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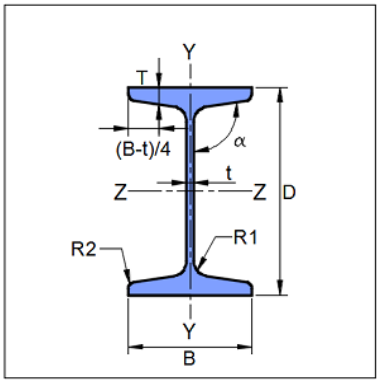
1 Input Parameters

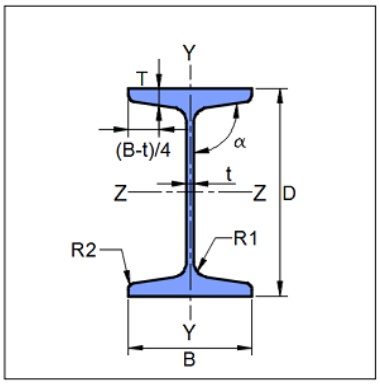
Main Module	Shear Connection
Module	Cleat Angle Connection
Connectivity	Beam-Beam
Shear Force (kN)	21.7

Supporting Section - Mechanical Properties



Supporting Section		JB 200	
Material		E 165 (Fe 290)	
Ultimate Strength, F_u (MPa)		290	
Yield Strength, F_y (MPa)		165	
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		

Supported Section - Mechanical Properties



Supported Section		JB 175	
Material		E 165 (Fe 290)	
Ultimate Strength, F_u (MPa)		290	
Yield Strength, F_y (MPa)		165	
Mass, m (kg/m)	8.07	I_z (cm^4)	480.0
Area, A (cm^2)	10.2	I_y(cm^4)	9.65
D (mm)	175.0	r_z (cm)	6.83
B (mm)	50.0	r_y (cm)	0.97
t (mm)	3.2	Z_z (cm^3)	54.9
T (mm)	4.8	Z_y (cm^3)	3.86
Flange Slope	91.5	Z_{pz} (cm^3)	64.2
R_1 (mm)	5.0	Z_{py} (cm^3)	6.32
R_2 (mm)	1.5		

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(39), 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(6.8), np.float64(8.8), np.float64(9.8), np.float64(10.9), np.float64(12.9)]
Type	Bearing Bolt
Hole Type	Standard
Slip Factor, (μ_f)	0.3
Detailing - Design Preference	
Edge Preparation Method	Sheared or hand flame cut
Gap Between Members (mm)	10.0
Are the Members Exposed to Corrosive Influences?	False

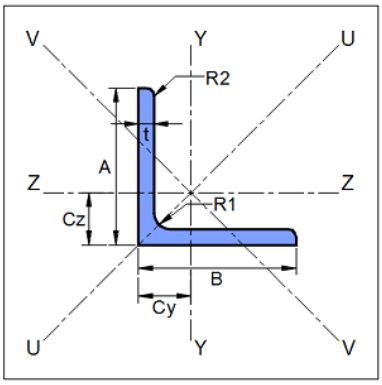
1.1 List of Input Section

Cleat Angle List	'50 x 50 x 3', '50 x 50 x 5', '50 x 50 x 6', '50 x 50 x 7', '50 x 50 x 8', '55 x 55 x 4', '55 x 55 x 5', '55 x 55 x 6', '55 x 55 x 8', '60 x 60 x 4', '60 x 60 x 5', '60 x 60 x 8', '65 x 65 x 4', '65 x 65 x 5', '65 x 65 x 6', '65 x 65 x 8', '70 x 70 x 5', '70 x 70 x 6', '70 x 70 x 7', '70 x 70 x 8', '75 x 75 x 5', '75 x 75 x 6', '75 x 75 x 8', '80 x 80 x 6', '80 x 80 x 8', '90 x 90 x 6', '90 x 90 x 8', '55 x 55 x 10', '60 x 60 x 10', '65 x 65 x 10', '70 x 70 x 10', '75 x 75 x 10', '80 x 80 x 10', '80 x 80 x 12', '90 x 90 x 10', '90 x 90 x 12', '100 x 100 x 6', '100 x 100 x 7', '100 x 100 x 8', '110 x 110 x 8', '120 x 120 x 8', '130 x 130 x 8', '130 x 130 x 9', '100 x 100 x 10', '100 x 100 x 12', '100 x 100 x 15', '110 x 110 x 10', '110 x 110 x 12', '110 x 110 x 16', '120 x 120 x 10', '120 x 120 x 12', '120 x 120 x 15', '130 x130 x 10', '130 x130 x 12', '130 x130 x 16', '150 x 150 x 10', '150 x 150 x 12', '150 x 150 x 15', '150 x 150 x 16', '150 x 150 x 18', '150 x 150 x 20', '180 x 180 x 15', '180 x 180 x 18', '180 x 180 x 20', '200 x 200 x 12', '200 x 200 x 16', '200 x 200 x 20', '200 x 200 x 24', '200 x 200 x 25'

2 Design Checks

Design Status	Pass

2.1 Selected Member Data



Section Size		50 x 50 x 3	
Material		E 165 (Fe 290)	
Ultimate Strength, Fu (MPa)		290	
Yield Strength, Fy (MPa)		165	
Mass, m (kg/m)	2.34	I_u (cm^4)	11.4
Area, A (cm^2)	2.99	I_v(cm^4)	3.01
A (mm)	50.0	r_z (cm)	1.55
B (mm)	50.0	r_y (cm)	1.55
t (mm)	3.0	r_u (cm)	1.96
R_1 (mm)	6.0	r_v (cm)	1.0
R_2 (mm)	0.0	Z_z (cm^3)	1.97
C_y (mm)	13.4	Z_y (cm^3)	1.97
C_z (mm)	13.4	Z_{pz} (cm^3)	3.53
I_z (cm^4)	7.21	Z_{py} (cm^3)	1.97
I_y(cm^4)	7.21		

2.2 Initial Section Check

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)	21.7	$V_{dy} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{155.0 \times 3.2 \times 165}{\sqrt{3} \times 1.1 \times 1000}$ $= 42.95$ [Ref. IS 800:2007, Cl.10.4.3]	Pass

Check	Required	Provided	Remarks
Allowable Shear Capacity (kN)	21.7	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 42.95$ $= 25.77$ [Limited to low shear]	Pass

2.3 Load Consideration

Check	Required	Provided	Remarks
Applied Shear Force (kN)	21.7	$V_{y_{\min}} = \min(0.15V_{d_y},\ 40.0)$ $= \min(0.15 \times 42.95,\ 40.0)$ $= 40$ $V_u = \max(V_y,\ V_{y_{\min}})$ $= \max(21.7, 40)$ $= 40$ [Ref. IS 800:2007, Cl.10.7]	

2.4 Bolt Design - Connected to Beam

Check	Required	Provided	Remarks
Diameter (mm)		10	
Property Class		3.6	
Cleat Angle Connection		50 x 50 x 3	
No. of Bolt Columns		1	
No. of Bolt Rows		3	
Min. Pitch Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 10$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	45	Pass

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Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p_{max} = \min(32t,\ 300)$ $= \min(32 \times 3.0,\ 300)$ $= \min(96.0,\ 300)$ $= 96.0$ Where, $t = \min(3.0, 3.2)$ [Ref. IS 800:2007, Cl.10.2.3]	45	**Pass**
Min. Gauge Distance (mm)	$g_{min} = 2.5d$ $= 2.5 \times 10$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	N/A	
Max. Gauge Distance (mm)	$g_{max} = \min(32t,\ 300)$ $= \min(32 \times 3.0,\ 300)$ $= \min(96.0,\ 300)$ $= 96.0$ Where, $t = \min(3.0, 3.2)$ [Ref. IS 800:2007, Cl.10.2.3]	N/A	
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**

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Check	Required	Provided	Remarks
Max. End Distance (mm)	$e_{max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 3.0 \times \sqrt{\frac{250}{165}} = 44.31$ $e_2 = 12 \times 3.2 \times \sqrt{\frac{250}{165}} = 47.27$ $e_{max} = \min(e_1,\ e_2) = 44.31$ [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**
Max. Edge Distance (mm)	$e'_{max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 3.0 \times \sqrt{\frac{250}{165}} = 44.31$ $e_2 = 12 \times 3.2 \times \sqrt{\frac{250}{165}} = 47.27$ $e'_{max} = min(e_1,\ e_2) = 44.31$ [Ref. IS 800:2007, Cl.10.2.4.3]	20	**Pass**
Moment Demand (kNm)		$M_d = (V_u \times \text{ecc} + M_w)$ ecc = eccentricity M_w = external moment acting on web $= \frac{(21.7 \times 10^3 \times 30.0 + 0.0 \times 10^6)}{10^6}$ $= 651.0$	

Check	Required	Provided	Remarks
Bolt Force Parameter(s) (mm)	l_n = length available $l_n = p\ (n_r - 1)$ $= 45 \times (3 - 1)$ $= 90$ $y_{max} = l_n/2$ $= 90/2$ $= 45.0$ $x_{max} = g(n_c - 1)/2$ $= 0.0 \times (1 - 1)/2$ $= 0.0$		

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Check	Required	Provided	Remarks
Bolt.Force (kN)	$vbv = V_u/(n_r \times n_c)$ $= \frac{21.7}{(3 \times 1)}$ $= 7.23$ $tmh = \frac{M_d \times y_{\max}}{\Sigma r_i^2}$ $= \frac{651.0 \times 45.0}{4.05}$ $= 7.23$ $tmv = \frac{M_d \times x_{\max}}{\Sigma r_i^2}$ $= \frac{651.0 \times 0.0}{4.05}$ $= 0.0$ $abh = \frac{A_u}{(n_r \times n_c)}$ $= \frac{0.0}{(3 \times 1)}$ $= 0.0$ $v_{\text{res}} = \sqrt{(vbv + tmv)^2 + (tmh + abh)^2}$ $= \sqrt{(7.23 + 0.0)^2 + (7.23 + 0.0)^2}$ $= 10.23$		
Shear Capacity (kN)		$V_{\text{dsb}} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}}$ $= \frac{330.0 \times 2 \times 58}{1000 \times \sqrt{3} \times 1.25}$ $= 17.68$ [Ref. IS 800:2007, Cl.10.3.3]	

Check	Required	Provided	Remarks
Kb		$k_b = \min\left(\frac{e}{3d_0},\ \frac{p}{3d_0} - 0.25,\ \frac{f_{ub}}{f_u},\ 1.0\right)$ $= \min\left(\frac{20}{3 \times 10},\ \frac{45}{3 \times 10} - 0.25,\ \frac{330.0}{290},\ 1.0\right)$ $= \min(0.67, 1.25, 1.14, 1.0)$ $= 0.67$ [Ref. IS 800:2007, Cl.10.3.4]	
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.67 \times 10 \times 3.2 \times 290}{1000 \times 1.25}$ $= 12.44$ [Ref. IS 800:2007, Cl.10.3.4]	
Capacity (kN)		$V_{\text{db}} = \min\ (V_{\text{dsb}},\ V_{\text{dpb}})$ $= \min\ (17.68,\ 12.44)$ $= 12.44$ [Ref. IS 800:2007, Cl.10.3.2]	
Long Joint Reduction Factor		$l_j = (n_r - 1) \times p$ $= (3 - 1) \times 45 = 90$ $l = 90$ $15 \times d = 15 \times 10 = 150$ 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		$l_g = \Sigma\ (t_p + t_{\text{member}})$ $= 9.2$ $5d = 50$ $8d = 80$ since, $l_g < 5d$; $\beta_{lg} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.2]	**Pass**

Check	Required	Provided	Remarks
Bolt Capacity (post reduction factor) (kN)		$V_{rd} = \beta_{lj}\beta_{lg}V_{db}$ $= 1.0 \times 1.0 \times 12.44$ $= 12.44$	
Capacity (kN)	10.23	12.44	Pass

2.5 Bolt Design - Connected to Column

Check	Required	Provided	Remarks
Diameter (mm)		10	
Property Class		3.6	
Cleat Angle Connection		50 x 50 x 3	
No. of Bolt Columns		1	
No. of Bolt Rows		3	
Min. Pitch Distance (mm)	$p_{min} = 2.5d$ $= 2.5 \times 10$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	45	Pass
Max. Pitch Distance (mm)	$p_{max} = \min(32t,\ 300)$ $= \min(32 \times 3.0,\ 300)$ $= \min(96.0,\ 300)$ $= 96.0$ Where, $t = \min(3.0, 3.4)$ [Ref. IS 800:2007, Cl.10.2.3]	45	Pass
Min. Gauge Distance (mm)	$g_{min} = 2.5d$ $= 2.5 \times 10$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	N/A	

Check	Required	Provided	Remarks
Max. Gauge Distance (mm)	$g_{max} = \min(32t,\ 300)$ $= \min(32 \times 3.0,\ 300)$ $= \min(96.0,\ 300)$ $= 96.0$ Where, $t = \min(3.0, 3.4)$ [Ref. IS 800:2007, Cl.10.2.3]	N/A	
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)	$e_{max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 3.0 \times \sqrt{\frac{250}{165}} = 44.31$ $e_2 = 12 \times 3.4 \times \sqrt{\frac{250}{165}} = 50.22$ $e_{max} = \min(e_1,\ e_2) = 44.31$ [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**

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 3.0 \times \sqrt{\frac{250}{165}} = 44.31$ $e_2 = 12 \times 3.4 \times \sqrt{\frac{250}{165}} = 50.22$ $e'_{max} = min(e_1,\ e_2) = 44.31$ [Ref. IS 800:2007, Cl.10.2.4.3]	20	**Pass**
Moment Demand (kNm)		$M_d = (V_u \times \text{ecc} + M_w)$ ecc = eccentricity M_w = external moment acting on web $= \frac{(10.85 \times 10^3 \times 29.0 + 0.0 \times 10^6)}{10^6}$ $= 314.65$	
Bolt Force Parameter(s) (mm)	l_n = length available $l_n = p\ (n_r - 1)$ $= 45 \times (3 - 1)$ $= 90$ $y_{max} = l_n/2$ $= 90/2$ $= 45.0$ $x_{max} = g(n_c - 1)/2$ $= 0.0 \times (1 - 1)/2$ $= 0.0$		

Check	Required	Provided	Remarks
Bolt.Force (kN)	$vbv = V_u/(n_r \times n_c)$ $= \frac{21.7}{(3 \times 1)}$ $= 3.62$ $tmh = \frac{M_d \times y_{\max}}{\Sigma r_i^2}$ $= \frac{314.65 \times 45.0}{4.05}$ $= 3.5$ $tmv = \frac{M_d \times x_{\max}}{\Sigma r_i^2}$ $= \frac{314.65 \times 0.0}{4.05}$ $= 0.0$ $abh = \frac{A_u}{(n_r \times n_c)}$ $= \frac{0.0}{(3 \times 1)}$ $= 0.0$ $v_{\text{res}} = \sqrt{(vbv + tmv)^2 + (tmh + abh)^2}$ $= \sqrt{(3.62 + 0.0)^2 + (3.5 + 0.0)^2}$ $= 5.03$		
Shear Capacity (kN)		$V_{\text{dsb}} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}}$ $= \frac{330.0 \times 1 \times 58}{1000 \times \sqrt{3} \times 1.25}$ $= 8.84$ [Ref. IS 800:2007, Cl.10.3.3]	

Check	Required	Provided	Remarks
Kb		$k_b = \min\left(\frac{e}{3d_0},\ \frac{p}{3d_0} - 0.25,\ \frac{f_{ub}}{f_u},\ 1.0\right)$ $= \min\left(\frac{20}{3 \times 10},\ \frac{45}{3 \times 10} - 0.25,\ \frac{330.0}{290},\ 1.0\right)$ $= \min(0.67, 1.25, 1.14, 1.0)$ $= 0.67$ [Ref. IS 800:2007, Cl.10.3.4]	
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.67 \times 10 \times 3.2 \times 290}{1000 \times 1.25}$ $= 11.66$ [Ref. IS 800:2007, Cl.10.3.4]	
Capacity (kN)		$V_{\text{db}} = \min\ (V_{\text{dsb}},\ V_{\text{dpb}})$ $= \min\ (8.84,\ 11.66)$ $= 8.84$ [Ref. IS 800:2007, Cl.10.3.2]	
Long Joint Reduction Factor		$l_j = (n_r - 1) \times p$ $= (3 - 1) \times 45 = 90$ $l = 90$ $15 \times d = 15 \times 10 = 150$ 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		$l_g = \Sigma\ (t_p + t_{\text{member}})$ $= 6.4$ $5d = 50$ $8d = 80$ since, $l_g < 5d$; $\beta_{lg} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.2]	**Pass**

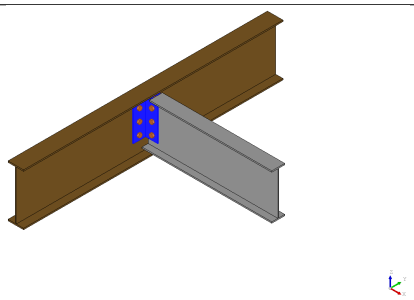
Check	Required	Provided	Remarks
Bolt Capacity (post reduction factor) (kN)		$V_{rd} = \beta_{lj}\beta_{lg}V_{db}$ $= 1.0 \times 1.0 \times 8.84$ $= 8.84$	
Capacity (kN)	5.03	8.84	Pass

2.6 Cleat Angle Check

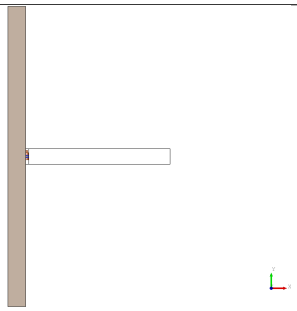
Check	Required	Provided	Remarks
Min. Cleat Angle Height	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (175.0 - 2 \times 4.8 - 2 \times 5.0)$ $= 93.24$ [Ref. INSDAG, Ch.5, sec.5.2.3]	130	Pass
Max. Cleat Angle Height	$d_b - t_{bf} + r_{b1} - notch_h$ $= 200.0 - 5.0 + 5.0 - 0.0$ $= 145.2$	130	Pass
Min. Leg Length (mm) (on supported leg)	$\max\left(\text{gap},\ t_{\text{cleat}} + r_{r_{\text{angle}}} + 2e'_{\min} + (n_c - 1)g_{\min}\right)$ $= \max\left(10.0,\ 3.0 + 6.0 + 2 \times 17.0 + (1 - 1) \times 25.0\right)$ $= 44.0$	50.0	Pass
Min. Leg Length (mm) (on supporting leg)	$t_{\text{cleat}} + r_{r_{\text{angle}}} + 2e'_{\min} + (n_c - 1)g_{\min}$ $= 3.0 + 6.0 + 2 \times 17.0 + (1 - 1) \times 25.0$ $= 44.0$	50.0	Pass
Min. Cleat Angle Thickness (mm)	$t_w = 0.5 \times 3.2 = 1.6$	3.0	Pass
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3}\gamma_{m0}}$ $= \frac{2 \times 130 \times 3.0 \times 165}{\sqrt{3} \times 1.1 \times 1000}$ $= 67.55$ [Ref. IS 800:2007, Cl.10.4.3]	

Check	Required	Provided	Remarks
Block Shear Capacity in Shear (kN)		$V_{\text{dbl1}} = \frac{A_{\text{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{\text{dbl2}} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{\text{db}} = \min(V_{db1},\ V_{db2}) = 75.95$ [Ref. IS 800:2007, Cl.6.4]	
Shear Capacity (kN)	21.7	$V_d = \min(V_{d_y},\ V_{d_b})$ $= \min(67.55, 75.95)$ $= 67.55$ [Ref. IS 800:2007, Cl.6.1]	**Pass**
Moment Capacity (kNm)	0.65	$M_{dz} = \frac{\beta_b Z_p f y}{\gamma_{m0}}$ $= \frac{1.0 \times 25350.0 \times 165}{1.1 \times 10^6}$ $= 3.8$ [Ref. IS 800:2007, Cl.8.2.1.2]	**Pass**

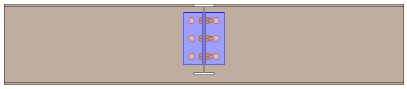
3 3D Views



(a) 3D View



(b) Top View



(c) Side View

(d) Front View

4 Design Log