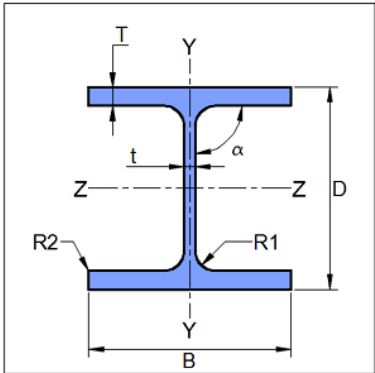




Company Name	IIT Bombay	Project Title	Moment Connection
Group/Team Name	Osdag	Subtitle	Column-to-Column Cover Plate (bolted)
Designer	Engineer#1	Job Number	1.2.3.1.2
Date	04 /02 /2021	Client	Dr. Pradyumna M, Bengaluru

1 Input Parameters

Module		Column-to-Column Cover Plate Bolted Connection		
Main Module		Moment Connection		
Bending Moment (kNm)		60.0		
Shear Force (kN)		40.0		
Axial Force (kN)		520.0		
Column Section - Mechanical Properties				
	Beam Section *		PBP 400 X 176.1	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		290	
	Mass, m (kg/m)	176.1	I_z (cm ⁴)	51700.0
	Area, A (cm ²)	224.0	I_y (cm ⁴)	20700.0
	D (mm)	360.0	r_z (cm)	15.2
	B (mm)	396.0	r_y (cm)	9.6
	t (mm)	20.0	Z_z (cm ³)	2870.0
	T (mm)	20	Z_y (cm ³)	1040.0
	Flange Slope	90	Z_{pz} (cm ³)	3230.0
	R_1 (mm)	15.0	Z_{py} (cm ³)	1600.0
	R_2 (mm)	0.0		
Bolt Details - Input and Design Preference				
Diameter (mm)		[24]		
Property Class		[8.8]		
Type		Friction Grip Bolt		
Bolt Tension		Pre-tensioned		
Hole Type		Standard		
Slip Factor, (μ_f)		0.52		
Detailing - Design Preference				
Edge Preparation Method		Rolled, machine-flame cut, sawn and planed		
Gap Between Columns (mm)		0.0		
Are the Members Exposed to Corrosive Influences?		True		
Plate Details - Input and Design Preference				
Preference		Outside		



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Material	E 300 (Fe 440)
Ultimate Strength, F_u (MPa)	440
Yield Strength, F_y (MPa)	290
Thickness (mm)	[16]



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2 Design Checks

Design Status	Fail
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2.1 Member Capacity

Check	Required	Provided	Remarks
Section Classification		Semi-Compact [Ref: Table 2, Cl.3.7.2 and 3.7.4, IS 800:2007]	
Axial Capacity Member (kN)	$P_x = 520.0$	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $= \frac{22400.0 \times 290}{1.1 \times 10^3}$ $= 5905.45$ [Ref. IS 800:2007, Cl.6.2]	
Shear Capacity Member (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{320.0 \times 20.0 \times 290}{\sqrt{3} \times 1.1 \times 1000}$ $= 974.15$ [Ref. IS 800:2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	$V_y = 40.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 974.15$ $= 584.49$ [Limited to low shear]	Pass
Plastic Moment Capacity (kNm)		$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{0.89 \times 3230000.0 \times 290}{1.1 \times 10^6}$ $= 756.64$ [Ref. IS 800:2007, Cl.8.2.1.2]	



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Check	Required	Provided	Remarks
Moment Deformation Criteria (kNm)		$M_{dc} = \frac{1.5Z_e f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.5 \times 2870000.0 \times 290}{1.1 \times 10^6}$ $= 1134.95$ [Ref. IS 800:2007, Cl.8.2.1.2]	
Moment Capacity Member (kNm)	$M_z = 60.0$	$M_{dz} = \min(M_{dz}, M_{dc})$ $= \min(756.64, 1134.95)$ $= 756.64$ [Ref. IS 800:2007, Cl.8.2]	

2.2 Load Consideration

Check	Required	Provided	Remarks
Interaction Ratio		<p>I.R. axial $= P_x / T_{dg}$ $= 520.0 / 5905.45$ $= 0.0881$</p> <p>I.R. moment $= M_z / M_{dz}$ $= 60.0 / 756.64$ $= 0.0793$</p> <p>I.R. sum $= \text{I.R. axial} + \text{I.R. moment}$ $= 0.0881 + 0.0793$ $= 0.1674$</p>	



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Check	Required	Provided	Remarks
Minimum Required Load	<p>if I.R. axial < 0.3 and I.R. moment < 0.5</p> $P_{x\min} = 0.3T_{dg}$ $M_{z\min} = 0.5M_{dz}$ <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> $M_{z\min} = 0.5 \times M_{dz}$ <p>else</p> $M_{z\min} = M_z + ((1 - \text{sum I.R.}) \times M_{dz})$ $P_{x\min} = P_x$ <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> $P_{x\min} = 0.3T_{dg}$ <p>else</p> $P_{x\min} = P_x + ((1 - \text{sum I.R.}) \times T_{dg})$ $M_{z\min} = M_z$ <p>else</p> $P_{x\min} = P_x$ $M_{z\min} = M_z$ <p>Note: AL is the user input for load</p>	$M_{z\min} = 378.32$ $P_{x\min} = 1771.64$ <p>[Ref. IS 800:2007, Cl.10.7]</p>	
Applied Axial Force (kN)	$P_x = 520.0$	$P_u = \max(P_x, P_{x\min})$ $= \max(520.0, 1771.64)$ $= 1771.64$	



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Check	Required	Provided	Remarks
Applied Shear Force (kN)	$V_y = 40.0$	$V_{y\min} = \min(0.15V_{dy}, 40.0)$ $= \min(0.15 \times 974.15, 40.0)$ $= 40.0$ $V_u = \max(V_y, V_{y\min})$ $= \max(40.0, 40.0)$ $= 40.0$ [Ref. IS 800:2007, Cl.10.7]	
Applied Moment (kNm)	$M_z = 60.0$	$M_u = \max(M_z, M_{z\min})$ $= \max(60.0, 378.32)$ $= 378.32$ [Ref. IS 800:2007, Cl.8.2.1.2]	
Force Carried by Web		$A_w = \text{Axial force in web}$ $= \frac{(D - 2T)tA_u}{A}$ $= \frac{(360.0 - 2 \times 20) \times 20.0 \times 1771.64}{22400.0}$ $= 506.18 \text{ kN}$ $M_w = \text{Moment in web}$ $= \frac{Z_w M_u}{Z}$ $= \frac{341333.33 \times 378.32}{3230000.0}$ $= 39.98 \text{ kNm}$	



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Check	Required	Provided	Remarks
Force Carried by Flange		$A_f = \text{Axial force in flange}$ $= \frac{AuBT}{A}$ $= \frac{1771.64 \times 396.0 \times 20}{22400.0}$ $= 626.4 \text{ kN}$ $M_f = \text{Moment in flange}$ $= Mu - M_w$ $= 378.32 - 39.98$ $= 338.34 \text{ kNm}$ $F_f = \text{flange force}$ $= \frac{M_f \times 10^3}{D - T} + A_f$ $= \frac{338.34 \times 10^3}{360.0 - 20} + 626.4$ $= 1621.51 \text{ kN}$	

2.3 Initial Member Check

Check	Required	Provided	Remarks
Flange Tension Yielding Capacity (kN)	$F_f = 1621.51$	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 396.0 \times 20$ $= \frac{7920.0 \times 290}{1.1 \times 10^3}$ $= 2088.0$ [Ref. IS 800:2007, Cl.6.2]	Pass



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Check	Required	Provided	Remarks
Web Tension Yielding Capacity (kN)	$A_w = 506.18$	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 320.0 \times 20.0$ $= \frac{6400.0 \times 290}{1.1 \times 10^3}$ $= 1687$ <p>[Ref. IS 800:2007, Cl.6.2]</p>	Pass

2.4 Initial Flange Plate Height Check

Check	Required	Provided	Remarks
Width (mm)	$B_{fp} \geq 50$	$B_{fp} = 396.0$	Pass

2.5 Flange Plate Thickness

Check	Required	Provided	Remarks
Thickness (mm)	$T = 20$	$t_{fp} = 20.0$	Fail

2.6 Initial Web Plate Height Check

Check	Required	Provided	Remarks
Height (mm)	$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (360.0 - 2 \times 20 - 2 \times 15.0)$ $= 216.0$ <p>[Ref. INSDAG, Ch.5, sec.5.2.3]</p>	$W_{wp} = D - (2 \times T) - (2 \times R1)$ $= 360.0 - (2 \times 20) - (2 \times 15.0)$ $= 290.0$	Pass



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2.7 Web Plate Thickness

Check	Required	Provided	Remarks
Thickness (mm)	$t = 10.0$	$t_{wp} = 16.0$	Pass
Plate Area Check (mm ²)	plate area \geq 1.05 X connected member area = 6720.0 [Ref: Cl.8.6.3.2, IS 800:2007]	$pt.area = t_{wp} \times 2 \times W_{wp}$ $= 16.0 \times 2 \times 216.0$ $= 6912.0$	Pass

3 Design Log

2021-02-04 14:49:49 - Osdag - WARNING - The defined factored load(s) are less than the minimum recommended value [Cl.10.7, IS 800:2007]

2021-02-04 14:49:49 - Osdag - INFO - The load values have been set as per the minimum recommendations of Cl.10.7, IS 800:2007

2021-02-04 14:49:49 - Osdag - WARNING - : Area of the Flange Plate is less than the area of the flange

2021-02-04 14:49:49 - Osdag - INFO - : Area of the Flange Plate should be greater than 1.05 times the area of the flange, 8316.0 mm²

2021-02-04 14:49:49 - Osdag - INFO - : Increase the thickness of the Flange Plate

2021-02-04 14:49:49 - Osdag - ERROR - : Design is UNSAFE

2021-02-04 14:49:49 - Osdag - INFO - : =====End of Design=====