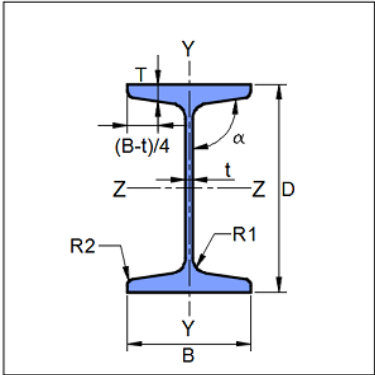




Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Column-Column Cover Plate Welded
Designer	Engineer #1	Job Number	1.2.3.2.2
Date	18 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

1 Input Parameters

Module		Column Cover Plate - Welded		
Main Module		Moment Connection		
Bending Moment (kNm)		50.0		
Shear Force (kN)		30.0		
Axial Force (kN)		480.0		
Column Section - Mechanical Properties				
	Beam Section *		HB 400	
	Material		E 250 (Fe 410 W)A	
	Ultimate Strength, Fu (MPa)		410	
	Yield Strength, Fy (MPa)		250	
	Mass, m (kg/m)	77.43	Iz (cm4)	28000.0
	Area, A (cm2)	98.6	Iy(cm4)	2720.0
	D (mm)	400.0	rz (cm)	16.8
	B (mm)	250.0	ry (cm)	5.25
	t (mm)	9.1	Zz (cm3)	1400.0
	T (mm)	12.7	Zy (cm3)	218.0
	Flange Slope	94	Zpz (cm3)	1560.0
	R1 (mm)	14.0	Zpy (cm3)	360.0
	R2 (mm)	7.0		
Weld Details - Input and Design Preference				
Weld Type		Fillet		
Type of Weld Fabrication		Field weld		
Material Grade Overwrite, Fu (MPa)		510.0		
Plate Details - Input and Design Preference				
Preference		Outside		
Ultimate Strength, Fu (MPa)		410		
Yield Strength, Fy (MPa)		250		
Material		E 250 (Fe 410 W)A		
Thickness (mm)		[14]		



Company Name	IIT Bombay	Project Title	Sample Connection Design
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2 Design Checks

Design Status	Pass
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2.1 Member Capacity

Check	Required	Provided	Remarks
Section Classification		<i>Compact</i> [Ref : Table 2, Cl.3.7.2 and 3.7.4 IS 800 : 2007]	
Axial Capacity Member (kN)	$P_x = 480.0$	$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $= \frac{9860.0 \times 250}{1.1 \times 10^3}$ $= 2240.91$ [Ref. IS 800 : 2007, Cl. 6.2]	
Shear Capacity Member (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{mo}}$ $= \frac{374.6 \times 9.1 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 447.3$ [Ref. IS 800 : 2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	$V_y = 30.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 447.3$ $= 268.38$ [Limited to low shear]	Pass
Plastic Moment Capacity (kNm)		$M_{dzz} = \frac{\beta_b \times Z_p \times f_y}{\gamma_{mo} \times 10^6}$ $= \frac{1 \times 1560000.0 \times 250}{1.1 \times 10^6}$ $= 354.55$ [Ref. IS 800 : 2007, Cl. 8.2.1.2]	



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Check	Required	Provided	Remarks
Moment Deformation Criteria (kNm)		$M_{dc} = \frac{1.5 \times Z_e \times f_y}{1.1 \times 10^6}$ $= \frac{1.5 \times 1400000.0 \times 250}{1.1 \times 10^6}$ $= 477.27$ <p>[Ref. IS 800 : 2007, Cl. 8.2.1.2]</p>	
Moment Capacity Member (kNm)	$M_z = 50.0$	$M_{dzz} = \min(M_{dzz}, M_{dc})$ $= \min(354.55, 477.27)$ $= 354.55$ <p>[Ref. IS 800 : 2007, Cl. 8.2]</p>	

2.2 Load Consideration

Check	Required	Provided	Remarks
Interaction Ratio		$IR_{axial} = P_x / T_{dg}$ $= 480.0 / 2240.91$ $= 0.2142$ $IR_{moment} = M_z / M_{dzz}$ $= 50.0 / 354.55$ $= 0.141$ $IR_{sum} = IR_{axial} + IR_{moment}$ $= 0.2142 + 0.141$ $= 0.3552$	



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Check	Required	Provided	Remarks
Minimum Required Load	<p><i>if</i> $IR\ axial < 0.3$ and $IR\ moment < 0.5$</p> $P_{x\ min} = 0.3 \times T_{dg}$ $M_{z\ min} = 0.5 \times M_{dzz}$ <p><i>elif</i> $sum\ IR \leq 1.0$ and $IR\ moment < 0.5$</p> <p><i>if</i> $(0.5 - IR\ moment) < (1 - sum\ IR)$</p> $M_{z\ min} = 0.5 \times M_{dzz}$ <p><i>else</i></p> $M_{z\ min} = M_z + ((1 - sum\ IR) \times M_{dzz})$ $P_{x\ min} = P_x$ <p><i>elif</i> $sum\ IR \leq 1.0$ and $IR\ axial < 0.3$</p> <p><i>if</i> $(0.3 - IR\ axial) < (1 - sum\ IR)$</p> $P_{x\ min} = 0.3 \times T_{dg}$ <p><i>else</i></p> $P_{x\ min} = P_x + ((1 - sum\ IR) \times T_{dg})$ $M_{z\ min} = M_z$ <p><i>else</i></p> $P_{x\ min} = P_x$ $M_{z\ min} = M_z$ <p><i>Note : AL = User Applied Load</i></p>	$M_{z\ min} = 177.27$ $P_{x\ min} = 672.27$ <p>[Ref. IS 800 : 2007, Cl. 10.7]</p>	
Applied Axial Force (kN)	$P_x = 480.0$	$P_u = \max(P_x, P_{x\ min})$ $= \max(480.0, 672.27)$ $= 672.27$	



Company Name	IIT Bombay	Project Title	Sample Connection Design
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Designer	Engineer #1	Job Number	1.2.3.2.2
Date	18 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

Check	Required	Provided	Remarks
Applied Shear Force (kN)	$V_y = 30.0$	$V_{ymin} = \min(0.15 \times V_{dy}, 40.0)$ $= \min(0.15 \times 447.3, 40.0)$ $= 40.0$ $V_u = \max(V_y, V_{ymin})$ $= \max(30.0, 40.0)$ $= 40.0$ [Ref. IS 800 : 2007, Cl. 10.7]	
Applied Moment (kNm)	$M_z = 50.0$	$M_u = \max(M_z, M_{zmin})$ $= \max(50.0, 177.27)$ $= 177.27$ [Ref. IS 800 : 2007, Cl. 8.2.1.2]	
Force Carried by Web		$A_w = \text{Axial force in web}$ $= \frac{(D - 2T) t A_u}{A}$ $= \frac{(400.0 - 2 \times 12.7) \times 9.1 \times 672.27}{9860.0}$ $= 232.42 \text{ kN}$ $M_w = \text{Moment in web}$ $= \frac{Z_w \times M_u}{Z}$ $= \frac{319239.74 \times 177.27}{1560000.0}$ $= 36.28 \text{ kNm}$	



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Group/Team Name	Osdag	Subtitle	Column-Column Cover Plate Welded
Designer	Engineer #1	Job Number	1.2.3.2.2
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Check	Required	Provided	Remarks
Force Carried by Flange		$A_f = \text{Axial force in flange}$ $= \frac{A_u B T}{A}$ $= \frac{672.27 \times 250.0 \times 12.7}{9860.0}$ $= 216.48 \text{ kN}$ $M_f = \text{Moment in flange}$ $= M_u - M_w$ $= 177.27 - 36.28$ $= 141.0 \text{ kNm}$ $F_f = \text{flange force}$ $= \frac{M_f \times 10^3}{D - T} + A_f$ $= \frac{141.0 \times 10^3}{400.0 - 12.7} + 216.48$ $= 580.52 \text{ kN}$	

2.3 Flange Weld Design

Check	Required	Provided	Remarks
Min. Flange Plate Thickness (mm)	$T = 12.7$	$t_{fp} = 18.0$	Pass
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= 12 \text{ or } 12$ s_{min} based on thicker part $= 5$ [Ref IS 800 : 2007, Table 21 (Cl. 10.5.2.3)]	$t_w = 11$	Pass
Max. Weld Size (mm)	Thickness of thinner part $= \min(12.7, 18.0) = 12.7$ $s_{max} = 12.7$ [Ref. IS 800 : 2007, Cl. 10.5.3.1]	$t_w = 11$	Pass



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Group/Team Name	Osdag	Subtitle	Column-Column Cover Plate Welded
Designer	Engineer #1	Job Number	1.2.3.2.2
Date	18 /12 /2020	Client	Yogesh D Pisal, Aker Powergas, Mumbai

Check	Required	Provided	Remarks
Clearance (mm)	$sp = \max(15, (t_w + 5))$ $= \max(15, (11 + 5))$ $= 16$	$sp = 16$	Pass
Throat Thickness (mm)	$t_t \geq 3$ [Ref. IS 800 : 2007, Cl. 10.5.3.1]	$t_t = 0.7t_w$ $= 0.7 \times 11$ $= 7.7$ [Ref. IS 800 : 2007, Cl. 10.5.3.1]	Pass
Effective Length (mm)		$l_{eff} = (2 \times l_w) + B_{fp} - 2 \times t_w$ $= (2 \times 250) + 215 - 2 \times 11$ $= 695$	
Flange Weld Strength (N/mm)	$Stress = \frac{F_f \times 10^3}{l_{eff}}$ $= \frac{580.52 \times 10^3}{695}$ $= 834.09$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{7.7 \times 410}{\sqrt{3} \times 1.5}$ $= 1458.16$ [Ref. IS 800 : 2007, Cl. 10.5.7.1.1]	Pass
Weld Strength (post long joint) (N/mm)	$if\ l \geq 150t_t\ then\ V_{rd} = \beta_{lw} V_{db}$ $if\ l < 150t_t\ then\ V_{rd} = V_{db}$ where, $l = pt.length\ or\ pt.height$ $\beta_{lw} = 1.2 - \frac{(0.2l)}{(150t_t)}$ but $0.6 \leq \beta_{lw} \leq 1.0$ [Ref. IS 800 : 2007, Cl. 10.5.7.3]	$l = pt.length\ or\ pt.height$ $l_l = 2(250 + (2 \times 11)) + 5.0$ $= 549.0$ $l_h = 215$ $l = 549.0$ $150 \times t_t = 150 \times 7.7 = 1155.0$ since, $l < 150 \times t_t$ then $V_{rd} = V_{db}$ $V_{rd} = 1458.16$ [Ref. IS 800 : 2007, Cl. 10.5.7.3]	
Weld Strength (N/mm)	834.09	1458.16	Pass



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2.4 Flange Plate Dimension Check - Outside

Check	Required	Provided	Remarks
Min. Flange Plate Width (mm)	50	$B_{fp} = B - 2sp$ $= 250.0 - 2 \times 16$ $= 215$	Pass
Max. Flange Plate Width (mm)	$B_{fp} = B - 2sp$ $= 250.0 - 2 \times 16$ $= 215$	215	Pass
Min. Flange Plate Length (mm)	500.0	$L_{fp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (250 + 2 \times 11) + 5.0]$ $= 549.0$	Pass
Min. Flange Plate Thickness (mm)	$T = 12.7$	$t_{fp} = 18.0$	Pass
Plate Area Check (mm ²)	$pt.area \geq$ $connected\ member\ area \times 1.05$ $= 3333.75$ [Ref : Cl.8.6.3.2 IS 800 : 2007]	$pt.area = B_{fp} \times t_{ifp}$ $= 215 \times 18.0$ $= 3870.0$	Pass

2.5 Web Weld Design

Check	Required	Provided	Remarks
Min. Web Plate Thickness (mm)	$t = 4.55$	$t_{wp} = 14.0$	Pass
Min. Weld Size (mm)	t_{wmin} based on thinner part $= 9$ or 9 s_{min} based on thicker part = 5 [Ref IS 800 : 2007, Table 21 (Cl.10.5.2.3)]	$t_w = 7$	Pass
Max. Weld Size (mm)	$Thickness\ of\ thinner\ part$ $= \min(9.1, 14.0) = 9.1$ $s_{max} = 9.1$ [Ref. IS 800 : 2007, Cl. 10.5.3.1]	$t_w = 7$	Pass



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Designer	Engineer #1	Job Number	1.2.3.2.2
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Check	Required	Provided	Remarks
Effective Length (mm)		$l_{eff} = (2 \times l_w) + W_{wp} - 2 \times t_w$ $= (2 \times 125) + 315 - 2 \times 7$ $= 555$	
Clearance (mm)	$sp = \max(15, (t_w + 5))$ $= \max(15, (7 + 5))$ $= 15$	$sp = 15$	Pass
Throat Thickness (mm)	$t_t \geq 3$ [Ref. IS 800 : 2007, Cl. 10.5.3.1]	$t_t = 0.7t_w$ $= 0.7 \times 7$ $= 4.9$ [Ref. IS 800 : 2007, Cl. 10.5.3.1]	Pass
Moment Demand (kNm)		$M_d = (V_u \times ecc + M_w)$ $ecc = \text{eccentricity}$ $M_w = \text{external moment acting on web}$ $= \frac{(20.0 \times 10^3 \times 96.64 + 18.14 \times 10^6)}{10^6}$ $= 20.07$	



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Check	Required	Provided	Remarks
Web Weld Strength (N/mm)	$R_w = \sqrt{(T_{wh} + A_{wh})^2 + (T_{wv} + V_{wv})^2}$ $T_{wh} = \frac{M_d \times y_{max}}{I_{pw}}$ $= \frac{20071470.95 \times 28.36}{8794134.48}$ $T_{wv} = \frac{M_d \times x_{max}}{I_{pw}}$ $= \frac{20071470.95 \times 150.5}{8794134.48}$ $V_{wv} = \frac{V_u}{l_{eff}}$ $= \frac{20000.0}{555}$ $A_{wh} = \frac{A_u}{l_{eff}}$ $= \frac{116211.14}{555}$ $R_w = \sqrt{(64.73 + 209.39)^2 + (343.5 + 36.04)^2}$ $= 469.27$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{4.9 \times 410}{\sqrt{3} \times 1.5}$ $= 927.92$ <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)	$\text{if } l \geq 150t_t \text{ then } V_{rd} = \beta_{lw} V_{db}$ $\text{if } l < 150t_t \text{ then } V_{rd} = V_{db}$ <p>where,</p> $l = \text{pt.length or pt.height}$ $\beta_{lw} = 1.2 - \frac{(0.2l)}{(150t_t)}$ $\text{but } 0.6 \leq \beta_{lw} \leq 1.0$ <p>[Ref. IS 800 : 2007, Cl. 10.5.7.3]</p>	$l = \text{pt.length or pt.height}$ $l_l = 2(125 + (2 \times 7)) + 5.0$ $= 283.0$ $l_h = 315$ $l = 315$ $150 \times t_t = 150 \times 4.9 = 735.0$ <p>since, $l < 150 \times t_t$</p> <p>then $V_{rd} = V_{db}$</p> $V_{rd} = 927.92$ <p>[Ref. IS 800 : 2007, Cl. 10.5.7.3]</p>	
Weld Strength (N/mm)	469.27	927.92	Pass

2.6 Web Plate Dimension Check

Check	Required	Provided	Remarks
Min. Web Plate Height (mm)	$= 0.6 \times D$ $= 0.6 \times 400.0$ $= 240.0$ <p>[Ref : INSDAG – Chp 5, Sect.5.2.3]</p>	$W_{wp} = D - 2T - 2R1 - 2sp$ $= 400.0 - 2 \times 12.7 - (2 \times 14.0) - 2 \times 15$ $= 315$	Pass
Min. Web Plate Width (mm)	250.0	$L_{wp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (125 + 2 \times 7) + 5.0]$ $= 285$	Pass
Min. Web Plate Thickness (mm)	$t = 4.55$	$t_{wp} = 14.0$	Pass



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Check	Required	Provided	Remarks
Plate Area Check (mm ²)	$pt.area \geq$ $connected\ member\ area \times 1.05$ $= 3579.3$ [Ref : Cl.8.6.3.2 IS 800 : 2007]	$pt.area = 2 \times W_{wp} \times t_{wp}$ $= 2 \times 315 \times 14.0$ $= 8820.0$	Pass

2.7 Member Check

Check	Required	Provided	Remarks
Flange Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = l \times t = 250.0 \times 12.7$ $= \frac{3175.0 \times 250}{1.1 \times 10^3}$ $= 721.59$ [Ref. IS 800 : 2007, Cl. 6.2]	
Flange Tension Capacity (kN)	$F_f = 580.52$	$T_d = T_{dg}$ $= 721.59$ [Ref. IS 800 : 2007, Cl. 6.1]	Pass
Web Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = l \times t = 374.6 \times 9.1$ $= \frac{3408.86 \times 250}{1.1 \times 10^3}$ $= 774.74$ [Ref. IS 800 : 2007, Cl. 6.2]	



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Check	Required	Provided	Remarks
Web Block Shear Capacity (kN)		$T_{dbl1} = \frac{A_{vg}f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn}f_u}{\gamma_{m1}}$ $T_{dbl2} = \frac{0.9A_{vn}f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg}f_y}{\gamma_{m0}}$ $T_{db} = \min(T_{db1}, T_{db2}) = 1039.21$ <p>[Ref. IS 800 : 2007, Cl. 6.4]</p>	
Web Tension Capacity (kN)	$A_w = 232.42$	$T_d = \min(T_{dg}, T_{db})$ $= \min(774.74, 1039.21)$ $= 774.74$ <p>[Ref. IS 800 : 2007, Cl. 6.1]</p>	Pass

2.8 Flange Plate Capacity Check for Axial Load - Outside

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = l \times t = 215 \times 18.0$ $= \frac{3870.0 \times 250}{1.1 \times 10^3}$ $= 879.55$ <p>[Ref. IS 800 : 2007, Cl. 6.2]</p>	
Flange Plate Tension Capacity (kN)	$F_f = 580.52$	$T_d = T_{dg}$ $= 879.55$ <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)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = 2l \times t = 2 \times 315 \times 14.0$ $= \frac{4410.0 \times 250}{1.1 \times 10^3}$ $= 2004.55$ <p>[Ref. IS 800 : 2007, Cl. 6.2]</p>	
Web Plate Tension Capacity (kN)	$A_w = 232.42$	$T_d = T_{dg}$ $= 2004.55$ <p>[Ref. IS 800 : 2007, Cl. 6.1]</p>	Pass

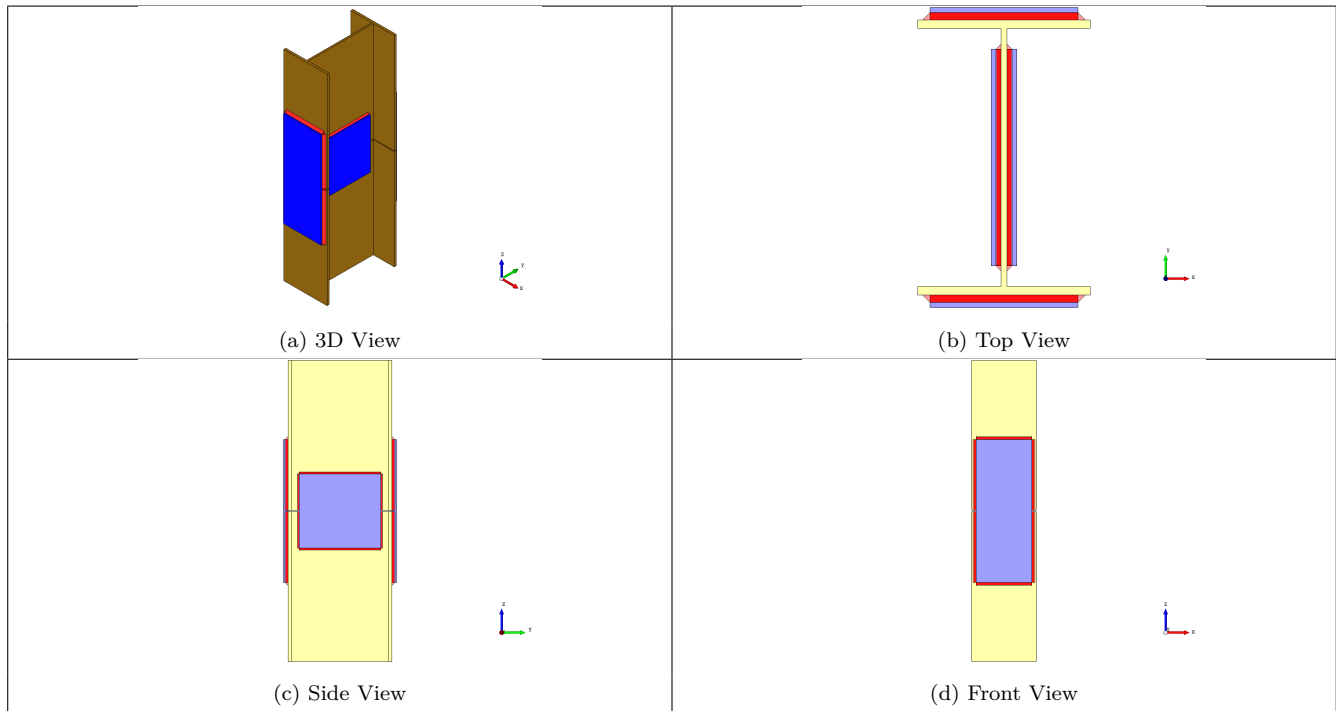
2.10 Web Plate Capacity Check for Shear Load

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{mo}}$ $= \frac{2 \times 315 \times 14.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 1157.32$ <p>[Ref. IS 800 : 2007, Cl. 10.4.3]</p>	
Allowable Shear Capacity (kN)	$V = 30.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 1157.32$ $= 694.39$ <p>[Limited to low shear]</p>	Pass
Web Plate Shear Capacity (kN)	$V_u = 40.0$	$V_d = S_c$ $= 694.39$ <p>[Ref. IS 800 : 2007, Cl. 6.1]</p>	Pass



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3 3D Views



4 Design Log

2020-12-18 01:22:58 - Osdag - WARNING - The defined factored load(s) are less than the minimum recommended value [Cl.10.7, IS 800:2007]

2020-12-18 01:22:58 - Osdag - INFO - The load values have been set as per the minimum recommendations of Cl.10.7, IS 800:2007

2020-12-18 01:22:58 - Osdag - INFO - : Overall Column Cover Plate Welded member design is SAFE