Company Name		Project Title	
Group/Team Name		Subtitle	
Designer		Job Number	
Date	30 /05 /2020	Client	

1 Input Parameters

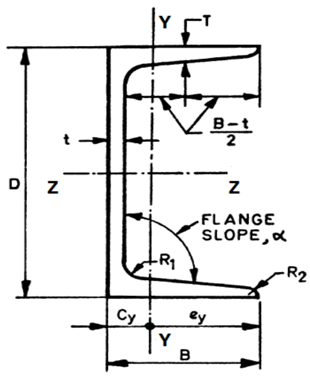
Module	Tension Members Bolted Design
Axial (kN) *	200.0
Length(mm) *	5000.0
Section Size*	Ref List of Input Section
Bolt Details	
Diameter (mm)*	[8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 27.0, 30.0, 33.0, 36.0, 39.0]
Grade *	[3.6, 4.6, 4.8, 5.6, 5.8, 6.8, 8.8, 9.8, 10.9, 12.9]
Type *	Bearing Bolt
Bolt hole type	Standard
Slip factor (µ_f)	0.3
Type of edges	a - Sheared or hand flame cut
Gap between beam and support (mm)	0.0
Are the members exposed to corrosive influences	False
Safety Factors - IS 800:2007 Table 5 (Clause 5.4.1)	
Governed by Yielding	$\gamma_{m0} = 1.1$
Governed by Ultimate Stress	$\gamma_{m1} = 1.25$
Connection Bolts - Bearing Type	$\gamma_{mb} = 1.25$

1.1 List of Input Section

Section Size*	['MC 75', 'MC 100', 'MC 125', 'MC 125*', 'MC 150', 'MC 150*', 'MC 175', 'MC 175*', '
	MC 200', 'MC 200*', 'MC 225', 'MC 225*', 'MC 250', 'MC 250*', 'MC 250*', 'MC 300',
	'MC 300*', 'MC 300*', 'MC 350', 'MC 400', 'JC 100', 'JC 125', 'JC 150', 'JC 175', '
	JC 200', 'LC 75', 'LC 100', 'LC 125', 'LC (P) 125', 'LC 150', 'LC (P) 150', 'LC 175
	', 'LC 200', 'LC (P) 200', 'LC 225', 'LC 250', 'LC 300', 'LC (P) 300', 'LC 350', 'L
	C 400', 'MPC 75', 'MPC 100', 'MPC 125', 'MPC 125*', 'MPC 150', 'MPC 150*', 'MPC 175
	', 'MPC 175*', 'MPC 200', 'MPC 200*', 'MPC 225', 'MPC 225*', 'MPC 250', 'MPC 250*',
	'MPC 250*', 'MPC 300', 'MPC 300*', 'MPC 300*', 'MPC 350', 'MPC 400']

2 Design Checks

2.1 Selected Member Data



Section Size*		('JC 125', 'Channels')	
Material *		E 250 (Fe 410 W)A	
Ultimate strength, fu (MPa)		410	
Yield Strength , fy (MPa)		250	
Mass	7.9	Iz(mm4)	2690000.0
Area(mm2) - A	1000.0	Iy(mm4)	251000.0
D(mm)	125	rz(mm)	51.7
B(mm)	50	ry(mm)	15.8
t(mm)	3.0	Zz(mm3)	43100.0
T(mm)	6.6	Zy(mm3)	7500.0
FlangeSlope	91.5	Zpz(mm3)	49100.0
R1(mm)	6.0	Zpy(mm3)	7500.0
R2(mm)	2.4	r(mm)	15.8
Cy(mm)	16.4		

2.2 Spacing Checks

Check	Required	Provided	Remarks
Min.Diameter (mm)		$d = 14$	
Hole Diameter (mm)		$d_0 = 15$	
Min. Gauge (mm)	$p/g_{min} = 2.5\ d$ $=2.5 * 14.0 \quad = 35.0$	35	Row Limit (rl) = 2
Min. Edge Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 15.0 = 25.5$	30	
Spacing Check	$depth = 2 * e + (rl - 1) * g$ $= 2 * 30 + (2 - 1) * 35$ $= 95$	99.8	Pass

2.3 Member Checks

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg}\ or\ A_c = \frac{1 * A_g\ f_y}{\gamma_{m0}}$ $= \frac{1 * 1000.0 * 250}{1.1}$ $= 227.27$	
Tension Rupture Capacity (kN)		$\beta = 1.4 - 0.076 * \frac{w}{t} * \frac{f_y}{0.9 * f_u} * \frac{b_s}{L_c}$ $\leq \frac{0.9 * f_u * \gamma_{m0}}{f_y * \gamma_{m1}} \geq 0.7$ $= 1.4 - 0.076 * \frac{50}{3.0} * \frac{250}{0.9 * 410} * \frac{92.0}{225}$ $\leq \frac{0.9 * 410 * 1.1}{250 * 1.25} \geq 0.7$ $= 1.05$ $T_{dn} = 1 * (\frac{0.9 * A_{nc} * f_u}{\gamma_{m1}} + \frac{\beta * A_{go} * f_y}{\gamma_{m0}})$ $= 1 * (\frac{0.9 * 245.4 * 410}{1.25} + \frac{1.05 * 660.0 * 250}{1.1})$ $= 229.94$	
Block Shear Capacity (kN)		$T_{db1} = \frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 200.26$	
Tension Capacity (kN)	200.0	$T_d = min(T_{dg}, T_{dn}, T_{db})$ $= min(227.27, 229.94, 200.26)$ $= 200.26$	Pass
Slenderness	$\frac{K * L}{r} \leq 400$	$\frac{K * L}{r} = \frac{1 * 5000.0}{15.8}$ $= 316.46$	Pass
Utilization Ratio	$Utilization\ Ratio \leq 1$	$Utilization\ Ratio = \frac{F}{Td} = \frac{200.0}{200.26}$ $= 1.0$	
Axial Load Considered (kN)	$Ac_{min} = 0.3 * A_c$ $= 0.3 * 227.27$ $= 68.18$ $Ac_{max} = 227.27$	$A = 200.0$	Pass

2.4 Bolt Checks

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Quantity Optimisation	$d = 14$	
Hole Diameter (mm)		$d_0 = 15$	
Grade	Bolt Grade Optimisation	3.6	
Bolt Ultimate Strength (N/mm2)		$f_{ub} = 330.0$	
Bolt Yield Strength (N/mm2)		$f_{yb} = 190.0$	
Nominal Stress Area (mm2)		$A_{nb} = 115\ (Ref\ IS\ 1367-3\ (2002))$	
Kb		$k_b = min(\frac{e}{3*d_0}, \frac{p}{3*d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0)$ $= min(\frac{30}{3*15.0}, \frac{45}{3*15.0} - 0.25, \frac{330.0}{410}, 1.0)$ $= min(0.67, 0.75, 0.8, 1.0)$ $= 0.67$	
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub}\ n_n\ A_{nb}}{\sqrt{3}\ \gamma_{mb}}$ $= \frac{330.0*1*115}{\sqrt{3}\ *\ 1.25}$ $= 17.53$	
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5\ k_b\ d\ t\ f_u}{\gamma_{mb}}$ $= \frac{2.5\ *0.67*14.0*3.0*410}{1.25}$ $= 23.07$	
Capacity (kN)		$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (17.53, 23.07)$ $= 17.53$	
No of Bolts	$R_u = \sqrt{V_u^2 + A_u^2}$ $n_{trial} = R_u/V_{bolt}$ $R_u = \frac{\sqrt{0.0^2 + 200.0^2}}{17.53}$ $= 12$	$n = 12$	
No of Columns		$n_c = 6$	
No of Rows		$n_r = 2$	
Min. Pitch (mm)	$p/g_{min} = 2.5\ d$ $= 2.5*14.0 \quad = 35.0$	45	Pass

Check	Required	Provided	Remarks
Max. Pitch (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 3.0,\ 300\ mm)$ $= 96.0$ $where,$ $t = min(8.0, 8.0)$	45	Pass
Min. Gauge (mm)	$p/g_{min} = 2.5\ d$ $=2.5 * 14.0 \quad = 35.0$	35	Pass
Max. Gauge (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 3.0,\ 300\ mm)$ $= 96.0$ $where,$ $t = min(8.0, 8.0)$	35	Pass
Min. End Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 15.0 = 25.5$	30	Pass
Max. End Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$ $\varepsilon = \sqrt{\frac{250}{f_y}}$ $e/e`_{max} = 12\ * 3.0 * \sqrt{\frac{250}{250}}$ $= 36.0$	30	Pass
Min. Edge Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 15.0 = 25.5$	32.4	Pass
Max. Edge Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$ $\varepsilon = \sqrt{\frac{250}{f_y}}$ $e/e`_{max} = 12\ * 3.0 * \sqrt{\frac{250}{250}}$ $= 36.0$	32.4	Pass
Bolt Capacity post Long Joint (kN)	$if\ l \geq 15 * d\ then\ V_{rd} = \beta_{ij} * V_{db}$ $if\ l < 15 * d\ then\ V_{rd} = V_{db}$ $where,$ $l = ((nc\ or\ nr) - 1) * (p\ or\ g)$ $\beta_{ij} = 1.075 - l/(200 * d)$ $but\ 0.75 \leq \beta_{ij} \leq 1.0$	$l = ((nc\ or\ nr) - 1) * (p\ or\ g)$ $= (6 - 1) * 45 = 225$ $= (2 - 1) * 35 = 35$ $l = 225$ $15 * d = 15 * 14.0 = 210.0$ $since,\ l \geq 15 * d\ then\ V_{rd} = \beta_{ij} * V_{db}$ $\beta_{ij} = 1.075 - 225/(200 * 14.0) = 0.99$ $V_{rd} = 0.99 * 17.53 = 17.35$	
Capacity (kN)	16.67	17.35	Pass

2.5 Gusset Plate Checks

Check	Required	Provided	Remarks
Min.Height (mm)		$H = 1 * Depth + clearance$ $= (1 * 125) + 30.0$ $= 155$	
Min.Length (mm)	5000.0	$L = (nc - 1) * p + 2 * e$ $= (6 - 1) * 45 + (2 * 30)$ $= 285$	Pass
Thickness (mm)		$t_p = 8.0$	
Tension Yielding Capacity (kN)		$T_{dg} = \frac{l * t * f_y}{\gamma_{mo}}$ $= \frac{1 * 125 * 8.0 * 250}{1.1}$ $= 227.27$	
Tension Rupture Capacity (kN)		$T_{dn} = \frac{0.9 * A_n * f_u}{\gamma_{m1}}$ $= \frac{0.9 * (125 - 2 * 15.0) * 8.0 * 410}{1.25}$ $= 224.35$	
Block Shear Capacity (kN)		$T_{db1} = \frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 380.65$	
Tension Capacity (kN)	$A = 200.0$	$T_d = min(T_{dg}, T_{dn}, T_{db})$ $= min(227.27, 224.35, 380.65)$ $= 224.35$	Pass

3 3D View

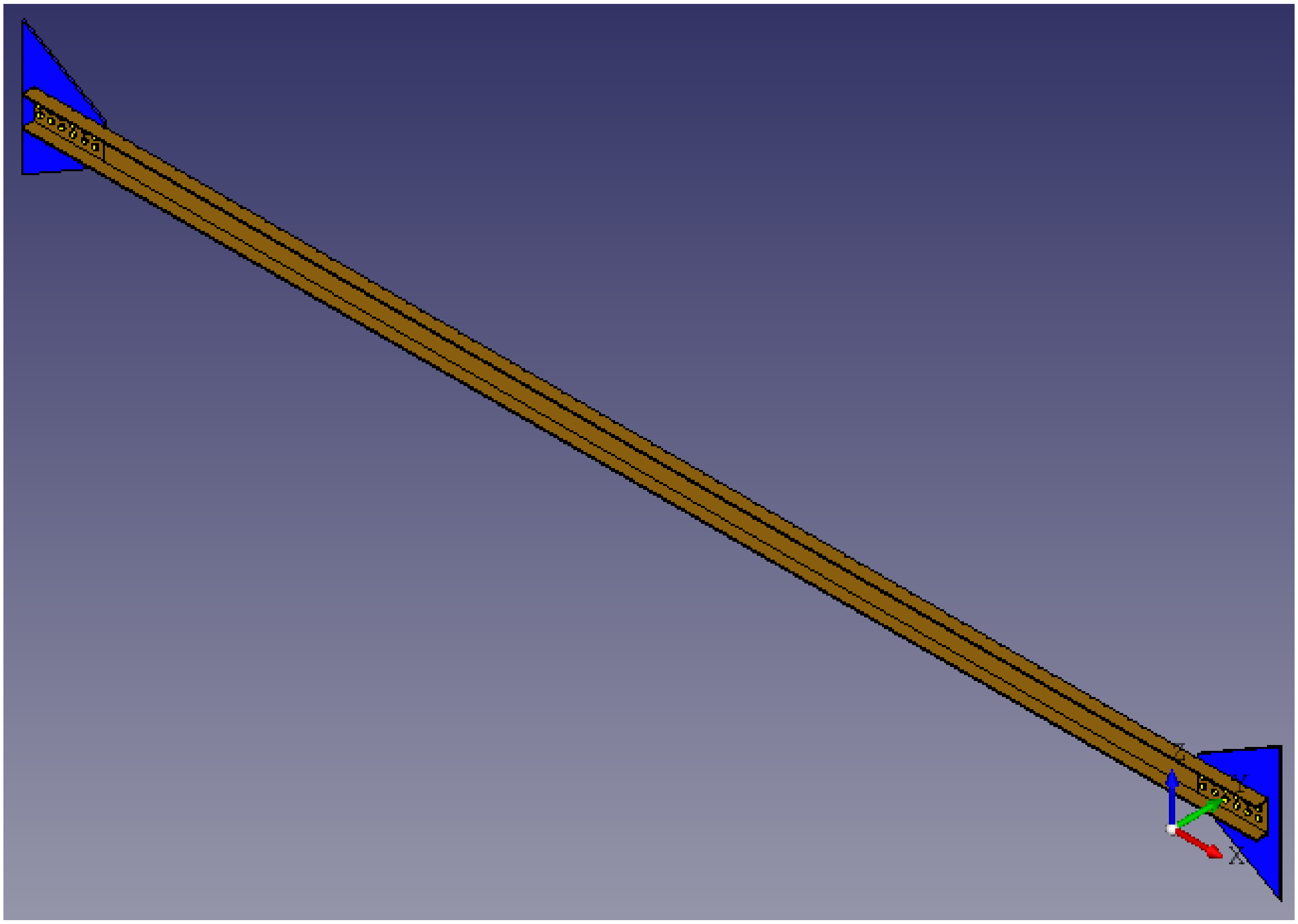


Figure 1: 3D View