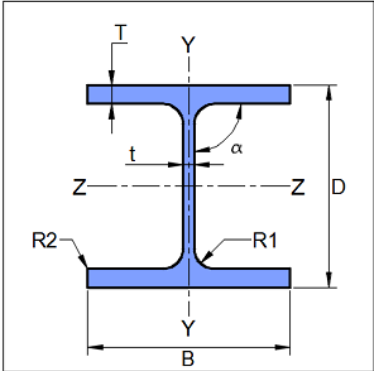




Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Beam Cover Plate (welded)
Designer	Engineer#1	Job Number	1.2.1.3.1
Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

1 Input Parameters

Module		Beam-to-Beam Cover Plate Welded Connection		
Main Module		Moment Connection		
Bending Moment (kNm)		235.0		
Shear Force (kN)		150.0		
Axial Force (kN)		20.0		
Beam Section - Mechanical Properties				
	Beam Section		UB 686 x 254 x 140	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		300	
	Mass, m (kg/m)	140.1	I_z (cm ⁴)	136267.0
	Area, A (cm ²)	17840.0	I_y (cm ⁴)	5182.0
	D (mm)	684.0	r_z (cm)	27.6
	B (mm)	253.7	r_y (cm)	5.4
	t (mm)	12.4	Z_z (cm ³)	3987.0
	T (mm)	19.0	Z_y (cm ³)	409.0
	Flange Slope	90	Z_{pz} (cm ³)	4558.0
	R_1 (mm)	15.2	Z_{py} (cm ³)	638.0
R_2 (mm)	0.0			
Weld Details - Input and Design Preference				
Weld Type		Fillet		
Type of Weld Fabrication		Field weld		
Material Grade Overwrite, F_u (MPa)		550.0		
Plate Details - Input and Design Preference				
Preference		Outside + Inside		
Ultimate Strength, F_u (MPa)		410		
Yield Strength, F_y (MPa)		250		
Material		E 250 (Fe 410 W)A		
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]		



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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

2 Design Checks

Design Status	Pass
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2.1 Member Capacity

Check	Required	Provided	Remarks
Section Classification		Plastic [Ref: Table 2, Cl.3.7.2 and 3.7.4, IS 800:2007]	
Axial Capacity Member (kN)	$P_x = 20.0$	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $= \frac{17840.0 \times 300}{1.1 \times 10^3}$ $= 4865.45$ [Ref. IS 800:2007, Cl.6.2]	
Shear Capacity Member (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{646.0 \times 12.4 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 1261.31$ [Ref. IS 800:2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	$V_y = 150.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 1261.31$ $= 756.79$ [Limited to low shear]	Pass
Plastic Moment Capacity (kNm)		$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1 \times 4558000.0 \times 300}{1.1 \times 10^6}$ $= 1243.09$ [Ref. IS 800:2007, Cl.8.2.1.2]	



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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

Check	Required	Provided	Remarks
Moment Deformation Criteria (kNm)		$M_{dc} = \frac{1.5Z_e f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.5 \times 3987000.0 \times 300}{1.1 \times 10^6}$ $= 1631.05$ [Ref. IS 800:2007, Cl.8.2.1.2]	
Moment Capacity Member (kNm)	$M_z = 235.0$	$M_{dz} = \min(M_{dz}, M_{dc})$ $= \min(1243.09, 1631.05)$ $= 1243.09$ [Ref. IS 800:2007, Cl.8.2]	

2.2 Load Consideration

Check	Required	Provided	Remarks
Interaction Ratio		<p>I.R. axial $= P_x / T_{dg}$</p> $= 20.0 / 4865.45$ $= 0.0041$ <p>I.R. moment $= M_z / M_{dz}$</p> $= 235.0 / 1243.09$ $= 0.189$ <p>I.R. sum $= \text{I.R. axial} + \text{I.R. moment}$</p> $= 0.0041 + 0.189$ $= 0.1931$	



Company Name	IIT Bombay	Project Title	Moment Connection
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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

Check	Required	Provided	Remarks
Minimum Required Load	<p>if I.R. axial < 0.3 and I.R. moment < 0.5</p> $P_{xmin} = 0.3T_{dg}$ $M_{zmin} = 0.5M_{dz}$ <p>elif sum I.R. ≤ 1.0 and I.R. moment < 0.5</p> <p>if $(0.5 - \text{I.R. moment}) < (1 - \text{sum I.R.})$</p> $M_{zmin} = 0.5 \times M_{dz}$ <p>else</p> $M_{zmin} = M_z + ((1 - \text{sum I.R.}) \times M_{dz})$ $P_{xmin} = P_x$ <p>elif sum I.R. ≤ 1.0 and I.R. axial < 0.3</p> <p>if $(0.3 - \text{I.R. axial}) < (1 - \text{sum I.R.})$</p> $P_{xmin} = 0.3T_{dg}$ <p>else</p> $P_{xmin} = P_x + ((1 - \text{sum I.R.}) \times T_{dg})$ $M_{zmin} = M_z$ <p>else</p> $P_{xmin} = P_x$ $M_{zmin} = M_z$ <p>Note: AL is the user input for load</p>	$M_{zmin} = 621.55$ $P_{xmin} = 1459.64$ <p>[Ref. IS 800:2007, Cl.10.7]</p>	
Applied Axial Force (kN)	$P_x = 20.0$	$P_u = \max(P_x, P_{xmin})$ $= \max(20.0, 1459.64)$ $= 1459.64$	



Company Name	IIT Bombay	Project Title	Moment Connection
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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

Check	Required	Provided	Remarks
Applied Shear Force (kN)	$V_y = 150.0$	$V_{y\min} = \min(0.15V_{dy}, 40.0)$ $= \min(0.15 \times 1261.31, 40.0)$ $= 40.0$ $V_u = \max(V_y, V_{y\min})$ $= \max(150.0, 40.0)$ $= 150.0$ [Ref. IS 800:2007, Cl.10.7]	
Applied Moment (kNm)	$M_z = 235.0$	$M_u = \max(M_z, M_{z\min})$ $= \max(235.0, 621.55)$ $= 621.55$ [Ref. IS 800:2007, Cl.8.2.1.2]	
Force Carried by Web		$A_w = \text{Axial force in web}$ $= \frac{(D - 2T)tA_u}{A}$ $= \frac{(684.0 - 2 \times 19.0) \times 12.4 \times 1459.64}{17840.0}$ $= 655.4 \text{ kN}$ $M_w = \text{Moment in web}$ $= \frac{Z_w M_u}{Z}$ $= \frac{1293679.6 \times 621.55}{4558000.0}$ $= 176.41 \text{ kNm}$	



Company Name	IIT Bombay	Project Title	Moment Connection
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Designer	Engineer#1	Job Number	1.2.1.3.1
Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

Check	Required	Provided	Remarks
Force Carried by Flange		$A_f = \text{Axial force in flange}$ $= \frac{AuBT}{A}$ $= \frac{1459.64 \times 253.7 \times 19.0}{17840.0}$ $= 394.39 \text{ kN}$ $M_f = \text{Moment in flange}$ $= Mu - M_w$ $= 621.55 - 176.41$ $= 445.13 \text{ kNm}$ $F_f = \text{flange force}$ $= \frac{M_f \times 10^3}{D - T} + A_f$ $= \frac{445.13 \times 10^3}{684.0 - 19.0} + 394.39$ $= 1063.76 \text{ kN}$	

2.3 Flange Weld Design

Check	Required	Provided	Remarks
Min. Flange Plate Thickness (mm)	$T = 9.5$	$t_{fp} = 16.0$	Pass
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= \max(16, 16)$ s_{min} based on thicker part = 5 [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	$t_w = 14$	Pass
Max. Weld Size (mm)	Thickness of thinner part $= \min(19.0, 16.0) = 16.0$ $s_{max} = 16.0$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_w = 14$	Pass



Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Beam-to-Beam Cover Plate (welded)
Designer	Engineer#1	Job Number	1.2.1.3.1
Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

Check	Required	Provided	Remarks
Clearance (mm)	$sp = \max(15, (t_w + 5))$ $= \max(15, (14 + 5))$ $= 19$	$sp = 19$	Pass
Throat Thickness (mm)	$t_t \geq 3$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_t = 0.7t_w$ $= 0.7 \times 14$ $= 9.8$ [Ref. IS 800:2007, Cl.10.5.3.1]	Pass
EffLength. Outer+Inner flange		$l_{eff} = (6 \times l_w) + B_{fp} + (2 \times B_{ifp}) - 6 \times t_w$ $= (6 \times 255) + 215 + 2 \times 65 - 6 \times 14$ $= 1800$	
Flange Weld Strength (N/mm)	$\text{Stress} = \frac{F_f \times 10^3}{l_{eff}}$ $= \frac{1063.76 \times 10^3}{1800}$ $= 592.1$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{9.8 \times 410}{\sqrt{3} \times 1.5}$ $= 1855.83$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	Pass
Weld Strength (post long joint) (N/mm)	<p>if $l \geq 150t_t$, then $V_{rd} = \beta_{lw} V_{db}$</p> <p>if $l < 150t_t$, then $V_{rd} = V_{db}$</p> <p>where,</p> <p>l = plate length or height</p> $\beta_{lw} = 1.2 - \frac{(0.2l)}{(150t_t)}$ <p>but, $0.6 \leq \beta_{lw} \leq 1.0$</p> [Ref. IS 800:2007, Cl.10.5.7.3]	<p>l = plate length or height</p> $l_l = 2(255 + (2 \times 14)) + 5.0$ $= 571.0$ $l_h = 215$ $l = 571.0$ $150 \times t_t = 150 \times 9.8 = 1470.0$ <p>since, $l < 150 \times t_t$</p> <p>then $V_{rd} = V_{db}$</p> $V_{rd} = 1855.83$ [Ref. IS 800:2007, Cl.10.5.7.3]	
Weld Strength (N/mm)	592.1	1855.83	Pass



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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

2.4 Flange Plate Dimension Check - Outside/Inside

Check	Required	Provided	Remarks
Min. Flange Plate Width (mm)	50	$B_{fp} = B - 2sp$ $= 253.7 - 2 \times 19$ $= 215$	Pass
Max. Flange Plate Width (mm)	$B_{fp} = B - 2sp$ $= 253.7 - 2 \times 19$ $= 215$	215	Pass
Min. Flange Plate Length (mm)	253.7	$L_{fp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (255 + 2 \times 14) + 5.0]$ $= 571.0$	Pass
Min. Inner Plate Width (mm)	50	$B_{ifp} = \frac{B - 4sp - t - 2R1}{2}$ $= \frac{253.7 - 4 \times 19 - 12.4 - 2 \times 15.2}{2}$ $= 65$	Pass
Max. Inner Plate Width (mm)	$B_{ifp} = \frac{B - 4sp - t - 2R1}{2}$ $= \frac{253.7 - 4 \times 19 - 12.4 - 2 \times 15.2}{2}$ $= 65$	65	Pass
Min. Inner Plate Length (mm)	253.7	$L_{fp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (255 + 2 \times 14) + 5.0]$ $= 571.0$	Pass
Min. Flange Plate Thickness (mm)	$T = 9.5$	$t_{fp} = 16.0$	Pass
Plate Area Check (mm ²)	plate area \geq 1.05 X connected member area $= 5061.32$ [Ref: Cl.8.6.3.2, IS 800:2007]	plate area $= (B_{fp} + (2 \times B_{ifp})) \times t_{ifp}$ $= (215 + (2 \times 65)) \times 16.0$ $= 5520.0$	Pass



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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

2.5 Web Weld Design

Check	Required	Provided	Remarks
Min. Web Plate Thickness (mm)	$t = 6.2$	$t_{wp} = 12.0$	Pass
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= \max(12, 12)$ s_{min} based on thicker part = 5 [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	$t_w = 10$	Pass
Max. Weld Size (mm)	Thickness of thinner part $= \min(12.4, 12.0) = 12.0$ $s_{max} = 12.0$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_w = 10$	Pass
Effective Length (mm)		$l_{eff} = (2l_w) + W_{wp} - 2t_w$ $= (2 \times 125) + 585 - 2 \times 10$ $= 815$	
Clearance (mm)	$sp = \max(15, (t_w + 5))$ $= \max(15, (10 + 5))$ $= 15$	$sp = 15$	Pass
Throat Thickness (mm)	$t_t \geq 3$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_t = 0.7t_w$ $= 0.7 \times 10$ $= 7.0$ [Ref. IS 800:2007, Cl.10.5.3.1]	Pass
Moment Demand (kNm)	$M_d = (V_u \times ecc + M_w)$ ecc = eccentricity M_w = external moment acting on web $= \frac{(75.0 \times 10^3 \times 105.83 + 88.21 \times 10^6)}{10^6}$ $= 96.14$		



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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

Check	Required	Provided	Remarks
Web Weld Strength (N/mm)	$R_w = \sqrt{(T_{wh} + A_{wh})^2 + (T_{wv} + V_{wv})^2}$ $T_{wh} = \frac{M_d \times y_{max}}{I_{pw}}$ $= \frac{96142543.83 \times 19.17}{35984263.87}$ $T_{wv} = \frac{M_d \times x_{max}}{I_{pw}}$ $= \frac{96142543.83 \times 282.5}{35984263.87}$ $V_{wv} = \frac{V_u}{l_{eff}}$ $= \frac{75000.0}{815}$ $A_{wh} = \frac{A_u}{l_{eff}}$ $= \frac{327698.18}{815}$ $R_w = \sqrt{(51.22 + 402.08)^2 + (754.78 + 92.02)^2}$ $= 960.5$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{7.0 \times 410}{\sqrt{3} \times 1.5}$ $= 1325.6$ <p>[Ref. IS 800:2007, Cl.10.5.7.1.1]</p>	Pass



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Check	Required	Provided	Remarks
Weld Strength (post long joint) (N/mm)	<p>if $l \geq 150t_t$, then $V_{rd} = \beta_{lw} V_{db}$</p> <p>if $l < 150t_t$, then $V_{rd} = V_{db}$</p> <p>where,</p> <p>l = plate length or height</p> <p>$\beta_{lw} = 1.2 - \frac{(0.2l)}{(150t_t)}$</p> <p>but, $0.6 \leq \beta_{lw} \leq 1.0$</p> <p>[Ref. IS 800:2007, Cl.10.5.7.3]</p>	<p>l = plate length or height</p> <p>$l_t = 2(125 + (2 \times 10)) + 5.0$ = 295.0</p> <p>$l_h = 585$</p> <p>$l = 585$</p> <p>$150 \times t_t = 150 \times 7.0 = 1050.0$ since, $l < 150 \times t_t$ then $V_{rd} = V_{db}$ $V_{rd} = 1325.6$</p> <p>[Ref. IS 800:2007, Cl.10.5.7.3]</p>	
Weld Strength (N/mm)	960.5	1325.6	Pass

2.6 Web Plate Dimension Check

Check	Required	Provided	Remarks
Min. Web Plate Height (mm)	<p>$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ = $0.6 \times (684.0 - 2 \times 19.0 - 2 \times 15.2)$ = 369.36</p> <p>[Ref. INSDAG, Ch.5, sec.5.2.3]</p>	<p>$W_{wp} = D - 2T - 2R1 - 2sp$ = $684.0 - 2 \times 19.0 - (2 \times 15.2) - 2 \times 15$ = 585</p>	Pass
Min. Web Plate Width (mm)	253.7	<p>$L_{wp} = [2 \times (l_w + 2 \times t_w) + g]$ = $[2 \times (125 + 2 \times 10) + 5.0]$ = 295</p>	Pass
Min. Web Plate Thickness (mm)	$t = 6.2$	$t_{wp} = 12.0$	Pass



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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

Check	Required	Provided	Remarks
Plate Area Check (mm ²)	plate area \geq $1.05 \times \text{connected member area}$ $= 8410.92$ [Ref: Cl.8.6.3.2, IS 800:2007]	$\text{plate area} = 2 \times W_{wp} \times t_{wp}$ $= 2 \times 585 \times 12.0$ $= 14040.0$	Pass

2.7 Member Check

Check	Required	Provided	Remarks
Flange Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 253.7 \times 19.0$ $= \frac{4820.3 \times 300}{1.1 \times 10^3}$ $= 1314.63$ [Ref. IS 800:2007, Cl.6.2]	
Flange Tension Capacity (kN)	$F_f = 1063.76$	$T_d = T_{dg}$ $= 1314.63$ [Ref.IS 800:2007, Cl.6.1]	Pass
Web Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 646.0 \times 12.4$ $= \frac{8010.4 \times 300}{1.1 \times 10^3}$ $= 2184.65$ [Ref. IS 800:2007, Cl.6.2]	



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Check	Required	Provided	Remarks
Web Block Shear Capacity (kN)		$T_{dbl1} = \frac{A_{vg}f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn}f_u}{\gamma_{m1}}$ $T_{dbl2} = \frac{0.9A_{vn}f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg}f_y}{\gamma_{m0}}$ $T_{db} = \min(T_{db1}, T_{db2}) = 2636.09$ <p>[Ref. IS 800:2007, Cl.6.4]</p>	
Web Tension Capacity (kN)	$A_w = 655.4$	$T_d = \min(T_{dg}, T_{dn}, T_{db})$ $= \min(2184.65, 2537.69, 2636.09)$ $= 2184.65$ <p>[Ref.IS 800:2007, Cl.6.1]</p>	Pass

2.8 Flange Plate Capacity Check for Axial Load - Outside/Inside

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 345 \times 16.0$ $= \frac{5520.0 \times 250}{1.1 \times 10^3}$ $= 1254.55$ <p>[Ref. IS 800:2007, Cl.6.2]</p>	
Flange Plate Tension Capacity (kN)	$F_f = 1063.76$	$T_d = T_{dg}$ $= 1254.55$ <p>[Ref.IS 800:2007, Cl.6.1]</p>	Pass



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2.9 Web Plate Capacity Check for Axial Load

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = 2lt = 2 \times 585 \times 12.0$ $= \frac{7020.0 \times 250}{1.1 \times 10^3}$ $= 3190.91$ <p>[Ref. IS 800:2007, Cl.6.2]</p>	
Web Plate Tension Capacity (kN)	$A_w = 655.4$	$T_d = T_{dg}$ $= 3190.91$ <p>[Ref. IS 800:2007, Cl.6.1]</p>	Pass

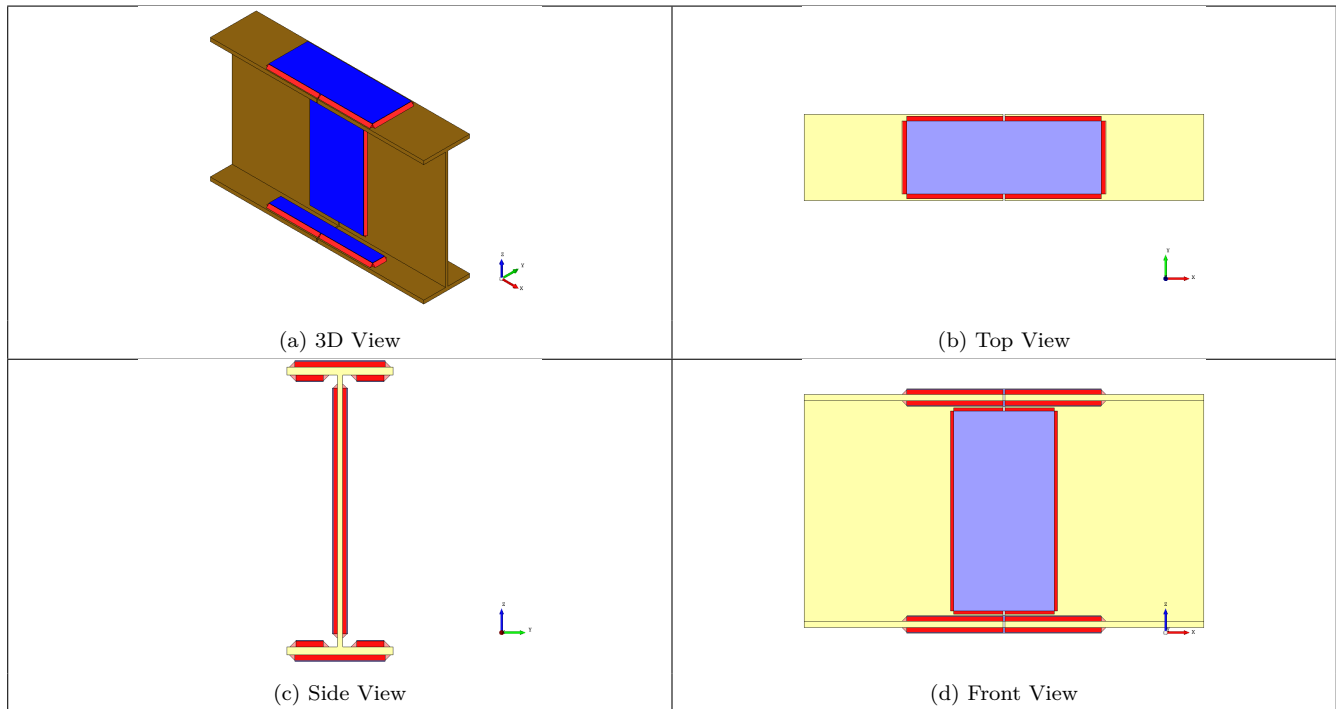
2.10 Web Plate Capacity Check for Shear Load

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{2 \times 585 \times 12.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 1842.27$ <p>[Ref. IS 800:2007, Cl.10.4.3]</p>	
Allowable Shear Capacity (kN)	$V = 150.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 1842.27$ $= 1105.36$ <p>[Limited to low shear]</p>	Pass
Web Plate Shear Capacity (kN)	$V_u = 150.0$	$V_d = S_c$ $= 1105.36$ <p>[Ref. IS 800:2007, Cl.6.1]</p>	Pass



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Date	04 /02 /2021	Client	Mr. Yogesh D Pisal, Mumbai

3 3D Views



4 Design Log

2021-02-04 13:37:03 - Osdag - INFO - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].

2021-02-04 13:37:03 - Osdag - INFO - The value of load(s) is/are set at minimum recommended value as per IS 800:2007, Cl.10.7.

2021-02-04 13:37:03 - Osdag - INFO - : Overall beam cover plate welded connection design is safe.

2021-02-04 13:37:03 - Osdag - INFO - :=====End Of design=====