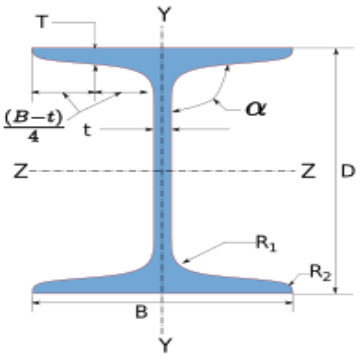
Company Name	IIT Bombay	Project Title	Sample Connection Design
Group/Team Name	Osdag	Subtitle	Beam-Column End Plate
Designer	Engineer #1	Job Number	1.2.2.1.1.2.2
Date	18 /12 /2020	Client	Harshavardhan Subbarao, Construma Consultancy, Mumbai

1 Input Parameters

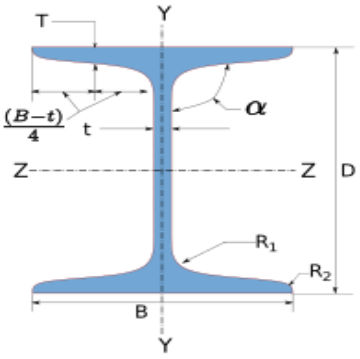
Main Module	Moment Connection
Module	Beam-Column End Plate
Connectivity	Column Flange-Beam Web
End Plate Type	Extended One Way - Irreversible Moment
Bending Moment (kNm)	100.0
Shear Force (kN)	55.0
Axial Force (kN)	12.0

Column Section - Mechanical Properties



Column Section		PBP 300 X 124.2	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (MPa)		250	
Mass, m (kg/m)	124.2	I_z (cm^4)	26900.0
Area, A (cm^2)	158.0	I_y(cm^4)	8850.0
D (mm)	312.0	r_z (cm)	13.0
B (mm)	313.0	r_y (cm)	7.48
t (mm)	17.3	Z_z (cm^3)	1720.0
T (mm)	17.3	Z_y (cm^3)	565.0
Flange Slope	90	Z_{pz} (cm^3)	1950.0
R_1 (mm)	15.0	Z_{py} (cm^3)	870.0
R_2 (mm)	0.0		

Beam Section - Mechanical Properties



Beam Section		LB 450	
Material		E 250 (Fe 410 W)A	
Ultimate Strength, Fu (MPa)		410	
Yield Strength, Fy (MPa)		250	
Mass, m (kg/m)	65.22	I_z (cm^4)	27500.0
Area, A (cm^2)	83.1	I_y(cm^4)	853.0
D (mm)	450.0	r_z (cm)	18.2
B (mm)	170.0	r_y (cm)	3.2
t (mm)	8.6	Z_z (cm^3)	1220.0
T (mm)	13.4	Z_y (cm^3)	100.0
Flange Slope	98	Z_{pz} (cm^3)	1400.0

	R_1 (mm)	16.0	Z_{py} (cm^3)	174.0
	R_2 (mm)	8.0		

Plate Details - Input and Design Preference	
Thickness (mm)	[16]
Material	E 250 (Fe 410 W)A
Ultimate Strength, Fu (MPa)	410
Yield Strength, Fy (MPa)	250
Bolt Details - Input and Design Preference	
Diameter (mm)	[24]
Property Class	[10.9]
Type	Bearing Bolt
Bolt Tension	Non pre-tensioned
Hole Type	Standard
Slip Factor, (mu_f)	0.3
Weld Details - Input and Design Preference	
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, f_u (MPa)	410.0
Beam Flange to End Plate	Groove Weld
Beam Web to End Plate	Fillet Weld
Stiffener	Fillet Weld
Continuity Plate	Fillet Weld
Detailing - Design Preference	
Edge Preparation Method	Rolled, machine-flame cut, sawn and planed
Gap Between Members (mm)	0.0
Are the Members Exposed to Corrosive Influences?	False

2 Design Checks

Design Status	Fail

2.1 Beam to Column - Compatibility Check

Check	Required	Provided	Remarks
Beam Section Compatibility	$B_{req} = B_b + 25$ $= 170.0 + 25$ $= 195.0$	$B_{available} = B_c$ $= 313.0$	**Compatible**

2.2 Member Capacity - Supported Section

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{0.6 \times 423.2 \times 8.6 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 286.54$ $[Ref. IS\ 800 : 2007, Cl. 10.4.3]$	**Restricted to low shear**
Plastic Moment Capacity (kNm)		$M_{dz-z} = \frac{\beta_b Z_{pz} fy}{\gamma_{mo}}$ $= \frac{1.0 \times 1400000.0 \times 250}{1.1 \times 10^6}$ $= 318.18$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 8.2.1.2]$	**V < 0.6 Vdy**

2.3 Member Capacity - Supporting Section

Check	Required	Provided	Remarks

Check	Required	Provided	Remarks
Plastic Moment Capacity (kNm)		$M_{dz-z} = \frac{\beta_b Z_{pz} fy}{\gamma_{mo}}$ $= \frac{0.88 \times 1950000.0 \times 250}{1.1 \times 10^6}$ $= 390.91$ *Note : The capacity of the section is not based on the beam – colum or column design. The actual capacity might vary.* [*Ref. IS* 800 : 2007, *Cl.* 8.2.1.2]	**Semi-compact**
Plastic Moment Capacity (kNm)		$M_{dy-y} = \frac{\beta_b Z_{py} fy}{\gamma_{mo}}$ $= \frac{0.65 \times 870000.0 \times 250}{1.1 \times 10^6}$ $= 128.41$ *Note : The capacity of the section is not based on the beam – colum or column design. The actual capacity might vary.* [*Ref. IS* 800 : 2007, *Cl.* 8.2.1.2]	**Semi-compact**

2.4 Load Consideration

Check	Required	Provided	Remarks
Shear Force (kN)	$V_y = 55.0$	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 286.54,\ 40.0)$ $= min(42.98,\ 40.0)$ $= 40.0$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(55.0,\ 40.0)$ $= 55.0$ [*Ref. IS* 800 : 2007, *Cl.* 10.7]	**OK**

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Check	Required	Provided	Remarks
Axial Force (kN)		P_x = 12.0	**OK**
Bending Moment (major axis) (kNm)	$M_z = 100.0$	$M_{zmin} = 0.5 * M_{dz-z}$ $= 0.5 \times 318.18$ $= 159.09$ $M_u = max(M_z,\ M_{zmin})$ $but,\ \leq M_{dz-z}\ of\ the\ column\ section$ $= max(100.0, 159.09)$ ≤ 390.91 $= 159.09$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	**OK**
Effective Bending Moment (major axis) (kNm)		$M_{ue} = M_u\ +\ P_x \times \left(\frac{D}{2} - \frac{T}{2}\right) \times 10^{-3}$ $= 159.09 +$ $12.0 \times \left(\frac{450.0}{2} - \frac{13.4}{2}\right) \times 10^{-3}$ $= 161.71$	**OK**

2.5 Column Web Shear Check

Check	Required	Provided	Remarks
Web Stiffener Plate Required ?	$t_{wc} = \frac{1.9 M_{ue}}{D_c\ D_b\ f_{yc}}$ $= \frac{1.9 \times 161.71}{312.0 \times 450.0 \times 250.0}$ $= 8.75$	$t_c = 17.3$	**No**

3 Design Log

2020-12-18 00:14:16 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].
2020-12-18 00:14:16 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (100.0 kNm) is less than 0.5 times the plastic moment capacity of the beam (318.18 kNm)
2020-12-18 00:14:16 - Osdag - INFO - The minimum factored bending moment should be at least 0.5 times the plastic moment capacity of the beam to qualify the connection as rigid connection (Annex. F-4.3.1, IS 800:2007)
2020-12-18 00:14:16 - Osdag - INFO - The value of load(s) is/are set at minimum recommended value as per Cl.10.7 and Annex. F, IS 800:2007
2020-12-18 00:14:16 - Osdag - INFO - Designing the connection for a factored moment of 159.09 kNm
2020-12-18 00:14:16 - Osdag - WARNING - [End Plate] The end plate of 16.0 mm is thinner than the thickest of the elements being connected
2020-12-18 00:14:16 - Osdag - INFO - Selecting a plate of higher thickness which is at least 17 mm thick
2020-12-18 00:14:16 - Osdag - ERROR - [End Plate] The list of plate thicknesses passed into the solver is insufficient to perform end plate design
2020-12-18 00:14:16 - Osdag - WARNING - The end plate should at least be thicker than the maximum thickness of the connecting element(s)
2020-12-18 00:14:16 - Osdag - INFO - Provide a plate/list of plates with a minimum thickness of 17.3 mm
2020-12-18 00:14:16 - Osdag - INFO - [Bolt Design] Bolt diameter and grade combination ready to perform bolt design
2020-12-18 00:14:16 - Osdag - INFO - The solver has selected 1.0 combinations of bolt diameter and grade to perform optimum bolt design in an iterative manner
2020-12-18 00:14:16 - Osdag - INFO - Checking the design with the following bolt diameter-grade combination [(24.0, 10.9)]
2020-12-18 00:14:16 - Osdag - WARNING - [Column Web] The web of the column is not susceptible to shear bucking due to the reaction transferred by the beam to the column
2020-12-18 00:14:16 - Osdag - INFO - The minimum required thickness of the web i.e. 8.75 mm is satisfied
2020-12-18 00:14:16 - Osdag - INFO - Additional stiffening of the column web is not required
2020-12-18 00:14:16 - Osdag - INFO - [Optimisation] Performing the design by optimising the plate thickness, using the thin plate and large (suitable) bolt diameter approach
2020-12-18 00:14:16 - Osdag - INFO - If you wish to optimise the bolt diameter-grade combination, pass a higher value of plate thickness using the Input Dock