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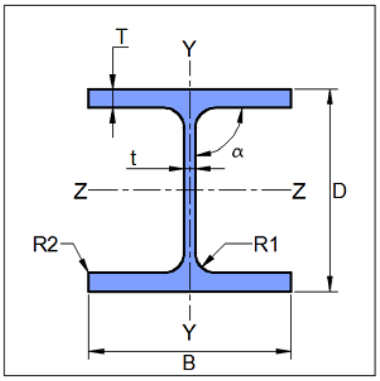
1 Input Parameters

Main Module	Moment Connection
Module	Base Plate Connection
Connectivity *	Moment Base Plate
End Condition	Fixed
Axial Compression (kN) *	21.0
Axial Tension/Uplift (kN)	34.0
Shear Force (kN) *	
- Along major axis (z-z)	34.0
- Along minor axis (y-y)	43.0
Bending Moment (kNm) *	
- Major axis (M_{z-z})	43.0
- Minor axis (M_{y-y})	34.0

Column Section - Mechanical Properties



Column Section		UC 356 x 406 x 551	
Material *		$Cus_4 00_5 00_6 00_1 400$	
Ultimate Strength, F_u (MPa)		1400.0	
Yield Strength, F_y (MPa)		600.0	
Mass, m (kg/m)	551.0	I_z (cm^4)	226938.0
Area, A (cm^2)	701.9	I_y(cm^4)	82668.0
None	None	r_z (cm)	18.0
D (mm)	455.6	r_y (cm)	10.9
B (mm)	418.5	Z_z (cm^3)	9962.0
T (mm)	67.5	Z_y (cm^3)	3951.0
t (mm)	42.1	Z_{pz} (cm^3)	12076.0
Flange Slope	90	Z_{py} (cm^3)	6058.0
R_1 (mm)	15.2		
R_2 (mm)	0.0		

Base Plate - Design Preference

Material	Cus_400_500_600_1400
Ultimate Strength, F_u (MPa)	1400
Yield Strength, F_y (MPa)	600

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Stiffener/Shear Key - Design Preference	
Material	Cus_400_500_600_1400
Anchor Bolt Outside Column Flange - Input and Design Preference	
Diameter (mm)	['M20', 'M24', 'M30', 'M36', 'M42', 'M48', 'M56', 'M64', 'M72']
Property Class	['3.6', '4.6', '4.8', '5.6', '5.8', '6.8', '8.8', '9.8', '10.9', '12.9']
Anchor Bolt Type	End Plate Type
Anchor Bolt Galvanized?	Yes
Designation	M20X0 IS5624 GALV
Hole Type	Over-sized
Total Length (mm)	1172.67
Material Grade, F_u (MPa)	1220.0
Anchor Bolt Inside Column Flange - Input and Design Prefereself.anchor_grade_list_outnce	
Diameter (mm)	['M20', 'M24', 'M30', 'M36', 'M42', 'M48', 'M56', 'M64', 'M72']
Property Class	['3.6', '4.6', '4.8', '5.6', '5.8', '6.8', '8.8', '9.8', '10.9', '12.9']
Anchor Bolt Type	End Plate Type
Anchor Bolt Galvanized?	Yes
Designation	M20X0 IS5624 GALV
Hole Type	Over-sized
Total Length (mm)	515.17
Material Grade, F_u (MPa)	330.0
Friction Coefficient (between concrete and anchor bolt)	0.3
Weld - Design Preference	
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, F_u (MPa)	1400.0
Detailing - Design Preference	
Edge Preparation Method	a - Sheared or hand flame cut
Are the Members Exposed to Corrosive Influences?	Yes
Design - Design Preference	
Design Method	Limit State Design

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Base Plate Analysis	Elastic Analysis Method

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2 Design Checks

Design Status	Fail

2.1 Design Parameters

Check	Required	Provided	Remarks
Bearing Strength of Concrete (N/mm^2)		$\sigma_{br} = 0.45 f_{ck}$ $= 0.45 \times 50$ $= 22.5$ [Ref. IS 456:2000, Cl.34.4]	OK
Grout Thickness (mm)		$t_g = 50$	OK
Modular Ratio		$E_s = 2 \times 10^5$ (N/mm^2) $E_c = 5000 \sqrt{f_{ck}}$ (N/mm^2) $= 5000 \times \sqrt{50} = 35355.339$ $n = \frac{E_s}{E_c}$ $n = \frac{200000}{35355.339}$ $= 5.657$ [Ref. IS 800:2007, IS 456:2000]	OK
Epsilon - stiffener plate		$\epsilon_{st} = \sqrt{\frac{250}{f_{y_{st}}}}$ $= \sqrt{\frac{250}{400}}$ $= 0.79$ [Ref. IS 800:2007, Table2]	OK

2.2 Load Consideration

Check	Required	Provided	Remarks
Axial Compression (kN) *	$P_x = 21.0$	$P_u = \max(P_x,\ 0.3P_d),\ \text{but},\ \leq P_d$ $= \max(21.0,\ 0.3 \times 38285.45)$ $= \max(21.0,\ 11485.63)$ ≤ 38285.45 $= 11485.64$ [Ref. IS 800:2007, Cl.10.7] Note: P_d is the design axial capacity of the column	**Pass**
Axial Tension/Uplift (kN)		$P_{up} = 34.0$	**OK**
Shear Force - along major (z-z) axis (kN)	$V_d = 2550.32$	$V_1 = 34.0$	**Pass**
Shear Force - along minor (y-y) axis (kN)	$V_d = 2550.32$	$V_2 = 43.0$	**Pass**
Bending Moment - major (z-z) axis (kNm)	$M_z = 43.0$	$M_{z\min} = 0.5 * M_{dz}$ $= 0.5 \times 6586.91$ $= 3293.45$ $M_{uz} = \max(M_z,\ M_{z\min}),\ \text{but}, \leq M_{dz}$ $= \max(43.0,\ 3293.45)$ ≤ 6586.91 $= 3293.45$ Note: The column is classified as compact. [Ref. IS 800:2007, Cl.8.2.1.2]	**Pass**
Bending Moment - minor (y-y) axis (kNm)	$M = 34.0$	$M_y = 34.0$	**Pass**

Check	Required	Provided	Remarks
Interaction Ratio	I.R. < 1.0	I.R. axial $= P_x/P_d$ $= 21.0/38285.45$ $= 0.001$ I.R. moment $= M_z/M_{dz}$ $= 43.0/6586.91$ $= 0.007$ I.R. sum $=$ I.R. axial + I.R. moment $= 0.001 + 0.007$ $= 0.008$	Pass

2.3 Plate Washer and Nut Details - Anchor Bolt Outside Column Flange

Check	Required	Provided	Remarks
Plate Washer Size (mm)		Square $-$ 100X100 [Ref. IS 6649:1985, Table 2]	Pass
Plate Washer Thickness (mm)		$t_w = 12.0$ [Ref. IS 6649:1985, Table 2]	Pass
Plate Washer Hole Diameter (mm)		$d_h = 59$ [Ref. IS 6649:1985, Table 2]	Pass
Nut (hexagon) Thickness (mm)		$t_n = 45.0$ [Ref. IS 1364-3:2002, Table 1]	Pass
End Plate Size (mm)		Square - 200 X 200	Pass
End Plate Thickness (mm)		18	Pass

2.4 Plate Washer and Nut Details - Anchor Bolt Inside Column Flange

Check	Required	Provided	Remarks
Plate Washer Size (mm)		Square – $45X45$ [Ref. IS 6649:1985, Table 2]	Pass
Plate Washer Thickness (mm)		$t_w = 8.5$ [Ref. IS 6649:1985, Table 2]	Pass
Plate Washer Hole Diameter (mm)		$d_h = 22$ [Ref. IS 6649:1985, Table 2]	Pass
Nut (hexagon) Thickness (mm)		$t_n = 18.0$ [Ref. IS 1364-3:2002, Table 1]	Pass
End Plate Size (mm)		Square - 90 X 90	Pass
End Plate Thickness (mm)		14	Pass

2.5 Anchor Bolt Summary - Outside Column Flange

Check	Required	Provided	Remarks
Diameter (mm)		56	Pass
Number of Bolts		$n_{\text{out}} = 8$	Pass
Property Class		12.9	Pass

2.6 Anchor Bolt Summary - Inside Column Flange

Check	Required	Provided	Remarks
Diameter (mm)		20	Pass
Number of Bolts		$n_{\text{in}} = 4$	Pass
Property Class		3.6	Pass

2.7 Detailing Checks - Outside Column Flange

Check	Required	Provided	Remarks
Min. End Distance (mm)	$e_{min} = 1.5d_0$ $= 1.5 \times 24.0$ $= 36.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	145	**Pass**
Max. End Distance (mm)	$e_{max} = 40 + 4t$ Where, $t = \min(180.67, 180.67)$ $= 40 + (4 \times 180)$ $e_{max} = 760.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	145	**Pass**
Min. Edge Distance (mm)	$e'_{min} = 1.5d_0$ $= 1.5 \times 24.0$ $= 36.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	145	**Pass**
Max. Edge Distance (mm)	$e'_{max} = 40 + 4t$ Where, $t = \min(180.67, 180.67)$ $= 40 + (4 \times 180)$ $e'_{max} = 760.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	145	**Pass**
Min. Pitch Distance (mm)	$p_{min} = 2.5d$ $= 2.5 \times 56$ $= 140.0$ [Ref. IS 800:2007, Cl.10.2.2]	210	**Pass**

Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p_{max} = \min(32t,\ 300)$ $= \min(32 \times 180.67,\ 300)$ $= \min(5781.44,\ 300)$ $= 300$ Where, $t = \min(180.67, 180.67)$ [Ref. IS 800:2007, Cl.10.2.3]	210	**Pass**

2.8 Detailing Checks - Inside Column Flange

Check	Required	Provided	Remarks
Min. End Distance (mm)	$e_{min} = 1.5d_0$ $= 1.5 \times 24.0$ $= 36.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	45	**Pass**
Max. End Distance (mm)	$e_{max} = 40 + 4t$ Where, $t = \min(180.67, 180.67)$ $= 40 + (4 \times 180)$ $e_{max} = 760.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	45	**Pass**
Min. Edge Distance (mm)	$e'_{min} = 1.5d_0$ $= 1.5 \times 24.0$ $= 36.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	45	**Pass**

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{max} = 40 + 4t$ Where, $t = \min(180.67, 180.67)$ $= 40 + (4 \times 180)$ $e'_{max} = 760.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	45	**Pass**

2.9 Base Plate Dimension (L X W)

Check	Required	Provided	Remarks
Length (mm)	$L = D + 2(e + e) + 2p$ $= 455.6 + 2 \times (145 + 145) + 2 \times 210$ $= 1455.6$ [Ref. based on detailing requirement]	1460	**Pass**
Width (mm)	$W = (0.85B) + 2(e' + e')$ $= (0.85 \times 418.5) + 2 \times (145 + 145)$ $= 935.72$ [Ref. based on detailing requirement]	940	**Pass**

2.10 Base Plate Analysis

Check	Required	Provided	Remarks
Eccentricity - about major axis (mm)		$e_{zz} = \frac{M_{uz}}{P_u}$ $= \frac{3293.45 \times 10^6}{11485.64 \times 10^3}$ $= 286.75$	**OK**

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Check	Required	Provided	Remarks
Base Plate Type	$\frac{L_{min}}{6} < e_{zz} < \frac{L_{min}}{3}$ $\frac{1455.6}{6} < 286.75 < \frac{1455.6}{3}$ $242.6 < 286.75 < 485.2$	Case 2: The base plate is mostly under compression/bearing while a small tension force being transferred through the anchor bolts outside column flange on the tension side	OK
k1	$k_1 = 3\left(e_{zz} - \frac{L}{2}\right)$ $= 3\left(286.75 - \frac{1460}{2}\right)$ $= -1329.75$ [Ref. Design of Welded Structures, Omer W Blodgett, section 3.3.]		OK
Total Area of Anchor Bolt - under tension (mm^2)	$A_s = n \times \left(\frac{\pi}{4}\right) d^2$ $= 4 \times \left(\frac{\pi}{4}\right) \times 56^2$ $= 9852.0$		OK
Lever Arm - distance between the centre of the column and the C.G of the bolt group under tension (mm)	$f = \left(\frac{L}{2} - e\right)$ $= \left(\frac{1460}{2} - 145\right)$ $= 585.0$ [Ref. Design of Welded Structures, Omer W Blodgett, section 3.3]		OK
k2	$k_2 = \frac{6\ n\ A_s}{W}\left(f + e_{zz}\right)$ $= \frac{6 \times 5.657 \times 9852.0}{940} \times \left(585.0 + 286.75\right)$ $= 310117.26$ Note: n is the modular ratio. [Ref. Design of Welded Structures, Omer W Blodgett, section 3.3]		OK

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Check	Required	Provided	Remarks
k3	$k_3 = -\ k_2\ \left(\frac{L}{2}\ +\ f\right)$ $= -\ 310117.26\ \left(\frac{1460}{2}\ +\ 585.0\right)$ $= -407804196.9$ [Ref. Design of Welded Structures, Omer W Blodgett, section 3.3]		OK
Effective Bearing Length (mm)	$y^3\ +\ k_1\ y^2\ +\ k_2\ y\ +\ k_3 = 0$ $y^3\ -1329.75 \times y^2\ +310117.26 \times y\ -407804196.9 = 0$ $y = 1328$ [Ref. Design of Welded Structures, Omer W Blodgett, section 3.3]		OK
Total Tension Demand (kN)	$P_t = -\ P_u\ \left[\frac{\frac{L}{2} - \frac{y}{3} - e_{zz}}{\frac{L}{2} - \frac{y}{3} + f}\right]$ $= -\ 11485.64 \times\ \left[\frac{\frac{1460}{2} - \frac{1328}{3} - 286.75}{\frac{1460}{2} - \frac{1328}{3} + 585.0}\right]$ $= 7.68$ [Ref. Design of Welded Structures, Omer W Blodgett, section 3.3]		OK
Critical Section - compression side (mm)	$y_{\text{critical}} = \frac{L - 0.95D}{2}$ $= \frac{1460 - (0.95 \times 455.6)}{2}$ $= 513.59$ $y\ >\ y_{\text{critical}}\quad (1328\ >\ 513.59)$ Therefore, $y_{\text{critical}} = 513.59$ Note: The critical section lies at $0.95D$ of the column section.		OK

Check	Required	Provided	Remarks
Bending Moment - at critical section (due to bearing stress) $(N-mm)$	$M_{\text{critical}1} = 0.45 f_{ck} W y_{\text{critical}} \times \left(\frac{y_{\text{critical}}}{2}\right)$ $= 0.45 \times 50.0 \times 940 \times 513.59 \times \left(\frac{513.59}{2}\right)$ $= 2789.42 \times 10^6$		OK
Lever Arm - distance between center of the flange and bolt group (tension side) (mm)	$l = \frac{L}{2} - \frac{D}{2} + \frac{T}{2} - e$ $= \frac{1460}{2} - \frac{455.6}{2} + \frac{67.5}{2} - 145$ $= 390.95$		OK
Bending Moment - at critical section (due to tension in the anchor bolts) $(N-mm)$	$M_{\text{critical}2} = P_t \; l$ $= 7.68 \times 1000 \times 390.95$ $= 3.0 \times 10^6$		OK
Maximum Bending Moment $(N-mm)$	$M_{\text{critical}} = \max\left(M_{\text{critical}1},\; M_{\text{critical}2}\right)$ $= \max\left(2789.42 \times 10^6,\; 3.0 \times 10^6\right)$ $= 2789.42 \times 10^6$	Bending of the base plate is governed by the bearing stress caused by the footing	OK
Moment Capacity of Base Plate	$z_{e\,\text{plate}} = \frac{W {t_p}^2}{6}$ $M_{d\,\text{plate}} = 1.5 z_{e\,\text{plate}} f_{y_p} \;/\; \gamma_{m0}$ $= \frac{1.5\left(\frac{W \times t_p^2}{6}\right) f_{y_p}}{\gamma_{m0}}$ [Ref. IS 800:2007, Cl.8.2.1.2]		OK
Thickness of Base Plate (mm)	$(T,\; t) < t_p \leq 120$ $(67.5,\; 42.1) < t_p \leq 120$	$M_{d\,\text{plate}} = M_{\text{critical}}$ $t_p = \left[\frac{4\; M_{\text{critical}}}{W\; (f_{y_p}/\gamma_{m0})}\right]^{0.5}$ $t_p = \left[\frac{4\; \times 2789.42 \times 10^6}{940 \times\; (400/1.1)}\right]^{0.5}$ $= 180.67$ $= 180.67$	Fail

Check	Required	Provided	Remarks
Maximum Bearing Stress on Footing (N/mm^2)	$\sigma_{c_{allowable}} = \sigma_{br}$ $= 22.5$	$\sigma_{c_{max}} = \frac{P_t\ y}{A_s\ n\ \left(\frac{L}{2} - y + f\right)}$ $= \frac{7.68 \times 10^3 \times 1328}{9852.0 \times 5.657 \times \left\lvert\left(\frac{1460}{2} - 1328 + 585.0\right)\right\rvert}$ $= 14.08$	Pass

2.11 Anchor Bolt Design - Outside Column Flange

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}}$ $= \frac{1220.0 \times 1 \times 1921}{1000 \times \sqrt{3}\ \times\ 1.25}$ $= 1082.47$ [Ref. IS 800:2007, Cl.10.3.3]	OK
Kb		$k_b = \min\left(\frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0\right)$ $= \min\left(\frac{145}{3 \times 24.0}, \frac{210}{3 \times 24.0} - 0.25, \frac{1220.0}{1400.0}, 1.0\right)$ $= \min(2.01, 2.67, 0.87, 1.0)$ $= 0.87$ [Ref. IS 800:2007, Cl.10.3.4]	OK

Check	Required	Provided	Remarks
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.87 \times 56 \times 180.67 \times 1400}{1000 \times 1.25}$ $= 21530.09$ $= 0.7 \times 21530.09$ $= 15071.06$ Note: The bearing capacity is reduced since the hole type is Over-sized or Short-slotted. [Ref. IS 800:2007, Cl.10.3.4]	**OK**
Bolt Capacity (kN)		$V_{\text{db}} = \min\ (V_{\text{dsb}},\ V_{\text{dpb}})$ $= \min\ (1082.47,\ 15071.06)$ $= 1082.47$ [Ref. IS 800:2007, Cl.10.3.2]	**OK**
Tension Demand - per anchor bolt (kN)	$T_{\text{b}} = \frac{P_t}{n_{\text{out}}/2}$ $= \frac{7.68}{8/2}$ $= \frac{7.68}{4}$ $= 1.92$	$T_{\text{db}} = 0.90 f_{ub} A_n\ /\ \gamma_{mb}$ $<\ f_{yb} A_{sb} (\gamma_{mb}\ /\ \gamma_{m0})$ $= \min\Big(0.90 \times 1220.0 \times 1921\ /\ 1.25,$ $1100.0 \times 2463 \times (1.25/1.1)\Big)$ $= \min(1687.41,\ 3078.75)$ $= 1687.41$ [Ref. IS 800:2007, Cl.10.3.5]	**Pass**
Anchor Length - above concrete footing (mm)		$l_1 = t_g + t_p + t_w + t_n + 20$ $= 50 + 180.67 + 12.0 + 45.0 + 20$ $= 307.66999999999996$	**Pass**

Check	Required	Provided	Remarks
Anchor Length - below concrete footing (mm)		$l_2 = \left[\frac{T_{db}}{15.5\sqrt{f_{ck}}}\right]^{0.67}$ $= \left[\frac{1687.41 \times 10^3}{15.5 \times \sqrt{50.0}}\right]^{0.67}$ $= 639.09$ $= 640$ $= \max(640,\ 800)$ $= 800$ $= 800 + t_n + 20$ $= 800 + 45.0 + 20$ $= 865.0$ [Reference: Design of Steel Structures by N.Subramanian, (2019 edition).]	**Pass**
Anchor Length - total (mm)	$800 \leq\ l_a\ \leq 3200$ [Reference: IS 5624:1993, Table 1]	$l_a = l_1\ +\ l_2$ $= 307.66999999999996\ +\ 865.0$ $= 1172.67$	**Pass**

2.12 Anchor Bolt Design - Inside Column Flange

Check	Required	Provided	Remarks
Shear Capacity (kN)	The bolts are not designed to carry shear force	N/A	**N/A**
Bearing Capacity (kN)	The bolts are not designed to carry shear force	N/A	**N/A**
Bolt Capacity (kN)	N/A	N/A	**N/A**
Tension Demand (kN)	$P_{\text{uplift}} = 34.0$		**OK**

Check	Required	Provided	Remarks
Tension Capacity (kN)		$T_{\text{db}} = 0.90 f_{ub} A_n \ / \ \gamma_{mb}$ $< \ f_{yb} A_{sb} (\gamma_{mb} \ / \ \gamma_{m0})$ $= \min\left(0.90 \times 330.0 \times 245 \ / \ 1.25,\right.$ $\left. 190.0 \times 314 \times (1.25/1.1)\right)$ $= \min(58.21,\ 67.8)$ $= 54.24$ [Ref. IS 800:2007, Cl.10.3.5]	**OK**
Anchor Bolts Required (kN)	$n_{in} = \frac{P_{\text{uplift}}}{T_{\text{db}}}$ $= \frac{34.0}{54.24}$ $= 0.63$	4	**Pass**
Anchor Length - above concrete footing (mm)		$l_1 = t_g + t_p + t_w + t_n + 20$ $= 50 + 180.67 + 8.5 + 18.0 + 20$ $= 277.16999999999996$	**Pass**
Anchor Length - below concrete footing (mm)		$l_2 = \left[\frac{T_{\text{db}}}{15.5\sqrt{f_{ck}}}\right]^{0.67}$ $= \left[\frac{54.24 \times 10^3}{15.5 \times \sqrt{50.0}}\right]^{0.67}$ $= 200$ $= 200$ $= \max(200,\ 200)$ $= 200$ $= 200 + t_n + 20$ $= 200 + 18.0 + 20$ $= 238.0$ [Reference: Design of Steel Structures by N.Subramanian, (2019 edition).]	**Pass**

Check	Required	Provided	Remarks
Anchor Length - total (mm)	$200 \leq\ l_a\ \leq 800$ [Reference: IS 5624:1993, Table 1]	$l_a = l_1\ +\ l_2$ $= 277.16999999999996\ +\ 238.0$ $= 515.17$	**Pass**

2.13 Stiffener Design - Along Column Flange

Check	Required	Provided	Remarks
Length of Stiffener (mm)		$L_{stf} = \frac{W - B}{2}$ $= \frac{940 - 418.5}{2}$ $= 260.75$ [Ref. based on detailing requirement]	**OK**
Height of Stiffener (mm)		$H_{stf} = L_{stf}\ +\ 50$ $= 260.75\ +\ 50$ $= 310.75$	**OK**
Thickness of Stiffener (mm)	$t_{stf} = \left(\frac{L_{stf}}{13.6 \times \epsilon_{st}}\right) \geq T$ $= \max\left(\left(\frac{260.75}{13.6 \times 0.79}\right),\ 67.5\right)$ $= \max(12.13, 67.5)$ Note: The stiffener is assumed as semi-compact. [Ref. IS 800:2007, Table 2]	75	**Pass**
Stress (average) at Stiffener (N/mm^2)	$= \sigma_{callowable}$ $= 22.5$	Since, $y > y_{critical}\quad (1328 > 513.59)$ $\sigma_{stf} = \frac{\sigma_{cmax}}{2}$ $= \frac{14.08}{2}$ $= 7.04$	**Pass**

Check	Required	Provided	Remarks
Shear on Stiffener (kN)	$V_{\mathrm{stf}} = \sigma_{\mathrm{stf}} \left(y \times L_{\mathrm{stf}}\right)$ $= 7.04 \times \left(1328 \times 260.75\right) \times 10^{-3}$ $= 2437.783$	$V_{\mathrm{df}} = \frac{A_{\mathrm{vg}} f_{y_{\mathrm{st}}}}{\sqrt{3}\gamma_{m0}}$ $= \frac{(H_{\mathrm{st}_f} \times t_{\mathrm{stf}}) f_{y_{\mathrm{st}}}}{\sqrt{3}\gamma_{m0}}$ $= \frac{(310.75 \times 75) \times 400}{\sqrt{3} \times 1.1 \times 10^3}$ $= 7339.565$ Note: Stiffener is not restricted to low shear. [Ref. IS 800:2007 (Cl.8.4.1)]	**Pass**
Section Modulus of the Stiffener (mm^3)		$z_{\mathrm{e_{st}}} = 1207.07 \times 10^3$	**OK**
Moment on Stiffener (kNm)	$M_{\mathrm{stf}} = \sigma_{\mathrm{stf}} \left(y \times \frac{{L_{\mathrm{stf}}}^2}{2}\right)$ $= 7.04 \times \left(1328 \times \frac{260.75^2}{2}\right) \times 10^{-6}$ $= 317.826$	$M_{\mathrm{df}} = \frac{\beta_b z_{\mathrm{e_{st}}} f_{y_{\mathrm{st}}}}{\gamma_{m0}}$ $= \frac{1 \times z_{\mathrm{e_{st}}} f_{y_{\mathrm{st}}}}{\gamma_{m0}} \quad (\beta_b = 1)$ $= \frac{1 \times \ 1207.07 \times 10^3 \times 400}{1.1 \times 10^6}$ $= 658.402$ [Ref. IS 800:2007 (Cl.8.2.1.2)]	**Pass**
Weld Size (mm)	10	12	**Pass**

2.14 Stiffener Design - Along Column Web

Check	Required	Provided	Remarks
Length of Stiffener (mm)		$L_{\mathrm{st_w}} = \frac{L - D}{2}$ $= \frac{1460 - 455.6}{2}$ $= 502.2$ [Ref. based on detailing requirement.]	**OK**
Height of Stiffener (mm)		$H_{\mathrm{st_w}} = L_{\mathrm{st_w}} + 50$ $= 502.2 + 50$ $= 552.2$	**OK**

Company Name		Project Title	Base plate connection
Group/Team Name		Subtitle	
Designer		Job Number	
Date	21 /01 /2025	Client	

Check	Required	Provided	Remarks
Thickness of Stiffener (mm)	$t_{\mathrm{stw}} = \left(\frac{L_{\mathrm{stw}} \ / \ 2}{13.6 \times \epsilon_{\mathrm{st}}}\right) \geq t$ $= \left(\frac{502.2 \ / \ 2}{13.6 \times 0.79}\right) \geq 42.1$ $= \max(23.37, 42.1)$ [Ref. IS 800:2007, Table 2.]	45	**Pass**
Stress (average) at Stiffener (mm)	$= \sigma_{\mathrm{callowable}}$ $= 22.5$	$\sigma_{\mathrm{stw}} = \frac{\sigma_{\mathrm{cmax}} + \sigma_{\mathrm{crt}}}{2}$ $= \frac{14.08 + 8.63}{2}$ $= 11.36$	**Pass**
Shear on Stiffener (kN)	$V_{\mathrm{stw}} = \sigma_{\mathrm{stw}}\left(B \ L_{\mathrm{stw}}\right)$ $= 11.36 \times \left(418.5 \times 502.2\right) \times 10^{-3}$ $= 2387.539$	$V_{\mathrm{dw}} = \frac{A_{\mathrm{vg}} f_{y_{\mathrm{st}}}}{\sqrt{3}\gamma_{m0}}$ $= \frac{(H_{\mathrm{st}_w} \times t_{\mathrm{stw}}) f_{y_{\mathrm{st}}}}{\sqrt{3}\gamma_{m0}}$ $= \frac{(552.2 \times 45) \times 400}{\sqrt{3} \times 1.1 \times 10^3}$ $= 7825.406$ Note: Stiffener is not restricted to low shear. [Ref. IS 800:2007 (Cl.8.4.1)]	**Pass**
Section Modulus of the Stiffener (mm^3)		$z_{\mathrm{est}} = 2286.94 \times 10^3$	**OK**
Moment on Stiffener (kNm)	$M_{\mathrm{stw}} = \left(\sigma_{\mathrm{crt}} \times B \times \frac{{L_{\mathrm{stw}}}^2}{2}\right) +$ $\left(\left(\sigma_{\mathrm{cmax}} - \sigma_{\mathrm{crt}}\right) \times B \times \frac{{L_{\mathrm{stw}}}^2}{3}\right)$ $= \left[\left(8.63 \times 418.5 \times \frac{502.2^2}{2}\right) +\right.$ $\left.\left(\left(14.08 - 8.63\right) \times 418.5 \times \frac{502.2^2}{3}\right)\right] \times 10^{-6}$ $= 647.183$	$M_{\mathrm{dw}} = \frac{\beta_b z_{\mathrm{est}} f_{y_{\mathrm{st}}}}{\gamma_{m0}}$ $= \frac{1 \times z_{\mathrm{est}} f_{y_{\mathrm{st}}}}{\gamma_{m0}} \quad (\beta_b = 1)$ $= \frac{1 \times \ 2286.94 \times 10^3 \times 400}{1.1 \times 10^6}$ $= 1247.42$ [Ref. IS 800:2007 (Cl.8.2.1.2)]	**Pass**
Weld Size (mm)	10	12	**Pass**

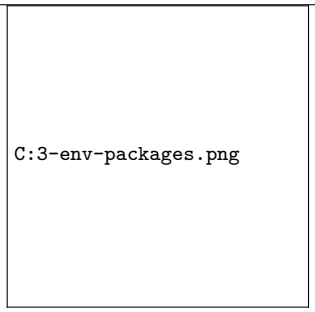
2.15 Stiffener Design - Across Column Web

Check	Required	Provided	Remarks
Length of Stiffener (mm)		$L_{\mathrm{staw}} = \max\ (L_{\mathrm{stf}},\ L_{\mathrm{stw}})$ $\leq \frac{W - t}{2}$ $= \max\ (260.75,\ 502.2)$ $= 448.95$	**Pass**
Height of Stiffener (mm)		$H_{\mathrm{staw}} = L_{\mathrm{staw}}\ +\ 50$ $= 448.95\ +\ 50$ $= 498.95$	**Pass**
Thickness of Stiffener (mm)	$t_{\mathrm{st}aw} = \left(\frac{L_{\mathrm{staw}}}{13.6 \times \epsilon_{\mathrm{st}}}\right) \geq t$ $= \max\left(\left(\frac{448.95}{13.6 \times 0.79}\right),\ 42.1\right)$ $= \max(20.89, 42.1)$ [Ref. IS 800:2007, Table 2.]	45	**Pass**
Weld Size (mm)	10	12	**Pass**

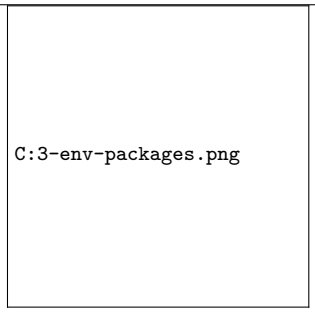
2.16 Shear Design

Check	Required	Provided	Remarks
Shear Resistance (kN)		$V_r = P_u \times \mu$ $= 11485.64 \times 0.45$ $= 5168.54$	**OK**
Shear Key Requirement - along column depth	$V_1 = 34.0\ \ kN$	$V_1 \leq V_r$ $34.0 \leq 5168.54$	**Shear key not required**
Shear Key Requirement - along column width	$V_2 = 43.0\ \ kN$	$V_2 \leq V_r$ $43.0 \leq 5168.54$	**Shear key not required**

3 3D Views



(a) 3D View



(b) Top View

(c) Side View

(d) Front View

4 Design Log

2025-01-21 20:28:17 - Osdag - WARNING - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].
2025-01-21 20:28:17 - Osdag - WARNING - [Minimum Factored Load] The external factored bending moment (43.0 kNm) is less than 0.5 times the plastic moment capacity of the column (3293.45 kNm)
2025-01-21 20:28:17 - 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
2025-01-21 20:28:17 - Osdag - INFO - The value of load(s) is/are set at minimum recommended value as per Cl.10.7
2025-01-21 20:28:17 - Osdag - INFO - Designing the connection for a factored moment of 3293.45 kNm
2025-01-21 20:28:17 - Osdag - WARNING - [Minimum Moment] The external factored bending moment (acting along the minor (y-y) axis) is less than the minimum recommended design action effect [Reference: clause 10.7, IS 800:2007]
2025-01-21 20:28:17 - Osdag - INFO - The minimum recommended design action effect for factored bending moment is 0.5 times the capacity of the column (i.e. 0.5 X 3304.36, kNm)
2025-01-21 20:28:17 - Osdag - INFO - The value of factored bending moment (M y-y) is set to 1652.18 kNm
2025-01-21 20:28:17 - Osdag - INFO - [Base Plate Type] The value of eccentricity about the major axis is 286 mm
2025-01-21 20:28:17 - Osdag - INFO - Eccentricity is greater than 225.2 (L/3) mm

2025-01-21 20:28:17 - Osdag - INFO - Case 3: A smaller part of the base plate is under pure compression/bearing with a large tension/uplift force being transferred through the anchor bolts outside column flange on the tension side
2025-01-21 20:28:17 - Osdag - WARNING - [Concrete Bearing Check] The compressive stress on the concrete footing/pedestal (22.597 N/mm2) is greater than the allowable bearing strength of the concrete (22.5 N/mm2)
2025-01-21 20:28:17 - Osdag - INFO - The check fails with 4 numbers of anchors
2025-01-21 20:28:17 - Osdag - INFO - Re-designing the connection with more or higher diameter anchor bolts to reduce the bearing stress
2025-01-21 20:28:17 - Osdag - WARNING - [Concrete Bearing Check] The compressive stress on the concrete footing/pedestal (23.033 N/mm2) is greater than the allowable bearing strength of the concrete (22.5 N/mm2)
2025-01-21 20:28:17 - Osdag - INFO - The check fails with 6 numbers of anchors
2025-01-21 20:28:17 - Osdag - INFO - Re-designing the connection with more or higher diameter anchor bolts to reduce the bearing stress
2025-01-21 20:28:17 - Osdag - INFO - [Base Plate Type] The value of eccentricity about the major axis is 286 mm
2025-01-21 20:28:17 - Osdag - INFO - Eccentricity is greater than 242.6 (L/6) mm but less than 485.2 (L/3) mm
2025-01-21 20:28:17 - Osdag - INFO - Case 2: A larger part of the base plate is under compression/bearing with a small to moderate tension/uplift force being transferred through the anchor bolts outside column flange on the tension side
2025-01-21 20:28:17 - Osdag - INFO - [Minor Axis Moment] The value of eccentricity about the minor axis is 142 mm
2025-01-21 20:28:17 - Osdag - INFO - Eccentricity is less than 156.67 mm (W/6)
2025-01-21 20:28:17 - Osdag - INFO - Case 1: The base plate is purely under compression/bearing over it's width, thus there is no requirement of anchor bolts along the width of the column section
2025-01-21 20:28:17 - Osdag - ERROR - [Plate Thickness] The thickness of the base plate exceeds the maximum available/allowable thickness of 120 mm
2025-01-21 20:28:17 - Osdag - INFO - If a plate of higher thickness(es) is available, update it into the Osdag data base and re-design the connection
2025-01-21 20:28:17 - Osdag - INFO - [Design for Shear] The shear resistance of the base plate assembly due to the friction between the base plate and the grout/concrete material is 5168.53575 kN
2025-01-21 20:28:17 - Osdag - INFO - The horizontal shear force - 34.0 kN, is less than the shear resistance of the base plate
2025-01-21 20:28:17 - Osdag - INFO - Shear key is not required
2025-01-21 20:28:17 - Osdag - INFO - [Design for Shear] The shear resistance of the base plate assembly due to the friction between the base plate and the grout/concrete material is 5168.53575 kN
2025-01-21 20:28:17 - Osdag - INFO - The horizontal shear force - 34.0 kN, is less than the shear resistance of the base plate
2025-01-21 20:28:17 - Osdag - INFO - Shear key is not required
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] The length of the anchor bolt is computed assuming the anchor bolt is casted in-situ during the erection of the column.
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] The recommended range for the length of the anchor bolt of thread size 56 mm is as follows:
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] Minimum length = 800 mm, Maximum length = 3200 mm.
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] The provided length of the anchor bolt is 1172.67 mm
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt] Designer/Erector should provide adequate anchorage depending on the availability of standard lengths and sizes, satisfying the recommended range
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] Reference: IS 5624:1993, Table 1
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] The recommended range for the length of the anchor bolt of thread size 20

mm is as follows:
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] Minimum length = 200 mm, Maximum length = 800 mm.
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] The provided length of the anchor bolt is 515.17 mm
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt] Designer/Erector should provide adequate anchorage depending on the availability of standard lengths and sizes, satisfying the recommended range
2025-01-21 20:28:17 - Osdag - INFO - [Anchor Bolt Length] Reference: IS 5624:1993, Table 1
2025-01-21 20:28:17 - Osdag - INFO - : ========== Design Status ==========
2025-01-21 20:28:17 - Osdag - INFO - : Overall base plate connection design is UNSAFE
2025-01-21 20:28:17 - Osdag - INFO - : ========== End Of Design ==========