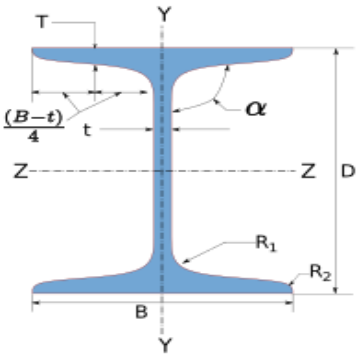
Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Column End Plate
Designer	Engineer #1	Job Number	1.2.2.1.2.2.2
Date	18 /12 /2020	Client	Meera Raghunandan, Professor, IIT Bombay

1 Input Parameters

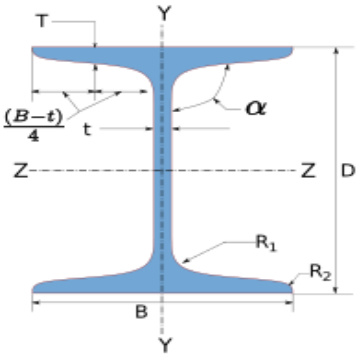
Main Module	Moment Connection
Module	Beam-Column End Plate
Connectivity	Column Web-Beam Web
End Plate Type	Extended One Way - Irreversible Moment
Bending Moment (kNm)	110.0
Shear Force (kN)	55.0
Axial Force (kN)	15.0

Column Section - Mechanical Properties



Column Section		PBP 400 X 122.4	
Material		E 300 (Fe 440)	
Ultimate Strength, Fu (MPa)		440	
Yield Strength, Fy (MPa)		300	
Mass, m (kg/m)	122.4	I_z (cm^4)	34700.0
Area, A (cm^2)	155.0	I_y(cm^4)	13800.0
D (mm)	348.0	r_z (cm)	14.9
B (mm)	390.0	r_y (cm)	9.4
t (mm)	14.0	Z_z (cm^3)	1990.0
T (mm)	14	Z_y (cm^3)	710.0
Flange Slope	90	Z_{pz} (cm^3)	2210.0
R_1 (mm)	15.0	Z_{py} (cm^3)	1080.0
R_2 (mm)	0.0		

Beam Section - Mechanical Properties



Beam Section		LB 400	
Material		E 300 (Fe 440)	
Ultimate Strength, Fu (MPa)		440	
Yield Strength, Fy (MPa)		300	
Mass, m (kg/m)	56.82	I_z (cm^4)	19300.0
Area, A (cm^2)	72.4	I_y(cm^4)	716.0
D (mm)	400.0	r_z (cm)	16.3
B (mm)	165.0	r_y (cm)	3.14
t (mm)	8.0	Z_z (cm^3)	965.0
T (mm)	12.5	Z_y (cm^3)	86.8
Flange Slope	98	Z_{pz} (cm^3)	1090.0

	R_1 (mm)	16.0	Z_{py} (cm^3)	151.0
	R_2 (mm)	8.0		

Plate Details - Input and Design Preference	
Thickness (mm)	[16]
Material	E 300 (Fe 440)
Ultimate Strength, Fu (MPa)	440
Yield Strength, Fy (MPa)	300
Bolt Details - Input and Design Preference	
Diameter (mm)	[20]
Property Class	[4.8]
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)	450.0
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	Rolled, machine-flame cut, sawn and planed
Gap Between Members (mm)	0.0
Are the Members Exposed to Corrosive Influences?	False

2 Design Checks

Design Status	Pass

2.1 Beam to Column - Compatibility Check

Check	Required	Provided	Remarks
Beam Section Compatibility	$B_{req} = B_b + 25$ $= 165.0 + 25$ $= 190.0$	$B_{available} = D_c - (2T_c) - (2R_{1c}) - 10$ $= 348.0 - (2 \times 14) - (2 \times 15.0) - 10$ $= 280.0$	**Compatible**

2.2 Member Capacity - Supported Section

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dy} = \frac{A_v \ f_y}{\sqrt{3} \ \gamma_{mo}}$ $= \frac{0.6 \times 375.0 \times 8.0 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 283.43$ $[Ref. IS\ 800:2007, Cl. 10.4.3]$	**Restricted to low shear**
Plastic Moment Capacity (kNm)		$M_{dz-z} = \frac{\beta_b Z_{pz} fy}{\gamma_{mo}}$ $= \frac{1.0 \times 1090000.0 \times 300}{1.1 \times 10^6}$ $= 297.27$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	**V < 0.6 Vdy**

2.3 Member Capacity - Supporting Section

Check	Required	Provided	Remarks
Plastic Moment Capacity (kNm)		$M_{dz-z} = \frac{\beta_b Z_{pz} fy}{\gamma_{mo}}$ $= \frac{0.9 \times 2210000.0 \times 300}{1.1 \times 10^6}$ $= 542.73$ *Note : The capacity of the section is not based on the beam – colum or column design. The actual capacity might vary.* [*Ref. IS* 800 : 2007, *Cl.* 8.2.1.2]	**Semi-compact**
Plastic Moment Capacity (kNm)		$M_{dy-y} = \frac{\beta_b Z_{py} fy}{\gamma_{mo}}$ $= \frac{0.66 \times 1080000.0 \times 300}{1.1 \times 10^6}$ $= 193.64$ *Note : The capacity of the section is not based on the beam – colum or column design. The actual capacity might vary.* [*Ref. IS* 800 : 2007, *Cl.* 8.2.1.2]	**Semi-compact**

2.4 Load Consideration

Check	Required	Provided	Remarks

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Column End Plate
Designer	Engineer #1	Job Number	1.2.2.1.2.2.2
Date	18 /12 /2020	Client	Meera Raghunandan, Professor, IIT Bombay

Check	Required	Provided	Remarks
Shear Force (kN)	$V_y = 55.0$	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 283.43,\ 40.0)$ $= min(42.51,\ 40.0)$ $= 40.0$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(55.0,\ 40.0)$ $= 55.0$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.7]$	**OK**
Axial Force (kN)		P_x = 15.0	**OK**
Bending Moment (major axis) (kNm)	$M = 110.0$	$M_{z min} = 0.5 * M_{dz-z}$ $= 0.5 \times 297.27$ $= 148.63$ $M_u = max(M_z,\ M_{z min})$ $but,\ \leq M_{dy-y}\ of\ the\ column\ section$ $= max(110.0, 148.63)$ ≤ 193.64 $= 148.63$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 8.2.1.2]$	**OK** **OK**
Effective Bending Moment (major axis) (kNm)		$M_{ue} = M_u\ +\ P_x \times \left(\frac{D}{2} - \frac{T}{2}\right) \times 10^{-3}$ $= 148.63\ +$ $15.0 \times \left(\frac{400.0}{2} - \frac{12.5}{2}\right) \times 10^{-3}$ $= 151.54$	**OK**

2.5 Bolt Optimization

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Diameter Optimization	$d = 20$	**Pass**
Property Class	Bolt Property Class Optimization	4.8	**Pass**
Hole Diameter (mm)		$d_0 = 22.0$	**OK**
No. of Bolt Columns		$n_c = 2$	**Pass**
No. of Bolt Rows		$n_r = 5$	**Pass**
Total No. of Bolts		$n = n_r X n_c = 10$	**Pass**

2.6 Detailing

Check	Required	Provided	Remarks
Min. Pitch Distance (mm)	$p_{min} = 2.5\ d$ $= 2.5 \times 20.0$ $= 50.0$ $[Ref\ IS\ 800 : 2007,\ Cl.\ 10.2.2]$	70	**Pass**
Max. Pitch Distance (mm)	$p_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 \times 16.0,\ 300\ mm)$ $= \min(512.0,\ 300\ mm)$ $= 300$ $Where,\ t = min(16.0, 16.0)$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.2.3]$	70	**Pass**
Min. End Distance (mm)	$e_{min} = 1.5\ d_0$ $= 1.5 \times 22.0$ $= 33.0$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.2.4.2]$	35	**Pass**

Check	Required	Provided	Remarks
Max. End Distance (mm)	$e_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 16.0 \times \sqrt{\frac{250}{300}} = 175.27$ $e_2 = 12 \times 16.0 \times \sqrt{\frac{250}{300}} = 175.27$ $e_{max} = min(e_1, e_2) = 175.27$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.3$]	35	**Pass**
Min. Edge Distance (mm)	$e'_{min} = 1.5\ d_0$ $= 1.5 \times 22.0$ $= 33.0$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.2$]	35	**Pass**
Max. Edge Distance (mm)	$e'_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 16.0 \times \sqrt{\frac{250}{300}} = 175.27$ $e_2 = 12 \times 16.0 \times \sqrt{\frac{250}{300}} = 175.27$ $e'_{max} = min(e_1, e_2) = 175.27$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.3$]	35	**Pass**
Cross-centre Gauge Distance (mm)		94	**Pass**

2.7 Critical Bolt Design

Check	Required	Provided	Remarks

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Column End Plate
Designer	Engineer #1	Job Number	1.2.2.1.2.2.2
Date	18 /12 /2020	Client	Meera Raghunandan, Professor, IIT Bombay

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub}\ n_n\ A_{nb}}{\sqrt{3}\ \gamma_{mb}}$ $= \frac{420.0 \times 1 \times 245}{1000 \times \sqrt{3}\ \times\ 1.25}$ $= 47.53$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3$]	OK
Kb		$k_b = min\left(\frac{e}{3d_0},\ \frac{p}{3d_0} - 0.25,\ \frac{f_{ub}}{f_u},1.0\right)$ $= min\left(\frac{35}{3 \times 22.0},\ \frac{70}{3 \times 22.0} - 0.25,\ \frac{420.0}{440},\ 1.0\right)$ $= min(0.53, 0.81, 0.95, 1.0)$ $= 0.53$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.4$]	OK
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5\ k_b\ d\ t\ f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.53 \times 20.0 \times 16.0 \times 440}{1000 \times 1.25}$ $= 149.25$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.4$]	OK
Bolt Capacity (kN)		$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (47.53, 149.25)$ $= 47.53$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.2$]	

Check	Required	Provided	Remarks
Large Grip Length Reduction Factor		$l_g = \sum \left(t_p + t_{member}\right)$ $= \sum \left(16.0 + 14.0\right)$ $= 30.0\ mm$ $5d = 5 \times 20.0 = 100.0$ $8d = 8 \times 20.0 = 160.0$ $Since,\ l_g < 5d$ $\beta_{lg} = 1.0$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.3.2]$	**Pass**
Bolt Capacity (post reduction factor) (kN)		$V_{db} = V_{db}\beta_{lg}$ $= 47.53 \times 1.0$ $= 47.53$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.3.2]$	**OK**
Shear Demand (kN)	$V_{sb} = \frac{V_u}{n}$ $= \frac{55.0}{10}$ $= 5.5$	Vdb = 47.53	**Pass**

Check	Required	Provided	Remarks
Lever Arm (mm)	$r = [387.5, 387.5, 41.25, 387.5, 387.5]$ *Note :* r_1 *is the first row outside tension/top flange* r_2 *is the first row inside tension/top flange* r_3 *is the first row inside compression/bottom flange* r_4 *is the second row inside tension/top flange* r_5 *is the second row outside tension/top flange* *row(s)* r_6 *and beyond are rows inside the flange.* *Note : The lever arm is computed by considering the NA 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**
Tension Due to Moment (kN)	$T_1 = \frac{M_{ue}}{4 \times n_c \times \left(r_1 + \sum_{i=3}^{n_r=3} \frac{r_i^2}{r_1}\right)}$ $= \frac{151.54 \times 10^3}{4 \times 2 \times \left(387.5 + \sum_{i=3}^{n_r=3} \frac{r_i^2}{387.5}\right)}$ $= 48.34$ *Note :* T_1 *is the tension in the critical bolt* *The critical bolt is the bolt nearest to the tension flange*		**OK**

Check	Required	Provided	Remarks
Prying Force (kN)	$Q = \frac{l_v}{2 \times l_e}\left[T_e - \frac{\beta \times \eta \times f_o \times b_e \times t^4}{27 \times l_e \times l_v^2}\right]$ $l_v = e - \frac{R_1}{2}$ $= 35 - \frac{16.0}{2} = 27.0\ mm$ $f_o = 0.7 \times f_{ub}$ $= 0.7 \times 420.0$ $= 294.0\ N/mm^2$ $l_e = min\left(e, 1.1\ t\ \sqrt{\frac{\beta\ f_o}{f_y}}\right)$ $= min\left(35, 1.1 \times 16 \times \sqrt{\frac{2 \times 294.0}{300}}\right)$ $= min(35, 24.64) = 24.64\ mm$ $\beta = 2\ (non\ pre-tensioned\ bolt)$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{165.0}{2} = 82.5\ mm$ $Q = \frac{27.0}{2 \times 24.64} \times$ $\left[48.34 - \left(\frac{2 \times 1.5 \times 294.0 \times 82.5 \times 16^4}{27 \times 24.64 \times 27.0^2}\right) \times 10^{-3}\right]$ $Q = 21.1$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.4.7]$		**OK**

Check	Required	Provided	Remarks
Tension Demand (kN)	$T_b = T_1 + Q$ $= 48.34 + 21.1$ $= 69.44$	$T_{db} = 0.90\ f_{ub}\ A_n\ /\ \gamma_{mb}$ $<\ f_{yb}\ A_{sb}\ (\gamma_{mb}\ /\ \gamma_{m0})$ $= min\Big(0.90\ \times 420.0 \times 245\ /\ 1.25,$ $340.0 \times 314.0 \times (1.25/1.1)\Big)$ $= min(74.09,\ 121.32)$ $= 74.09$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.5]$	**Pass**
Combined Capacity, (I.R)	≤ 1	$\left(\frac{V_{sb}}{V_{db}}\right)^2 + \left(\frac{T_b}{T_{db}}\right)^2 \leq 1.0$ $\left(\frac{5.5}{47.53}\right)^2 + \left(\frac{69.44}{74.09}\right)^2 = 0.89$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.6]$	**Pass**

2.8 Compression Flange Check

Check	Required	Provided	Remarks
Tension in Bolt Rows (kN)		$T = [48.34, 48.34, 20.58, 48.34, 48.34]$	**OK**
Reaction at Compression Flange (kN)	$R_c = n_c \sum_{n_r=1}^{n_r} T_{n_r}$ $= 2 \times \sum_{n_r=1}^{5} T_{n_r}$ $= 2 \times 213.94$ $= 427.88$	$F_c = A_g f_y\ /\ \gamma_{m0}$ $= \frac{B \times T \times f_y}{\gamma_{m0}}$ $= \frac{165.0 \times 12.5 \times 300}{1.1 \times 1000}$ $= 562.5$	**Pass**

2.9 End Plate Checks

Check	Required	Provided	Remarks
Height (mm)		$H_p = D + 12.5 + (2 \times e) + p$ $= 400.0 + 12.5 + (2 \times 35) + 70$ $= 552.5$	**Pass**
Width (mm)		$B_p = B + 25$ $= 165.0 + 25$ $= 190.0$	**Pass**
Moment at Critical Section (kNm)		$M_{cr} = T_1\ l_v - Q\ l_e$ $= (48.34 \times 27.0 - 21.1 \times 24.64) \times 10^{-3}$ $= 0.79$ *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)	$t_p = \sqrt{\frac{4M_{cr}}{b_e(f_y/\gamma_{m0})}}$ $= \sqrt{\frac{4 \times 0.79 \times 10^6}{82 \times (300/1.1)}}$ $= 11.81$	16	**Pass**
Moment Capacity (kNm)	0.79	$M_p = \left(\frac{b_e t_p^2}{4}\right) \times \frac{f_y}{\gamma_{m0}}$ $= \frac{82 \times 16^2}{4} \times \frac{300}{1.1} \times 10^{-6}$ $= 1.44$	**Pass**

2.10 Stiffener Design

Check	Required	Provided	Remarks
Height (mm)		$H_{st} = H_p - D - 12.5$ $= 552.5 - 400.0 - 12.5$ $= 140.0$	**140.0**
Length (mm)		$L_{st} = \frac{H_{st}}{tan(30)}$ $= \frac{140.0}{tan(30)}$ $= 244$	**Pass**
Thickness (mm)	$t = 8.0$	$tst = 8$	**Pass**

Check	Required	Provided	Remarks
Weld Size (mm)	5	tw = 6	**Pass**

2.11 Weld Design - Beam Web to End Plate Connection

Check	Required	Provided	Remarks
Weld Strength (N/mm2)	$f_{uw} = min(f_w,\ f_u)$ $= min(450.0,\ 440)$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1]$	$f_{uw} = 440$	**Pass**
Total Weld Length (mm)		$L_w = 2 \times \left[D - (2 \times T) - (2 \times R1) - 20\right]$ $= 2 \times \left[400.0 - (2 \times 12.5) - (2 \times 16.0) - 20\right]$ $= 638.0$ $Note:\ Weld\ is\ provided\ on\ both\ sides\ of\ the\ web$	**OK**
Weld Size (mm)	$t_w = \frac{V_u}{f_{uw} k L_w} \times \sqrt{3}\ \gamma_{mw}$ $= \frac{55.0 \times 10^3}{440 \times 0.7 \times 638.0} \times \sqrt{3} \times 1.25$ $= 0.61$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7]$	6	**Pass**

Check	Required	Provided	Remarks
Min. Weld Size (mm)	1) t_{wmin} – *based on thickness of the thicker part* $t_{thicker} = max(16.0,\ 8.0)$ $= 16.0$ $t_{wmin} = 5$ 2) t_{wmin} – *based on thickness of the thinner part* $t_{thinner} = min(16.0,\ 8.0)$ $= 8.0$ $t_{wmin} \leq min(5,\ 8.0)$ [*Ref IS* 800 : 2007, *Table* 21 , *Cl*10.5.2.3]	$t_w = max(t_w,\ t_{wmin})$ $= max(0.61,\ 5)$ $= 6$	**Pass**
Max. Weld Size (mm)	t_{wmax} *based on thickness of the thinner part* $t_{thinner} = min(16.0,\ 8.0)$ $= 8.0$ $t_{wmax} = 8.0$ [*Ref. IS* 800 : 2007, *Cl.* 10.5.3.1]	$t_w \leq t_{wmax}$ $6 \leq 8.0$	**Pass**
Normal Stress (N/mm2)		$f_a = \frac{H}{0.7 \times t_w \times L_w}$ $= \frac{15.0 \times 10^3}{0.7 \times 6 \times 638.0}$ $= 5.6$ [*Ref. IS* 800 : 2007, *Cl.* 10.5.9]	

Check	Required	Provided	Remarks
Shear Stress (N/mm2)		$q = \frac{V}{0.7 \times t_w \times L_w}$ $= \frac{55.0 \times 10^3}{0.7 \times 6 \times 638.0}$ $= 20.53$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.9$]	
Equivalent Stress (N/mm2)	$f_e = \sqrt{f_a^2 + 3q^2}$ $= \sqrt{5.6^2 + (3 \times 20.53^2)}$ $= 35.64$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.10.1.1$]	$f_w = \frac{f_u}{\sqrt{3}\ \gamma_{mw}}$ $= \frac{440}{\sqrt{3} \times 1.25}$ $= 203.23$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1$]	**Pass**

2.12 Continuity Plate Design

Check	Required	Provided	Remarks
Notch Size (mm)		$n = 24$	**OK**
Length (mm)		$l_{cp1} = Outer\ length$ $l_{cp1} = D_c - 2 \times T_c$ $= 348.0 - (2 \times 14)$ $= 320.0$ $l_{cp2} = Inner\ length$ $l_{cp2} = D_c - 2(T_c + n)$ $= 348.0 - \left[2 \times (14 + 24)\right]$ $= 272.0$	**OK**
Width (mm)		$w_{cp} = \frac{B_c - T_c - 2n}{2}$ $= \frac{390.0 - 14.0 - 2 \times 24}{2}$ $= 164.0$	**OK**
Thickness (mm)	tc = 14.0	14	**Pass**

2.13 Weld Design - Continuity Plate

Check	Required	Provided	Remarks
Weld Strength (N/mm2)	$f_{uw} = min(f_w,\ f_{u\,cp})$ $= min(450.0,\ 440)$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1]$	$f_{uw} = 440$	**Pass**
Total (effective) Weld Length (mm)		$L_{w\,cp} = 258.0$ $Note$: $Provide\ weld\ on\ one\ side\ of\ the\ continuity\ plate$	**OK**
Weld Size (mm)	5	6	**Pass**
Min. Weld Size (mm)	1) $t_{w\,min}$ – $based\ on\ thickness\ of\ the\ thicker\ part$ $t_{thicker} = max(14,\ 14.0)$ $= 14$ $t_{w\,min} = 5$ 2) $t_{w\,min}$ – $based\ on\ thickness\ of\ the\ thinner\ part$ $t_{thinner} = min(14,\ 14.0)$ $= 14$ $t_{w\,min} \leq min(5,\ 14)$ $[Ref\ IS\ 800:2007, Table\ 21\ ,\ Cl 10.5.2.3]$	$t_w = max(t_w,\ t_{w\,min})$ $= max(6,\ 5)$ $= 6$	**Pass**
Max. Weld Size (mm)	$t_{w\,max}$ $based\ on\ thickness\ of\ the\ thinner\ part$ $t_{thinner} = min(14,\ 14.0)$ $= 14$ $t_{w\,max} = 14$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.3.1]$	$t_w \leq t_{w\,max}$ $6 \leq 14$	**Pass**

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Column End Plate
Designer	Engineer #1	Job Number	1.2.2.1.2.2.2
Date	18 /12 /2020	Client	Meera Raghunandan, Professor, IIT Bombay

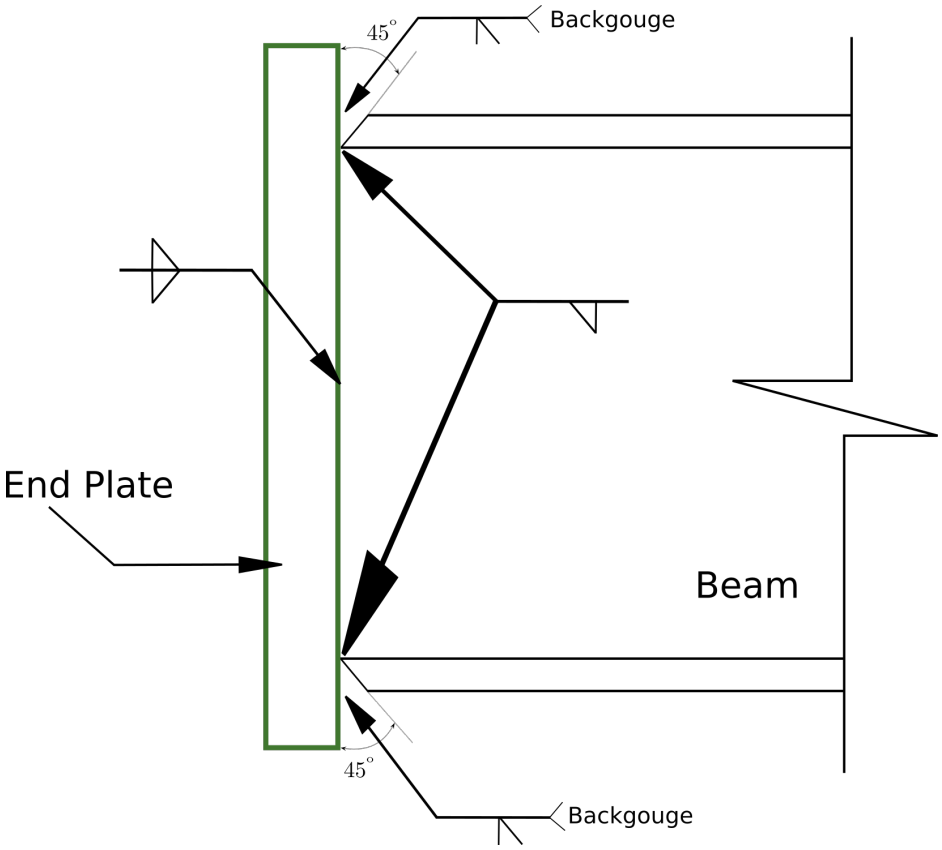


Figure 1: Typical Weld Details - Beam to End Plate Connection

3 2D Drawings (Typical)

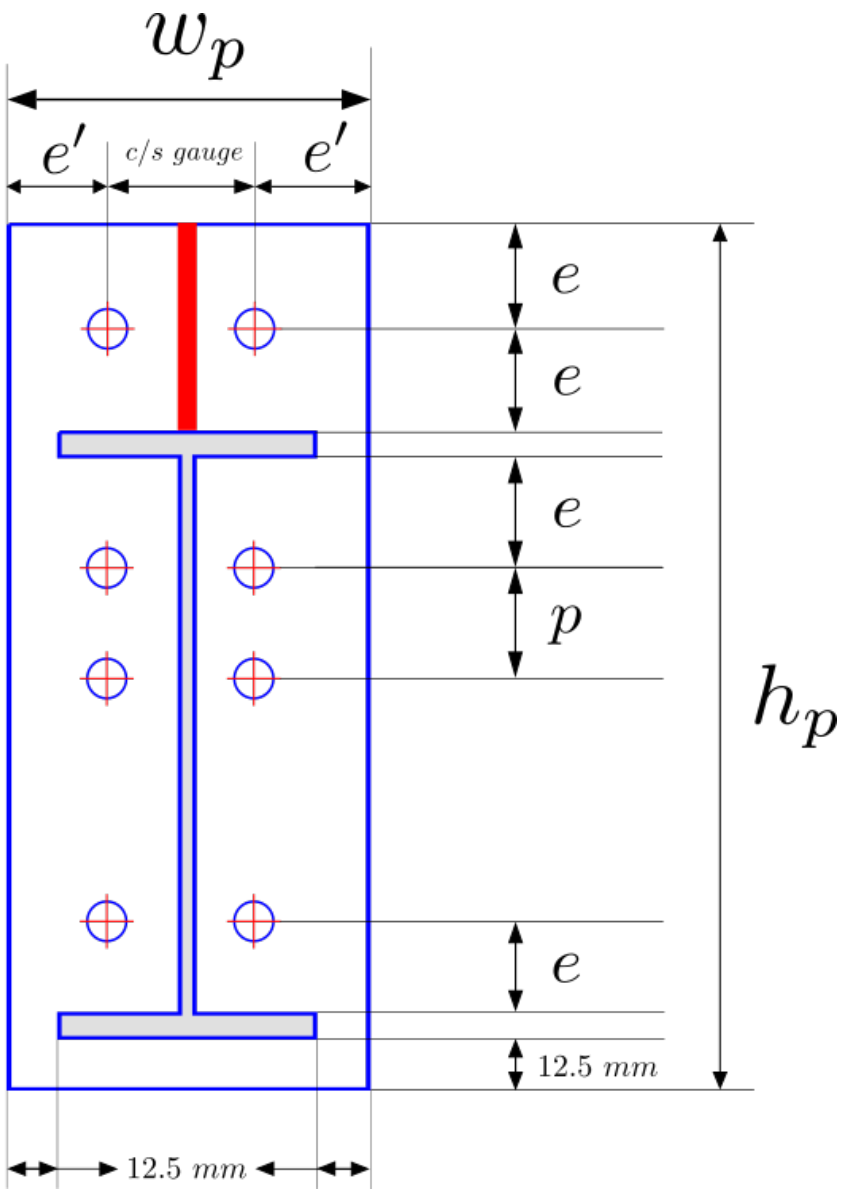


Figure 2: Typical Detailing

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Column End Plate
Designer	Engineer #1	Job Number	1.2.2.1.2.2.2
Date	18 /12 /2020	Client	Meera Raghunandan, Professor, IIT Bombay

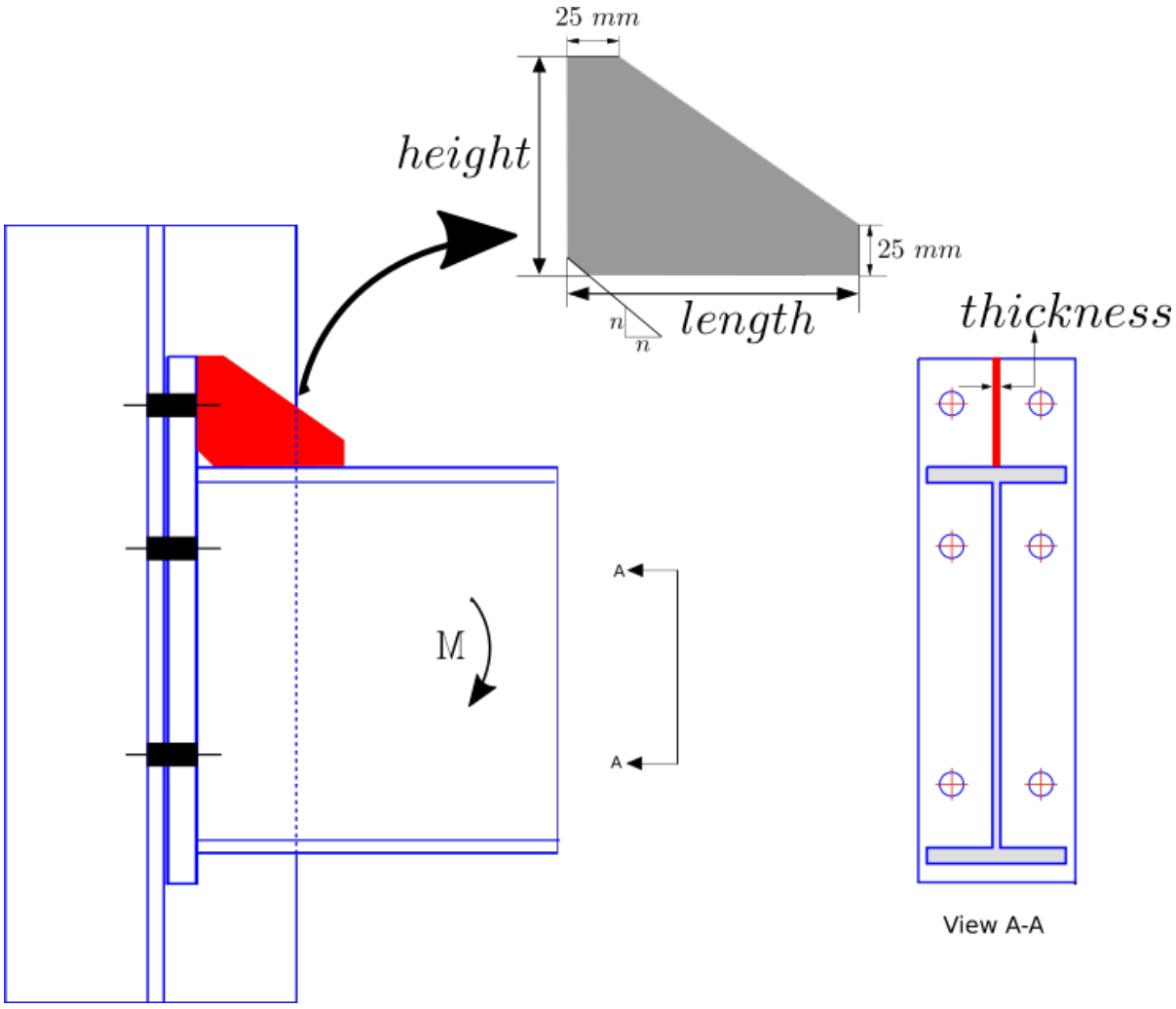
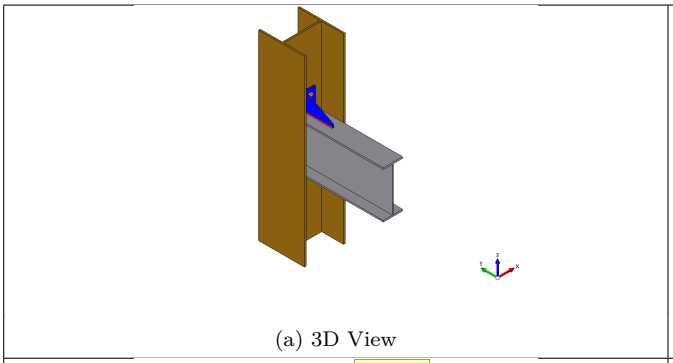
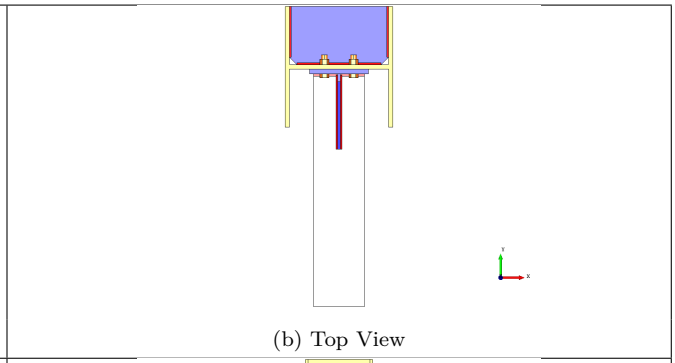


Figure 3: Typical Stiffener Details

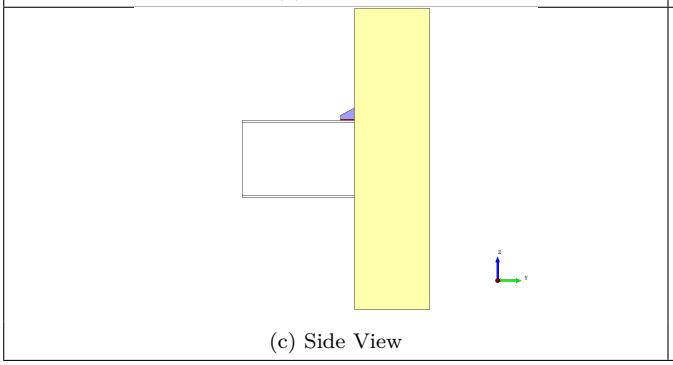
4 3D Views



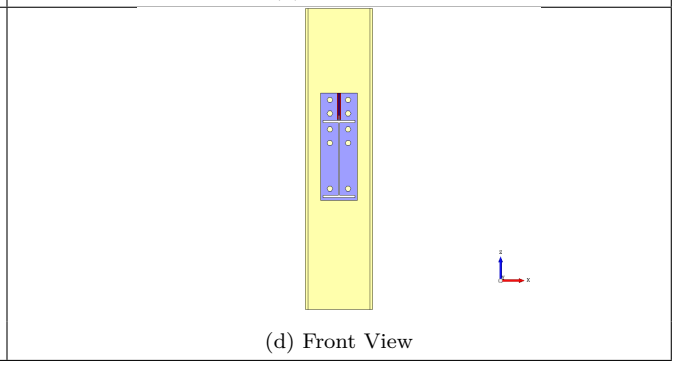
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

5 Design Log

2020-12-18 00:38:36 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].
2020-12-18 00:38:36 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (110.0 kNm) is less than 0.5 times the plastic moment capacity of the beam (297.27 kNm)
2020-12-18 00:38:36 - 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)
2020-12-18 00:38:36 - 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
2020-12-18 00:38:36 - Osdag - INFO - Designing the connection for a factored moment of 148.63 kNm
2020-12-18 00:38:36 - Osdag - INFO - [Bolt Design] Bolt diameter and grade combination ready to perform bolt design
2020-12-18 00:38:36 - Osdag - INFO - The solver has selected 1.0 combinations of bolt diameter and grade to perform optimum bolt design in an iterative manner
2020-12-18 00:38:36 - Osdag - INFO - Checking the design with the following bolt diameter-grade combination [(20.0, 4.8)]
2020-12-18 00:38:36 - Osdag - INFO - [Optimisation] Performing the design by optimising the plate thickness, using the thin plate and large (suitable) bolt diameter approach

2020-12-18 00:38:36 - Osdag - INFO - If you wish to optimise the bolt diameter-grade combination, pass a higher value of plate thickness using the Input Dock

2020-12-18 00:38:36 - Osdag - INFO - The provided beam can accommodate a single column of bolt on either side of the web [Ref. based on detailing requirement]

2020-12-18 00:38:36 - Osdag - INFO - Performing the design with a single column of bolt on each side

2020-12-18 00:38:36 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 427.84 kN is less than the flange capacity 562.5 kN. The flange strength requirement is satisfied.

2020-12-18 00:38:36 - Osdag - INFO - [End Plate] The end plate of 16.0 mm passes the moment capacity check. The end plate is checked for yielding due tension caused by bending moment and prying force

2020-12-18 00:38:36 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 4.8 grade fails the tension check

2020-12-18 00:38:36 - Osdag - ERROR - Total tension demand on bolt (due to direct tension + prying action) is 144.2522571484427 kN and exceeds the bolt tension capacity (74.09 kN)

2020-12-18 00:38:36 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter

2020-12-18 00:38:36 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 4.8 grade fails the combined shear + tension check

2020-12-18 00:38:36 - Osdag - ERROR - The Interaction Ratio (IR) of the critical bolt is 3.828

2020-12-18 00:38:36 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter

2020-12-18 00:38:36 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 447.56 kN is less than the flange capacity 562.5 kN. The flange strength requirement is satisfied.

2020-12-18 00:38:36 - Osdag - INFO - [End Plate] The end plate of 16.0 mm passes the moment capacity check. The end plate is checked for yielding due tension caused by bending moment and prying force

2020-12-18 00:38:36 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 4.8 grade fails the tension check

2020-12-18 00:38:36 - Osdag - ERROR - Total tension demand on bolt (due to direct tension + prying action) is 84.55259423023406 kN and exceeds the bolt tension capacity (74.09 kN)

2020-12-18 00:38:36 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter

2020-12-18 00:38:36 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 4.8 grade fails the combined shear + tension check

2020-12-18 00:38:36 - Osdag - ERROR - The Interaction Ratio (IR) of the critical bolt is 1.323

2020-12-18 00:38:36 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter