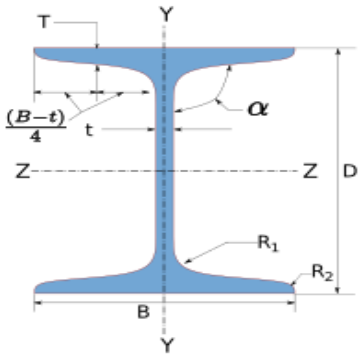
Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Beam End Plate Splice
Designer	Engineer #1	Job Number	1.2.1.2.1.3.1
Date	17 /12 /2020	Client	S R Satish Kumar, Professor, IIT Madras

1 Input Parameters

Main Module			Moment Connection	
Module			Beam-Beam End Plate Splice	
Connectivity			Coplanar Tension-Compression Flange	
End Plate Type			Extended Both Ways - Reversible Moment	
Bending Moment (kNm)			120.0	
Shear Force (kN)			75.0	
Axial Force (kN)			0.0	
Beam Section - Mechanical Properties				
	Beam Section		WPB 360 X 300 X 91.04	
	Material		E 250 (Fe 410 W)A	
	Ultimate Strength, Fu (MPa)		410	
	Yield Strength, Fy (MPa)		250	
	Mass, m (kg/m)	91.04	I_z (cm^4)	23000.0
	Area, A (cm^2)	10600.0	I_y(cm^4)	5410.0
	D (mm)	339.0	r_z (cm)	14.7
	B (mm)	300.0	r_y (cm)	7.12
	t (mm)	9.0	Z_z (cm^3)	1350.0
	T (mm)	12.0	Z_y (cm^3)	360.0
	Flange Slope	90	Z_{pz} (cm^3)	1490.0
	R_1 (mm)	27.0	Z_{py} (cm^3)	552.0
	R_2 (mm)	0.0		
Plate Details - Input and Design Preference				
Thickness (mm)			[16]	
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			[4.6, 4.8, 5.6, 5.8]	
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)	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	Rolled, machine-flame cut, sawn and planed
Gap Between Beams (mm)	0.0
Are the Members Exposed to Corrosive Influences?	False

2 Design Checks

Design Status	Pass

2.1 Member Capacity

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{0.6 \times 315.0 \times 9.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 223.2$ $[Ref. IS\ 800:2007, Cl. 10.4.3]$	**Restricted to low shear**
Plastic Moment Capacity (kNm)		$M_{dz-z} = \frac{\beta_b Z_{pz} fy}{\gamma_{mo}}$ $= \frac{1 \times 1490000.0 \times 250}{1.1 \times 10^6}$ $= 306.82$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	**V < 0.6 Vdy**

2.2 Load Consideration

Check	Required	Provided	Remarks
Shear Force (kN)	$V_y = 75.0$	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 223.2,\ 40.0)$ $= min(33.48,\ 40.0)$ $= 33.48$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(75.0,\ 33.48)$ $= 75.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.7]$	**OK**
Axial Force (kN)		P_x = 0.0	**OK**

Check	Required	Provided	Remarks
Bending Moment (kNm)	$M_z = 120.0$	$M_{zmin} = 0.5 * M_{dz-z}$ $= 0.5 \times 306.82$ $= 153.41$ $M_u = max(M_z,\ M_{zmin})$ $= max(120.0, 153.41)$ $= 153.41$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 8.2.1.2]$	**OK**
Effective Bending Moment (kNm)		$M_{ue} = M_u\ +\ P_x \times \left(\frac{D}{2} - \frac{T}{2}\right) \times 10^{-3}$ $= 153.41 +$ $0.0 \times \left(\frac{339.0}{2} - \frac{12.0}{2}\right) \times 10^{-3}$ $= 153.41$	**OK**

2.3 Bolt Optimization

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Diameter Optimization	$d = 20$	**Pass**
Property Class	Bolt Property Class Optimization	4.6	**Pass**
Hole Diameter (mm)		$d_0 = 22.0$	**OK**
No. of Bolt Columns		$n_c = 4$	**Pass**
No. of Bolt Rows		$n_r = 6$	**Pass**
Total No. of Bolts		$n = n_r X n_c = 24$	**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)	$p_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 \times 16.0,\ 300\ mm)$ $= \min(512.0,\ 300\ mm)$ $= 300$ $Where,\ t = min(16.0, 16.0)$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.2.3]$	70	Pass
Min. Gauge Distance (mm)	$g_{min} = 2.5\ d$ $= 2.5 \times 20.0$ $= 50.0$ $[Ref\ IS\ 800:2007,\ Cl.\ 10.2.2]$	70	Pass
Max. Gauge Distance (mm)	$g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 \times 16.0,\ 300\ mm)$ $= \min(512.0,\ 300\ mm)$ $= 300$ $Where,\ t = min(16.0, 16.0)$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.2.3]$	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)	$e_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 16.0 \times \sqrt{\frac{250}{250}} = 192.0$ $e_2 = 12 \times 16.0 \times \sqrt{\frac{250}{250}} = 192.0$ $e_{max} = min(e_1, e_2) = 192.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.3]$	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)	$e'_{max} = 12\ t\ \varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 16.0 \times \sqrt{\frac{250}{250}} = 192.0$ $e_2 = 12 \times 16.0 \times \sqrt{\frac{250}{250}} = 192.0$ $e'_{max} = min(e_1, e_2) = 192.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.2.4.3]$	35	**Pass**
Cross-centre Gauge Distance (mm)		106	**Pass**

2.5 Critical Bolt Design

Check	Required	Provided	Remarks

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Beam End Plate Splice
Designer	Engineer #1	Job Number	1.2.1.2.1.3.1
Date	17 /12 /2020	Client	S R Satish Kumar, Professor, IIT Madras

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub}\ n_n\ A_{nb}}{\sqrt{3}\ \gamma_{mb}}$ $= \frac{400.0 \times 1 \times 245}{1000 \times \sqrt{3}\ \times\ 1.25}$ $= 45.26$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.3$]	OK
Kb		$k_b = min\left(\frac{e}{3d_0},\ \frac{p}{3d_0} - 0.25,\ \frac{f_{ub}}{f_u},1.0\right)$ $= min\left(\frac{35}{3 \times 22.0},\ \frac{70}{3 \times 22.0} - 0.25,\ \frac{400.0}{410},\ 1.0\right)$ $= min(0.53, 0.81, 0.98, 1.0)$ $= 0.53$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.4$]	OK
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5\ k_b\ d\ t\ f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.53 \times 20.0 \times 16.0 \times 410}{1000 \times 1.25}$ $= 139.07$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.4$]	OK
Bolt Capacity (kN)		$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (45.26, 139.07)$ $= 45.26$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.3.2$]	

Check	Required	Provided	Remarks
Large Grip Length Reduction Factor		$l_g = \sum \left(t_p + t_{member}\right)$ $= \sum \left(16.0 + 16.0\right)$ $= 32.0\ mm$ $5d = 5 \times 20.0 = 100.0$ $8d = 8 \times 20.0 = 160.0$ $Since,\ l_g < 5d$ $\beta_{lg} = 1.0$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.3.2]$	**Pass**
Bolt Capacity (post reduction factor) (kN)		$V_{db} = V_{db}\beta_{lg}$ $= 45.26 \times 1.0$ $= 45.26$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.3.3.2]$	**OK**
Shear Demand (kN)	$V_{sb} = \frac{V_u}{n}$ $= \frac{75.0}{24}$ $= 3.12$	Vdb = 45.26	**Pass**

Check	Required	Provided	Remarks
Lever Arm (mm)	$r = [327.0, 327.0, 0, 41.0, 216.0, 111.0]$ *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 inside tension/top flange and* r_6 *is the second row inside the compression/bottom flange* $row(s)$ r_7 *and beyond are rows inside the flange, placed in a symmetrical manner.* *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)	$T_1 = \frac{M_{ue}}{2 \times n_c \times \left(r_1 + \sum_{i=4}^{n_r} \frac{r_i^2}{r_1}\right)}$ $= \frac{153.41 \times 10^3}{2 \times 4 \times \left(327.0 + \sum_{i=4}^{6} \frac{r_i^2}{327.0}\right)}$ $= 37.42$ *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)	$Q = \frac{l_v}{2 \times l_e}\left[T_e - \frac{\beta \times \eta \times f_o \times b_e \times t^4}{27 \times l_e \times l_v^2}\right]$ $l_v = e - \frac{R_1}{2}$ $= 35 - \frac{27.0}{2} = 21.5\ mm$ $f_o = 0.7 \times f_{ub}$ $= 0.7 \times 400.0$ $= 280.0\ N/mm^2$ $l_e = min\left(e, 1.1\ t\ \sqrt{\frac{\beta\ f_o}{f_y}}\right)$ $= min\left(35, 1.1 \times 16 \times \sqrt{\frac{2 \times 280.0}{250}}\right)$ $= min(35, 26.34) = 26.34\ mm$ $\beta = 2\ (non\ pre-tensioned\ bolt)$ $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{300.0}{4} = 75.0\ mm$ $Q = \frac{21.5}{2 \times 26.34} \times$ $\left[37.42 - \left(\frac{2 \times 1.5 \times 280.0 \times 75.0 \times 16^4}{27 \times 26.34 \times 21.5^2}\right) \times 10^{-3}\right]$ $Q = 10.14$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.4.7]$		**OK**

Check	Required	Provided	Remarks
Tension Demand (kN)	$T_b = T_1 + Q$ $= 37.42 + 10.14$ $= 47.56$	$T_{db} = 0.90\ f_{ub}\ A_n\ /\ \gamma_{mb}$ $<\ f_{yb}\ A_{sb}\ (\gamma_{mb}\ /\ \gamma_{m0})$ $= min\Big(0.90\ \times 400.0 \times 245\ /\ 1.25,$ $240.0 \times 314.0 \times (1.25/1.1)\Big)$ $= min(70.56,\ 85.64)$ $= 68.51$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.5]$	**Pass**
Combined Capacity, (I.R)	≤ 1	$\left(\frac{V_{sb}}{V_{db}}\right)^2 + \left(\frac{T_b}{T_{db}}\right)^2 \leq 1.0$ $\left(\frac{3.12}{45.26}\right)^2 + \left(\frac{47.56}{68.51}\right)^2 = 0.49$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.3.6]$	**Pass**

2.6 Compression Flange Check

Check	Required	Provided	Remarks
Tension in Bolt Rows (kN)		$T = [37.42, 37.42, 0, 9.38, 49.43, 25.4]$	**OK**
Reaction at Compression Flange (kN)	$R_c = n_c \sum_{n_r=1}^{n_r} T_{n_r}$ $= 4 \times \sum_{n_r=1}^{6} T_{n_r}$ $= 4 \times 159.05$ $= 636.2$	$F_c = A_g f_y\ /\ \gamma_{m0}$ $= \frac{B \times T \times f_y}{\gamma_{m0}}$ $= \frac{300.0 \times 12.0 \times 250}{1.1 \times 1000}$ $= 818.18$	**Pass**

2.7 End Plate Checks

Check	Required	Provided	Remarks
Height (mm)		$H_p = D + (2 \times (2 \times e))$ $= 339.0 + (2 \times (2 \times 35))$ $= 479.0$	**Pass**
Width (mm)		$B_p = B + 25$ $= 300.0 + 25$ $= 325.0$	**Pass**
Moment at Critical Section (kNm)		$M_{cr} = T_1\ l_v - Q\ l_e$ $= (37.42 \times 21.5 - 10.14 \times 26.34) \times 10^{-3}$ $= 0.54$ *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)	$t_p = \sqrt{\frac{4M_{cr}}{b_e(f_y/\gamma_{m0})}}$ $= \sqrt{\frac{4 \times 0.54 \times 10^6}{75 \times (250/1.1)}}$ $= 11.23$	16	**Pass**
Moment Capacity (kNm)	0.54	$M_p = \left(\frac{b_e t_p^2}{4}\right) \times \frac{f_y}{\gamma_{m0}}$ $= \frac{75 \times 16^2}{4} \times \frac{250}{1.1} \times 10^{-6}$ $= 1.09$	**Pass**

2.8 Stiffener Design

Check	Required	Provided	Remarks
Height (mm)		$H_{st} = \frac{H_p - D}{2}$ $= \frac{479.0 - 339.0}{2}$ $= 70.0$	**Pass**
Length (mm)		$L_{st} = \frac{H_{st}}{tan(30)}$ $= \frac{70.0}{tan(30)}$ $= 122$	**Pass**

Check	Required	Provided	Remarks
Thickness (mm)	$t = 9.0$	$tst = 10$	**Pass**
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)		$L_w = 2 \times \left[D - (2 \times T) - (2 \times R1) - 20\right]$ $= 2 \times \left[339.0 - (2 \times 12.0) - (2 \times 27.0) - 20\right]$ $= 482.0$ *Note : Weld is provided on both sides of the web*	
Weld Size (mm)	$t_w = \frac{V_u}{f_{uw} k L_w} \times \sqrt{3}\ \gamma_{mw}$ $= \frac{75.0 \times 10^3}{410.0 \times 0.7 \times 482.0} \times \sqrt{3} \times 1.25$ $= 1.17$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7$]	6	**Pass**

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Beam End Plate Splice
Designer	Engineer #1	Job Number	1.2.1.2.1.3.1
Date	17 /12 /2020	Client	S R Satish Kumar, Professor, IIT Madras

Check	Required	Provided	Remarks
Min. Weld Size (mm)	1) t_{wmin} – *based on thickness of the thicker part* $t_{thicker} = max(16.0,\ 9.0)$ $= 16.0$ $t_{wmin} = 5$ 2) t_{wmin} – *based on thickness of the thinner part* $t_{thinner} = min(16.0,\ 9.0)$ $= 9.0$ $t_{wmin} \leq min(5,\ 9.0)$ [$Ref\ IS\ 800:2007, Table\ 21\ ,\ Cl 10.5.2.3$]	$t_w = max(t_w,\ t_{wmin})$ $= max(1.17,\ 5)$ $= 6$	**Pass**
Max. Weld Size (mm)	t_{wmax} *based on thickness of the thinner part* $t_{thinner} = min(16.0,\ 9.0)$ $= 9.0$ $t_{wmax} = 9.0$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.3.1$]	$t_w \leq t_{wmax}$ $6 \leq 9.0$	**Pass**
Normal Stress (N/mm2)		$f_a = \frac{H}{0.7 \times t_w \times L_w}$ $= \frac{0.0 \times 10^3}{0.7 \times 6 \times 482.0}$ $= 0.0$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.9$]	**OK**

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Beam End Plate Splice
Designer	Engineer #1	Job Number	1.2.1.2.1.3.1
Date	17 /12 /2020	Client	S R Satish Kumar, Professor, IIT Madras

Check	Required	Provided	Remarks
Shear Stress (N/mm2)		$q = \frac{V}{0.7 \times t_w \times L_w}$ $= \frac{75.0 \times 10^3}{0.7 \times 6 \times 482.0}$ $= 37.05$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.9$]	**OK**
Equivalent Stress (N/mm2)	$f_e = \sqrt{f_a^2 + 3q^2}$ $= \sqrt{0.0^2 + (3 \times 37.05^2)}$ $= 64.17$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.10.1.1$]	$f_w = \frac{f_u}{\sqrt{3}\ \gamma_{mw}}$ $= \frac{410.0}{\sqrt{3} \times 1.25}$ $= 189.37$ [$Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1$]	**Pass**

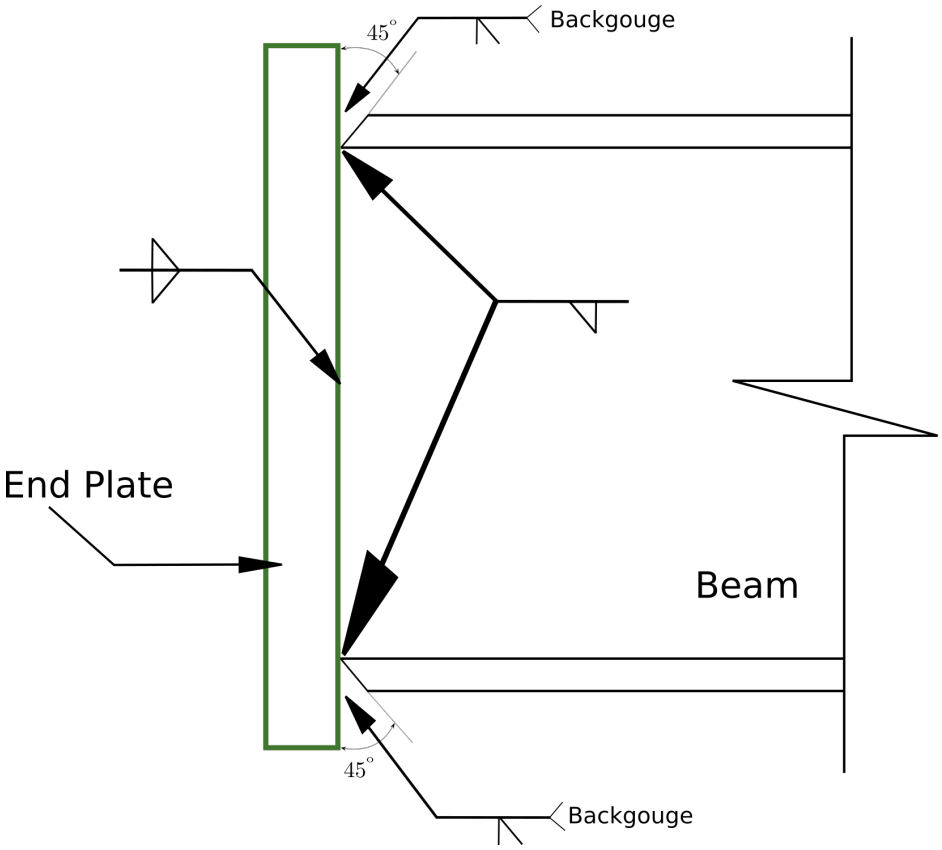


Figure 1: Typical Weld Details - Beam to End Plate Connection

3 2D Drawings (Typical)

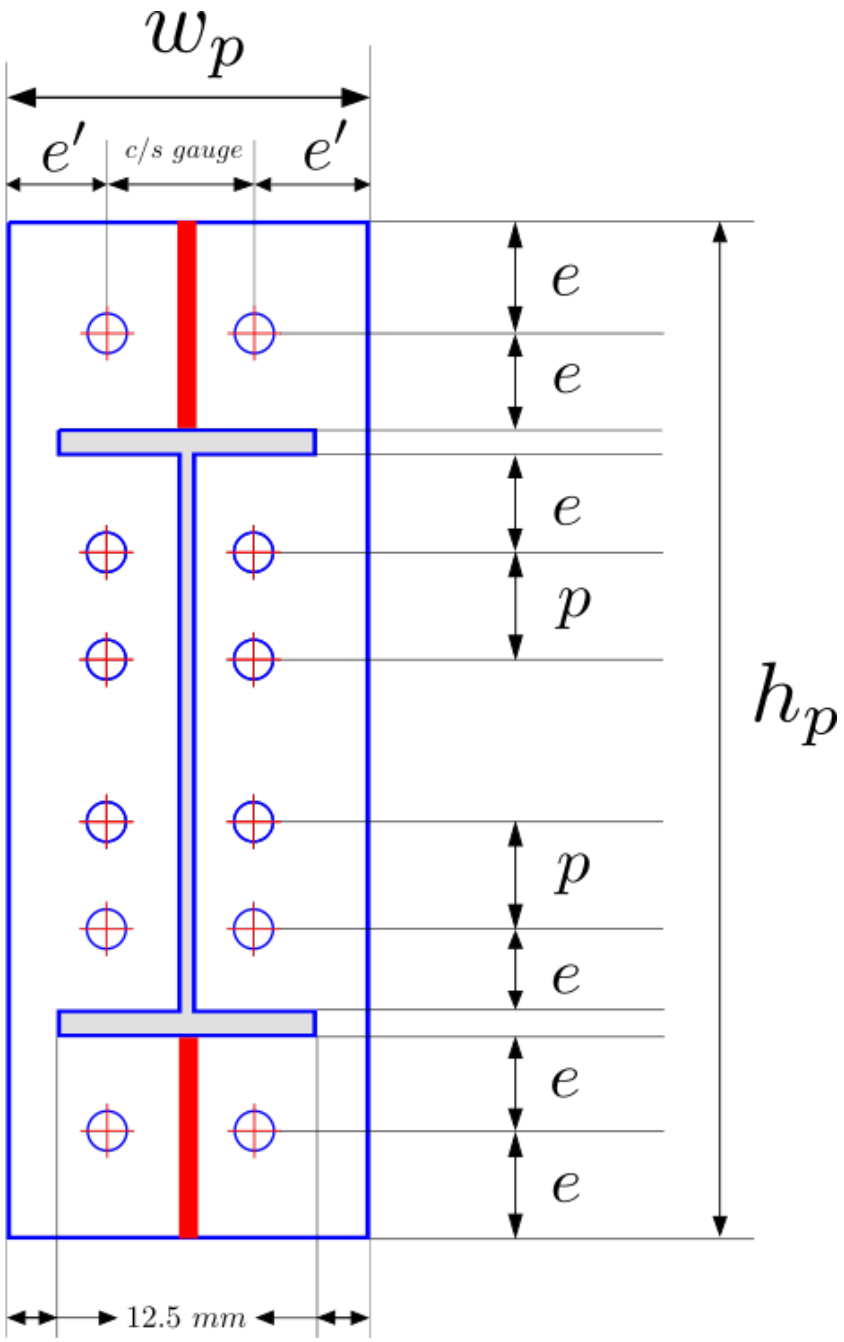


Figure 2: Typical Detailing

Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Beam End Plate Splice
Designer	Engineer #1	Job Number	1.2.1.2.1.3.1
Date	17 /12 /2020	Client	S R Satish Kumar, Professor, IIT Madras

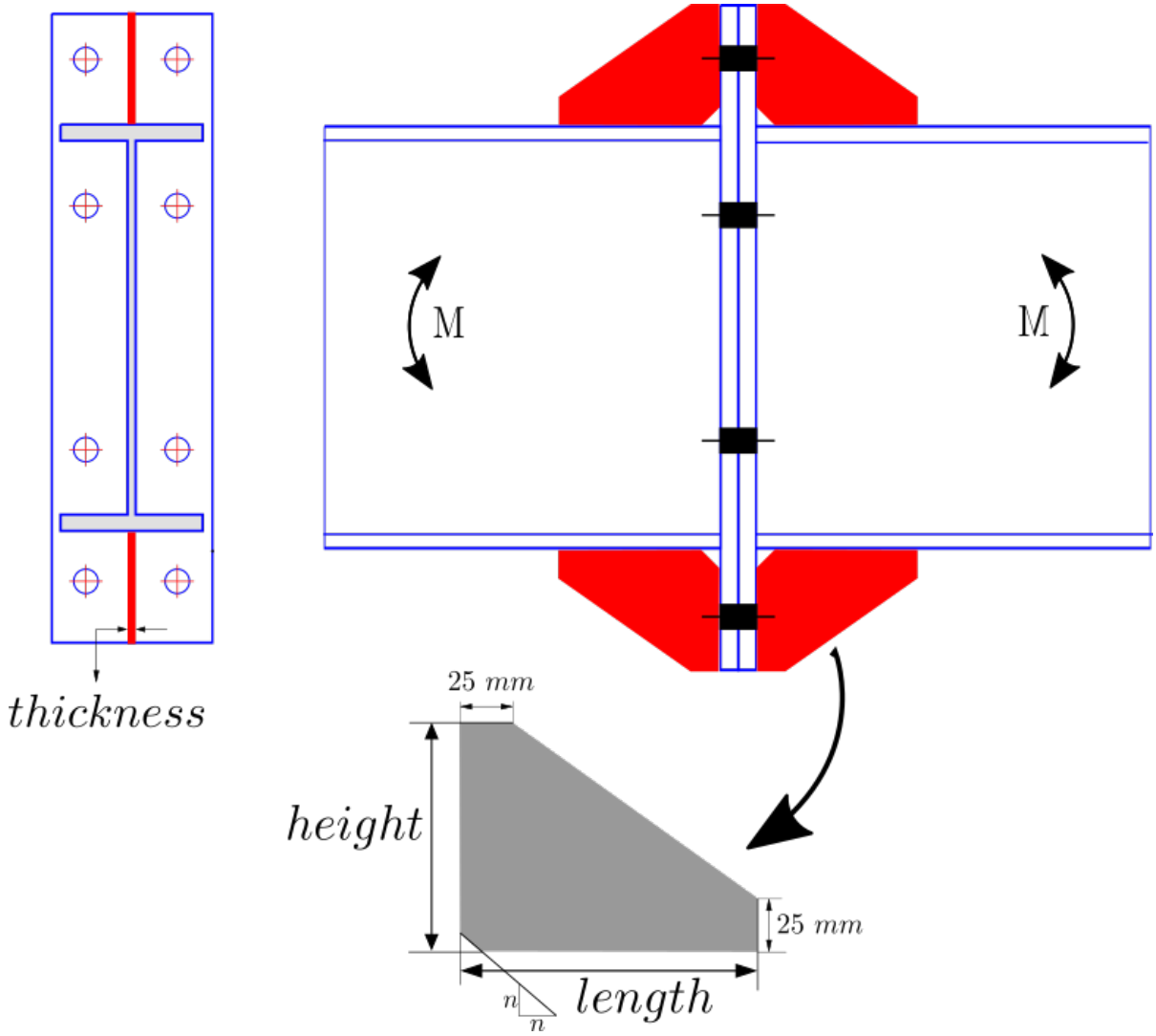
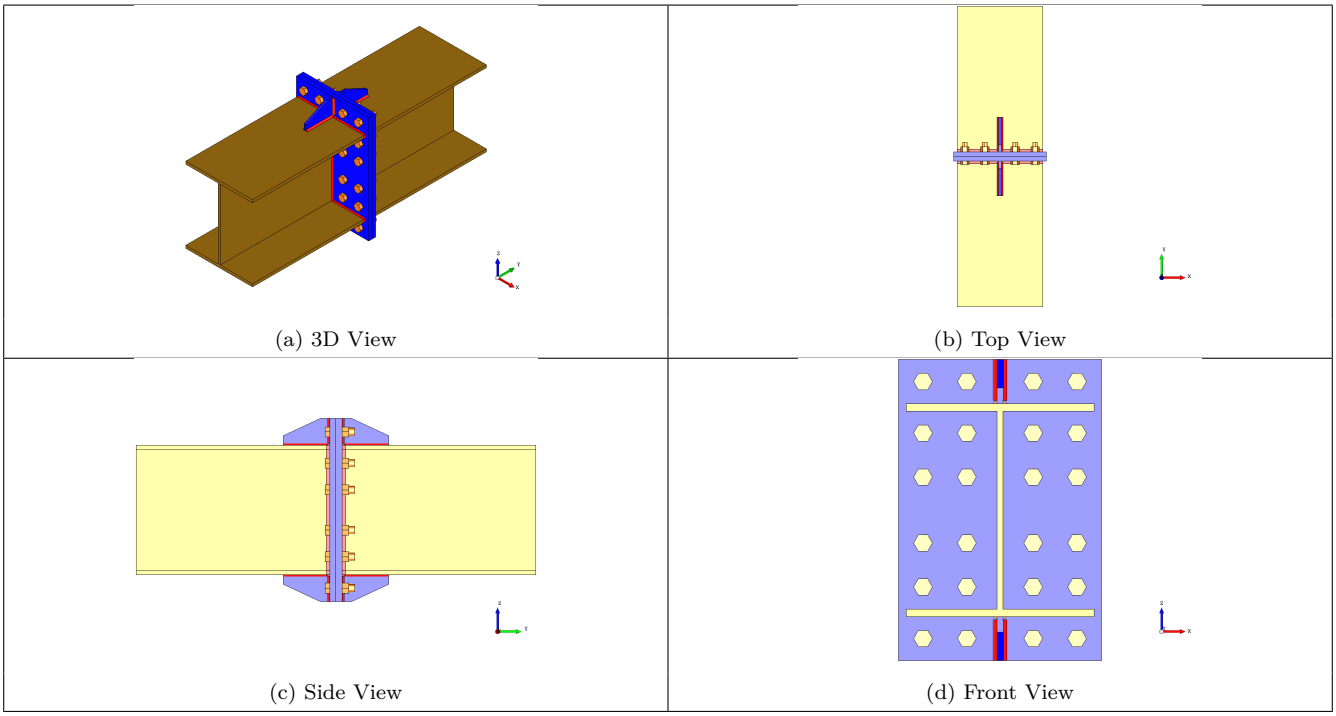


Figure 3: Typical Stiffener Details

4 3D Views



(a) 3D View

(b) Top View

(c) Side View

(d) Front View

5 Design Log

2020-12-17 23:52:05 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].

2020-12-17 23:52:05 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (120.0 kNm) is less than 0.5 times the plastic moment capacity of the beam (306.82 kNm)

2020-12-17 23:52:05 - 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 23:52:05 - 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 23:52:05 - Osdag - INFO - Designing the connection for a factored moment of 153.41 kNm

2020-12-17 23:52:05 - Osdag - INFO - [Bolt Design] Bolt diameter and grade combination ready to perform bolt design

2020-12-17 23:52:05 - Osdag - INFO - The solver has selected 8 combinations of bolt diameter and grade to perform optimum bolt design in an iterative manner

2020-12-17 23:52:05 - Osdag - INFO - Checking the design with the following bolt diameter-grade combination [(20.0, 4.6), (20.0, 4.8), (20.0, 5.6), (20.0, 5.8), (24.0, 4.6), (24.0, 4.8), (24.0, 5.6), (24.0, 5.8)]

2020-12-17 23:52:05 - Osdag - INFO - [Optimisation] Performing the design by optimising the plate thickness, using the thin plate and

large (suitable) bolt diameter approach
2020-12-17 23:52:05 - 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 23:52:05 - Osdag - INFO - The provided beam can accommodate two columns of bolts on either side of the web [Ref. based on the detailing requirement]
2020-12-17 23:52:05 - Osdag - INFO - Performing the design with two column of bolts on each side
2020-12-17 23:52:05 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 519.84 kN is less than the flange capacity 818.18 kN. The flange strength requirement is satisfied.
2020-12-17 23:52:05 - 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
2020-12-17 23:52:05 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 4.6 grade fails the tension check
2020-12-17 23:52:05 - Osdag - ERROR - Total tension demand on bolt (due to direct tension + prying action) is 76.17532593683823 kN and exceeds the bolt tension capacity (68.51 kN)
2020-12-17 23:52:05 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter
2020-12-17 23:52:05 - Osdag - ERROR - [Bolt Design] The bolt of 20.0 mm diameter and 4.6 grade fails the combined shear + tension check
2020-12-17 23:52:05 - Osdag - ERROR - The Interaction Ratio (IR) of the critical bolt is 1.247
2020-12-17 23:52:05 - Osdag - INFO - Re-designing the connection with a bolt of higher grade and/or diameter