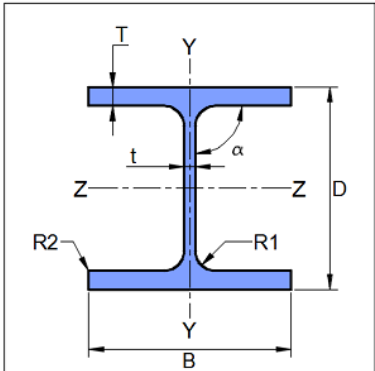




Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Column-Column Cover Plate Welded
Designer	Engineer #1	Job Number	1.2.3.2.1
Date	18 /12 /2020	Client	Pradyumna M, Independent Consultant, Bengaluru

## 1 Input Parameters

Module		Column Cover Plate - Welded		
Main Module		Moment Connection		
Bending Moment (kNm)		127.0		
Shear Force (kN)		0.0		
Axial Force (kN)		370.0		
Column Section - Mechanical Properties				
	Beam Section *		PBP 400 X 140.2	
	Material		E 300 (Fe 440)	
	Ultimate Strength, Fu (MPa)		440	
	Yield Strength, Fy (MPa)		300	
	Mass, m (kg/m)	140.2	Iz (cm4)	40200.0
	Area, A (cm2)	178.0	Iy(cm4)	16000.0
	D (mm)	352.0	rz (cm)	15.0
	B (mm)	392.0	ry (cm)	9.5
	t (mm)	16.0	Zz (cm3)	2280.0
	T (mm)	16	Zy (cm3)	820.0
	Flange Slope	90	Zpz (cm3)	2540.0
	R1 (mm)	15.0	Zpy (cm3)	1250.0
	R2 (mm)	0.0		
Weld Details - Input and Design Preference				
Weld Type		Fillet		
Type of Weld Fabrication		Field weld		
Material Grade Overwrite, Fu (MPa)		540.0		
Plate Details - Input and Design Preference				
Preference		Outside + Inside		
Ultimate Strength, Fu (MPa)		440		
Yield Strength, Fy (MPa)		300		
Material		E 300 (Fe 440)		
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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## 2 Design Checks

Design Status	Pass
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### 2.1 Member Capacity

Check	Required	Provided	Remarks
Section Classification		<i>Semi – Compact</i>  [Ref : Table 2, Cl.3.7.2 and 3.7.4 IS 800 : 2007]	
Axial Capacity Member (kN)	$P_x = 370.0$	$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $= \frac{17800.0 \times 300}{1.1 \times 10^3}$ $= 4854.55$ [Ref. IS 800 : 2007, Cl. 6.2]	
Shear Capacity Member (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{mo}}$ $= \frac{320.0 \times 16.0 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 806.19$ [Ref. IS 800 : 2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	$V_y = 0.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 806.19$ $= 483.71$ [Limited to low shear]	
Plastic Moment Capacity (kNm)		$M_{dzz} = \frac{\beta_b \times Z_p \times f_y}{\gamma_{mo} \times 10^6}$ $= \frac{0.9 \times 2540000.0 \times 300}{1.1 \times 10^6}$ $= 621.82$ [Ref. IS 800 : 2007, Cl. 8.2.1.2]	



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Check	Required	Provided	Remarks
Moment Deformation Criteria (kNm)		$M_{dc} = \frac{1.5 \times Z_e \times f_y}{1.1 \times 10^6}$ $= \frac{1.5 \times 2280000.0 \times 300}{1.1 \times 10^6}$ $= 932.73$ [Ref. IS 800 : 2007, Cl. 8.2.1.2]	
Moment Capacity Member (kNm)	$M_z = 127.0$	$M_{dzz} = \min(M_{dzz}, M_{dc})$ $= \min(621.82, 932.73)$ $= 621.82$ [Ref. IS 800 : 2007, Cl. 8.2]	

## 2.2 Load Consideration

Check	Required	Provided	Remarks
Interaction Ratio		$IR_{axial} = P_x / T_{dg}$ $= 370.0 / 4854.55$ $= 0.0762$ $IR_{moment} = M_z / M_{dzz}$ $= 127.0 / 621.82$ $= 0.2042$ $IR_{sum} = IR_{axial} + IR_{moment}$ $= 0.0762 + 0.2042$ $= 0.2804$	



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Check	Required	Provided	Remarks
Minimum Required Load	<p><i>if</i> <math>IR\ axial &lt; 0.3</math> and <math>IR\ moment &lt; 0.5</math></p> $P_{x\ min} = 0.3 \times T_{dg}$ $M_{z\ min} = 0.5 \times M_{dzz}$ <p><i>elif</i> <math>sum\ IR \leq 1.0</math> and <math>IR\ moment &lt; 0.5</math></p> <p><i>if</i> <math>(0.5 - IR\ moment) &lt; (1 - sum\ IR)</math></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> <math>sum\ IR \leq 1.0</math> and <math>IR\ axial &lt; 0.3</math></p> <p><i>if</i> <math>(0.3 - IR\ axial) &lt; (1 - sum\ IR)</math></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>	$M_{z\ min} = 310.91$ $P_{x\ min} = 1456.36$ <p>[Ref. IS 800 : 2007, Cl. 10.7]</p>	
Applied Axial Force (kN)	$P_x = 370.0$	$P_u = \max(P_x, P_{x\ min})$ $= \max(370.0, 1456.36)$ $= 1456.36$	



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Check	Required	Provided	Remarks
Applied Shear Force (kN)	$V_y = 0.0$	$V_{ymin} = \min(0.15 \times V_{dy}, 40.0)$ $= \min(0.15 \times 806.19, 40.0)$ $= 40.0$ $V_u = \max(V_y, V_{ymin})$ $= \max(0.0, 40.0)$ $= 40.0$ [Ref. IS 800 : 2007, Cl. 10.7]	
Applied Moment (kNm)	$M_z = 127.0$	$M_u = \max(M_z, M_{zmin})$ $= \max(127.0, 310.91)$ $= 310.91$ [Ref. IS 800 : 2007, Cl. 8.2.1.2]	
Force Carried by Web		$A_w = \text{Axial force in web}$ $= \frac{(D - 2T) t A_u}{A}$ $= \frac{(352.0 - 2 \times 16) \times 16.0 \times 1456.36}{17800.0}$ $= 418.91 \text{ kN}$ $M_w = \text{Moment in web}$ $= \frac{Z_w \times M_u}{Z}$ $= \frac{273066.67 \times 310.91}{2540000.0}$ $= 33.42 \text{ kNm}$	



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Designer	Engineer #1	Job Number	1.2.3.2.1
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Check	Required	Provided	Remarks
Force Carried by Flange		$A_f = \text{Axial force in flange}$ $= \frac{A_u B T}{A}$ $= \frac{1456.36 \times 392.0 \times 16}{17800.0}$ $= 513.16 \text{ kN}$ $M_f = \text{Moment in flange}$ $= Mu - M_w$ $= 310.91 - 33.42$ $= 277.48 \text{ kNm}$ $F_f = \text{flange force}$ $= \frac{M_f \times 10^3}{D - T} + A_f$ $= \frac{277.48 \times 10^3}{352.0 - 16} + 513.16$ $= 1339.01 \text{ kN}$	

## 2.3 Flange Weld Design

Check	Required	Provided	Remarks
Min. Flange Plate Thickness (mm)	$T = 8.0$	$t_{fp} = 12.0$	Pass
Min. Weld Size (mm)	$t_{w_{min}} \text{ based on thinner part}$ $= 12 \text{ or } 12$ $s_{min} \text{ based on thicker part} = 5$ $[Ref IS 800 : 2007, Table 21 (Cl. 10.5.2.3)]$	$t_w = 10$	Pass
Max. Weld Size (mm)	$\text{Thickness of thinner part}$ $= \min(16, 12.0) = 12.0$ $s_{max} = 12.0$ $[Ref. IS 800 : 2007, Cl. 10.5.3.1]$	$t_w = 10$	Pass



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Designer	Engineer #1	Job Number	1.2.3.2.1
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Check	Required	Provided	Remarks
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
EffLength. Outer+Inner flange		$l_{eff} = (6 \times l_w) + B_{fp} + (2 \times B_{ifp}) - 6 \times t_w$ $= (6 \times 395) + 360 + 2 \times 140 - 6 \times 10$ $= 2960$	
Flange Weld Strength (N/mm)	$Stress = \frac{F_f \times 10^3}{l_{eff}}$ $= \frac{1339.01 \times 10^3}{2960}$ $= 452.67$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{7.0 \times 440}{\sqrt{3} \times 1.5}$ $= 1422.59$  [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]	$l = pt.length\ or\ pt.height$  $l_t = 2(395 + (2 \times 10)) + 3.0$ $= 833.0$  $l_h = 360$  $l = 833.0$  $150 \times t_t = 150 \times 7.0 = 1050.0$ since, $l < 150 \times t_t$ then $V_{rd} = V_{db}$ $V_{rd} = 1422.59$  [Ref. IS 800 : 2007, Cl. 10.5.7.3]	
Weld Strength (N/mm)	452.67	1422.59	Pass



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## 2.4 Flange Plate Dimension Check - Outside/Inside

Check	Required	Provided	Remarks
Min. Flange Plate Width (mm)	50	$B_{fp} = B - 2sp$ $= 392.0 - 2 \times 15$ $= 360$	Pass
Max. Flange Plate Width (mm)	$B_{fp} = B - 2sp$ $= 392.0 - 2 \times 15$ $= 360$	360	Pass
Min. Flange Plate Length (mm)	784.0	$L_{fp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (395 + 2 \times 10) + 3.0]$ $= 833.0$	Pass
Min. Inner Plate Width (mm)	$\geq 50$	140	Pass
Max. Inner Plate Width (mm)	$B_{ifp} = \frac{B - 4sp - t - 2R1}{2}$ $= \frac{392.0 - 4 \times 15 - 16.0 - 2 \times 15.0}{2}$ $= 140$	140	Pass
Min. Inner Plate Length (mm)	784.0	$L_{fp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (395 + 2 \times 10) + 3.0]$ $= 833.0$	Pass
Min. Flange Plate Thickness (mm)	$T = 8.0$	$t_{fp} = 12.0$	Pass
Plate Area Check (mm <sup>2</sup> )	$pt.area \geq$ $connected\ member\ area \times 1.05$ $= 6585.6$  $[Ref : Cl.8.6.3.2 IS 800 : 2007]$	$pt.area = (B_{fp} + (2 \times B_{ifp})) \times t_{ifp}$ $= (360 + (2 \times 140)) \times 12.0$ $= 7680.0$	Pass





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## 2.5 Web Weld Design

Check	Required	Provided	Remarks
Min. Web Plate Thickness (mm)	$t = 8.0$	$t_{wp} = 14.0$	Pass
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= 14 \text{ or } 14$ $s_{min}$ based on thicker part $= 5$  [Ref IS 800 : 2007, Table 21 (Cl10.5.2.3)]	$t_w = 12$	Pass
Max. Weld Size (mm)	Thickness of thinner part $= \min(16.0, 14.0) = 14.0$ $s_{max} = 14.0$  [Ref. IS 800 : 2007, Cl. 10.5.3.1]	$t_w = 12$	Pass
Effective Length (mm)		$l_{eff} = (2 \times l_w) + W_{wp} - 2 \times t_w$ $= (2 \times 195) + 255 - 2 \times 12$ $= 625$	
Clearance (mm)	$sp = \max(15, (t_w + 5))$ $= \max(15, (12 + 5))$ $= 17$	$sp = 17$	Pass
Throat Thickness (mm)	$t_t \geq 3$  [Ref. IS 800 : 2007, Cl. 10.5.3.1]	$t_t = 0.7t_w$ $= 0.7 \times 12$ $= 8.4$  [Ref. IS 800 : 2007, Cl. 10.5.3.1]	Pass
Moment Demand (kNm)		$M_d = (V_u \times ecc + M_w)$  $ecc = \text{eccentricity}$ $M_w = \text{external moment acting on web}$  $= \frac{(20.0 \times 10^3 \times 133.77 + 16.71 \times 10^6)}{10^6}$ $= 19.39$	



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Check	Required	Provided	Remarks
Web Weld Strength (N/mm)	$R_w = \sqrt{(T_{wh} + A_{wh})^2 + (T_{wv} + V_{wv})^2}$ $T_{wh} = \frac{M_d \times y_{max}}{I_{pw}}$ $= \frac{19387746.2 \times 61.23}{8844804.36}$ $T_{wv} = \frac{M_d \times x_{max}}{I_{pw}}$ $= \frac{19387746.2 \times 115.5}{8844804.36}$ $V_{wv} = \frac{V_u}{l_{eff}}$ $= \frac{20000.0}{625}$ $A_{wh} = \frac{A_u}{l_{eff}}$ $= \frac{209454.55}{625}$ $R_w = \sqrt{(134.22 + 335.13)^2 + (253.18 + 32.0)^2}$ $= 551.14$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{8.4 \times 440}{\sqrt{3} \times 1.5}$ $= 1707.11$ <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> $l = \text{pt.length or pt.height}$ $\beta_{lw} = 1.2 - \frac{(0.2l)}{(150t_t)}$ <p>but <math>0.6 \leq \beta_{lw} \leq 1.0</math></p> <p>[Ref. IS 800 : 2007, Cl. 10.5.7.3]</p>	$l = \text{pt.length or pt.height}$ $l_l = 2(195 + (2 \times 12)) + 3.0$ $= 441.0$ $l_h = 255$ $l = 441.0$ $150 \times t_t = 150 \times 8.4 = 1260.0$ <p>since, <math>l &lt; 150 \times t_t</math></p> <p>then <math>V_{rd} = V_{db}</math></p> $V_{rd} = 1707.11$ <p>[Ref. IS 800 : 2007, Cl. 10.5.7.3]</p>	
Weld Strength (N/mm)	551.14	1707.11	Pass

## 2.6 Web Plate Dimension Check

Check	Required	Provided	Remarks
Min. Web Plate Height (mm)	$= 0.6 \times D$ $= 0.6 \times 352.0$ $= 211.2$ <p>[Ref : INSDAG – Chp 5, Sect.5.2.3]</p>	$W_{wp} = D - 2T - 2R1 - 2sp$ $= 352.0 - 2 \times 16 - (2 \times 15.0) - 2 \times 17$ $= 255$	Pass
Min. Web Plate Width (mm)	392.0	$L_{wp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (195 + 2 \times 12) + 3.0]$ $= 445$	Pass
Min. Web Plate Thickness (mm)	$t = 8.0$	$t_{wp} = 14.0$	Pass



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Check	Required	Provided	Remarks
Plate Area Check (mm <sup>2</sup> )	$pt.area \geq$ $connected\ member\ area \times 1.05$ $= 5376.0$  [Ref : Cl.8.6.3.2 IS 800 : 2007]	$pt.area = 2 \times W_{wp} \times t_{wp}$ $= 2 \times 255 \times 14.0$ $= 7140.0$	Pass

## 2.7 Member Check

Check	Required	Provided	Remarks
Flange Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$  $A_g = l \times t = 392.0 \times 16$ $= \frac{6272.0 \times 300}{1.1 \times 10^3}$ $= 1710.55$  [Ref. IS 800 : 2007, Cl. 6.2]	
Flange Tension Capacity (kN)	$F_f = 1339.01$	$T_d = T_{dg}$ $= 1710.55$  [Ref. IS 800 : 2007, Cl. 6.1]	Pass
Web Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$  $A_g = l \times t = 320.0 \times 16.0$ $= \frac{5120.0 \times 300}{1.1 \times 10^3}$ $= 1396.36$  [Ref. IS 800 : 2007, Cl. 6.2]	



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Check	Required	Provided	Remarks
Web Block Shear Capacity (kN)		$T_{dbl1} = \frac{A_{vg}f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn}f_u}{\gamma_{m1}}$ $T_{dbl2} = \frac{0.9A_{vn}f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg}f_y}{\gamma_{m0}}$ $T_{db} = \min(T_{db1}, T_{db2}) = 2254.05$ <p>[Ref. IS 800 : 2007, Cl. 6.4]</p>	
Web Tension Capacity (kN)	$A_w = 418.91$	$T_d = \min(T_{dg}, T_{db})$ $= \min(1396.36, 2254.05)$ $= 1396.36$ <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)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = l \times t = 640 \times 12.0$ $= \frac{7680.0 \times 300}{1.1 \times 10^3}$ $= 2094.55$ <p>[Ref. IS 800 : 2007, Cl. 6.2]</p>	
Flange Plate Tension Capacity (kN)	$F_f = 1339.01$	$T_d = T_{dg}$ $= 2094.55$ <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)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = 2l \times t = 2 \times 255 \times 14.0$ $= \frac{3570.0 \times 300}{1.1 \times 10^3}$ $= 1947.27$ <p>[Ref. IS 800 : 2007, Cl. 6.2]</p>	
Web Plate Tension Capacity (kN)	$A_w = 418.91$	$T_d = T_{dg}$ $= 1947.27$ <p>[Ref. IS 800 : 2007, Cl. 6.1]</p>	Pass

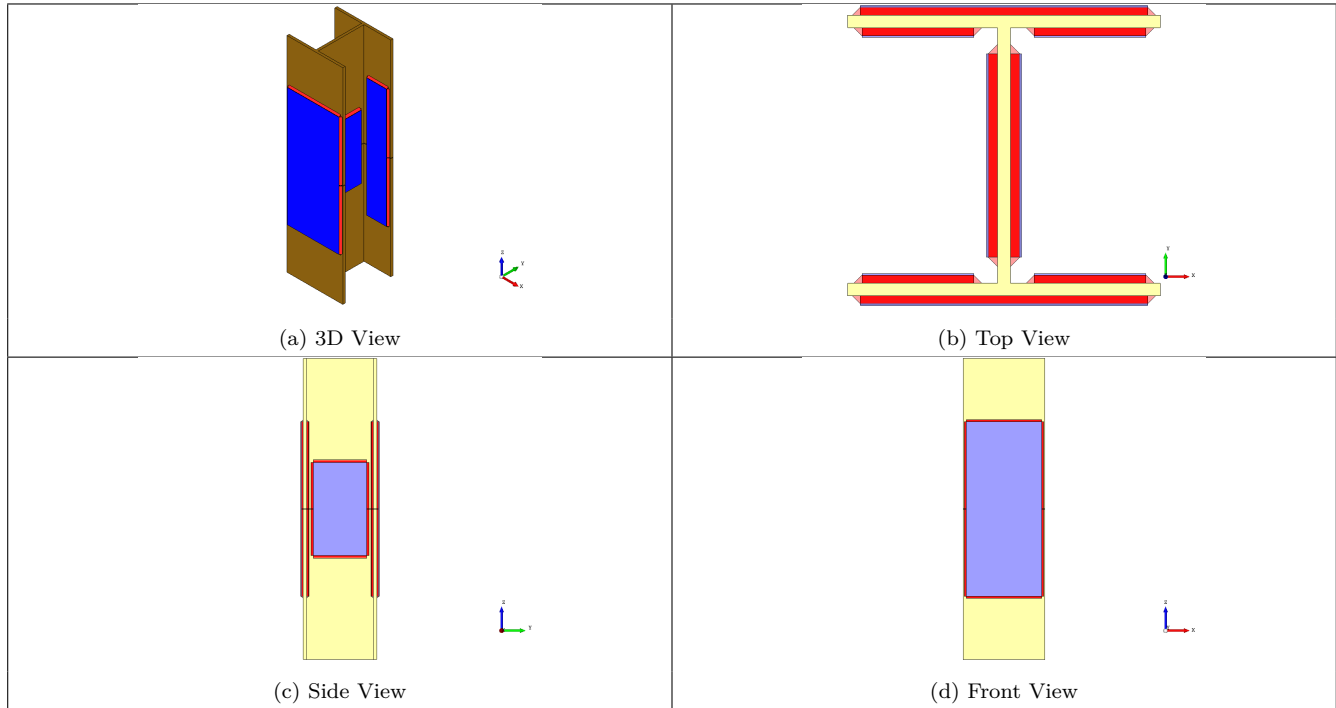
## 2.10 Web Plate Capacity Check for Shear Load

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{mo}}$ $= \frac{2 \times 255 \times 14.0 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 1124.26$ <p>[Ref. IS 800 : 2007, Cl. 10.4.3]</p>	
Allowable Shear Capacity (kN)	$V = 0.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 1124.26$ $= 674.56$ <p>[Limited to low shear]</p>	
Web Plate Shear Capacity (kN)	$V_u = 40.0$	$V_d = S_c$ $= 674.56$ <p>[Ref. IS 800 : 2007, Cl. 6.1]</p>	Pass



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### 3 3D Views



### 4 Design Log

2020-12-18 01:22:05 - Osdag - WARNING - The defined factored load(s) are less than the minimum recommended value [Cl.10.7, IS 800:2007]

2020-12-18 01:22:05 - Osdag - INFO - The load values have been set as per the minimum recommendations of Cl.10.7, IS 800:2007

2020-12-18 01:22:05 - Osdag - INFO - : Overall Column Cover Plate Welded member design is SAFE