 41.16) = 40 \text{ mm}$ $\beta = 2 \text{ (non pre-tensioned bolt)}$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{180.0}{2} = 90.0 \text{ mm}$ $Q = \frac{31.5}{2 \times 40} \times \left[ 68.27 - \left( \frac{2 \times 1.5 \times 420.0 \times 90.0 \times 20^4}{27 \times 40 \times 31.5^2} \right) \times 10^{-3} \right]$ $Q = 20.21$ <p>[Ref. IS 800:2007, Cl.10.4.7]</p>		OK



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Tension Demand (kN)	$T_b = T_1 + Q$ $= 68.27 + 20.21$ $= 88.48$	$T_{db} = 0.90 f_{ub} A_n / \gamma_{mb}$ $< f_{yb} A_{sb} (\gamma_{mb} / \gamma_{m0})$ $= \min \left( 0.90 \times 600.0 \times 245 / 1.25, \right.$ $\left. 480.0 \times 314.0 \times (1.25/1.1) \right)$ $= \min(105.84, 171.27)$ $= 105.84$  [Ref. IS 800:2007, Cl.10.3.5]	Pass
Combined Capacity (I.R.)	$\leq 1$	$\left( \frac{V_{sb}}{V_{db}} \right)^2 + \left( \frac{T_b}{T_{db}} \right)^2 \leq 1.0$ $\left( \frac{6.25}{67.9} \right)^2 + \left( \frac{88.48}{105.84} \right)^2 = 0.71$  [Ref. IS 800:2007, Cl.10.3.6]	Pass

## 2.8 Compression Flange Check

Check	Required	Provided	Remarks
Tension in Bolt Rows (kN)		$T = [68.27, 68.27, 0, 27.49, 68.27, 68.27, 0, 67.08]$	OK
Reaction at Compression Flange (kN)	$R_c = n_c \sum_{n_r=1}^{n_r} T_{n_r}$ $= 2 \times \sum_{n_r=1}^8 T_{n_r}$ $= 2 \times 367.65$ $= 735.3$	$F_c = A_g f_y / \gamma_{m0}$ $= \frac{B T f_y}{\gamma_{m0}}$ $= \frac{180.0 \times 17.2 \times 300}{1.1 \times 1000}$ $= 844.36$	Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

## 2.9 End Plate Checks

Check	Required	Provided	Remarks
Height (mm)		$H_p = D + (2 \times (2 \times e)) + (2 \times p)$ $= 500.0 + (2 \times (2 \times 40)) + (2 \times 70)$ $= 800.0$	Pass
Width (mm)		$B_p = B + 25$ $= 180.0 + 25$ $= 205.0$	Pass
Moment at Critical Section (kNm)		$M_{cr} = T_1 l_v - Q l_e$ $= (68.27 \times 31.5 - 20.21 \times 40) \times 10^{-3}$ $= 1.34$  Note: The critical section is at the toe of the weld or the edge of the flange from bolt center-line	OK
Plate Thickness (mm)	$t_p = \sqrt{\frac{4M_{cr}}{b_e(f_y/\gamma_{m0})}}$ $= \sqrt{\frac{4 \times 1.34 \times 10^6}{90 \times (240/1.1)}}$ $= 16.53$	20	Pass
Moment Capacity (kNm)	1.34	$M_p = \left(\frac{b_e t_p^2}{4}\right) \times \frac{f_y}{\gamma_{m0}}$ $= \frac{90 \times 20^2}{4} \times \frac{240}{1.1} \times 10^{-6}$ $= 1.96$	Pass

## 2.10 Stiffener Design

Check	Required	Provided	Remarks
Height (mm)		$H_{st} = \frac{H_p - D}{2}$ $= \frac{800.0 - 500.0}{2}$ $= 150.0$	150.0
Length (mm)		$L_{st} = \frac{H_{st}}{\tan 30^\circ}$ $= \frac{150.0}{\tan 30^\circ}$ $= 260$	Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Thickness (mm)	$t = 10.2$	$t_{st} = 12$	Pass
Weld Size (mm)	5	$t_w = 6$	Pass

## 2.11 Weld Design - Beam Web to End Plate Connection

Check	Required	Provided	Remarks
Weld Strength (N/mm <sup>2</sup> )	$f_{uw} = \min(f_w, f_u)$ $= \min(590.0, 410)$  [Ref. IS 800:2007, Cl.10.5.7.1.1]	$f_{uw} = 410$	Pass
Total Weld Length (mm)		$L_w = 2 \times [D - (2 \times T) - (2 \times R1) - 20]$ $= 2 \times [500.0 - (2 \times 17.2) - (2 \times 17.0) - 20]$ $= 813.0$  Note: Weld is provided on both sides of the web	OK
Weld Size (mm)	$t_w = \frac{V_u}{f_{uw} k L_w} \times \sqrt{3} \gamma_{mw}$ $= \frac{100.0 \times 10^3}{410 \times 0.7 \times 813.0} \times \sqrt{3} \times 1.25$ $= 0.93$  [Ref. IS 800:2007, Cl.10.5.7]	6	Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Min. Weld Size (mm)	<p>1) <math>t_{w\min}</math> – based on thickness of the thicker part</p> $t_{\text{thicker}} = \max(20.0, 10.2)$ $= 20.0$ $t_{w\min} = 5$ <p>2) <math>t_{w\min}</math> – based on thickness of the thinner part</p> $t_{\text{thinner}} = \min(20.0, 10.2)$ $= 10.2$ $t_{w\min} \leq \min(5, 10.2)$ <p>[Ref. IS 800:2007, Table 21, Cl 10.5.2.3]</p>	$t_w = \max(t_w, t_{w\min})$ $= \max(0.93, 5)$ $= 6$	Pass
Max. Weld Size (mm)	<p><math>t_{w\max}</math> based on thickness of the thinner part</p> $t_{\text{thinner}} = \min(20.0, 10.2)$ $= 10.2$ $t_{w\max} = 10.2$ <p>[Ref. IS 800:2007, Cl.10.5.3.1]</p>	$t_w \leq t_{w\max}$ $6 \leq 10.2$	Pass

## 2.12 Continuity Plate Check - Compression/Tension Flange

Check	Required	Provided	Remarks
-------	----------	----------	---------



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Local Web Yielding Capacity (kN)		$P_{cw1} = \frac{f_{wc} (5k + T_b)}{\gamma_{m0}}$ $k = T_c + R_{1c}$ $= 18 + 15.0$ $= 33.0$ $f_{wc} = f_{yc} t_c$ $= 350.0 \times 18.0$ $= 6300.0$ $P_{cw1} = \frac{6300.0 \times ((5 \times 33.0) + 17.2)}{1.1 \times 1000}$ $= 1043.51$ <p>Note: subscript c denotes column section, and, subscript b denotes beam section</p>	OK
Web Compression Buckling Capacity (kN)		$P_{cw2} = 10710 \left( \frac{t_c^3}{h_c} \right) \sqrt{\frac{f_{yc}}{\gamma_{m0}}}$ $h_c = D_c - (2k)$ $= 356.0 - (2 \times 33.0)$ $= 290.0$ $P_{cw2} = 10710 \times \frac{18.0^3}{290.0} \times \sqrt{\frac{350.0}{1.1}} \times 10^{-3}$ $= 3841.91$	OK





Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Web Crippling Capacity (kN)		$P_{cw3} = \left( \frac{300t_c^2}{\gamma_{m1}} \right) \left[ 1 + 3 \left( T_b/D_c \right) \left( t_c/T_c \right)^{1.5} \right] \sqrt{f_{yc} \left( T_c/t_c \right)}$ $= \left( \frac{300 \times 18.0^2}{1.25} \right) \times \left[ 1 + 3 \times \left( 17.2/356.0 \right) \times \left( 18.0/18 \right)^{1.5} \right] \times \sqrt{350.0 \times \left( 18/18.0 \right)} \times 10^{-3}$ $= 1665.61$	OK
Compression Strength (kN)		$P_{cw} = \min(P_{cw1}, P_{cw2}, P_{cw3})$ $= \min(1043.51, 3841.91, 1665.61)$ $= 1043.51$	OK
Continuity Plate Required?	$R_c = 735.3$	$P_{cw} = 1043.51$	No

## 2.13 Column Web Shear Check

Check	Required	Provided	Remarks
Web Stiffener Plate Required?	$t_{wc} = \frac{1.9M_{ue}}{D_c D_b f_{yc}}$ $= \frac{1.9 \times 282.27}{356.0 \times 500.0 \times 350.0}$ $= 8.61$	$t_c = 18.0$	No



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

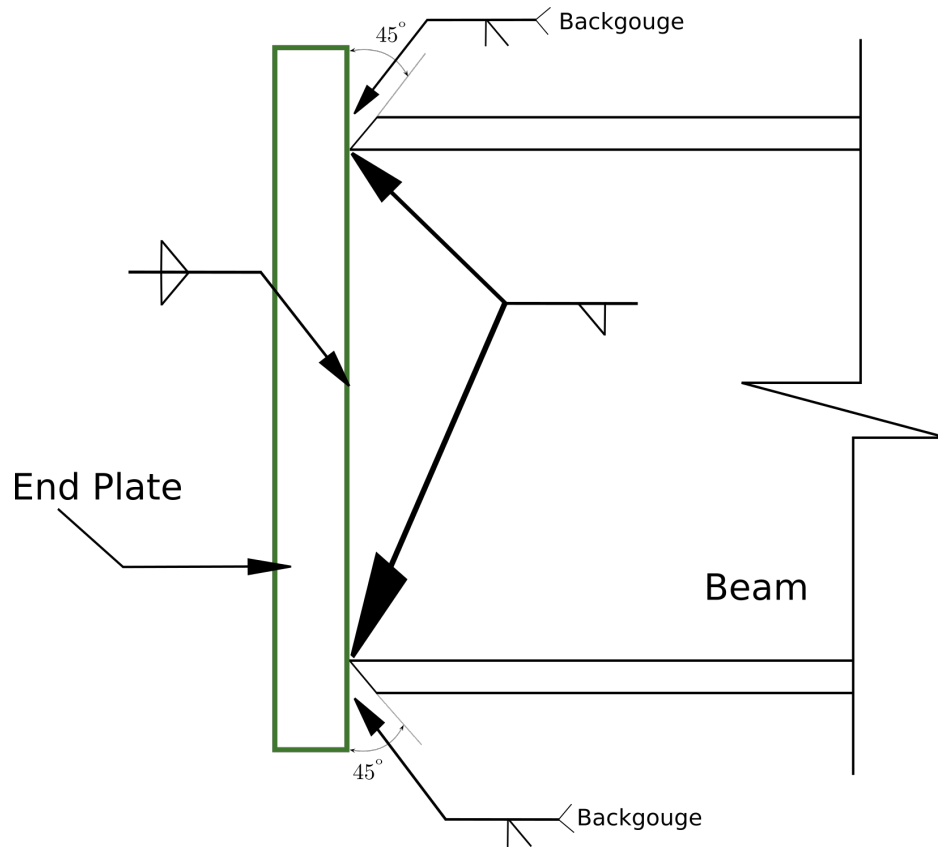


Figure 1: Typical Weld Details -- Beam to End Plate Connection

### 3 2D Drawings (Typical)



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

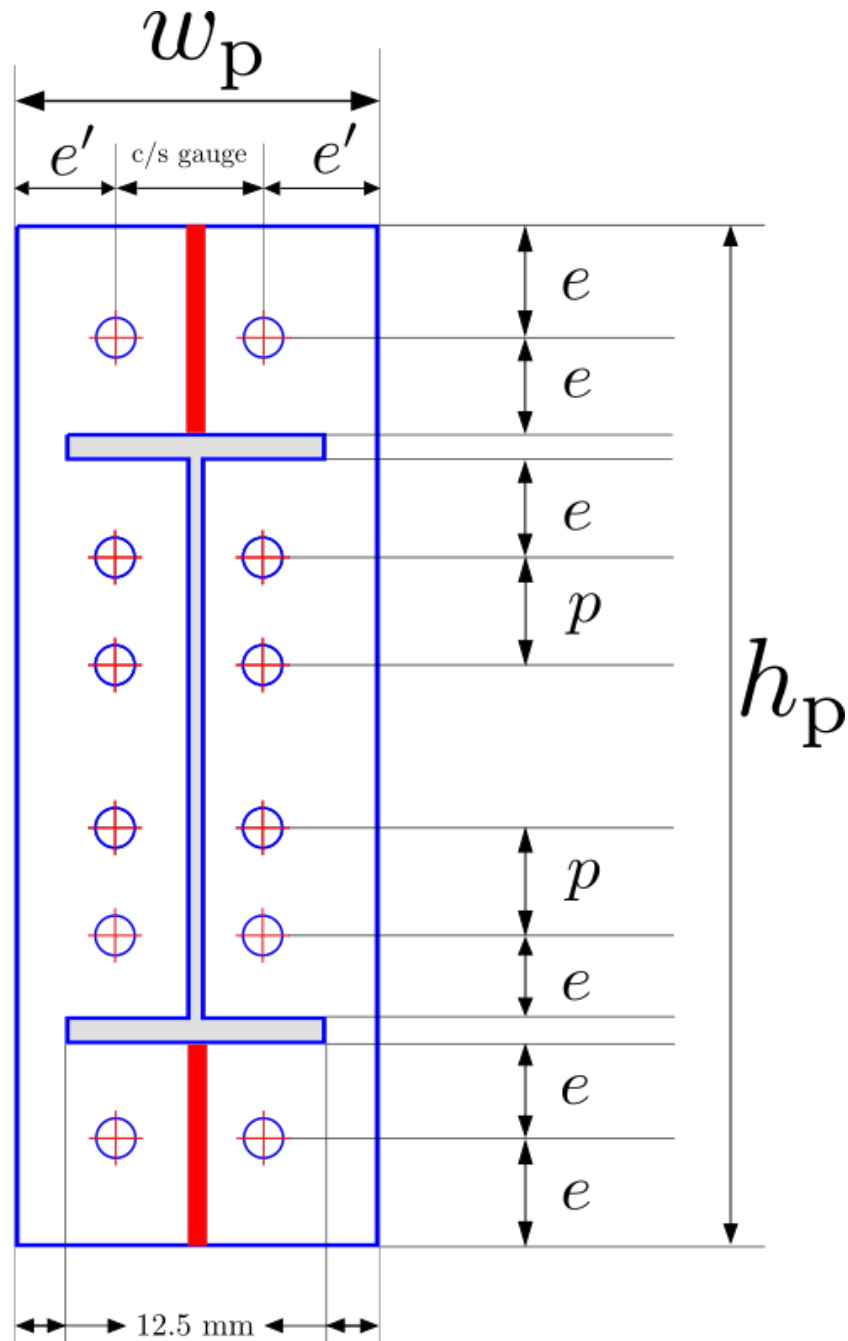


Figure 2: Typical Detailing



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

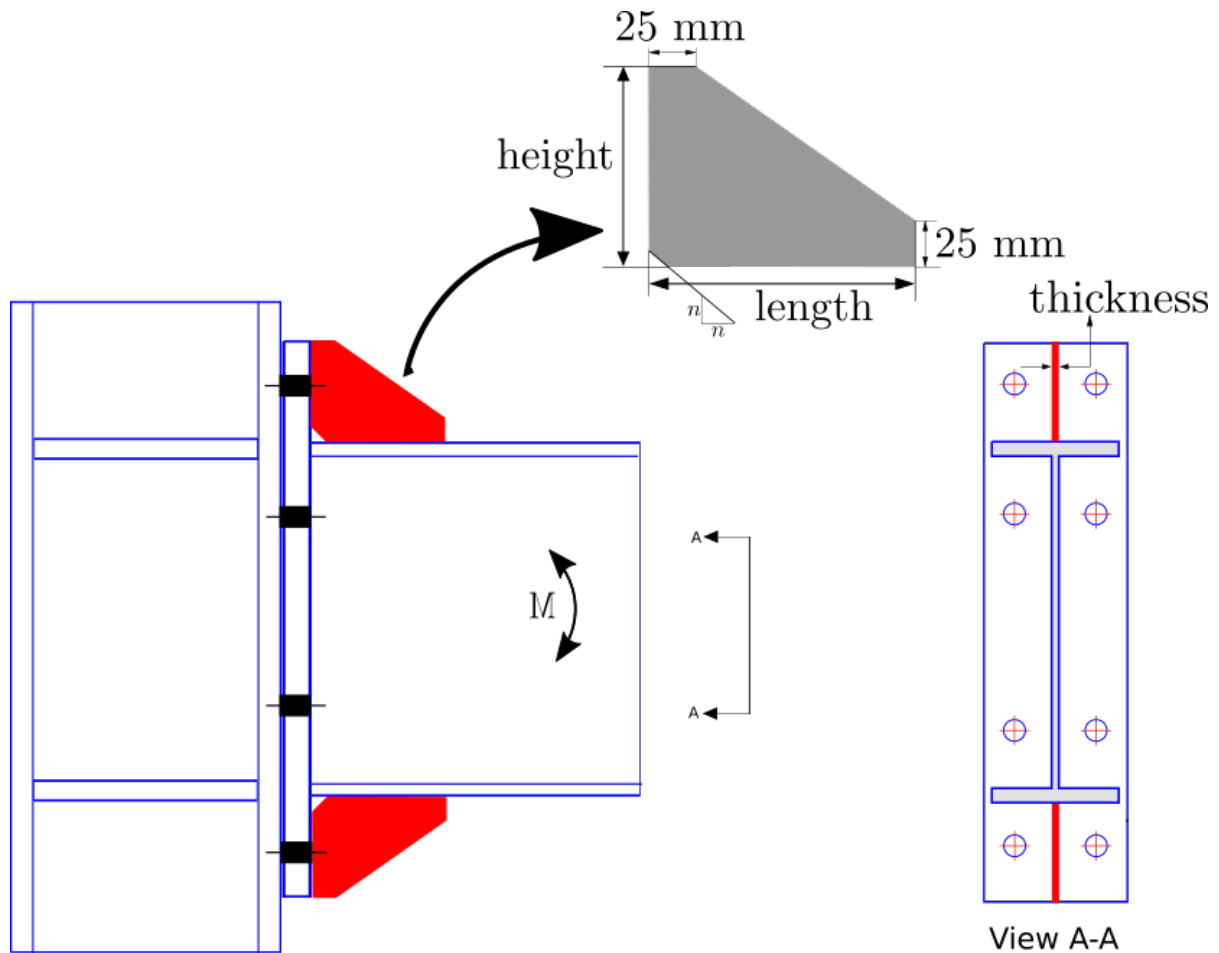
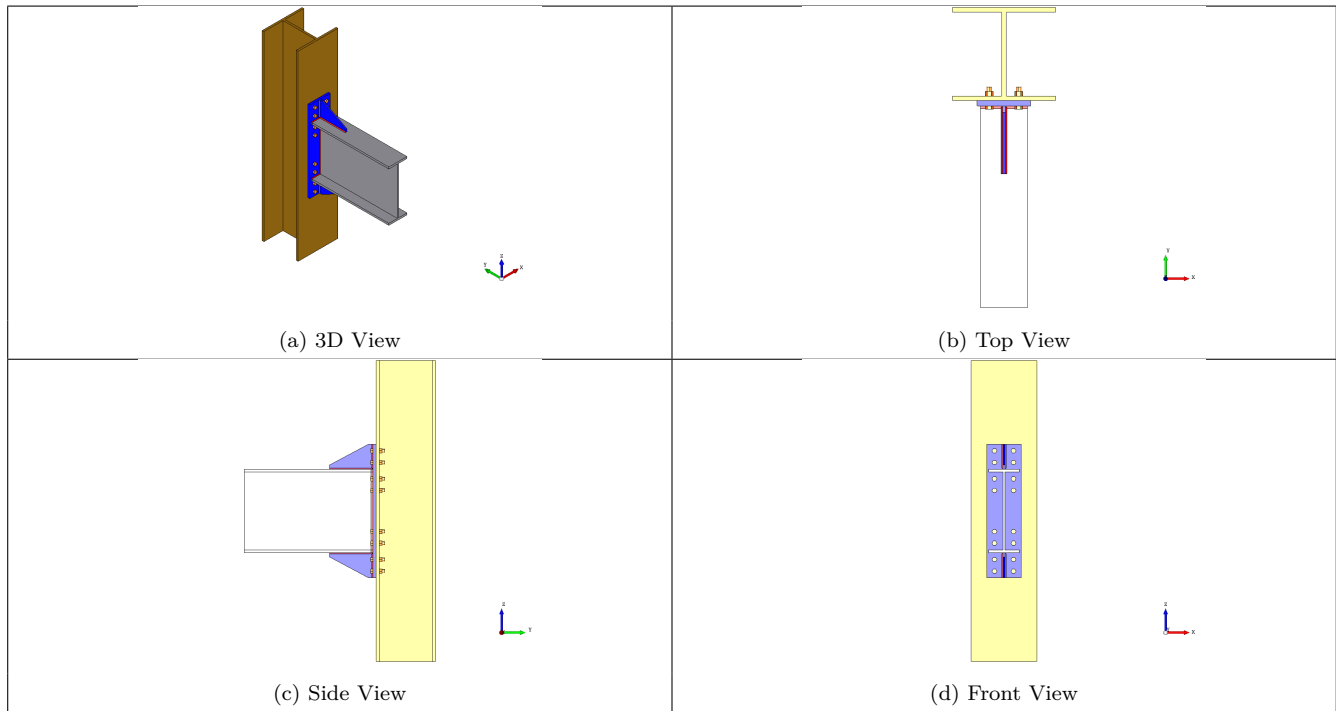


Figure 3: Typical Stiffener Details



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

## 4 3D Views



## 5 Design Log

2021-02-04 13:51:14 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].

2021-02-04 13:51:14 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (180.0 kNm) is less than 0.5 times the plastic moment capacity of the beam (564.55 kNm)

2021-02-04 13:51:14 - Osdag - INFO - The minimum factored bending moment should be at least 0.5 times the plastic moment capacity of the beam to qualify the connection as rigid connection (Annex. F-4.3.1, IS 800:2007)

2021-02-04 13:51:14 - Osdag - INFO - The value of load(s) is/are set at minimum recommended value as per Cl.10.7 and Annex. F, IS 800:2007



2021-02-04 13:51:14 - Osdag - INFO - Designing the connection for a factored moment of 282.27 kNm

2021-02-04 13:51:14 - Osdag - WARNING - [End Plate] The end plate of 16.0 mm is thinner than the thickest of the elements being connected

2021-02-04 13:51:14 - Osdag - INFO - Selecting a plate of higher thickness which is at least 18 mm thick

2021-02-04 13:51:14 - Osdag - INFO - [Bolt Design] Bolt diameter and grade combination ready to perform bolt design

2021-02-04 13:51:14 - Osdag - INFO - The solver has selected 9.0 combinations of bolt diameter and grade to perform optimum bolt design in an iterative manner

		Created with  Osdag®	
Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

2021-02-04 13:51:14 - Osdag - WARNING - [Column Web] The web of the column is safe against shear buckling due to the reaction transferred by the beam to the column

2021-02-04 13:51:14 - Osdag - INFO - The minimum required thickness of the web i.e. 8.61 mm is satisfied

2021-02-04 13:51:14 - Osdag - INFO - Additional stiffening of the column web is not required

2021-02-04 13:51:14 - Osdag - INFO - [Optimisation] Performing the design by optimising the plate thickness, using the most optimum plate and a suitable bolt diameter approach

2021-02-04 13:51:14 - Osdag - INFO - If you wish to optimise the bolt diameter-grade combination, pass a higher value of plate thickness using the Input Dock

2021-02-04 13:51:14 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 735.3 kN is less than the flange capacity 844.36 kN. The flange strength requirement is satisfied.

2021-02-04 13:51:14 - Osdag - INFO - [End Plate] The end plate of 20.0 mm passes the moment capacity check. The end plate is checked for yielding due tension caused by bending moment and prying force

2021-02-04 13:51:14 - Osdag - INFO - [Bolt Design] The bolt of 20.0 mm diameter and 6.8 grade passes the tension check

2021-02-04 13:51:14 - Osdag - INFO - Total tension demand on bolt (due to direct tension + prying action) is 88.48002967573109 kN and the bolt tension capacity is (105.84 kN)

2021-02-04 13:51:14 - Osdag - INFO - [Bolt Design] The bolt of 20.0 mm diameter and 6.8 grade passes the combined shear + tension check

2021-02-04 13:51:14 - Osdag - INFO - The Interaction Ratio (IR) of the critical bolt is 0.707

2021-02-04 13:51:14 - Osdag - INFO - : ===== Design Status =====

2021-02-04 13:51:14 - Osdag - INFO - : Overall beam to column end plate connection design is SAFE

2021-02-04 13:51:14 - Osdag - INFO - : ===== End Of Design =====