1 Input Parameters

Module	Tension Member Design - Welded to End Gusset
Axial Force (kN)	180.0
Length (mm) *	2500.0
Section Profile*	Star Angles
Section Size*	Ref List of Input Section
Plate Details - Input and Design Preference	
Thickness (mm)	[10, 12, 14]
Material	E 250 (Fe 410 W)A
Ultimate Strength, F_u (MPa)	410
Yield Strength, F_y (MPa)	250
Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Field weld
Material Grade Overwrite, F_u (MPa)	410.0

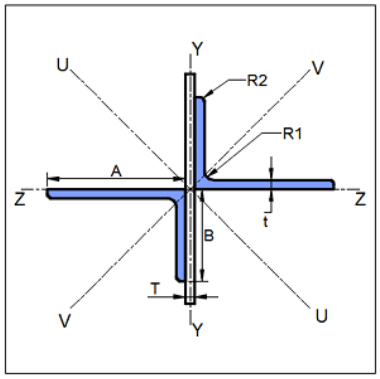
1.1 List of Input Section

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 x130 x 10', '130 x130 x 12', '130 x130 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'

2 Design Checks

Design Status	Pass

2.1 Selected Member Data



Section Size*		('75 x 50 x 5', 'Star Angles')	
Material		E 165 (Fe 290)	
Mass, m (kg/m)		9.56	
Area, A (cm^2)		1218.0	
A (mm)	75.0	r_z (cm)	1.86
B (mm)	50.0	r_y (cm)	3.4
t (mm)	5.0	r_u (cm)	3.41
T (mm)	10.0	r_v (cm)	1.84
R_1 (mm)	6.5	Z_z (cm^3)	8.47
R_2 (mm)	0.0	Z_y (cm^3)	18.79
I_z (cm^4)	42.36	Z_{pz} (cm^3)	14.37
I_y(cm^4)	140.94	Z_{py} (cm^3)	29.35
I_u (cm^4)	141.97	Radius of gyration, r (cm)	18.4
I_v(cm^4)	41.33		

2.2 Member Check

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $= \frac{609.0 \times 165}{1.1 \times 10^3}$ $= 182.7$ [Ref. IS 800:2007, Cl.6.2]	

Company Name	IIT Bombay	Project Title	Tension Member
Group/Team Name	Osdag	Subtitle	Welded to End Gusset
Designer	Engineer#1	Job Number	2.2.3
Date	04 /02 /2021	Client	Prof. V Kalyanaraman, IIT Madras

Check	Required	Provided	Remarks
Tension Rupture Capacity (kN)		$\beta = 1.4 - 0.076 \times \frac{w}{t} \times \frac{f_y}{0.9 f_u} \times \frac{b_s}{L_c}$ $\leq \frac{0.9 f_u \gamma_{m0}}{f_y \gamma_{m1}} \geq 0.7$ $= 1.4 - 0.076 \times \frac{75.0}{5.0} \times \frac{165}{0.9 \times 290} \times \frac{75.0}{133}$ $\leq \frac{0.9 \times 290 \times 1.1}{165 \times 1.25} \geq 0.7$ $= 0.99$ $T_{\text{dn}} = 2 \times \left(\frac{0.9 A_{nc} f_u}{\gamma_{m1}} + \frac{\beta A_{go} f_y}{\gamma_{m0}} \right)$ $= 2 \times \left(\frac{0.9 \times 225.0 \times 290}{1.25} + \frac{0.99 \times 375.0 \times 165}{1.1} \right)$ $= 205.34$ [Ref. IS 800:2007, Cl.6.3.3]	
Tension Capacity (kN)	180.0	$T_{\text{d}} = \min(T_{\text{dg}},\ T_{\text{dn}})$ $= \min(182.7, 205.34)$ $= 182.7$ [Ref.IS 800:2007, Cl.6.1]	**Pass**
Slenderness	$\frac{KL}{r} \leq 400$	$\frac{KL}{r} = \frac{1 \times 2500.0}{18.4}$ $= 135.87$ [Ref. IS 800:2007, Cl.7.1.2]	**Pass**
Utilization Ratio	≤ 1	Utilization Ratio $= \frac{F}{T_d} = \frac{180.0}{182.7}$ $= 0.99$	

Check	Required	Provided	Remarks
Axial Load Considered (kN)	$A_{cmin} = 0.3A_c$ $= 0.3 \times 182.7$ $= 54.81$ $A_{cmax} = 182.7$ [Ref. IS 800:2007, Cl.10.7]	$A = 180.0$	**Pass**

2.3 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= \max(5,\ 3)$ s_{min} based on thicker part $= 3$ [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	3	**Pass**
Max. Weld Size (mm)	Thickness of thinner part $= \min(10.0,\ 5.0) = 5.0$ $s_{max} = 16.0$ [Ref. IS 800:2007, Cl.10.5.3.1]	3	**Pass**
Throat Thickness (mm)	$t_t \geq 3$ [Ref. IS 800:2007, Cl.10.5.3.1]	$t_t = 0.7t_w$ $= 0.7 \times 3$ $= 3$ [Ref. IS 800:2007, Cl.10.5.3.1]	**Pass**
Effective Length (mm)		$l_w = 560.0$	

Check	Required	Provided	Remarks
Weld Strength (N/mm)	$R_{\mathrm{w}} = \sqrt{(A_{\mathrm{wh}})^2 + (V_{\mathrm{wv}})^2}$ $V_{\mathrm{wv}} = \frac{V}{l_w} = \frac{0.0}{560.0}$ $A_{\mathrm{wh}} = \frac{A}{l_w} = \frac{180000.0}{560.0}$ $R_{\mathrm{w}} = \sqrt{(321.43)^2 + (0.0)^2}$ $= 321.43$	$f_w = \frac{t_t f_u}{\sqrt{3}\gamma_{mw}}$ $= \frac{3 \times 290}{\sqrt{3} \times 1.5}$ $= 334.86$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	**Pass**
Weld Strength (post long joint) (N/mm)	if $l \geq 150t_t$, then $V_{\mathrm{rd}} = \beta_{l_w} V_{\mathrm{db}}$ if $l < 150t_t$, *then* $V_{\mathrm{rd}} = V_{\mathrm{db}}$ where, l = plate length or height $\beta_{l_w} = 1.2 - \frac{(0.2l)}{(150t_t)}$ but, $0.6 \leq \beta_{l_w} \leq 1.0$ [Ref. IS 800:2007, Cl.10.5.7.3]	l = plate length or height $l_l = \max(130.0, 148)$ $= 148$ $150t_t = 150 \times 3 = 450$ since, $l < 150t_t$ *then* $f_{\mathrm{wrd}} = f_{\mathrm{w}}$ $f_{\mathrm{wrd}} = 334.86$ [Ref. IS 800:2007, Cl.10.5.7.3.]	
Weld Strength (N/mm)	321.43	334.86	**Pass**

2.4 Gusset Plate Check

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)	180.0	$T_{\mathrm{dg}} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 300.0 \times 10.0$ $= \frac{3000.0 \times 250}{1.1 \times 10^3}$ $= 227.27$ [Ref. IS 800:2007, Cl.6.2]	**Pass**

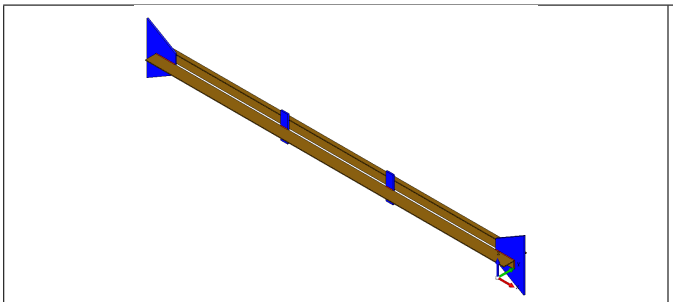
Company Name	IIT Bombay	Project Title	Tension Member
Group/Team Name	Osdag	Subtitle	Welded to End Gusset
Designer	Engineer#1	Job Number	2.2.3
Date	04 /02 /2021	Client	Prof. V Kalyanaraman, IIT Madras

Check	Required	Provided	Remarks
Min.Height (mm)		$H = 1 \times \text{Depth} + \text{Clearance}$ $= (1 \times 300.0) + 30$ $= 130.0$	
Min.Plate Length (mm)		$L = \text{Flange weld} + \text{Clearance}$ $= 118 + 30$ $= 148$	Pass
Min.Member Length (mm)	296	2500.0	Pass
Thickness (mm)		$T = 10.0$	
Weld Strength (N/mm)	$R_{\text{w}} = \sqrt{(A_{\text{wh}})^2 + (V_{\text{wv}})^2}$ $V_{\text{wv}} = \frac{V}{l_w} = \frac{0.0}{560.0}$ $A_{\text{wh}} = \frac{A}{l_w} = \frac{180000.0}{560.0}$ $R_{\text{w}} = \sqrt{(321.43)^2 + (0.0)^2}$ $= 321.43$	$f_w = \frac{t_t f_u}{\sqrt{3}\gamma_{mw}}$ $= \frac{3 \times 290}{\sqrt{3} \times 1.5}$ $= 334.86$ [Ref. IS 800:2007, Cl.10.5.7.1.1]	Pass
Block Shear Capacity (kN)		$T_{\text{dbl1}} = \frac{A_{\text{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{\text{dbl2}} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{\text{db}} = \min(T_{db1},\ T_{db2}) = 488.04$ [Ref. IS 800:2007, Cl.6.4]	
Tension Capacity (kN)	$A = 180.0$	$T_{\text{d}} = \min(T_{\text{dg}},\ T_{\text{db}})$ $= \min(227.27, 488.04)$ $= 227.27$ [Ref.IS 800:2007, Cl.6.1]	Pass

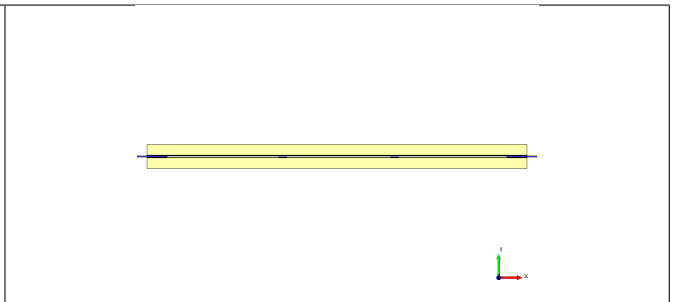
2.5 Intermittent Connection

Check	Required	Provided	Remarks
Connection (nos)		2	
Spacing (mm)	1000	734.67	**Pass**
Min.Height (mm)		180	
Min.Plate Length (mm)		50	

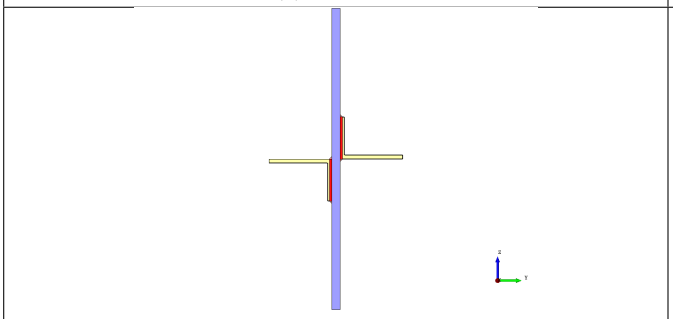
3 3D Views



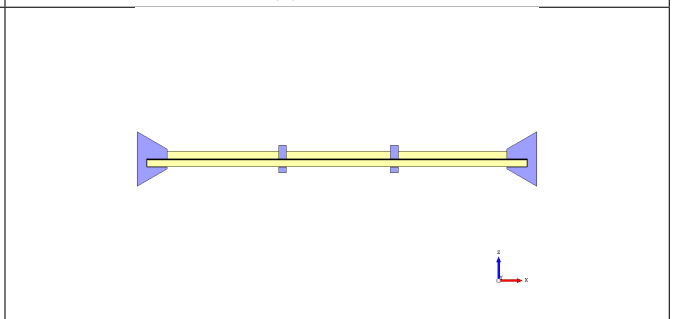
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log

15:40:17 - Osdag - INFO - :In the case of reverse loading, slenderness value shall be less than 180 [Ref. Table 3, IS 800:2007].
15:40:17 - Osdag - INFO - :In the case of reverse loading for double sections, spacing of the intermittent connection shall be less than 600 [Ref. Cl. 10.2.5.5, IS 800:2007].
15:40:17 - Osdag - INFO - Size of weld is calculated based on the edge type i.e. square edge or round edge (IS 800:2007 Clause 10.5)).
15:40:17 - Osdag - INFO - :Overall welded tension member design is safe.
15:40:17 - Osdag - INFO - :==========End Of design==========