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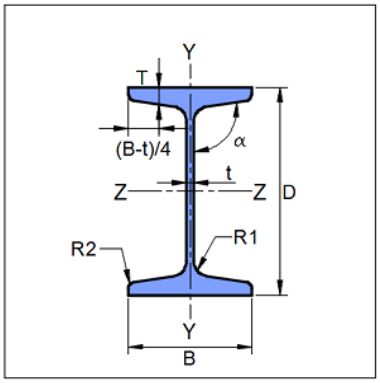
1 Input Parameters

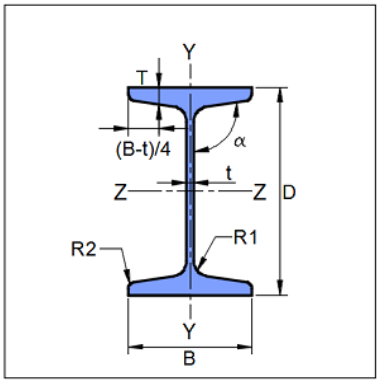
Main Module	Shear Connection
Module	End Plate Connection
Connectivity	Column Flange-Beam Web
Shear Force (kN)	41.0
Axial Force (kN)	45.0

Supporting Section - Mechanical Properties



Supporting Section		HB 150	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, F_u (MPa)		410	
Yield Strength, F_y (MPa)		250	
Mass, m (kg/m)	27.06	I_z (cm^4)	1450.0
Area, A (cm^2)	34.4	I_y(cm^4)	431.0
D (mm)	150.0	r_z (cm)	6.49
B (mm)	150.0	r_y (cm)	3.53
t (mm)	5.4	Z_z (cm^3)	194.0
T (mm)	9	Z_y (cm^3)	57.5
Flange Slope	94	Z_{pz} (cm^3)	215.0
R_1 (mm)	8.0	Z_{py} (cm^3)	92.7
R_2 (mm)	4.0		

Supported Section - Mechanical Properties



Supported Section		JB 200	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, F_u (MPa)		410	
Yield Strength, F_y (MPa)		250	
Mass, m (kg/m)	9.92	I_z (cm^4)	780.0
Area, A (cm^2)	12.6	I_y(cm^4)	17.2
D (mm)	200.0	r_z (cm)	7.85
B (mm)	60.0	r_y (cm)	1.16
t (mm)	3.4	Z_z (cm^3)	78.0
T (mm)	5.0	Z_y (cm^3)	5.76
Flange Slope	91.5	Z_{pz} (cm^3)	90.9
R_1 (mm)	5.0	Z_{py} (cm^3)	9.35
R_2 (mm)	1.5		

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Bolt Details - Input and Design Preference	
Diameter (mm)	[np.int64(8), np.int64(10), np.int64(12), np.int64(14), np.int64(16), np.int64(18), np.int64(20), np.int64(22), np.int64(24), np.int64(27), np.int64(30), np.int64(33), np.int64(36), np.int64(42), np.int64(45), np.int64(48), np.int64(52), np.int64(56), np.int64(60), np.int64(64)]
Property Class	[np.float64(3.6), np.float64(4.6), np.float64(4.8), np.float64(5.6), np.float64(5.8), np.float64(8.8), np.float64(9.8), np.float64(10.9), np.float64(12.9)]
Type	Bearing Bolt
Hole Type	Standard
Bolt Tension	Non pre-tensioned
Slip Factor, (μ_f)	0.3
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
Plate Details - Input and Design Preference	
Thickness (mm)	[np.int64(8), np.int64(10), np.int64(12), np.int64(14), np.int64(16), np.int64(18), np.int64(20), np.int64(22), np.int64(25), np.int64(28), np.int64(32), np.int64(36), np.int64(40), np.int64(45), np.int64(50), np.int64(56), np.int64(63), np.int64(75), np.int64(80), np.int64(90), np.int64(100), np.int64(110), np.int64(120)]
Material	E 250 (Fe 410 W)A
Ultimate Strength, Fu (MPa)	410
Yield Strength, Fy (MPa)	250
Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, Fu (MPa)	410.0

2 Design Checks

Design Status	Pass

2.1 Section Design Check

Check	Required	Provided	Remarks
Shear Capacity (kN)	41.0	$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{200.0 \times 3.4 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 89226.85978385125$ [Ref. IS 800:2007, Cl.10.4.3]	Pass
Tension Capacity (kN)	45.0	$T_{\text{dg}} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 200.0 \times 3.4$ $= \frac{680.0 \times 250}{1.1 \times 10^3}$ $= 154545.45$ [Ref. IS 800:2007, Cl.6.2]	Pass

2.2 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)		10	
Property Class		5.6	
Plate Thickness (mm)		8	
No. of Bolt Columns	2	2	Pass
No. of Bolt Rows		5	Pass
Min. Pitch Distance (mm)	$p_{\text{min}} = 2.5d$ $= 2.5 \times 10$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	35	Pass

Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p/g_{max} = \min(32t,\ 300)$ $= \min(32 \times 3.4,\ 300)$ $= \min(108.8,\ 300)$ $= 108.8$ Where, $t = \min(120.0, 3.4)$ [Ref. IS 800:2007, Cl.10.2.3]	35	Pass
Min. End Distance (mm)	$e_{min} = 1.7d_0$ $= 1.7 \times 10$ $= 17.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	20	Pass
Max. End Distance (mm)	$e_{max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 8 \times \sqrt{\frac{250}{230}} = 100.09$ $e_2 = 12 \times 9 \times \sqrt{\frac{250}{250}} = 108.0$ $e_{max} = \min(e_1,\ e_2) = 100.09$ [Ref. IS 800:2007, Cl.10.2.4.3]	20	Pass
Min. Edge Distance (mm)	$e'_{min} = 1.7d_0$ $= 1.7 \times 10$ $= 17.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	20	Pass

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Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{\max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 8 \times \sqrt{\frac{250}{230}} = 100.09$ $e_2 = 12 \times 9 \times \sqrt{\frac{250}{250}} = 108.0$ $e'_{\max} = min(e_1,\ e_2) = 100.09$ [Ref. IS 800:2007, Cl.10.2.4.3]	20	**Pass**
Min. Gauge Distance (mm)	$g_1 = 2(e'_{min} + s) + t_w$ $= 2(17.0 + 3) + 3.4$ $= 43.4$ $g_2 = 2(e'_{min} + R_r) + T_w$ $= 2(17.0 + 8.0) + 5.4$ $= 55.4$ $g_{min} = max(g_1, g_2)$ $= 55.4$	62	**Pass**
Shear Capacity (kN)		$V_{\text{dsb}} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}}$ $= \frac{500.0 \times 1 \times 58}{1000 \times \sqrt{3}\ \times\ 1.25}$ $= 13.39$ [Ref. IS 800:2007, Cl.10.3.3]	
Kb		$k_b = \min\left(\frac{e}{3d_0},\ \frac{p}{3d_0} - 0.25,\ \frac{f_{ub}}{f_u},\ 1.0\right)$ $= \min\left(\frac{20}{3 \times 10},\ \frac{35}{3 \times 10} - 0.25,\ \frac{500.0}{410},\ 1.0\right)$ $= \min(0.67, 0.92, 1.22, 1.0)$ $= 0.67$ [Ref. IS 800:2007, Cl.10.3.4]	

Check	Required	Provided	Remarks
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.67 \times 10 \times 8 \times 410}{1000 \times 1.25}$ $= 43.95$ [Ref. IS 800:2007, Cl.10.3.4]	
Capacity (kN)	$V_{bv} = \frac{V}{n}$ $= \frac{41.0}{10}$ $= 4.1$	$V_{\text{db}} = \min\ (V_{\text{dsb}},\ V_{\text{dpb}})$ $= \min\ (13.39,\ 43.95)$ $= 13394.526245199319$ [Ref. IS 800:2007, Cl.10.3.2]	
Long Joint Reduction Factor		$l_j = (n_r - 1) \times p$ $= (5 - 1) \times 35 = 140$ $l = 140$ $15 \times d = 15 \times 10 = 150$ since, $l_j < 15 \times d$ then $\beta_{lj} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.1]	
Large Grip Length Reduction Factor		$l_g = \Sigma\ (t_p + t_{\text{member}})$ $= 17.0$ $5d = 50$ $8d = 80$ since, $l_g < 5d$; $\beta_{lg} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.2]	
Packing Plate Reduction Factor		$t_{pk} = \text{gap}$ $= 0.0\text{mm}$ since, $t_{pk} \leq 6\text{mm}$, then $V_{\text{rd}} = V_{\text{db}}$ [Ref. IS 800:2007, Cl.10.3.3.3]	

Check	Required	Provided	Remarks
Bolt Capacity (post reduction factor) (kN)	4.1	$V_{\text{rd}} = \beta_{lj}\ \beta_{lg}\beta_{pk}V_{\text{db}}$ $= 1.0 \times 1.0 \times 1.0 \times 13.39$ $= 13.39$ [Ref. IS 800:2007, Cl.10.3.3]	
Bolt Tension Force (kN)	$T_{ba} = \frac{P}{n}$ $= \frac{45.0}{10}$ $= 4.5$		

Check	Required	Provided	Remarks
Bolt Prying Force (kN)	$Q = \frac{l_v}{2l_e}\left[T_e - \frac{\beta\eta f_o b_e t^4}{27 l_e l_v^2}\right]$ $l_v = e - \frac{R_1}{2}$ $= 20 - \frac{5.0}{2} = 26.3$ mm $f_o = 0.7 f_{ub}$ $= 0.7 \times 500.0$ $= 350.0$ N/mm^2 $l_e = \min\left(e, 1.1t\sqrt{\frac{\beta f_o}{f_y}}\right)$ $= \min\left(20, 1.1 \times 8 \times \sqrt{\frac{2 \times 350.0}{250}}\right)$ $= \min(20,\ 14.73) = 14.73$ mm $\beta = 2$ (non pre-tensioned bolt) $\eta = 1.5$ $b_e = \frac{B}{n_c}$ $= \frac{60.0}{2} = 35$ mm $Q = \frac{26.3}{2 \times 14.73} \times$ $\left[4.5 - \left(\frac{2 \times 1.5 \times 350.0 \times 35 \times 8^4}{27 \times 14.73 \times 26.3^2}\right) \times 10^{-3}\right]$ $Q = 3.48$ [Ref. IS 800:2007, Cl.10.4.7]		

Check	Required	Provided	Remarks
Bolt Tension Force (kN)	$T_f = T_1 + Q$ $= 4.5 + 3.48$ $= 7.98$	$T_{\text{db}} = 0.90 f_{ub} A_n \ / \ \gamma_{mb}$ $< \ f_{yb} A_{sb} (\gamma_{mb} \ / \ \gamma_{m0})$ $= \min\left(0.90 \times 500.0 \times 58 \ / \ 1.25,\right.$ $\left. 500.0 \times 79 \times (1.25/1.1)\right)$ $= \min(20.88,\ 44.89)$ $= 20.88$ [Ref. IS 800:2007, Cl.10.3.5]	Pass
Interaction Ratio	≤ 1	$\left(\frac{V_{sb}}{V_{\text{db}}}\right)^2 + \left(\frac{T_{\text{b}}}{T_{\text{db}}}\right)^2 \leq 1.0$ $\left(\frac{4.1}{13.39}\right)^2 + \left(\frac{7.98}{20.88}\right)^2 = 0.24$ [Ref. IS 800:2007, Cl.10.3.6]	Pass

2.3 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (200.0 - 2 \times 5.0 - 2 \times 5.0)$ $= 108.0$ [Ref. INSDAG, Ch.5, sec.5.2.3]	180	Pass
Max. Plate Height (mm)	$d_b - 2(t_{bf} + r_{b1} + \text{gap})$ $= 200.0 - 2 \times (5.0 + 5.0 + 10)$ $= 180.0$	180	Pass
Min. Plate Thickness (mm)	$t_w = 3.4$	8	Pass
Min. Plate Width (mm)	$w_{p\min} = g' + e'_{\min}\ 2$ $= 62 + 17.0 \times 2$ $= 96.0$	102	Pass
Max. Plate Width (mm)	$w_{p\max} = T_f$ $= 150.0$	102	Pass

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Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{d_y} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{180 \times 8 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 188.95$ [Ref. IS 800:2007, Cl.10.4.3]	
Block Shear Capacity in Shear (kN)		$V_{\mathrm{dbl1}} = \frac{A_{\mathrm{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{\mathrm{dbl2}} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{\mathrm{db}} = \min(V_{db1},\ V_{db2}) = 229.53$ [Ref. IS 800:2007, Cl.6.4]	
Shear Capacity (kN)	41.0	$V_d = \min(S_c,\ V_{d_b})$ $= \min(188.95, 229.53)$ $= 188.95$ [Ref. IS 800:2007, Cl.6.1]	**Pass**
Moment Capacity (kNm)	$M = T_e \times \mathrm{ecc}$ $ecc_1 = \frac{g}{2} - \frac{t_w}{2} - s \quad = 26.3$ $ecc_2 = \frac{g}{2} - \frac{T_w}{2} - R_r \quad = 20.3$ $\max(ecc_1,\ ecc_2) \quad = 26.3$ $M = 4.5 \times 26.3 \times 10^{-3} \quad = 0.117$	$M_{dz} = \frac{\beta_b Z_p fy}{\gamma_{m0}}$ $= \frac{1.0 \times 2880.0 \times 250}{1.1 \times 10^6}$ $= 0.127$ [Ref. IS 800:2007, Cl.8.2.1.2]	**Pass**

2.4 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{\min}}$ based on thinner part $= \max(3,\ 3)$ $s_{\min}$ based on thicker part $= 3$ [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	3	**Pass**
Max. Weld Size (mm)	Thickness of thinner part $= \min(8,\ 3.4) = 3.4$ $s_{\max} = 4$ [Ref. IS 800:2007, Cl.10.5.3.1]	3	**Pass**
Weld Strength (N/mm)	$R_{\mathrm{w}} = \sqrt{(A_{\mathrm{wh}})^2 + (V_{\mathrm{wv}})^2}$ $V_{\mathrm{wv}} = \frac{V}{l_w} = \frac{41000.0}{214.0}$ $A_{\mathrm{wh}} = \frac{A}{l_w} = \frac{45000.0}{214.0}$ $R_{\mathrm{w}} = \sqrt{(210.28)^2 + (191.59)^2}$ $= 174.93$	$f_w = \frac{t_t f_u}{\sqrt{3}\gamma_{mw}}$ $= \frac{3 \times 410}{\sqrt{3} \times 1.25}$ $= 568.11$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	
Weld Strength (post long joint) (N/mm)	if $l \geq 150t_t$, then $V_{\mathrm{rd}} = \beta_{l_w} V_{\mathrm{db}}$ if $l < 150t_t$, *then* $V_{\mathrm{rd}} = V_{\mathrm{db}}$ where, l = plate length or height $\beta_{l_w} = 1.2 - \frac{(0.2l)}{(150t_t)}$ but, $0.6 \leq \beta_{l_w} \leq 1.0$ [Ref. IS 800:2007, Cl.10.5.7.3]	$l_w = h$ $= 180$ $150t_t = 150 \times 3 = 450$ since, $l < 150t_t$ *then* $f_{\mathrm{wrd}} = f_{\mathrm{w}}$ $f_{\mathrm{wrd}} = 568.11$ [Ref. IS 800:2007, Cl.10.5.7.3.]	
Weld Strength (N/mm)	174.93	568.11	**Pass**

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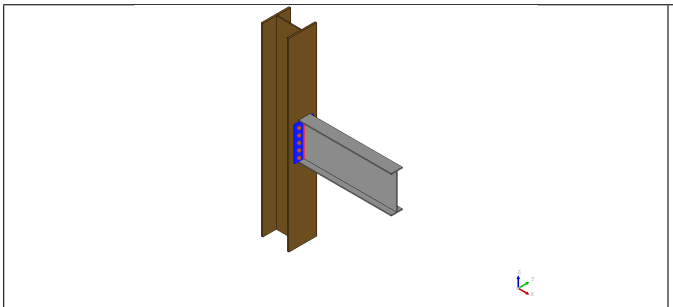
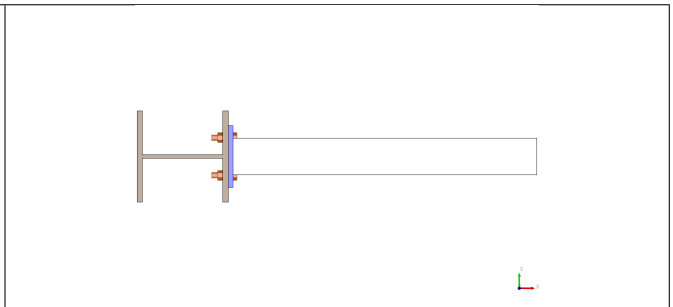
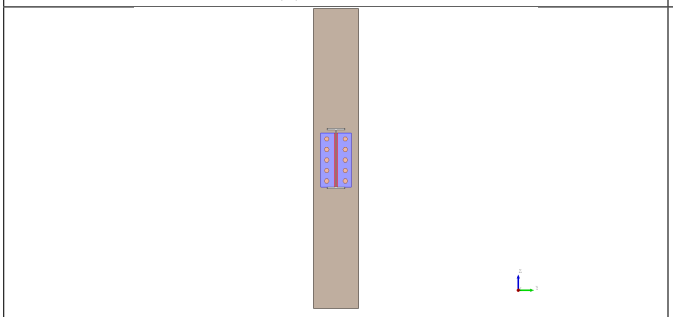
3 3D Views



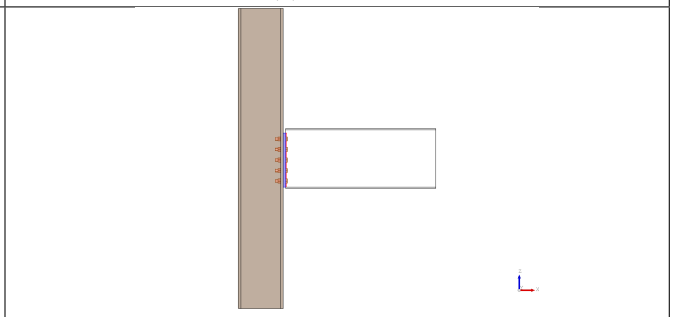
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log

2024-12-26 08:57:05 - Osdag - INFO - : The minimum recommended weld throat thickness suggested by IS 800:2007 is 3 mm, as per cl. 10.5.3.1. Weld throat thickness is not considered as per cl. 10.5.3.2. Please take necessary detailing precautions at site accordingly.
2024-12-26 08:57:05 - Osdag - INFO - End plate is designed with minimum possible plate thickness.
2024-12-26 08:57:05 - Osdag - INFO - Bolt columns are limited to two (one on each side) in shear end plate.
2024-12-26 08:57:05 - Osdag - INFO - === End Of Design ===