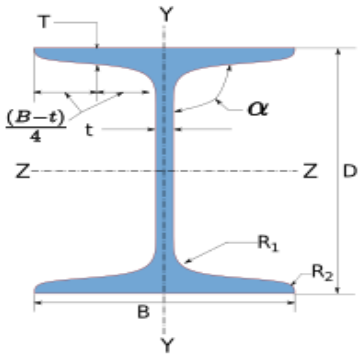
		Created with Osdag®	
Company Name		Project Title	beam to beam end plate connection
Group/Team Name		Subtitle	
Designer		Job Number	
Date	21 /01 /2025	Client	

1 Input Parameters

Main Module		Moment Connection	
Module		Beam-to-Beam End Plate Connection	
Connectivity *		Coplanar Tension-Compression Flange	
End Plate Type *		Flushed - Reversible Moment	
Bending Moment (kNm) *		23.0	
Shear Force (kN) *		230.0	
Axial Force (kN)		239.0	
Beam Section - Mechanical Properties			
	Beam Section	UB 1016 x 305 x 437	
	Material *	E 250 (Fe 410 W)C	
	Ultimate Strength, F_u (MPa)	410	
	Yield Strength, F_y (MPa)	230	
	Mass, m (kg/m) 436.9	I_z (cm^4)	909906.0
	Area, A (cm^2) 55660.0	I_y(cm^4)	23430.0
	D (mm) 1025.9	r_z (cm)	40.4
	B (mm) 305.4	r_y (cm)	6.5
	t (mm) 26.9	Z_z (cm^3)	17739.0
	T (mm) 49.0	Z_y (cm^3)	1534.0
	Flange Slope 90	Z_{pz} (cm^3)	20762.0
	R_1 (mm) 30.0	Z_{py} (cm^3)	2469.0
	R_2 (mm) 0.0		
Plate Details - Input and Design Preference			
Thickness (mm) *		[8, 10, 12, 14, 16, 18, 20, 22, 25, 28, 32, 36, 40, 45, 50, 56, 63, 75, 80, 90, 100, 110, 120]	
Material *		E 250 (Fe 410 W)C	
Ultimate Strength, F_u (MPa)		410	
Yield Strength, F_y (MPa)		230	
Bolt Details - Input and Design Preference			
Diameter (mm) *		[8, 12, 14, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 42, 45, 48, 52, 56, 60, 64]	
Property Class *		[3.6, 4.6, 4.8, 5.6, 5.8, 6.8, 8.8, 9.8, 10.9, 12.9]	
Type *		Friction Grip Bolt	

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Bolt Tension	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)	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

2 Design Checks

Design Status	Fail

2.1 Member Capacity

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{0.6 \times 927.9000000000001 \times 26.9 \times 230}{\sqrt{3} \times 1.1 \times 1000}$ $= 1807.92$ [Ref. IS 800:2007, Cl.10.4.3]	**Restricted to low shear**
Plastic Moment Capacity (kNm)		$M_{d_z} = \frac{\beta_b Z_{p_z} fy}{\gamma_{m0}}$ $= \frac{1 \times 20762000.0 \times 230}{1.1 \times 10^6}$ $= 4341.15$ [Ref. IS 800:2007, Cl.8.2.1.2]	**V < 0.6 Vdy**

2.2 Load Consideration

Check	Required	Provided	Remarks

Check	Required	Provided	Remarks
Shear Force (kN) *	$V_y = 230.0$	$V_{y_{min}} = \min(0.15V_{d_y},\ 40.0)$ $= \min(0.15 \times 1807.92,\ 40.0)$ $= \min(271.19,\ 40.0)$ $= 40$ $V_u = \max(V_y,\ V_{y_{min}})$ but, $\leq V_{dy}$ $= \max(230.0,\ 40)$ but, ≤ 1807.92 $= 230.0$ [Ref. IS 800:2007, Cl.10.7]	**Pass**
Axial Force (kN)		$P_x = 239.0$	**OK**
Bending Moment (kNm) *	$M_z = 23.0$	$M_{z_{min}} = 0.5M_{dz}$ $= 0.5 \times 4341.15$ $= 2170.57$ $M_u = \max(M_z,\ M_{z_{min}})$ but, $\leq M_{dz}$ $= \max(23.0, 2170.57)$ ≤ 4341.15 $= 2170.57$ [Ref. IS 800:2007, Cl.8.2.1.2]	**Pass**
Effective Bending Moment (kNm)		$M_{ue} = M_u + P_x \times \left(\frac{D}{2} - \frac{T}{2}\right) \times 10^{-3}$ $= 2170.57 +$ $239.0 \times \left(\frac{1025.9}{2} - \frac{49.0}{2}\right) \times 10^{-3}$ $= 2287.31$	**OK**

2.3 Bolt Optimization

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Diameter Optimization	$d = 8$	**Fail**
Property Class	Bolt Property Class Optimization	3.6	**Fail**
Hole Diameter (mm)		$d_0 = 8$	**OK**
No. of Bolt Columns		$n_c = 4$	**Fail**
No. of Bolt Rows		$n_r = 6$	**Fail**
Total No. of Bolts		$n = n_r X n_c = 24$	**Fail**

2.4 Detailing

Check	Required	Provided	Remarks
Min. Pitch Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 8.0$ $= 20.0$ [Ref. IS 800:2007, Cl.10.2.2]	30	**Pass**
Max. Pitch Distance (mm)	$p_{\max} = \min(32t,\ 300)$ $= \min(32 \times 50.0,\ 300)$ $= \min(1600.0,\ 300)$ $= 300$ Where, $t = \min(50.0, 50.0)$ [Ref. IS 800:2007, Cl.10.2.3]	30	**Pass**
Min. Gauge Distance (mm)	$g_{\min} = 2.5d$ $= 2.5 \times 8.0$ $= 20.0$ [Ref. IS 800:2007, Cl.10.2.2]	30	**Pass**

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Check	Required	Provided	Remarks
Max. Gauge Distance (mm)	$g_{max} = \min(32t,\ 300)$ $= \min(32 \times 50.0,\ 300)$ $= \min(1600.0,\ 300)$ $= 300$ Where, $t = \min(50.0, 50.0)$ [Ref. IS 800:2007, Cl.10.2.3]	30	**Pass**
Min. End Distance (mm)	$e_{min} = 1.7d_0$ $= 1.7 \times 8$ $= 13.6$ [Ref. IS 800:2007, Cl.10.2.4.2]	15	**Pass**
Max. End Distance (mm)	$e_{max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 50.0 \times \sqrt{\frac{250}{230}} = 625.54$ $e_2 = 12 \times 50.0 \times \sqrt{\frac{250}{230}} = 625.54$ $e_{max} = \min(e_1,\ e_2) = 625.54$ [Ref. IS 800:2007, Cl.10.2.4.3]	15	**Pass**
Min. Edge Distance (mm)	$e'_{min} = 1.7d_0$ $= 1.7 \times 8$ $= 13.6$ [Ref. IS 800:2007, Cl.10.2.4.2]	15	**Pass**

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 50.0 \times \sqrt{\frac{250}{230}} = 625.54$ $e_2 = 12 \times 50.0 \times \sqrt{\frac{250}{230}} = 625.54$ $e'_{max} = min(e_1,\ e_2) = 625.54$ [Ref. IS 800:2007, Cl.10.2.4.3]	15	**Pass**
Cross-centre Gauge Distance (mm)		88	**Pass**

2.5 Critical Bolt Design

Check	Required	Provided	Remarks
Slip Resistance (kN)	$V_{sf} = \frac{V_u}{n}$ $= \frac{230.0}{24}$ $= 9.58$	$V_{dsf} = \frac{\mu_f n_e K_h F_o}{\gamma_{mf}}$ Where , $F_o = 0.7 f_{ub} A_{nb}$ $V_{dsf} = \frac{0.3 \times 1 \times 1 \times 0.7 \times 330.0 \times 36.6}{1.25 \times 10^3}$ $= 2.03$ [Ref. IS 800:2007, Cl.10.4.3]	**Fail**

Check	Required	Provided	Remarks
Lever Arm (mm)	$r = [937.4, 39.5, 907.4, 69.5, 348.8, 628.1]$ Note: r_1 is the first row inside tension/top flange, r_2 is the first row inside compression/bottom flange. Further row(s) are added in a symmetrical manner with odd rows placed near the tension/top flange and even row placed near the compression/bottom flange respectively. 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.		**Fail**
Tension Due to Moment (kN)	$T_1 = \frac{M_{ue}}{n_c \times \left(r_1 + \sum_{i=2}^{n_r} \frac{r_i^2}{r_1}\right)}$ $= \frac{2287.31 \times 10^3}{4 \times \left(937.4 + \sum_{i=2}^{6} \frac{r_i^2}{937.4}\right)}$ $= 240.95$ 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)	$Q = \frac{l_v}{2l_e}\left[T_e - \frac{\beta\eta f_o b_e t^4}{27 l_e l_v^2}\right]$ $l_v = e - \frac{R_1}{2}$ $= 15 - \frac{30.0}{2} = 0.0$ mm $f_o = 0.7 f_{ub}$ $= 0.7 \times 330.0$ $= 231.0$ N/mm^2 $l_e = \min\left(e, 1.1t\sqrt{\frac{\beta f_o}{f_y}}\right)$ $= \min\left(15, 1.1 \times 50 \times \sqrt{\frac{1 \times 231.0}{230}}\right)$ $= \min(15,\ 55.12) = 15$ mm $\beta = 1$ (pre-tensioned bolt) $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{305.4}{4} = 76.35$ mm $Q = \frac{0.0}{2 \times 15} \times$ $\left[240.95 - \left(\frac{1 \times 1.5 \times 231.0 \times 76.35 \times 50^4}{27 \times 15 \times 0.0^2}\right) \times 10^{-3}\right]$ $Q = nan$ [Ref. IS 800:2007, Cl.10.4.7]		**Fail**

Check	Required	Provided	Remarks
Tension Demand (kN)	$T_f = T_1 + Q$ $= 240.95 + nan$ $= nan$	$T_f = 0.90 f_{ub} A_n \ / \ \gamma_{mf}$ $< \ f_{yb} A_{sb} (\gamma_{m1} \ / \ \gamma_{m0})$ $= \min\left(0.90 \times 330.0 \times 36.6 \ / \ 1.25,\right.$ $\left. 190.0 \times 50 \times (1.25/1.1)\right)$ $= \min(8.7,\ 10.8)$ $= 8.64$ [Ref. IS 800:2007, Cl.10.3.5]	**Fail**
Combined Capacity, (I.R.)	≤ 1	$\left(\frac{V_{sf}}{V_{df}}\right)^2 + \left(\frac{T_f}{T_{df}}\right)^2 \leq 1.0$ $\left(\frac{9.58}{2.03}\right)^2 + \left(\frac{nan}{8.64}\right)^2 = nan$ [Ref. IS 800:2007, Cl.10.3.6]	**Fail**

2.6 Compression Flange Check

Check	Required	Provided	Remarks
Tension in Bolt Rows (kN)		$T = [240.95, 10.15, 233.24, 17.86, 89.66, 161.45]$	**OK**
Reaction at Compression Flange (kN)	$R_c = n_c \sum_{n_r=1}^{n_r} T_{n_r}$ $= 4 \times \sum_{n_r=1}^{6} T_{n_r}$ $= 4 \times 753.31$ $= 3013.24$	$F_c = A_g f_y \ / \ \gamma_{m0}$ $= \frac{BTf_y}{\gamma_{m0}}$ $= \frac{305.4 \times 49.0 \times 230}{1.1 \times 1000}$ $= 3128.96$	**Pass**

2.7 End Plate Checks

Check	Required	Provided	Remarks
Height (mm)		$H_p = D + 25$ $= 1025.9 + 25$ $= 1050.9$	**Pass**
Width (mm)		$B_p = B + 25$ $= 305.4 + 25$ $= 330.4$	**Pass**
Moment at Critical Section (kNm)		$M_{cr} = T_1\ l_v - Q\ l_e$ $= (240.95 \times 0.0 - nan \times 15) \times 10^{-3}$ $= nan$ 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)	$t_p = \sqrt{\frac{4M_{cr}}{b_e(f_y/\gamma_{m0})}}$ $= \sqrt{\frac{4 \times nan \times 10^6}{76 \times (230/1.1)}}$ $= nan$	50	**Fail**
Moment Capacity (kNm)	nan	$M_p = \left(\frac{b_e t_p^2}{4}\right) \times \frac{f_y}{\gamma_{m0}}$ $= \frac{76 \times 50^2}{4} \times \frac{230}{1.1} \times 10^{-6}$ $= 9.98$	**Fail**

2.8 Longitudinal Stiffener Design

Check	Required	Provided	Remarks
Width (mm)		$W_{st} = B_p - \frac{t}{2}$ $= 330.4 - \frac{26.9}{2}$ $= 150$	**Pass**
Length (mm)		$L_{st} = 2W_{st}$ $= 2 \times 150$ $= 302$	**Pass**

Check	Required	Provided	Remarks
Thickness (mm)	$t = 26.9$	$t_{st} = 28$	**Pass**
Weld Size (mm)	10	tw = 10	**Pass**

2.9 Weld Design - Beam Web to End Plate Connection

Check	Required	Provided	Remarks
Weld Strength (N/mm2)	$f_{u_w} = \min(f_w,\ f_u)$ $= \min(410.0,\ 410)$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	$f_{u_w} = 410.0$	**Pass**
Total Weld Length (mm)		$L_w = 2 \times \left[D - (2 \times T) - (2 \times R1) - 20\right]$ $= 2 \times \left[1025.9 - (2 \times 49.0) - (2 \times 30.0) - 20\right]$ $= 1694$ Note: Weld is provided on both sides of the web	
Weld Size (mm)	$t_w = \frac{V_u}{f_{uw} k L_w} \times \sqrt{3}\ \gamma_{mw}$ $= \frac{230.0 \times 10^3}{410.0 \times 0.7 \times 1694} \times \sqrt{3} \times 1.25$ $= 1.02$ [Ref. IS 800:2007, Cl.10.5.7]	10	**Pass**

Check	Required	Provided	Remarks
Min. Weld Size (mm)	1) $t_{w\min}$– based on thickness of the thicker part $t_{\text{thicker}} = \max(50.0,\ 26.9)$ $= 50.0$ $t_{w\min} = 10$ 2) $t_{w\min}$– based on thickness of the thinner part $t_{\text{thinner}} = \min(50.0,\ 26.9)$ $= 26.9$ $t_{w\min} \leq \min(10,\ 26.9)$ [Ref. IS 800:2007, Table 21, Cl 10.5.2.3]	$t_w = \max(t_w,\ t_{w\min})$ $= \max(1.02,\ 10)$ $= 10$	**Pass**
Max. Weld Size (mm)	$t_{w\max}$ based on thickness of the thinner part $t_{\text{thinner}} = \min(50.0,\ 26.9)$ $= 26.9$ $t_{w\max} = 26.9$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_w \leq t_{w\max}$ $10 \leq 26.9$	**Pass**
Normal Stress (N/mm2)		$f_a = \frac{H}{0.7 t_w L_w}$ $= \frac{239.0 \times 10^3}{0.7 \times 10 \times 1694}$ $= 20.13$ [Ref. IS 800:2007, Cl.10.5.9]	**OK**

Check	Required	Provided	Remarks
Shear Stress (N/mm2)		$q = \frac{V}{0.7 t_w L_w}$ $= \frac{230.0 \times 10^3}{0.7 \times 10 \times 1694}$ $= 19.38$ [Ref. IS 800:2007, Cl.10.5.9]	**OK**
Equivalent Stress (N/mm2)	$f_e = \sqrt{f_a^2 + 3q^2}$ $= \sqrt{20.13^2 + (3 \times 19.38^2)}$ $= 33.87$ [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**

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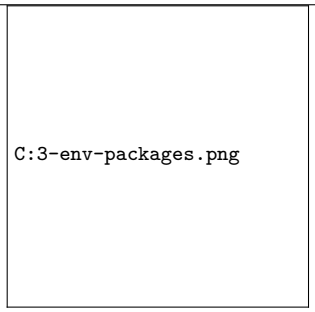
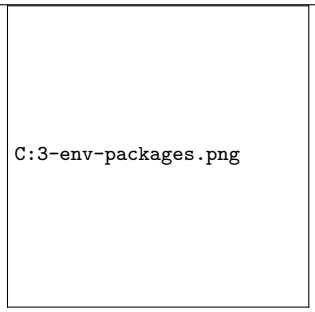
3 3D Views



(a) 3D View



(b) Top View

(c) Side View

(d) Front View

4 Design Log

2025-01-21 20:14:34 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].
2025-01-21 20:14:34 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (23.0 kNm) is less than 0.5 times the plastic moment capacity of the beam (4341.15 kNm)
2025-01-21 20:14:34 - 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)
2025-01-21 20:14:34 - 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
2025-01-21 20:14:34 - Osdag - INFO - Designing the connection for a factored moment of 2170.57 kNm
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 8.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 10.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick

2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 12.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 14.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 16.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 18.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 20.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 22.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 25.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 28.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 32.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 36.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 40.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - WARNING - [End Plate] The end plate of 45.0 mm is thinner than the thickest part of the elements being connected
2025-01-21 20:14:34 - Osdag - INFO - Selecting a plate of higher thickness which is at least 49.0 mm thick
2025-01-21 20:14:34 - Osdag - INFO - [Bolt Design] Bolt diameter and grade combination ready to perform bolt design
2025-01-21 20:14:34 - Osdag - INFO - The solver has selected 200 combinations of bolt diameter and grade to perform optimum bolt design in an iterative manner
2025-01-21 20:14:34 - Osdag - INFO - [Optimisation] Performing the design by optimising the plate thickness, using the most optimum plate and a suitable bolt diameter approach
2025-01-21 20:14:34 - Osdag - INFO - If you wish to optimise the bolt diameter-grade combination, pass a higher value of plate thickness

using the Input Dock
2025-01-21 20:14:34 - Osdag - INFO - [Flange Strength] The reaction at the compression flange of the beam 3013.24 kN is less than the flange capacity 3128.96 kN. The flange strength requirement is satisfied.
2025-01-21 20:14:34 - Osdag - INFO - [End Plate] The end plate of 50.0 mm passes the moment capacity check. The end plate is checked for yielding due tension caused by bending moment and prying force
2025-01-21 20:14:34 - Osdag - INFO - [Bolt Design] The bolt of 8.0 mm diameter and 3.6 grade passes the tension check
2025-01-21 20:14:34 - Osdag - INFO - Total tension demand on bolt (due to direct tension + prying action) is nan kN and the bolt tension capacity is (8.64 kN)
2025-01-21 20:14:34 - Osdag - INFO - [Bolt Design] The bolt of 8.0 mm diameter and 3.6 grade passes the combined shear + tension check
2025-01-21 20:14:34 - Osdag - INFO - The Interaction Ratio (IR) of the critical bolt is nan
2025-01-21 20:14:34 - Osdag - INFO - : ========== Design Status ==========
2025-01-21 20:14:34 - Osdag - INFO - : Overall beam to beam end plate splice connection design is UNSAFE
2025-01-21 20:14:34 - Osdag - INFO - : ========== End Of Design ==========