



Company Name	IIT Bombay	Project Title	Tension Member
Group/Team Name	Osdag	Subtitle	Welded to End Gusset
Designer	Engineer#1	Job Number	2.2.2
Date	04 /02 /2021	Client	Mr. Pratip Bhattacharya, Kolkata

1 Input Parameters

Module	Tension Member Design - Welded to End Gusset
Axial Force (kN)	330.0
Length (mm) *	2200.0
Section Profile*	Back to Back Angles
Section Size*	Ref List of Input Section
Plate Details - Input and Design Preference	
Thickness (mm)	[10, 12, 14, 16, 20]
Material	E 250 (Fe 410 W)A
Ultimate Strength, F_u (MPa)	410
Yield Strength, F_y (MPa)	240
Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, F_u (MPa)	410.0



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1.1 List of Input Section

Section Size*	'20 x 20 x 3', '20 x 20 x 4', '25 x 25 x 3', '25 x 25 x 4', '25 x 25 x 5', '30 x 30 x 3', '30 x 30 x 4', '30 x 30 x 5', '35 x 35 x 3', '35 x 35 x 4', '35 x 35 x 5', '35 x 35 x 6', '40 x 40 x 3', '40 x 40 x 4', '40 x 40 x 5', '40 x 40 x 6', '45 x 45 x 3', '45 x 45 x 4', '45 x 45 x 5', '45 x 45 x 6', '50 x 50 x 3', '50 x 50 x 4', '50 x 50 x 5', '50 x 50 x 6', '55 x 55 x 4', '55 x 55 x 5', '55 x 55 x 6', '55 x 55 x 8', '60 x 60 x 4', '60 x 60 x 5', '60 x 60 x 6', '60 x 60 x 8', '65 x 65 x 4', '65 x 65 x 5', '65 x 65 x 6', '65 x 65 x 8', '70 x 70 x 5', '70 x 70 x 6', '70 x 70 x 8', '70 x 70 x 10', '75 x 75 x 5', '75 x 75 x 6', '75 x 75 x 8', '75 x 75 x 10', '80 x 80 x 6', '80 x 80 x 8', '80 x 80 x 10', '80 x 80 x 12', '90 x 90 x 6', '90 x 90 x 8', '90 x 90 x 10', '90 x 90 x 12', '100 x 100 x 6', '100 x 100 x 8', '100 x 100 x 10', '100 x 100 x 12', '110 x 110 x 8', '110 x 110 x 10', '110 x 110 x 12', '110 x 110 x 16', '130 x 130 x 8', '130 x 130 x 10', '130 x 130 x 12', '130 x 130 x 16', '150 x 150 x 10', '150 x 150 x 12', '150 x 150 x 16', '150 x 150 x 20', '200 x 200 x 12', '200 x 200 x 16', '200 x 200 x 20', '200 x 200 x 25', '50 x 50 x 7', '50 x 50 x 8', '55 x 55 x 10', '60 x 60 x 10', '65 x 65 x 10', '70 x 70 x 7', '100 x 100 x 7', '100 x 100 x 15', '120 x 120 x 8', '120 x 120 x 10', '120 x 120 x 12', '120 x 120 x 15', '130 x 130 x 9', '150 x 150 x 15', '150 x 150 x 18', '180 x 180 x 15', '180 x 180 x 18', '180 x 180 x 20', '200 x 200 x 24', '30 x 20 x 3', '30 x 20 x 4', '30 x 20 x 5', '40 x 25 x 3', '40 x 25 x 4', '40 x 25 x 5', '40 x 25 x 6', '45 x 30 x 3', '45 x 30 x 4', '45 x 30 x 5', '45 x 30 x 6', '50 x 30 x 3', '50 x 30 x 4', '50 x 30 x 5', '50 x 30 x 6', '60 x 40 x 5', '60 x 40 x 6', '60 x 40 x 8', '65 x 45 x 5', '65 x 45 x 6', '65 x 45 x 8', '70 x 45 x 5', '70 x 45 x 6', '70 x 45 x 8', '70 x 45 x 10', '75 x 50 x 5', '75 x 50 x 6', '75 x 50 x 8', '75 x 50 x 10', '80 x 50 x 5', '80 x 50 x 6', '80 x 50 x 8', '80 x 50 x 10', '90 x 60 x 6', '90 x 60 x 8', '90 x 60 x 10', '90 x 60 x 12', '100 x 65 x 6', '100 x 65 x 8', '100 x 65 x 10', '100 x 75 x 6', '100 x 75 x 8', '100 x 75 x 10', '100 x 75 x 12', '125 x 75 x 6', '125 x 75 x 8', '125 x 75 x 10', '125 x 95 x 6', '125 x 95 x 8', '125 x 95 x 10', '125 x 95 x 12', '150 x 115 x 8', '150 x 115 x 10', '150 x 115 x 12', '150 x 115 x 16', '200 x 100 x 10', '200 x 100 x 12', '200 x 100 x 16', '200 x 150 x 10', '200 x 150 x 12', '200 x 150 x 16', '200 x 150 x 20', '40 x 20 x 3', '40 x 20 x 4', '40 x 20 x 5', '60 x 30 x 5', '60 x 30 x 6', '60 x 40 x 7', '65 x 50 x 5', '65 x 50 x 6', '65 x 50 x 7', '65 x 50 x 8', '70 x 50 x 5', '70 x 50 x 6', '70 x 50 x 7', '70 x 50 x 8', '75 x 50 x 7', '80 x 40 x 5', '80 x 40 x 6', '80 x 40 x 7', '80 x 40 x 8', '80 x 60 x 6', '80 x 60 x 7', '80 x 60 x 8', '90 x 65 x 6', '90 x 65 x 7', '90 x 65 x 8', '90 x 65 x 10', '100 x 50 x 6', '100 x 50 x 7', '100 x 50 x 8', '100 x 50 x 10', '100 x 65 x 7', '120 x 80 x 8', '120 x 80 x 10', '120 x 80 x 12', '125 x 75 x 12', '135 x 65 x 8', '135 x 65 x 10', '135 x 65 x 12', '150 x 75 x 9', '150 x 75 x 15', '150 x 90 x 10', '150 x 90 x 12', '150 x 90 x 15', '200 x 100 x 15', '200 x 150 x 15', '200 x 150 x 18'
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2 Design Checks

Design Status	Fail
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2.1 Selected Member Data

	Section Size*		('75 x 75 x 5', 'Back to Back Angles')	
	Material		E 250 (Fe 410 W)A	
	Mass, m (kg/m)		11.54	
	Area, A (cm ²)		1472.0	
	A (mm)	75.0	I_v (cm ⁴)	80.0
	B (mm)	75.0	r_z (cm)	2.33
	t (mm)	5.0	r_y (cm)	3.1
	T (mm)	20.0	r_u (cm)	3.1
	R_1 (mm)	7.0	r_v (cm)	2.33
	R_2 (mm)	0.0	Z_z (cm ³)	14.65
	C_y (mm)	N/A	Z_y (cm ³)	18.83
	C'_z (mm)	20.4	Z_{pz} (cm ³)	26.4
	I_z (cm ⁴)	80.0	Z_{py} (cm ³)	30.32
	I_y (cm ⁴)	141.26	Radius of gyration, r (cm)	58.3
	I_u (cm ⁴)	141.26		

2.2 Member Check

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $= \frac{736.0 \times 250}{1.1 \times 10^3}$ $= 334.55$ <p>[Ref. IS 800:2007, Cl.6.2]</p>	



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Check	Required	Provided	Remarks
Tension Rupture Capacity (kN)		$\beta = 1.4 - 0.076 \times \frac{w}{t} \times \frac{f_y}{0.9f_u} \times \frac{b_s}{L_c}$ $\leq \frac{0.9f_u\gamma_{m0}}{f_y\gamma_{m1}} \geq 0.7$ $= 1.4 - 0.076 \times \frac{75.0}{5.0} \times \frac{250}{0.9 \times 410} \times \frac{75.0}{164}$ $\leq \frac{0.9 \times 410 \times 1.1}{250 \times 1.25} \geq 0.7$ $= 1.05$ $T_{dn} = 2 \times \left(\frac{0.9A_{nc}f_u}{\gamma_{m1}} + \frac{\beta A_{go}f_y}{\gamma_{m0}} \right)$ $= 2 \times \left(\frac{0.9 \times 350.0 \times 410}{1.25} + \frac{1.05 \times 375.0 \times 250}{1.1} \right)$ $= 385.62$ <p>[Ref. IS 800:2007, Cl.6.3.3]</p>	
Tension Capacity (kN)	330.0	$T_d = \min(T_{dg}, T_{dn})$ $= \min(334.55, 385.62)$ $= 334.55$ <p>[Ref.IS 800:2007, Cl.6.1]</p>	Pass
Slenderness	$\frac{KL}{r} \leq 400$	$\frac{KL}{r} = \frac{1 \times 2200.0}{58.3}$ $= 37.74$ <p>[Ref. IS 800:2007, Cl.7.1.2]</p>	Pass
Utilization Ratio	≤ 1	$\text{Utilization Ratio} = \frac{F}{T_d} = \frac{330.0}{334.55}$ $= 0.99$	



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Check	Required	Provided	Remarks
Axial Load Considered (kN)	$A_{cmin} = 0.3A_c$ $= 0.3 \times 334.55$ $= 100.36$ $A_{cmax} = 334.55$ [Ref. IS 800:2007, Cl.10.7]	$A = 330.0$	Pass

2.3 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	t_{wmin} based on thinner part $= \max(5, 3)$ s_{min} based on thicker part = 5 [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	5	Pass
Max. Weld Size (mm)	Thickness of thinner part $= \min(20.0, 5.0) = 5.0$ $s_{max} = 16.0$ [Ref. IS 800:2007, Cl.10.5.3.1]	5	Pass
Throat Thickness (mm)	$t_t \geq 3$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_t = 0.7t_w$ $= 0.7 \times 5$ $= 3.5$ [Ref. IS 800:2007, Cl.10.5.3.1]	Pass
Effective Length (mm)		$l_w = 726.0$	



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Check	Required	Provided	Remarks
Weld Strength (N/mm)	$R_w = \sqrt{(A_{wh})^2 + (V_{wv})^2}$ $V_{wv} = \frac{V}{l_w} = \frac{0.0}{726.0}$ $A_{wh} = \frac{A}{l_w} = \frac{330000.0}{726.0}$ $R_w = \sqrt{(454.55)^2 + (0.0)^2}$ $= 454.55$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{3.5 \times 410}{\sqrt{3} \times 1.25}$ $= 662.8$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	Pass
Weld Strength (post long joint) (N/mm)	<p>if $l \geq 150t_t$, then $V_{rd} = \beta_{lw} V_{db}$</p> <p>if $l < 150t_t$, then $V_{rd} = V_{db}$</p> <p>where,</p> <p>l = plate length or height</p> $\beta_{lw} = 1.2 - \frac{(0.2l)}{(150t_t)}$ <p>but, $0.6 \leq \beta_{lw} \leq 1.0$</p> [Ref. IS 800:2007, Cl.10.5.7.3]	<p>l = plate length or height</p> $l_t = \max(105.0, 179)$ $= 179$ $150t_t = 150 \times 3.5 = 525.0$ <p>since, $l < 150t_t$</p> <p>then $f_{wrd} = f_w$</p> $f_{wrd} = 662.8$ [Ref. IS 800:2007, Cl.10.5.7.3.]	
Weld Strength (N/mm)	454.55	662.8	Pass

2.4 Gusset Plate Check

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)	330.0	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 200.0 \times 20.0$ $= \frac{4000.0 \times 240}{1.1 \times 10^3}$ $= 327.27$ [Ref. IS 800:2007, Cl.6.2]	Fail



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Check	Required	Provided	Remarks
Min.Height (mm)		$H = 1 \times \text{Depth} + \text{Clearance}$ $= (1 \times 200.0) + 30$ $= 105.0$	
Min.Plate Length (mm)		$L = \text{Flange weld} + \text{Clearance}$ $= 149 + 30$ $= 179$	Pass
Min.Member Length (mm)	358	2200.0	Pass
Thickness (mm)		$T = 20.0$	
Weld Strength (N/mm)	$R_w = \sqrt{(A_{wh})^2 + (V_{wv})^2}$ $V_{wv} = \frac{V}{l_w} = \frac{0.0}{726.0}$ $A_{wh} = \frac{A}{l_w} = \frac{330000.0}{726.0}$ $R_w = \sqrt{(454.55)^2 + (0.0)^2}$ $= 454.55$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{3.5 \times 410}{\sqrt{3} \times 1.25}$ $= 662.8$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	Pass
Block Shear Capacity (kN)		$T_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = \min(T_{db1}, T_{db2}) = 944.53$ [Ref. IS 800:2007, Cl.6.4]	
Tension Capacity (kN)	$A = 330.0$	$T_d = \min(T_{dg}, T_{db})$ $= \min(327.27, 944.53)$ $= 327.27$ [Ref. IS 800:2007, Cl.6.1]	Pass

3 Design Log



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15:38:51 - Osdag - WARNING - : The factored tension force (330.0 kN) exceeds the tension capacity of 909.09 kN with respect to the maximum available plate thickness of 20.0 mm.

15:38:51 - Osdag - ERROR - :Design is unsafe.

15:38:51 - Osdag - INFO - :=====End Of design=====

15:38:51 - Osdag - ERROR - : Design is not safe.

15:38:51 - Osdag - INFO - :=====End Of design=====