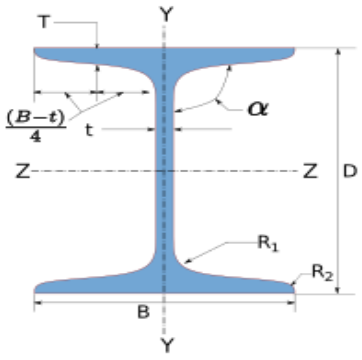
Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Beam End Plate Splice
Designer	Engineer #1	Job Number	1.2.1.2.1.2.1
Date	17 /12 /2020	Client	V Kalyanaraman, Retd. Professor, IIT Madras

1 Input Parameters

Main Module			Moment Connection	
Module			Beam-Beam End Plate Splice	
Connectivity			Coplanar Tension-Compression Flange	
End Plate Type			Extended One Way - Irreversible Moment	
Bending Moment (kNm)			300.0	
Shear Force (kN)			140.0	
Axial Force (kN)			50.0	
Beam Section - Mechanical Properties				
	Beam Section		UB 610 x 229 x 125	
	Material		E 300 (Fe 440)	
	Ultimate Strength, Fu (MPa)		440	
	Yield Strength, Fy (MPa)		300	
	Mass, m (kg/m)	125.1	I_z (cm^4)	98610.0
	Area, A (cm^2)	15930.0	I_y(cm^4)	3932.0
	D (mm)	612.0	r_z (cm)	24.9
	B (mm)	229.0	r_y (cm)	5.0
	t (mm)	11.9	Z_z (cm^3)	3221.0
	T (mm)	19.6	Z_y (cm^3)	343.0
	Flange Slope	90	Z_{pz} (cm^3)	3676.0
	R_1 (mm)	12.7	Z_{py} (cm^3)	535.0
	R_2 (mm)	0.0		
Plate Details - Input and Design Preference				
Thickness (mm)			[18, 20, 22]	
Material			E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)			410	
Yield Strength, Fy (MPa)			240	
Bolt Details - Input and Design Preference				
Diameter (mm)			[20, 24, 30]	
Property Class			[8.8, 10.9]	
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)	410.0
Beam Flange to End Plate	Groove Weld
Beam Web to End Plate	Fillet Weld
Stiffener	Fillet Weld
Detailing - Design Preference	
Edge Preparation Method	Sheared or hand flame cut
Gap Between Beams (mm)	0.0
Are the Members Exposed to Corrosive Influences?	False

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Date	17 /12 /2020	Client	V Kalyanaraman, Retd. Professor, IIT Madras

2 Design Checks

Design Status	Pass

2.1 Member Capacity

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{0.6 \times 572.8 \times 11.9 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 643.98$ $[Ref. IS\ 800:2007, Cl. 10.4.3]$	**Restricted to low shear**
Plastic Moment Capacity (kNm)		$M_{dz-z} = \frac{\beta_b Z_{pz} fy}{\gamma_{mo}}$ $= \frac{1 \times 3676000.0 \times 300}{1.1 \times 10^6}$ $= 1002.55$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	**V < 0.6 Vdy**

2.2 Load Consideration

Check	Required	Provided	Remarks
Shear Force (kN)	$V_y = 140.0$	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 643.98,\ 40.0)$ $= min(96.6,\ 40.0)$ $= 40$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(140.0,\ 40)$ $= 140.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.7]$	**OK**
Axial Force (kN)		P_x = 50.0	**OK**

Check	Required	Provided	Remarks
Bending Moment (kNm)	$M_z = 300.0$	$M_{z\,min} = 0.5 * M_{dz-z}$ $= 0.5 \times 1002.55$ $= 501.27$ $M_u = max(M_z,\ M_{z\,min})$ $= max(300.0, 501.27)$ $= 501.27$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 8.2.1.2]$	**OK**
Effective Bending Moment (kNm)		$M_{ue} = M_u\ +\ P_x \times \left(\frac{D}{2} - \frac{T}{2}\right) \times 10^{-3}$ $= 501.27 +$ $50.0 \times \left(\frac{612.0}{2} - \frac{19.6}{2}\right) \times 10^{-3}$ $= 516.08$	**OK**

2.3 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		$n_r = 6$	**Pass**
Total No. of Bolts		$n = n_r X n_c = 12$	**Pass**

2.4 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)	$p_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 \times 20.0,\ 300\ mm)$ $= \min(640.0,\ 300\ mm)$ $= 300$ $Where,\ t = min(20.0, 20.0)$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.2.3$]	70	**Pass**
Min. End Distance (mm)	$e_{min} = 1.7\ d_0$ $= 1.7 \times 22.0$ $= 37.4$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.2$]	40	**Pass**
Max. End Distance (mm)	$e_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 20.0 \times \sqrt{\frac{250}{240}} = 244.95$ $e_2 = 12 \times 20.0 \times \sqrt{\frac{250}{240}} = 244.95$ $e_{max} = min(e_1, e_2) = 244.95$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.3$]	40	**Pass**
Min. Edge Distance (mm)	$e'_{min} = 1.7\ d_0$ $= 1.7 \times 22.0$ $= 37.4$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.2$]	40	**Pass**

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 20.0 \times \sqrt{\frac{250}{240}} = 244.95$ $e_2 = 12 \times 20.0 \times \sqrt{\frac{250}{240}} = 244.95$ $e'_{max} = min(e_1, e_2) = 244.95$ [*Ref. IS* 800 : 2007, *Cl.* 10.2.4.3]	40	**Pass**
Cross-centre Gauge Distance (mm)		106	**Pass**

2.5 Critical Bolt Design

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub}\ n_n\ A_{nb}}{\sqrt{3}\ \gamma_{mb}}$ $= \frac{830.0 \times 1 \times 245}{1000 \times \sqrt{3}\ \times\ 1.25}$ $= 93.92$ [*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**

Check	Required	Provided	Remarks
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5\ k_b\ d\ t\ f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.61 \times 20.0 \times 20.0 \times 410}{1000 \times 1.25}$ $= 200.08$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.4$]	**OK**
Bolt Capacity (kN)		$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (93.92, 200.08)$ $= 93.92$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.2$]	
Large Grip Length Reduction Factor		$l_g = \sum \left(t_p + t_{member}\right)$ $= \sum \left(20.0 + 20.0\right)$ $= 40.0\ mm$ $5d = 5 \times 20.0 = 100.0$ $8d = 8 \times 20.0 = 160.0$ $Since,\ l_g < 5d$ $\beta_{lg} = 1.0$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3.2$]	**Pass**
Bolt Capacity (post reduction factor) (kN)		$V_{db} = V_{db}\beta_{lg}$ $= 93.92 \times 1.0$ $= 93.92$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3.2$]	**OK**
Shear Demand (kN)	$V_{sb} = \frac{V_u}{n}$ $= \frac{140.0}{12}$ $= 11.67$	Vdb = 93.92	**Pass**

Check	Required	Provided	Remarks
Lever Arm (mm)	$r = [592.4, 592.4, 49.8, 592.4, 592.4, 261.2]$ *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)	$T_1 = \frac{M_{ue}}{4 \times n_c \times \left(r_1 + \frac{r_3^2}{r_1} + \sum_{i=6}^{n_r} \frac{r_i^2}{r_1}\right)}$ $= \frac{516.08 \times 10^3}{4 \times 2 \times \left(592.4 + \frac{49.8^2}{592.4} + \sum_{i=6}^{6} \frac{r_i^2}{592.4}\right)}$ $= 90.64$ *Note :* T_1 *is the tension in the critical bolt* *The critical bolt is the bolt nearest to the tension flange*		**OK**

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Date	17 /12 /2020	Client	V Kalyanaraman, Retd. Professor, IIT Madras

Check	Required	Provided	Remarks
Prying Force (kN)	$Q = \frac{l_v}{2 \times l_e}\left[T_e - \frac{\beta \times \eta \times f_o \times b_e \times t^4}{27 \times l_e \times l_v^2}\right]$ $l_v = e - \frac{R_1}{2}$ $= 40 - \frac{12.7}{2} = 33.65\ mm$ $f_o = 0.7 \times f_{ub}$ $= 0.7 \times 830.0$ $= 581.0\ N/mm^2$ $l_e = min\left(e, 1.1\ t\ \sqrt{\frac{\beta\ f_o}{f_y}}\right)$ $= min\left(40, 1.1 \times 20 \times \sqrt{\frac{2 \times 581.0}{240}}\right)$ $= min(40, 48.41) = 40\ mm$ $\beta = 2\ (non\ pre - tensioned\ bolt)$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{229.0}{2} = 114.5\ mm$ $Q = \frac{33.65}{2 \times 40} \times$ $\left[90.64 - \left(\frac{2 \times 1.5 \times 581.0 \times 114.5 \times 20^4}{27 \times 40 \times 33.65^2}\right) \times 10^{-3}\right]$ $Q = 27.14$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.4.7]$		**OK**

Check	Required	Provided	Remarks
Tension Demand (kN)	$T_b = T_1 + Q$ $= 90.64 + 27.14$ $= 117.78$	$T_{db} = 0.90\ f_{ub}\ A_n\ /\ \gamma_{mb}$ $<\ f_{yb}\ A_{sb}\ (\gamma_{mb}\ /\ \gamma_{m0})$ $= min\Big(0.90\ \times 830.0 \times 245\ /\ 1.25,$ $660.0 \times 314.0 \times (1.25/1.1)\Big)$ $= min(146.41,\ 235.5)$ $= 146.41$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.5]$	**Pass**
Combined Capacity, (I.R)	≤ 1	$\left(\frac{V_{sb}}{V_{db}}\right)^2 + \left(\frac{T_b}{T_{db}}\right)^2 \leq 1.0$ $\left(\frac{11.67}{93.92}\right)^2 + \left(\frac{117.78}{146.41}\right)^2 = 0.66$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.6]$	**Pass**

2.6 Compression Flange Check

Check	Required	Provided	Remarks
Tension in Bolt Rows (kN)		$T = [90.64, 90.64, 30.48, 90.64, 90.64, 159.85]$	**OK**
Reaction at Compression Flange (kN)	$R_c = n_c \sum_{n_r=1}^{n_r} T_{n_r}$ $= 2 \times \sum_{n_r=1}^{6} T_{n_r}$ $= 2 \times 552.89$ $= 1105.78$	$F_c = A_g f_y\ /\ \gamma_{m0}$ $= \frac{B \times T \times f_y}{\gamma_{m0}}$ $= \frac{229.0 \times 19.6 \times 300}{1.1 \times 1000}$ $= 1224.11$	**Pass**

2.7 End Plate Checks

Check	Required	Provided	Remarks
Height (mm)		$H_p = D + 12.5 + (2 \times e) + p$ $= 612.0 + 12.5 + (2 \times 40) + 70$ $= 774.5$	**Pass**
Width (mm)		$B_p = B + 25$ $= 229.0 + 25$ $= 254.0$	**Pass**
Moment at Critical Section (kNm)		$M_{cr} = T_1\ l_v - Q\ l_e$ $= (90.64 \times 33.65 - 27.14 \times 40) \times 10^{-3}$ $= 1.96$ *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)	$t_p = \sqrt{\frac{4M_{cr}}{b_e(f_y/\gamma_{m0})}}$ $= \sqrt{\frac{4 \times 1.96 \times 10^6}{114 \times (240/1.1)}}$ $= 17.73$	20	**Pass**
Moment Capacity (kNm)	1.96	$M_p = \left(\frac{b_e t_p^2}{4}\right) \times \frac{f_y}{\gamma_{m0}}$ $= \frac{114 \times 20^2}{4} \times \frac{240}{1.1} \times 10^{-6}$ $= 2.5$	**Pass**

2.8 Stiffener Design

Check	Required	Provided	Remarks
Height (mm)		$H_{st} = H_p - D - 12.5$ $= 774.5 - 612.0 - 12.5$ $= 150.0$	**Pass**
Length (mm)		$L_{st} = \frac{H_{st}}{tan(30)}$ $= \frac{150.0}{tan(30)}$ $= 260$	**Pass**
Thickness (mm)	$t = 11.9$	$tst = 12$	**Pass**

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

2.9 Weld Design - Beam Web to End Plate Connection

Check	Required	Provided	Remarks
Weld Strength (N/mm2)	$f_{uw} = min(f_w,\ f_u)$ $= min(410.0,\ 410)$ [*Ref. IS* 800 : 2007, *Cl.* 10.5.7.1.1]	$f_{uw} = 410.0$	**Pass**
Total Weld Length (mm)		$L_w = 2 \times \left[D - (2 \times T) - (2 \times R1) - 20\right]$ $= 2 \times \left[612.0 - (2 \times 19.6) - (2 \times 12.7) - 20\right]$ $= 1054.8$ *Note : Weld is provided on both sides of the web*	
Weld Size (mm)	$t_w = \frac{V_u}{f_{uw} k L_w} \times \sqrt{3}\ \gamma_{mw}$ $= \frac{140.0 \times 10^3}{410.0 \times 0.7 \times 1054.8} \times \sqrt{3} \times 1.25$ $= 1.0$ [*Ref. IS* 800 : 2007, *Cl.* 10.5.7]	6	**Pass**

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Check	Required	Provided	Remarks
Min. Weld Size (mm)	1) t_{wmin} – *based on thickness of the thicker part* $t_{thicker} = max(20.0,\ 11.9)$ $= 20.0$ $t_{wmin} = 5$ 2) t_{wmin} – *based on thickness of the thinner part* $t_{thinner} = min(20.0,\ 11.9)$ $= 11.9$ $t_{wmin} \leq min(5,\ 11.9)$ [*Ref IS* 800 : 2007, *Table* 21 , *Cl*10.5.2.3]	$t_w = max(t_w,\ t_{wmin})$ $= max(1.0,\ 5)$ $= 6$	**Pass**
Max. Weld Size (mm)	t_{wmax} *based on thickness of the thinner part* $t_{thinner} = min(20.0,\ 11.9)$ $= 11.9$ $t_{wmax} = 11.9$ [*Ref. IS* 800 : 2007, *Cl.* 10.5.3.1]	$t_w \leq t_{wmax}$ $6 \leq 11.9$	**Pass**
Normal Stress (N/mm2)		$f_a = \frac{H}{0.7 \times t_w \times L_w}$ $= \frac{50.0 \times 10^3}{0.7 \times 6 \times 1054.8}$ $= 11.29$ [*Ref. IS* 800 : 2007, *Cl.* 10.5.9]	**OK**

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Check	Required	Provided	Remarks
Shear Stress (N/mm2)		$q = \frac{V}{0.7 \times t_w \times L_w}$ $= \frac{140.0 \times 10^3}{0.7 \times 6 \times 1054.8}$ $= 31.6$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.9$]	**OK**
Equivalent Stress (N/mm2)	$f_e = \sqrt{f_a^2 + 3q^2}$ $= \sqrt{11.29^2 + (3 \times 31.6^2)}$ $= 54.84$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.10.1.1$]	$f_w = \frac{f_u}{\sqrt{3}\ \gamma_{mw}}$ $= \frac{410.0}{\sqrt{3} \times 1.25}$ $= 189.37$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1$]	**Pass**

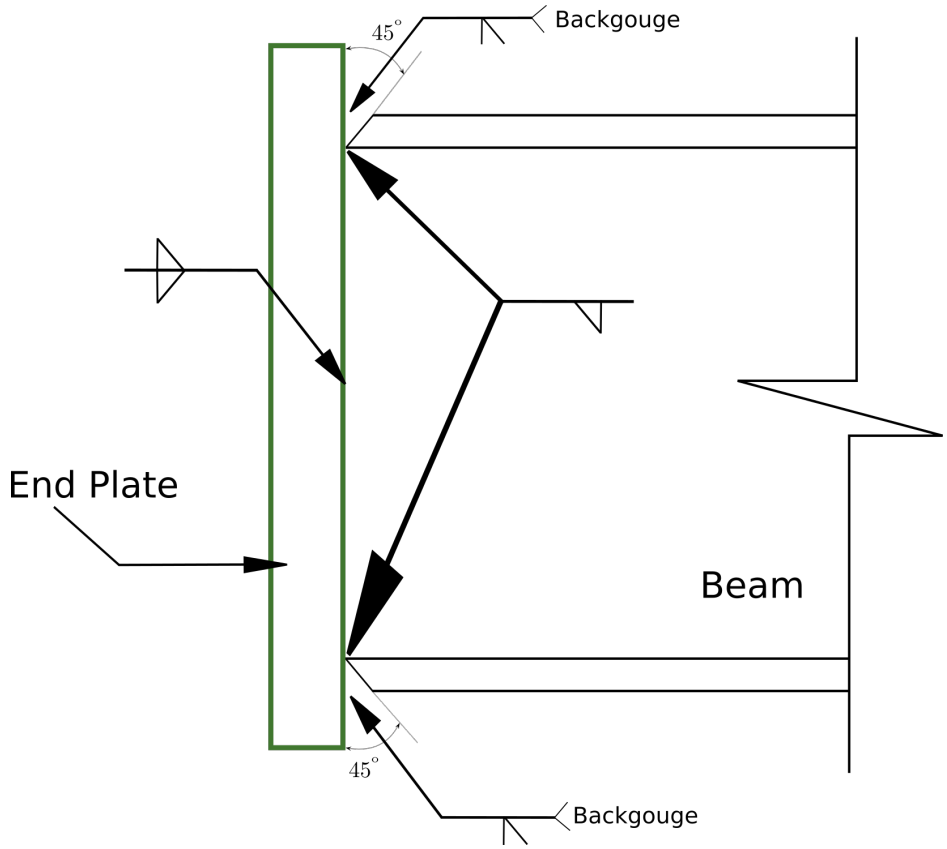


Figure 1: Typical Weld Details - Beam to End Plate Connection

3 2D Drawings (Typical)

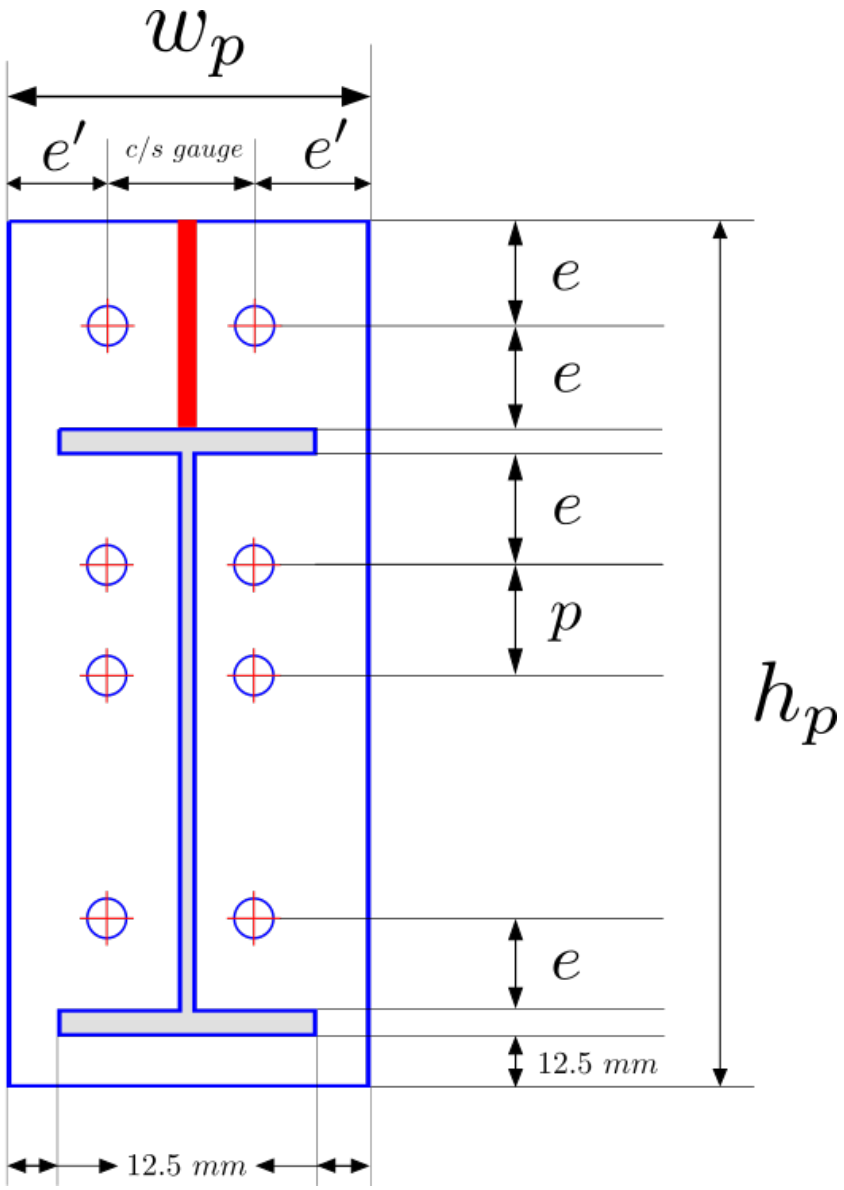


Figure 2: Typical Detailing

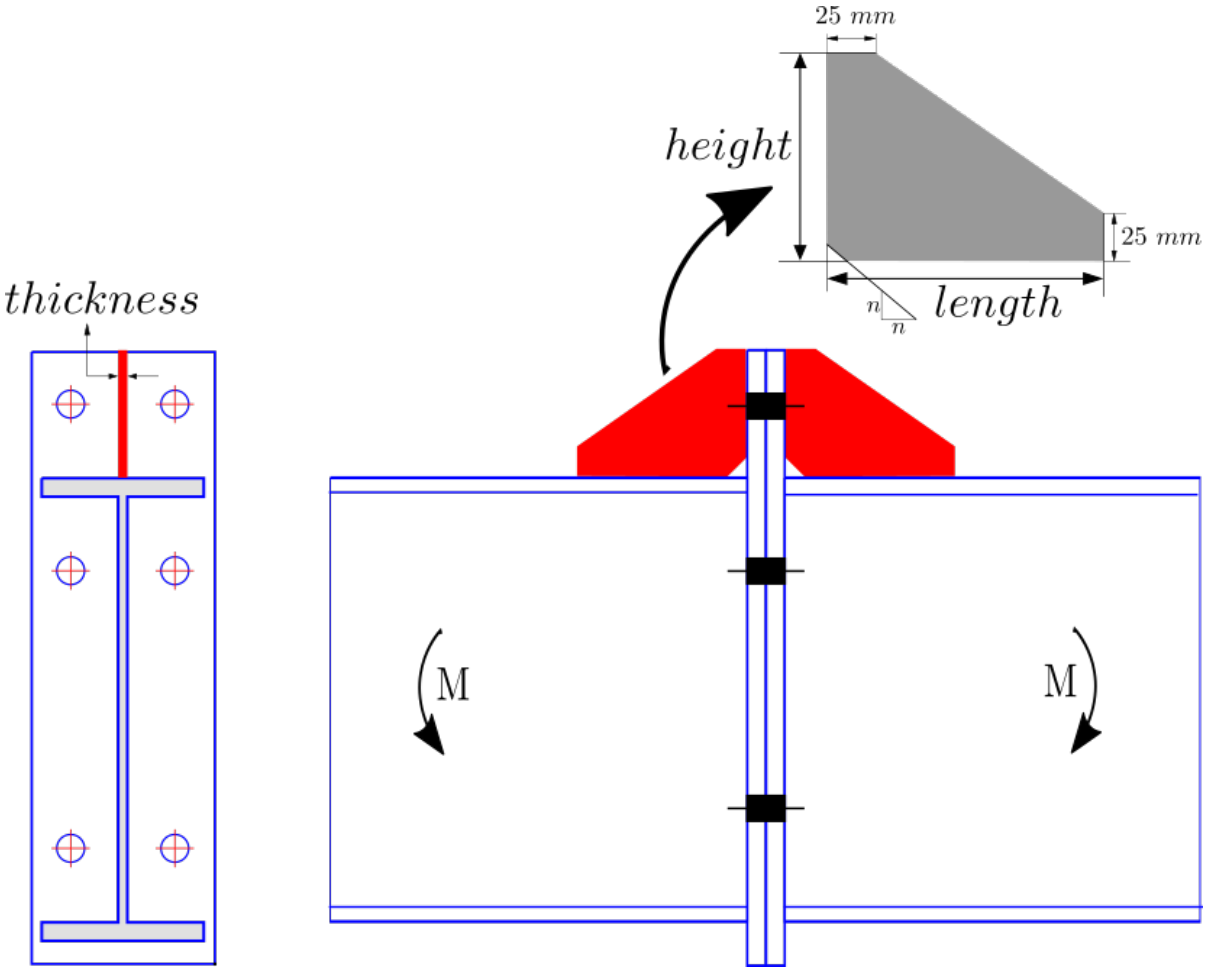
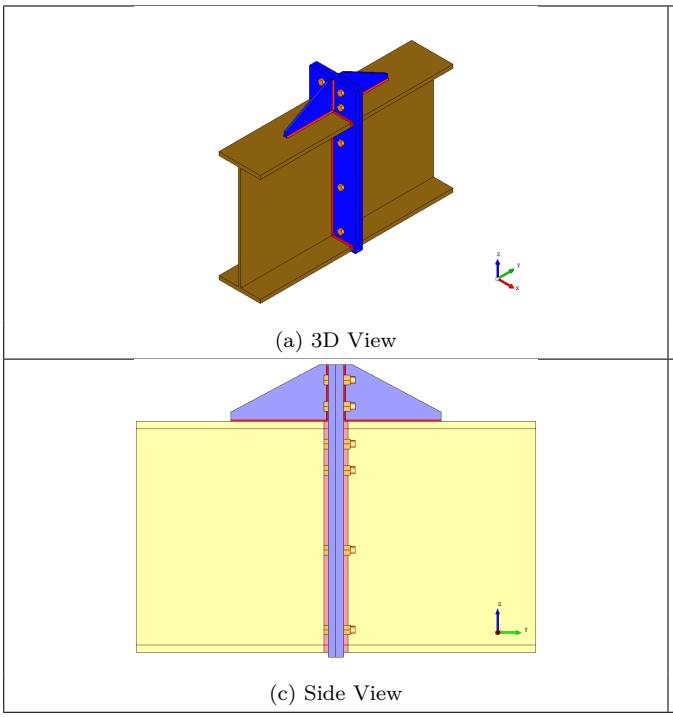
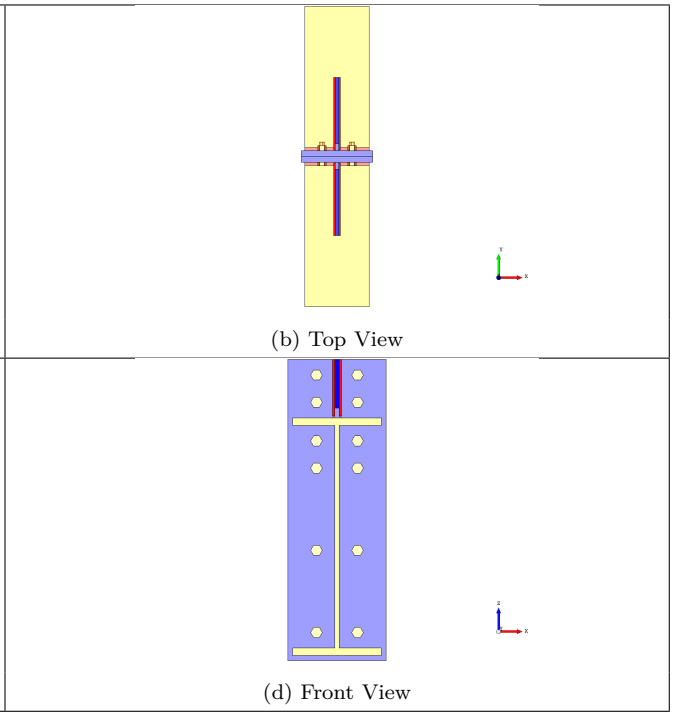


Figure 3: Typical Stiffener Details

4 3D Views



(a) 3D View



(b) Top View

(c) Side View

(d) Front View

5 Design Log

2020-12-17 23:49:44 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].

2020-12-17 23:49:44 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (300.0 kNm) is less than 0.5 times the plastic moment capacity of the beam (1002.55 kNm)

2020-12-17 23:49:44 - 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)

2020-12-17 23:49:44 - 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

2020-12-17 23:49:44 - Osdag - INFO - Designing the connection for a factored moment of 501.27 kNm

2020-12-17 23:49:44 - Osdag - WARNING - [End Plate] The end plate of 18.0 mm is thinner than the thickest part of the elements being connected

2020-12-17 23:49:44 - Osdag - INFO - Selecting a plate of higher thickness which is at least 19.6 mm thick

2020-12-17 23:49:44 - Osdag - INFO - [Bolt Design] Bolt diameter and grade combination ready to perform bolt design

2020-12-17 23:49:44 - Osdag - INFO - The solver has selected 6 combinations of bolt diameter and grade to perform optimum bolt design in an iterative manner

2020-12-17 23:49:44 - Osdag - INFO - Checking the design with the following bolt diameter-grade combination [(20.0, 8.8), (20.0, 10.9), (24.0, 8.8), (24.0, 10.9), (30.0, 8.8), (30.0, 10.9)]
2020-12-17 23:49:44 - Osdag - INFO - [Optimisation] Performing the design by optimising the plate thickness, using the thin plate and large (suitable) bolt diameter approach
2020-12-17 23:49:44 - Osdag - INFO - If you wish to optimise the bolt diameter-grade combination, pass a higher value of plate thickness using the Input Dock
2020-12-17 23:49:44 - Osdag - INFO - The provided beam can accommodate a single column of bolt on either side of the web [Ref. based on the detailing requirement]
2020-12-17 23:49:44 - Osdag - INFO - Performing the design with a single column of bolt on each side
2020-12-17 23:49:44 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 937.76 kN is less than the flange capacity 1224.11 kN. The flange strength requirement is satisfied.
2020-12-17 23:49:44 - Osdag - ERROR - [End Plate] The selected trial end plate of 20.0 mm is insufficient and fails in the moment capacity check
2020-12-17 23:49:44 - Osdag - INFO - The minimum required thickness of end plate is 25.55 mm
2020-12-17 23:49:44 - Osdag - INFO - Re-designing the connection with a plate of available higher thickness
2020-12-17 23:49:44 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 8.8 grade fails the tension check
2020-12-17 23:49:44 - Osdag - ERROR - Total tension demand on bolt (due to direct tension + prying action) is 296.2437195975981 kN and exceeds the bolt tension capacity (146.41 kN)
2020-12-17 23:49:44 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter
2020-12-17 23:49:44 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 8.8 grade fails the combined shear + tension check
2020-12-17 23:49:44 - Osdag - ERROR - The Interaction Ratio (IR) of the critical bolt is 4.156
2020-12-17 23:49:44 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter
2020-12-17 23:49:44 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 959.62 kN is less than the flange capacity 1224.11 kN. The flange strength requirement is satisfied.
2020-12-17 23:49:44 - 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
2020-12-17 23:49:44 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 8.8 grade fails the tension check
2020-12-17 23:49:44 - Osdag - ERROR - Total tension demand on bolt (due to direct tension + prying action) is 162.38266971256655 kN and exceeds the bolt tension capacity (146.41 kN)
2020-12-17 23:49:44 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter
2020-12-17 23:49:44 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 8.8 grade fails the combined shear + tension check
2020-12-17 23:49:44 - Osdag - ERROR - The Interaction Ratio (IR) of the critical bolt is 1.265
2020-12-17 23:49:44 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter