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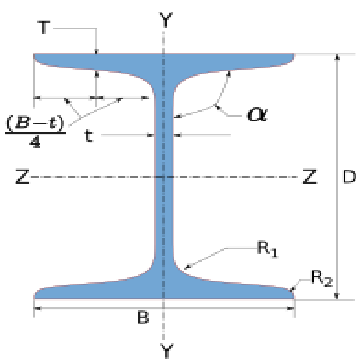
Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Column End Plate
Designer	Engineer#1	Job Number	1.2.2.1.2.2.1
Date	04 /02 /2021	Client	Prof. V Kalyanaraman, IIT Madras

1 Input Parameters

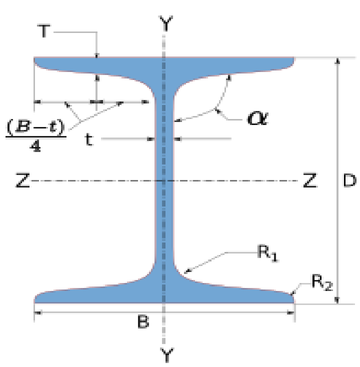
Main Module	Moment Connection
Module	Beam-to-Column End Plate Connection
Connectivity	Column Web-Beam Web
End Plate Type	Extended One Way - Irreversible Moment
Bending Moment (kNm)	73.0
Shear Force (kN)	50.0
Axial Force (kN)	15.0

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		NPB 300 X 200 X 59.57	
Material		E 300 (Fe 440)	
Ultimate Strength, F_u (MPa)		440	
Yield Strength, F_y (MPa)		300	
Mass, m (kg/m)	59.57	I_z (cm^4)	12800.0
Area, A (cm^2)	75.8	I_y(cm^4)	1820.0
D (mm)	303.0	r_z (cm)	13.0
B (mm)	203.0	r_y (cm)	4.9
t (mm)	7.5	Z_z (cm^3)	848.0
T (mm)	13.1	Z_y (cm^3)	180.0
Flange Slope	90	Z_{pz} (cm^3)	940.0

	R_1 (mm)	15.0	Z_{py} (cm^3)	275.0
	R_2 (mm)	0.0		

Plate Details - Input and Design Preference	
Thickness (mm)	[14, 16, 18]
Material	E 250 (Fe 410 W)A
Ultimate Strength, Fu (MPa)	410
Yield Strength, Fy (MPa)	250
Bolt Details - Input and Design Preference	
Diameter (mm)	[20, 24]
Property Class	[8.8, 9.8]
Type	Bearing Bolt
Bolt Tension	Non pre-tensioned
Hole Type	Standard
Slip Factor, (μ_f)	0.3
Weld Details - Input and Design Preference	
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, F_u (MPa)	440.0
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?	False

2 Design Checks

Design Status	Pass

2.1 Beam to Column - Compatibility Check

Check	Required	Provided	Remarks
Beam Section Compatibility	$B_{\text{req}} = B_b + 25$ $= 203.0 + 25$ $= 228.0$	$B_{available} = D_c - (2T_c) - (2R_{1c}) - 10$ $= 348.0 - (2 \times 14) - (2 \times 15.0) - 10$ $= 280.0$	Compatible

2.2 Member Capacity - Supported Section

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{0.6 \times 276.8 \times 7.5 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 196.13$ [Ref. IS 800:2007, Cl.10.4.3]	Restricted to low shear
Plastic Moment Capacity (kNm)		$M_{d_z} = \frac{\beta_b Z_{p_z} fy}{\gamma_{m0}}$ $= \frac{1.0 \times 940000.0 \times 300}{1.1 \times 10^6}$ $= 256.36$ [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)		$M_{d_z} = \frac{\beta_b Z_{p_z} fy}{\gamma_{m0}}$ $= \frac{0.9 \times 2210000.0 \times 300}{1.1 \times 10^6}$ $= 542.73$ 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)		$M_{d_y} = \frac{\beta_b Z_{py} fy}{\gamma_{m0}}$ $= \frac{0.66 \times 1080000.0 \times 300}{1.1 \times 10^6}$ $= 193.64$ 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
Axial Force (kN)		$P_x = 15.0$	**OK**

Check	Required	Provided	Remarks
Shear Force (kN)	$V_y = 50.0$	$V_{y\,\mathrm{min}} = \min(0.15V_{d_y},\ 40.0)$ $= \min(0.15 \times 196.13,\ 40.0)$ $= \min(29.42,\ 40.0)$ $= 29.42$ $V_u = \max(V_y,\ V_{y\,\mathrm{min}})$ but, $\leq V_{dy}$ $= \max(50.0,\ 29.42)$ but, ≤ 196.13 $= 50.0$ [Ref. IS 800:2007, Cl.10.7]	**Pass**
Bending Moment (major axis) (kNm)	$M = 73.0$	$M_{z\,\mathrm{min}} = 0.5M_{dz}$ $= 0.5 \times 256.36$ $= 128.18$ $M_u = \max(M_z,\ M_{z\,\mathrm{min}})$ but, $\leq M_{dy}$ of the column section $= \max(73.0, 128.18)$ ≤ 193.64 $= 128.18$ [Ref. IS 800:2007, Cl.8.2.1.2]	**Pass**
Effective Bending Moment (major axis) (kNm)		$M_{ue} = M_u \ + \ P_x \times \left(\frac{D}{2} - \frac{T}{2}\right) \times 10^{-3}$ $= 128.18 +$ $15.0 \times \left(\frac{303.0}{2} - \frac{13.1}{2}\right) \times 10^{-3}$ $= 130.35$	**OK**

2.5 Bolt Optimization

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Diameter Optimization	$d = 20$	Pass
Property Class	Bolt Property Class Optimization	8.8	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)	$p_{\min} = 2.5d$ $= 2.5 \times 20.0$ $= 50.0$ [Ref. IS 800:2007, Cl.10.2.2]	70	Pass
Max. Pitch Distance (mm)	$p_{\max} = \min(32t,\ 300)$ $= \min(32 \times 14.0,\ 300)$ $= \min(448.0,\ 300)$ $= 300$ Where, $t = \min(14.0, 14.0)$ [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

Check	Required	Provided	Remarks
Max. End Distance (mm)	$e_{\max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14.0 \times \sqrt{\frac{250}{250}} = 168.0$ $e_2 = 12 \times 14.0 \times \sqrt{\frac{250}{250}} = 168.0$ $e_{\max} = \min(e_1,\ e_2) = 168.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	40	Pass
Min. Edge 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
Max. Edge Distance (mm)	$e'_{\max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 14.0 \times \sqrt{\frac{250}{250}} = 168.0$ $e_2 = 12 \times 14.0 \times \sqrt{\frac{250}{250}} = 168.0$ $e'_{\max} = min(e_1,\ e_2) = 168.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	40	Pass
Cross-centre Gauge Distance (mm)		104	Pass

2.7 Critical Bolt Design

Check	Required	Provided	Remarks

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{\text{dsb}} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}}$ $= \frac{830.0 \times 1 \times 245}{1000 \times \sqrt{3} \ \times \ 1.25}$ $= 93.92$ [Ref. IS 800:2007, Cl.10.3.3]	OK
Kb		$k_b = \min\left(\frac{e}{3d_0}, \ \frac{p}{3d_0} - 0.25, \ \frac{f_{ub}}{f_u}, \ 1.0\right)$ $= \min\left(\frac{40}{3 \times 22.0}, \ \frac{70}{3 \times 22.0} - 0.25, \ \frac{830.0}{440}, \ 1.0\right)$ $= \min(0.61, 0.81, 1.89, 1.0)$ $= 0.61$ [Ref. IS 800:2007, Cl.10.3.4]	OK
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.61 \times 20.0 \times 14.0 \times 410}{1000 \times 1.25}$ $= 140.06$ [Ref. IS 800:2007, Cl.10.3.4]	OK
Bolt Capacity (kN)		$V_{\text{db}} = \min \ (V_{\text{dsb}}, \ V_{\text{dpb}})$ $= \min \ (93.92, \ 140.06)$ $= 93.92$ [Ref. IS 800:2007, Cl.10.3.2]	

Check	Required	Provided	Remarks
Large Grip Length Reduction Factor		$l_g = \sum \left(t_p + t_{\text{member}}\right)$ $= \sum \left(14.0 + 14.0\right)$ $= 28.0$ 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)		$V_{\text{db}} = V_{\text{db}}\beta_{lg}$ $= 93.92 \times 1.0$ $= 93.92$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3.2]$	OK
Shear Demand (per bolt) (kN)	$V_{sb} = \frac{V_u}{n}$ $= \frac{50.0}{10}$ $= 5.0$	$V_{db} = 93.92$	Pass

Check	Required	Provided	Remarks
Lever Arm (mm)	$r = [289.9, 289.9, 46.55, 289.9, 289.9]$ 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 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**
Tension Due to Moment (kN)	$T_1 = \frac{M_{ue}}{4 \times n_c \times \left(r_1 + \sum_{i=3}^{n_r=3} \frac{r_i^2}{r_1}\right)}$ $= \frac{130.35 \times 10^3}{4 \times 2 \times \left(289.9 + \sum_{i=3}^{n_r=3} \frac{r_i^2}{289.9}\right)}$ $= 54.79$ 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)	$Q = \frac{l_v}{2l_e}\left[T_e - \frac{\beta\eta f_o b_e t^4}{27 l_e l_v^2}\right]$ $l_v = e - \frac{R_1}{2}$ $= 40 - \frac{15.0}{2} = 32.5$ mm $f_o = 0.7 f_{ub}$ $= 0.7 \times 830.0$ $= 581.0$ N/mm^2 $l_e = \min\left(e, 1.1t\sqrt{\frac{\beta f_o}{f_y}}\right)$ $= \min\left(40, 1.1 \times 14 \times \sqrt{\frac{2 \times 581.0}{250}}\right)$ $= \min(40,\ 33.2) = 33.2$ mm $\beta = 2$ (non pre-tensioned bolt) $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{203.0}{2} = 101.5$ mm $Q = \frac{32.5}{2 \times 33.2} \times \left[54.79 - \left(\frac{2 \times 1.5 \times 581.0 \times 101.5 \times 14^4}{27 \times 33.2 \times 32.5^2}\right) \times 10^{-3}\right]$ $Q = 23.3$ [Ref. IS 800:2007, Cl.10.4.7]		**OK**

Check	Required	Provided	Remarks
Tension Demand (kN)	$T_b = T_1 + Q$ $= 54.79 + 23.3$ $= 78.09$	$T_{\text{db}} = 0.90 f_{ub} A_n \ / \ \gamma_{mb}$ $< \ f_{yb} A_{sb} (\gamma_{mb} \ / \ \gamma_{m0})$ $= \min\Big(0.90 \times 830.0 \times 245 \ / \ 1.25,$ $660.0 \times 314.0 \times (1.25/1.1)\Big)$ $= \min(146.41, \ 235.5)$ $= 146.41$ [Ref. IS 800:2007, Cl.10.3.5]	**Pass**
Combined Capacity (I.R.)	≤ 1	$\left(\frac{V_{sb}}{V_{\text{db}}}\right)^2 + \left(\frac{T_{\text{b}}}{T_{\text{db}}}\right)^2 \leq 1.0$ $\left(\frac{5.0}{93.92}\right)^2 + \left(\frac{78.09}{146.41}\right)^2 = 0.29$ [Ref. IS 800:2007, Cl.10.3.6]	**Pass**

2.8 Compression Flange Check

Check	Required	Provided	Remarks
Tension in Bolt Rows (kN)		$T = [54.79, 54.79, 35.19, 54.79, 54.79]$	**OK**
Reaction at Compression Flange (kN)	$R_c = n_c \sum_{n_r=1}^{n_r} T_{n_r}$ $= 2 \times \sum_{n_r=1}^{5} T_{n_r}$ $= 2 \times 254.35$ $= 508.7$	$F_c = A_g f_y \ / \ \gamma_{m0}$ $= \frac{B T f_y}{\gamma_{m0}}$ $= \frac{203.0 \times 13.1 \times 300}{1.1 \times 1000}$ $= 725.26$	**Pass**

2.9 End Plate Checks

Check	Required	Provided	Remarks
Height (mm)		$H_p = D + 12.5 + (2 \times e) + p$ $= 303.0 + 12.5 + (2 \times 40) + 70$ $= 465.5$	Pass
Width (mm)		$B_p = B + 25$ $= 203.0 + 25$ $= 228.0$	Pass
Moment at Critical Section (kNm)		$M_{cr} = T_1\ l_v - Q\ l_e$ $= (54.79 \times 32.5 - 23.3 \times 33.2) \times 10^{-3}$ $= 1.01$ 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)	$t_p = \sqrt{\frac{4M_{cr}}{b_e(f_y/\gamma_{m0})}}$ $= \sqrt{\frac{4 \times 1.01 \times 10^6}{101 \times (250/1.1)}}$ $= 13.22$	14	Pass
Moment Capacity (kNm)	1.01	$M_p = \left(\frac{b_e t_p^2}{4}\right) \times \frac{f_y}{\gamma_{m0}}$ $= \frac{101 \times 14^2}{4} \times \frac{250}{1.1} \times 10^{-6}$ $= 1.13$	Pass

2.10 Stiffener Design

Check	Required	Provided	Remarks
Height (mm)		$H_{\rm st} = H_p - D - 12.5$ $= 465.5 - 303.0 - 12.5$ $= 150.0$	150.0
Length (mm)		$L_{\rm st} = \frac{H_{\rm st}}{\tan 30^\circ}$ $= \frac{150.0}{\tan 30^\circ}$ $= 260$	Pass
Thickness (mm)	$t = 7.5$	$t_{st} = 8$	Pass

Check	Required	Provided	Remarks
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/mm2)	$f_{u_w} = \min(f_{\mathrm{w}},\ f_u)$ $= \min(440.0,\ 410)$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	$f_{u_w} = 410$	**Pass**
Total Weld Length (mm)		$L_w = 2 \times \Big[D - (2 \times T) - (2 \times R1) - 20\Big]$ $= 2 \times \Big[303.0 - (2 \times 13.1) - (2 \times 15.0) - 20\Big]$ $= 446.1$ Note: Weld is provided on both sides of the web	**OK**
Weld Size (mm)	$t_w = \dfrac{V_u}{f_{uw} k L_w} \times \sqrt{3}\ \gamma_{mw}$ $= \dfrac{50.0 \times 10^3}{410 \times 0.7 \times 446.1} \times \sqrt{3} \times 1.25$ $= 0.85$ [Ref. IS 800:2007, Cl.10.5.7]	6	**Pass**

Check	Required	Provided	Remarks
Min. Weld Size (mm)	1) $t_{w\min}-$ based on thickness of the thicker part $t_{\text{thicker}} = \max(14.0,\ 7.5)$ $= 14.0$ $t_{w\min} = 5$ 2) $t_{w\min}-$ based on thickness of the thinner part $t_{\text{thinner}} = \min(14.0,\ 7.5)$ $= 7.5$ $t_{w\min} \leq \min(5,\ 7.5)$ [Ref. IS 800:2007, Table 21, Cl 10.5.2.3]	$t_w = \max(t_w,\ t_{w\min})$ $= \max(0.85,\ 5)$ $= 6$	**Pass**
Max. Weld Size (mm)	$t_{w\max}$ based on thickness of the thinner part $t_{\text{thinner}} = \min(14.0,\ 7.5)$ $= 7.5$ $t_{w\max} = 7.5$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_w \leq t_{w\max}$ $6 \leq 7.5$	**Pass**
Normal Stress (N/mm2)		$f_a = \frac{H}{0.7 t_w L_w}$ $= \frac{15.0 \times 10^3}{0.7 \times 6 \times 446.1}$ $= 8.01$ [Ref. IS 800:2007, Cl.10.5.9]	

Check	Required	Provided	Remarks
Shear Stress (N/mm2)		$q = \frac{V}{0.7 t_w L_w}$ $= \frac{50.0 \times 10^3}{0.7 \times 6 \times 446.1}$ $= 26.69$ [Ref. IS 800:2007, Cl.10.5.9]	
Equivalent Stress (N/mm2)	$f_e = \sqrt{f_a^2 + 3q^2}$ $= \sqrt{8.01^2 + (3 \times 26.69^2)}$ $= 46.31$ [Ref. IS 800:2007, Cl.10.5.10.1.1]	$f_w = \frac{f_u}{\sqrt{3}\gamma_{mw}}$ $= \frac{410}{\sqrt{3} \times 1.25}$ $= 189.37$ [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 $l_{cp1} = D_c - 2T_c$ $= 348.0 - (2 \times 14)$ $= 320.0$ $l_{cp2} =$ 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)	$f_{uw} = \min(f_w,\ f_{u_{cp}})$ $= \min(440.0,\ 410)$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1]$	$f_{u_w} = 410$	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 $t_{\text{thicker}} = \max(14,\ 14.0)$ $= 14$ $t_{w_{\min}} = 5$ 2) $t_{w_{\min}}-$ based on thickness of the thinner part $t_{\text{thinner}} = \min(14,\ 14.0)$ $= 14$ $t_{w_{\min}} \leq \min(5,\ 14)$ [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 $t_{\text{thinner}} = \min(14,\ 14.0)$ $= 14$ $t_{w_{\max}} = 14$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_w \leq t_{w_{\max}}$ $6 \leq 14$	Pass

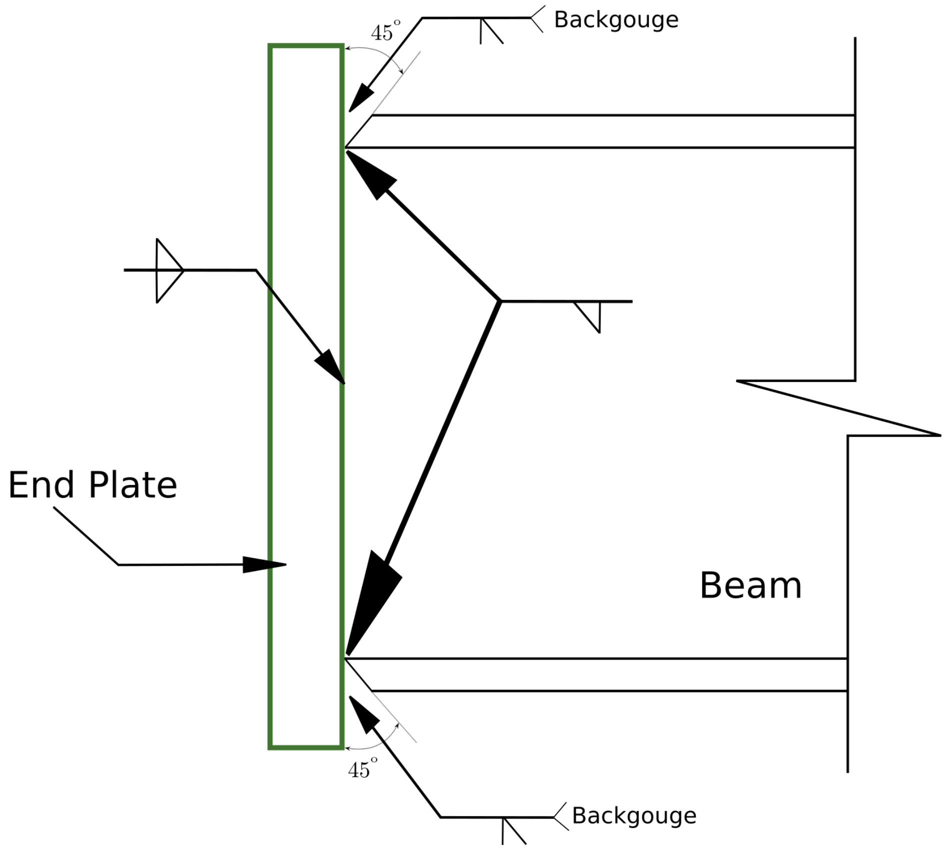


Figure 1: Typical Weld Details -- Beam to End Plate Connection

3 2D Drawings (Typical)

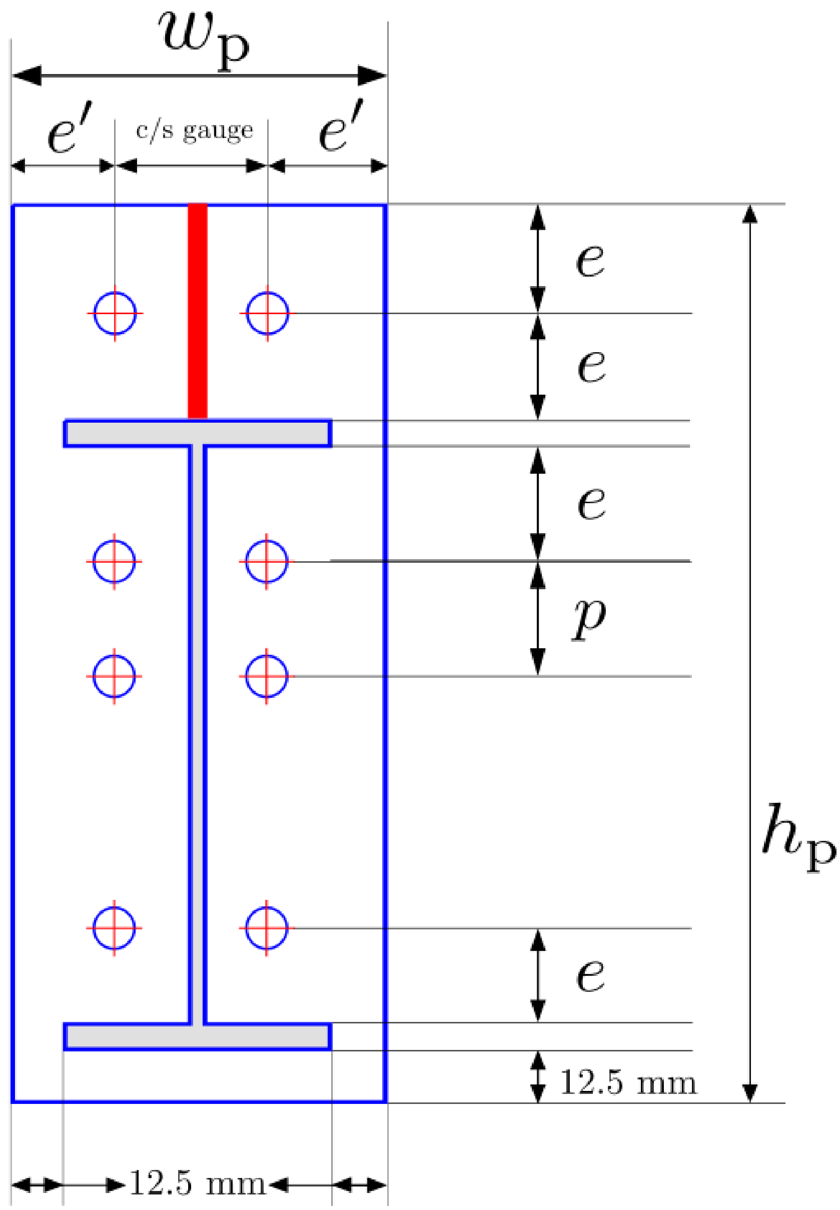


Figure 2: Typical Detailing

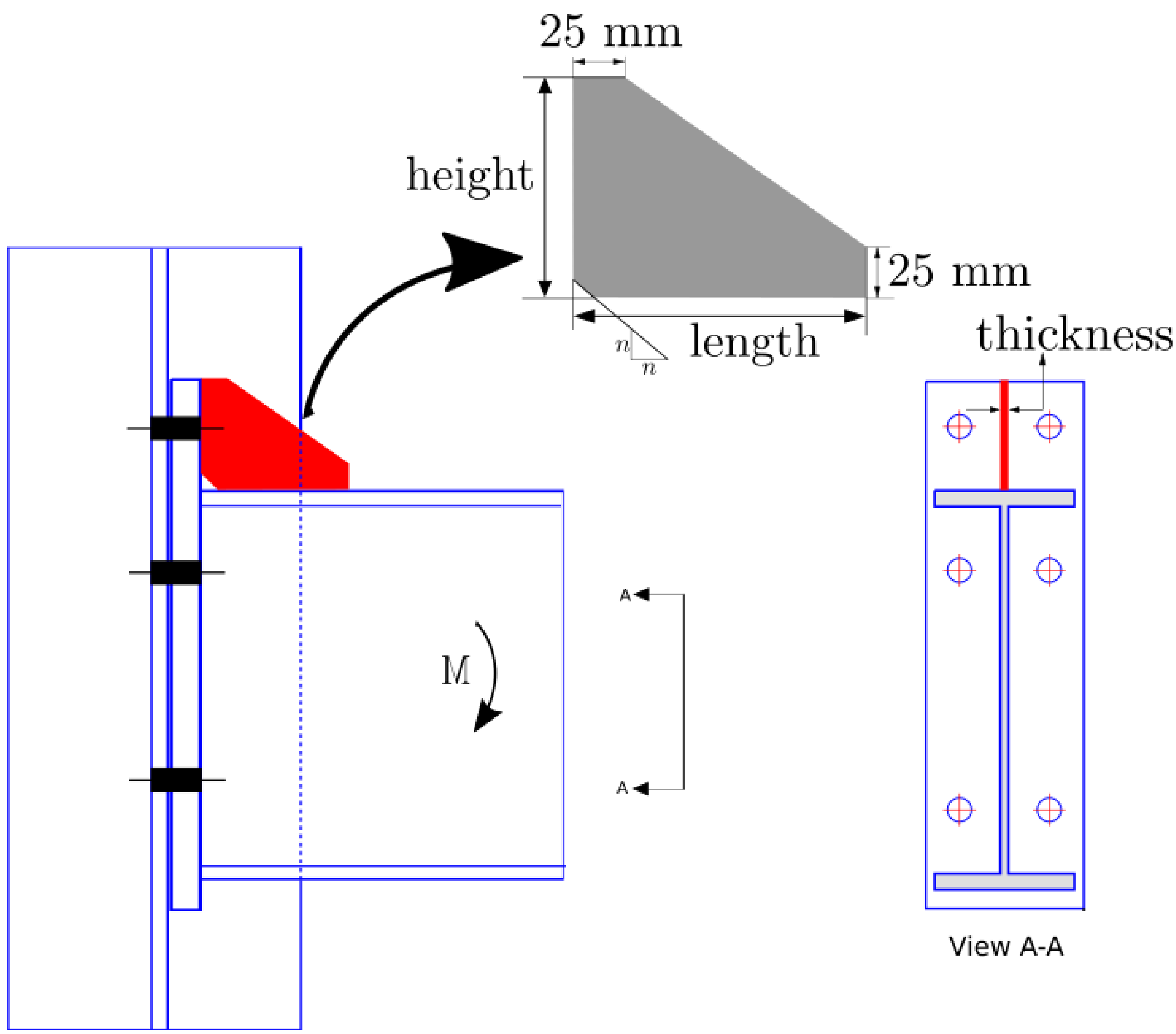
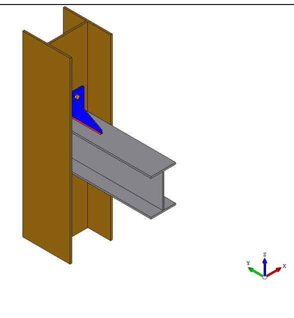
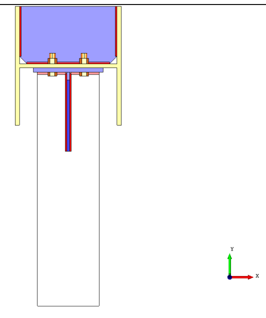
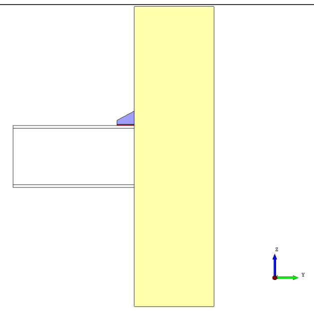


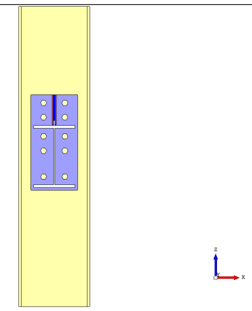
Figure 3: Typical Stiffener Details

4 3D Views


(a) 3D View


(b) Top View


(c) Side View


(d) Front View

5 Design Log

2021-02-04 13:57:31 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].

2021-02-04 13:57:31 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (73.0 kNm) is less than 0.5 times the plastic moment capacity of the beam (256.36 kNm)

2021-02-04 13:57:31 - 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 13:57:31 - 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 13:57:31 - Osdag - INFO - Designing the connection for a factored moment of 128.18 kNm

2021-02-04 13:57:31 - Osdag - INFO - [Bolt Design] Bolt diameter and grade combination ready to perform bolt design

2021-02-04 13:57:31 - Osdag - INFO - The solver has selected 4.0 combinations of bolt diameter and grade to perform optimum bolt design in an iterative manner

2021-02-04 13:57:31 - 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 13:57:31 - 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 13:57:31 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 508.7 kN is less than the flange capacity 725.26 kN. The flange strength requirement is satisfied.
2021-02-04 13:57:31 - Osdag - INFO - [End Plate] The end plate of 14.0 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 13:57:31 - Osdag - INFO - [Bolt Design] The bolt of 20.0 mm diameter and 8.8 grade passes the tension check
2021-02-04 13:57:31 - Osdag - INFO - Total tension demand on bolt (due to direct tension + prying action) is 78.09199293924512 kN and the bolt tension capacity is (146.41 kN)
2021-02-04 13:57:31 - Osdag - INFO - [Bolt Design] The bolt of 20.0 mm diameter and 8.8 grade passes the combined shear + tension check
2021-02-04 13:57:31 - Osdag - INFO - The Interaction Ratio (IR) of the critical bolt is 0.287
2021-02-04 13:57:31 - Osdag - INFO - : ========== Design Status ============
2021-02-04 13:57:31 - Osdag - INFO - : Overall beam to column end plate connection design is SAFE
2021-02-04 13:57:31 - Osdag - INFO - : ========== End Of Design ============