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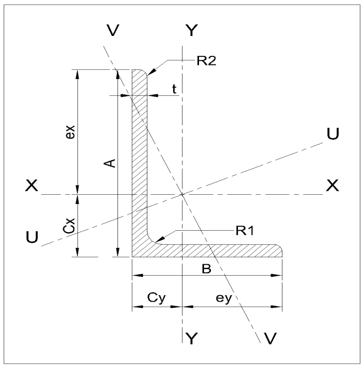
1 Input Parameters

Module	Tension Members Bolted Design
Axial (kN) *	400.0
Length(mm) *	2000.0

Section



Section Size*		('100 65 X 6', 'Back to Back Angles')	
Material *		E 250 (Fe 410 W)A	
Ultimate strength, fu (MPa)		410	
Yield Strength , fy (MPa)		230	
Mass	7.5	Iu(mm4)	978000.0
Area(mm2) - A	958.0	Iv(mm4)	335000.0
A(mm)	100.0	rz(mm)	32.1
B(mm)	65.0	ry(mm)	18.5
t(mm)	0.0	ru(mm)	32.0
R1(mm)	8.0	rv(mm)	18.7
R2(mm)	0.0	Zz(mm3)	14500.0
Cy(mm)	15.4	Zy(mm3)	6600.0
Cz(mm)	32.0	Zpz(mm3)	26400.0
Iz(mm4)	980000.0	Zpy(mm3)	6600.0
Iy(mm4)	330000.0		

Bolt Details

Diameter(mm)*	[12.0, 16.0, 20.0, 24.0, 30.0, 36.0]
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
Bolt Ultimate Strength (N/mm2)	500.0
Bolt Yield Strength (N/mm2)	300.0
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

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2 Design Checks

2.1 Member Checks

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g\ f_y}{\gamma_{m0}}$ $= \frac{2*958.0*230}{1.1}$ $= 400.62$	
Tension Rupture Capacity(kN)		$\beta = 1.4 - 0.076 * \frac{w}{t} * \frac{f_y}{f_u} * \frac{b_s}{L_c}$ $\leq \frac{0.9*f_u*\gamma_{m0}}{f_y*\gamma_{m1}} \geq 0.7$ $= 1.4 - 0.076 * \frac{65.0}{6.0} * \frac{230}{410} * \frac{116.0}{180}$ $\leq \frac{0.9*410*1.1}{230*1.25} \geq 0.7$ $= 1.07$ $T_{dn} = 2 * (\frac{0.9*A_{nc}*f_u}{\gamma_{m1}} + \frac{\beta*A_{go}*f_y}{\gamma_{m0}})$ $= 2 * (\frac{0.9*432.0*410}{1.25} + \frac{1.07*390.0*230}{1.1})$ $= 429.56$	
Block Shear Capacity (KN)		$T_{db1} = \frac{A_{vg}f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn}f_u}{\gamma_{m1}}$ $T_{db2} = \frac{0.9*A_{vn}f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg}f_y}{\gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 400.36$	
Tension Capacity (kN)		$T_d = Min(T_{dg}, T_{dn}, T_{db})$ $= Min(400.62, 429.56, 400.36)$ $= 400.36$	Pass
Slenderness	$\frac{K*L}{r} \leq 400$	$\frac{K*L}{r} = \frac{1*2000.0}{34.11}$ $= 58.64$	
Efficiency	$Efficiency \leq 1$	$Efficiency = \frac{F}{Td} = \frac{400.0}{400.36}$ $= 1.0$	

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2.2 Bolt Checks

Check	Required	Provided	Remarks
Diameter(d) (mm)	Bolt Quantity Optimisation	20.0	
Grade	Bolt Grade Optimisation	5.6	
Bolt Hole Diameter(d0) (mm)		22.0	
Shear Capacity (kN)		$V_{dsb} = \frac{f_u b\ n_n\ A_{nb}}{\sqrt{3}\ \gamma_{mb}}$ $= \frac{500.0 * 2 * 245}{\sqrt{3}\ *\ 1.25}$ $= 113.16$	
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5\ k_b\ d\ t\ f_u}{\gamma_{mb}}$ $= \frac{2.5\ * 0.61 * 20.0 * 12.0 * 410}{1.25}$ $= 120.05$	
Capacity (KN)		$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (113.16, 120.05)$ $= 113.16$	
No of Bolts (n)	$R_u = \sqrt{V_u^2 + A_u^2}$ $n_{trial} = R_u/V_{bolt}$ $R_u = \frac{\sqrt{0.0^2 + 400.0^2}}{113.16}$ $= 4$	4	
No of Columns (nc)		4	
No of Rows (nr)		1	
Min. Pitch (mm)	$p/g_{min} = 2.5\ d$ $=2.5 * 20.0 \quad = 50.0$	60	Pass
Max. Pitch (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 0.0,\ 300\ mm)$ $= 300$	60	Pass
Min. Gauge (mm)	$p/g_{min} = 2.5\ d$ $=2.5 * 20.0 \quad = 50.0$	0	N/A
Max. Gauge (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 0.0,\ 300\ mm)$ $= 300$	0	N/A
Min. End Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 22.0 = 37.4$	40	Pass
Max. End Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$ $\varepsilon = \sqrt{\frac{250}{f_y}}$ $e/e`_{max} = 12\ * 20.0 * \sqrt{\frac{250}{230}}$ $= 249.6$	40	Pass

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Check	Required	Provided	Remarks
Min. Edge Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 22.0 = 37.4$	43.0	Pass
Max. Edge Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$ $\varepsilon = \sqrt{\frac{250}{f_y}}$ $e/e`_{max} = 12\ * 20.0 * \sqrt{\frac{250}{230}}$ $= 249.6$	43.0	Pass
Capacity (KN)	100.0	113.16	Pass

2.3 Gusset Plate Checks

Check	Required	Provided	Remarks
Height (mm)		$H = 1 * Depth + clearance$ $= (1 * 100.0) + 30.0$ $= 130.0$	
Length (mm)		$L = (nc - 1) * p + 2 * e$ $= (4 - 1) * 60 + (2 * 40)$ $= 260$	
Tension Yielding Capacity (kN)		$T_{dg} = \frac{l * t * f_y}{\gamma_{mo}}$ $= \frac{100.0 * 20.0 * 230}{1.1}$ $= 418.18$	
Tension Rupture Capacity(kN)		$T_{dn} = \frac{0.9 * A_n * f_u}{\gamma_{m1}}$ $= \frac{0.9 * (100.0 - 1 * 22.0) * 20.0 * 410}{1.25}$ $= 460.51$	
Block Shear Capacity (KN)		$T_{db1} = \frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 667.26$	
Tension Capacity (kN)		$T_d = Min(T_{dg}, T_{dn}, T_{db})$ $= Min(418.18, 460.51, 667.26)$ $= 418.18$	Pass

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3 3D View

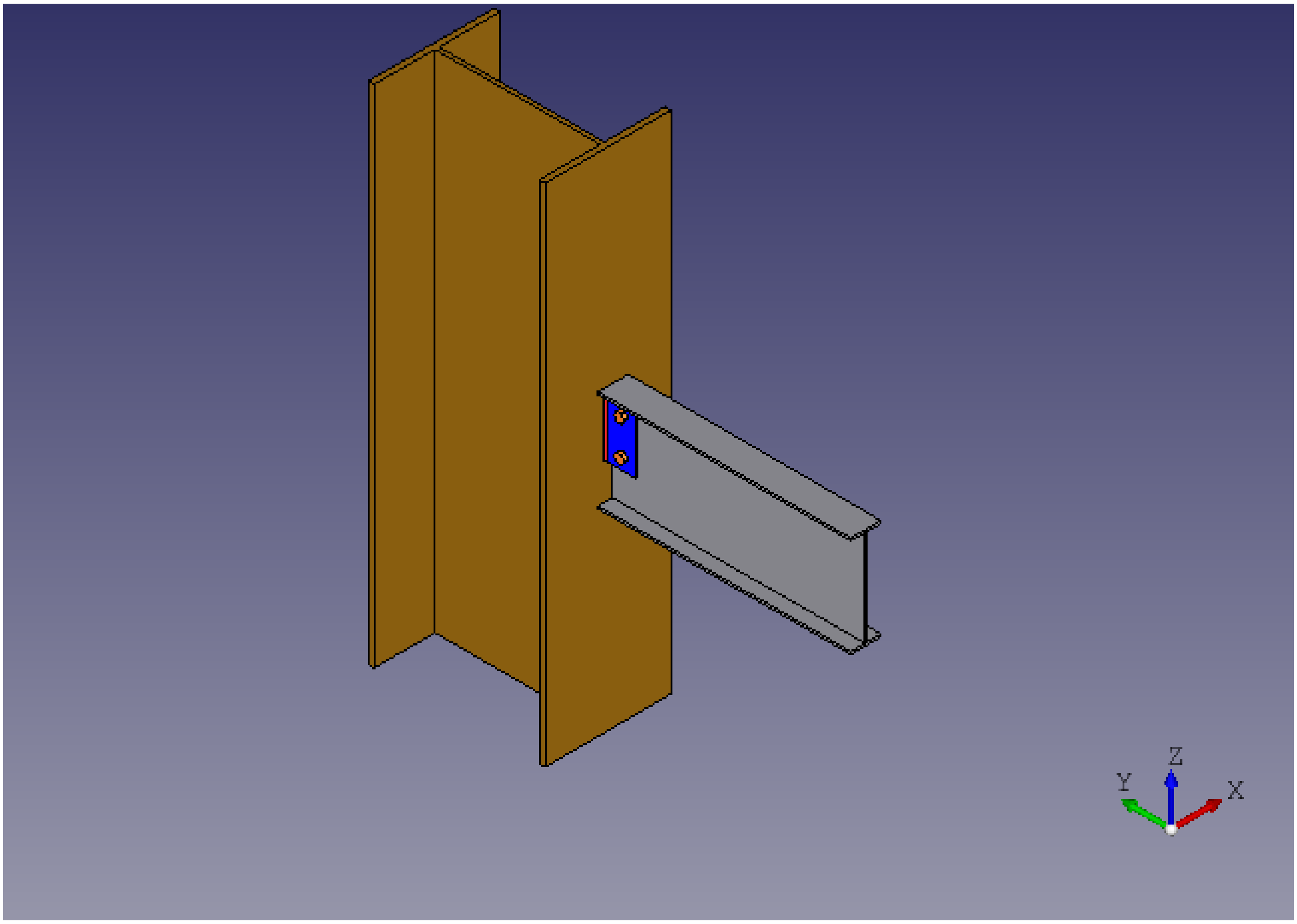

Figure 1: 3D View