		Created with Osdag®	
Company Name	bto g gusset	Project Title	
Group/Team Name		Subtitle	
Designer		Job Number	
Date	28 /12 /2024	Client	

1 Input Parameters

Module	Tension Member Design - Bolted to End Gusset
Axial (kN)*	65.0
Length (mm) *	300.0
Section Profile*	Angles
Section Size*	Ref List of Input Section
Section Material	E 250 (Fe 410 W)A
Ultimate Strength, F_u (MPa)	410
Yield Strength, F_y (MPa)	250
Bolt Details - Input and Design Preference	
Diameter (mm)	[np.int64(8), np.int64(10), np.int64(12), np.int64(14), np.int64(16), np.int64(18), np.int64(20), np.int64(22), np.int64(24), np.int64(27), np.int64(33), np.int64(36) , np.int64(39), np.int64(42), np.int64(45), np.int64(48), np.int64(52), np.int64(56), np.int64(60), np.int64(6 4)]
Property Class	[np.float64(3.6), np.float64(4.6), np.float64(4.8), np.f loat64(5.6), np.float64(5.8), np.float64(8.8), np.float 64(9.8), np.float64(10.9), np.float64(12.9)]
Type	Bearing Bolt
Hole Type	Standard
Detailing - Design Preference	
Edge Preparation Method	Sheared or hand flame cut
Are the Members Exposed to Corrosive Influences?	False
Plate Details - Input and Design Preference	
Thickness (mm)	[np.int64(8), np.int64(10), np.int64(12), np.int64(16), np.int64(18), np.int64(20), np.int64(22), np.int64(25), np.int64(28), np.int64(32), np.int64(36), np.int64(40) , np.int64(45), np.int64(50), np.int64(56), np.int64(63), np.int64(75), np.int64(80), np.int64(90), np.int64(1 00), np.int64(110), np.int64(120)]
Material	E 250 (Fe 410 W)A

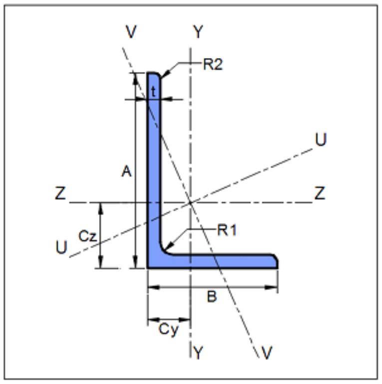
1.1 List of Input Section

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*		('45 x 30 x 4', 'Angles')	
Material		E 250 (Fe 410 W)A	
Mass, m (kg/m)		2.27	
Area, A (cm^2)		289.0	
A (mm)	45.0	I_v(cm^4)	1.22
B (mm)	30.0	r_z (cm)	1.42
t (mm)	4.0	r_y (cm)	0.85
R_1 (mm)	5.0	r_u (cm)	1.53
R_2 (mm)	0.0	r_v (cm)	0.65
C_y (mm)	7.4	Z_z (cm^3)	1.95
C_z (mm)	14.8	Z_y (cm^3)	0.93
I_z (cm^4)	5.87	Z_{pz} (cm^3)	3.5
I_y(cm^4)	2.1	Z_{py} (cm^3)	1.69
I_u (cm^4)	6.75	Radius of gyration, r (cm)	6.5

2.2 Spacing Check

Check	Required	Provided	Remarks
Min. Diameter (mm)		$d = 10$	
Hole Diameter (mm)		$d_0 = 10$	
Minimum Bolts (nos)		$r_l = 1$	
Min. Gauge Distance (mm)	$p/g_{\min} = 2.5d$ $= 2.5 \times 10.0$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	25	Pass

Check	Required	Provided	Remarks
Min. Edge Distance (mm)	$e_{\min} = 1.5d_0$ $= 1.5 \times 10$ $= 15.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	15	**Pass**
Spacing Check	$\text{depth} = 2\ e + (r_l - 1)\ g$ $= 2 \times 15 + (1 - 1) \times 25$ $= 30$	36.0	**Pass**

2.3 Member Check

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{\text{dg}} = \frac{A_g f_y}{\gamma_{m0}}$ $= \frac{289.0 \times 250}{1.1 \times 10^3}$ $= 65.68$ [Ref. IS 800:2007, Cl.6.2]	

Check	Required	Provided	Remarks
Tension Rupture Capacity (kN)		$\beta = 1.4 - 0.076 \times \frac{w}{t} \times \frac{f_y}{0.9 f_u} \times \frac{b_s}{L_c} \leq \frac{0.9 f_u \gamma_{m0}}{f_y \gamma_{m1}} \geq 0.7$ $= 1.4 - 0.076 \times \frac{30.0}{4.0} \times \frac{250}{0.9 \times 410} \times \frac{53.0}{100} \leq \frac{0.9 \times 410 \times 1.1}{250 \times 1.25} \geq 0.7$ $= 1.2$ $T_{\text{dn}} = 1 \times \left(\frac{0.9 A_{nc} f_u}{\gamma_{m1}} + \frac{\beta A_{go} f_y}{\gamma_{m0}}\right)$ $= 1 \times \left(\frac{0.9 \times 124.0 \times 410}{1.25} + \frac{1.2 \times 120.0 \times 250}{1.1}\right)$ $= 69.33$ [Ref. IS 800:2007, Cl.6.3.3]	
Block Shear Capacity (kN)		$T_{\text{dbl1}} = \frac{A_{\text{vg}} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{\text{dbl2}} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{\text{db}} = \min(T_{db1},\ T_{db2}) = 67.49$ [Ref. IS 800:2007, Cl.6.4]	
Tension Capacity (kN)	65.0	$T_{\text{d}} = \min(T_{\text{dg}},\ T_{\text{dn}},\ T_{\text{db}})$ $= \min(65.68, 69.33, 67.49)$ $= 65.68$ [Ref.IS 800:2007, Cl.6.1]	Pass

Check	Required	Provided	Remarks
Slenderness ratio	$\frac{KL}{r} \leq 400$	$\frac{KL}{r} = \frac{1 \times 300.0}{6.5}$ $= 46.15$ [Ref. IS 800:2007, Cl.7.1.2]	Pass
Utilization Ratio	≤ 1	Utilization Ratio $= \frac{F}{T_d} = \frac{65.0}{65.68}$ $= 0.99$	
Axial Load Considered (kN)	$A_{c\min} = 0.3A_c$ $= 0.3 \times 65.68$ $= 19.7$ $A_{c\max} = 65.68$ [Ref. IS 800:2007, Cl.10.7]	$A_u = 65.0$	Pass

2.4 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Quantity Optimization	$d = 10$	
Hole Diameter (mm)		$d_0 = 10$	
Property Class	Bolt Grade Optimization	8.8	
Bolt Ultimate Strength (N/mm2)		$f_{u_b} = 800.0$	
Bolt Yield Strength (N/mm2)		$f_{y_b} = 640.0$	
Nominal Stress Area (mm2)		$A_{n_b} = 58\ ([Ref.\ IS\ 1367-3\ (2002)])$	
Min. Pitch Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 10.0$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	25	Pass

Check	Required	Provided	Remarks
Max. Pitch Distance (mm)	$p/g_{\text{max}} = \min(32t,\ 300)$ $= \min(32 \times 4.0,\ 300)$ $= \min(128.0,\ 300)$ $= 128.0$ Where, $t = \min(8.0, 4.0)$ [Ref. IS 800:2007, Cl.10.2.3]	25	**Pass**
Min. Gauge Distance (mm)	$p_{\text{min}} = 2.5d$ $= 2.5 \times 10.0$ $= 25.0$ [Ref. IS 800:2007, Cl.10.2.2]	0	
Max. Gauge Distance (mm)	$p/g_{\text{max}} = \min(32t,\ 300)$ $= \min(32 \times 4.0,\ 300)$ $= \min(128.0,\ 300)$ $= 128.0$ Where, $t = \min(8.0, 4.0)$ [Ref. IS 800:2007, Cl.10.2.3]	0	
Min. End Distance (mm)	$e_{\text{min}} = 1.7d_0$ $= 1.7 \times 10$ $= 17.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	20	**Pass**

Check	Required	Provided	Remarks
Max. End Distance (mm)	$e_{\max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 4.0 \times \sqrt{\frac{250}{250}} = 48.0$ $e_2 = 12 \times 8.0 \times \sqrt{\frac{250}{250}} = 96.0$ $e_{\max} = \min(e_1,\ e_2) = 48.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	20	**Pass**
Min. Edge Distance (mm)	$e_{\min} = 1.5d_0$ $= 1.5 \times 10$ $= 15.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	18.0	**Pass**
Max. Edge Distance (mm)	$e_{\max} = 12t\varepsilon;\ \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 4.0 \times \sqrt{\frac{250}{250}} = 48.0$ $e_2 = 12 \times 8.0 \times \sqrt{\frac{250}{250}} = 96.0$ $e_{\max} = \min(e_1,\ e_2) = 48.0$ [Ref. IS 800:2007, Cl.10.2.4.3]	18.0	**Pass**
Kb		$k_b = \min\left(\frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0\right)$ $= \min\left(\frac{20}{3 \times 10}, \frac{25}{3 \times 10} - 0.25, \frac{800.0}{410}, 1.0\right)$ $= \min(0.67, 0.58, 1.95, 1.0)$ $= 0.58$ [Ref. IS 800:2007, Cl.10.3.4]	

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{\text{dsb}} = \frac{f_{ub} n_n A_{nb}}{\sqrt{3}\gamma_{mb}}$ $= \frac{800.0 \times 1 \times 58}{1000 \times \sqrt{3} \ \times \ 1.25}$ $= 21.43$ [Ref. IS 800:2007, Cl.10.3.3]	
Bearing Capacity (kN)		$V_{\text{dpb}} = \frac{2.5 k_b d t f_u}{\gamma_{mb}}$ $= \frac{2.5 \times 0.58 \times 10.0 \times 4.0 \times 410}{1000 \times 1.25}$ $= 19.02$ [Ref. IS 800:2007, Cl.10.3.4]	
Capacity (kN)		$V_{\text{db}} = \min\left(V_{\text{dsb}},\ V_{\text{dpb}}\right)$ $= \min\left(21.43,\ 19.02\right)$ $= 19.02$ [Ref. IS 800:2007, Cl.10.3.2]	
No. of Bolts	$R_u = \sqrt{V_u^2 + A_u^2}$ $n_{\text{trial}} = R_u / V_{bolt}$ $R_u = \frac{\sqrt{0.0^2 + 65.0^2}}{19.02}$ $= 4$	$n = 5$	
No. of Bolt Columns		$n_c = 5$	
No. of Bolt Rows		$n_r = 1$	

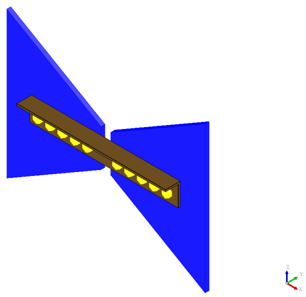
Check	Required	Provided	Remarks
Long Joint Reduction Factor	if $l_j \geq 15d$ then $V_{\text{rd}} = \beta_{lj} V_{\text{db}}$ if $l_j < 15d$ then $V_{\text{rd}} = V_{\text{db}}$ where, $l_j = ((nc \text{ or } nr) - 1) \times (p \text{ or } g)$ $\beta_{lj} = 1.075 - l/(200d)$ but $0.75 \leq \beta_{lj} \leq 1.0$ [Ref. IS 800:2007, Cl.10.3.3.1]	$l_j = ((n_c \text{ or } n_r) - 1) \times (p \text{ or } g)$ $= (5 - 1) \times 25 = 100$ $= (1 - 1) \times 0 = 0$ $l = 100$ $15 \times d = 15 \times 10.0 = 150.0$ since, $l_j < 15 \times d$ then $\beta_{lj} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.1]	
Large Grip Length Reduction Factor	if $l_g \geq 5d,$ then $V_{\text{rd}} = \beta_{lg} V_{\text{db}}$ if $l_g < 5d$ then $V_{\text{rd}} = V_{\text{db}}$ $l_g \leq 8d$ where, $l_g = \Sigma(t_{\text{ep}} + t_{\text{member}})$ $\beta_{lg} = 8d/(3d + l_g)$ but $\beta_{lg} \leq \beta_{lj}$ [Ref. IS 800:2007, Cl.10.3.3.2]	$l_g = \Sigma\ (t_p + t_{\text{member}})$ $= 12.0$ $5d = 50.0$ $8d = 80.0$ since, $l_g < 5d$; $\beta_{lg} = 1.0$ [Ref. IS 800:2007, Cl.10.3.3.2]	
Capacity (kN)	13.0	$V_{\text{rd}} = \beta_{lj} \beta_{lg} V_{\text{db}}$ $= 1.0 \times 1.0 \times 19.02$ $= 19.02$	**Pass**

2.5 Gusset Plate Check

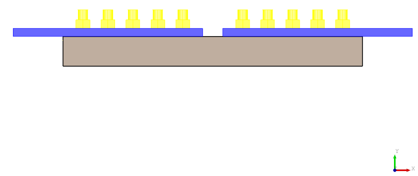
Check	Required	Provided	Remarks
Min.Height (mm)		$H = 1 \times \text{Depth} + \text{Clearance}$ $= (1 \times 45.0) + 30.0$ $= 75$	
Min.Plate Length (mm)		$L = (nc - 1)p + 2e$ $= (5 - 1) \times 25 + (2 \times 20)$ $= 140$	
Min.Member Length (mm)	280	300.0	**Pass**
Thickness (mm)		$T = 8.0$	
Tension Yielding Capacity (kN)		$T_{\text{dg}} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 45.0 \times 8.0$ $= \frac{360.0 \times 250}{1.1 \times 10^3}$ $= 81.82$ [Ref. IS 800:2007, Cl.6.2]	
Tension Rupture Capacity (kN)		$T_{\text{dn}} = \frac{0.9 A_n f_u}{\gamma_{m1}}$ $= \frac{1 \times \ 0.9 \times (45.0 - 1 \times 10) \times 8.0 \times 410}{1.25}$ $= 82.66$ [Ref. IS 800:2007, Cl.6.3.1]	
Block Shear Capacity (kN)		$T_{\text{dbl1}} = \frac{A_{\text{vg}} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{\text{dbl2}} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{\text{db}} = \min(T_{db1},\ T_{db2}) = 134.99$ [Ref. IS 800:2007, Cl.6.4]	

Check	Required	Provided	Remarks
Tension Capacity (kN)	$A = 65.0$	$T_{\mathrm{d}} = \min(T_{\mathrm{dg}},\ T_{\mathrm{dn}},\ T_{\mathrm{db}})$ $= \min(81.82, 82.66, 134.99)$ $= 81.82$ [Ref.IS 800:2007, Cl.6.1]	**Pass**

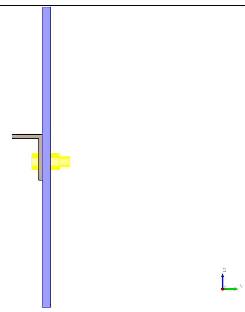
3 3D Views



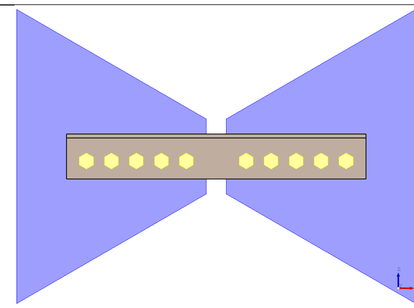
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log

2024-12-28 10:42:11 - Osdag - INFO - :In the case of reverse loading, the slenderness value shall be less than 180 [Ref. Table 3, IS 800:2007].
2024-12-28 10:42:11 - Osdag - INFO - :To reduce the quantity of bolts, define a list of diameter, plate thickness and/or member size higher than the one currently defined.
2024-12-28 10:42:11 - Osdag - INFO - :Overall bolted tension member design is safe.
2024-12-28 10:42:11 - Osdag - INFO - :=========End Of design===========